Technology and the Laws of Thought
Part 3

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All stable processes we shall predict.
All unstable processes we shall control.
– John von Neumann

As the new concepts of digital computing were taking root in the years following World War I, World War II arrived on the scene—and with it a period during which computing technology came into its own. The focus of World War I was on bigger and better guns, while the focus of World War II was on bigger and better bombs. The basic structures of computers known today—memory, stored programs, subroutines, etc.—were developed during the years 1941–1945, and the person at the center of it all was John von Neumann.

Von Neumann had a knack for identifying ideas that could be implemented; working next door to Alan Turing at Princeton, he provided the impetus for the development of the programmable computer. The program and the *software,* as it came to be called, was related to the machine or *hardware*, in this way:

> *Hardware* denotes the electrical circuits that make up a computer. *Software* denotes a list of instructions for the order in which switches open and close. *Computer program* denotes a specific file holding these instructions. (courtesy plyojump.com)

Prior to his time, computers could mainly be programmed with only one set of instructions. A different program required a physical reconfiguration of the machine. Von Neumann's interest was to transition to a machine that could alter its functioning depending only on the input instructions, a concept very similar to his collaborator Turing's Universal Machine. Taking an interest in modeling the shock-wave of a bomb, von Neumann focused on the development of high-speed computers for the same purpose. Several electronic computers were being developed simultaneously in this time period, such as the ENIAC, Harvard's Mark I (where Grace Hopper, one of the very first computer *programmers*, worked), Stibitz's Complex Number Calculator, the Selectron, and the Stored Program computer at IAS. Von Neumann was the catalyzing factor between all of them:

> Throughout the summer and fall of that year (1944), he shuttled by train between Harvard, Princeton, Bell Labs and Aberdeen, acting as an idea bee, pollinating and cross-pollinating

> various teams with the notions that had adhered to his mind as he buzzed around … von Neumann wandered around gathering elements and concepts that became part of the stored program computer architecture. (Walter Isaacson, *The Innovators*, p. 104)

This fact is quite important as it shows a transition in the nature of creativity, from the brilliant insights of a lone investigator or inventor to collaborative advancement of technology. If the will for the creative development of George Boole's laws of thought came from his religious devotion, the will for the development of computers during this period came from waging wars, which necessarily are a group effort. Hence the transition in creativity is marked clearly:

[T]he fundamental repercussion of the development of mechanical symbolic logic can be identified: a denial of the very process of creativity.

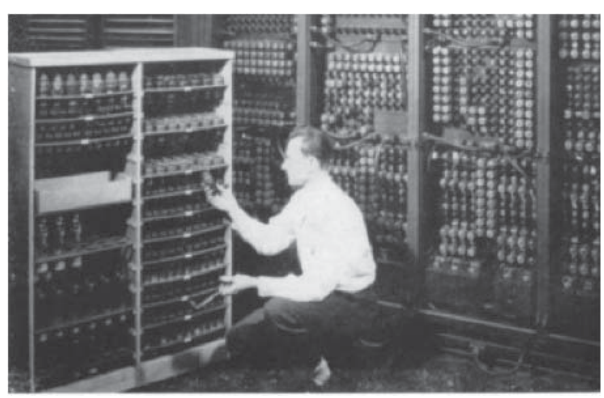
> But the main lesson to draw from the birth of computers is that innovation is usually a group effort, involving collaboration between visionaries and engineers, and that creativity comes from drawing on many sources. Only in storybooks do inventions come like a thunderbolt, or a light bulb popping out of the head of a lone individual in a basement or garret or garage… The sparks come from ideas rubbing against each other rather than as bolts from the blue. (Isaacson, pp. 85, 110)

This is claimed in direct contradiction to the fact that virtually all major developments leading to the computer were done by individuals who received a "bolt from the blue": Leibniz (mathematical logic), Bacon (binary codes), Boole (binary logic), Pascal (mechanical calculator). Here, the fundamental repercussion of the development of mechanical symbolic logic can be identified: *a denial of the very process of creativity.* If the nature of thinking is deemed to be mechanical, and hence finite, the only way to make progress is to add up more finite chunks. It is hence a direct consequence of rejecting the notion of infinity in human thinking, a point that was highlighted in the previous installment of this essay. The main lesson to draw from this is that if one thinks only mechanically, then innovation is possible only by collaboration.

A second consequence of rejecting the infinite in logic is to make up for the same in terms of time and space, i.e., to make computations *faster* (in time) and the computing elements *smaller* (in space). That is the only approach left open for this restricted form of creativity. These two themes, *faster* and *smaller*, reinforced each other and directed all computing innovations every decade since World War II.

Switching had transitioned from the clunky electro-mechanical switches of the 1930s to the silent electronic vacuum tubes of the 1940s (e.g., ENIAC). This increased the speed of operation, even though the tubes failed regularly.

Speed increased every decade from this point onwards. The next shift was accomplished in the 1950s with the invention of the solid state transistor, which eliminated most problems of vacuum tubes and was also smaller. Speeds increased, and sizes decreased again in the 1960s with the invention of the integrated circuit, which was smaller than a penny and had thousands of



Replacing a bad tube meant checking among ENIAC's 19,000 possibilities.

Vacuum tube to transistors to integrated circuits within 25 years (courtesy chipsetc.com)

transistors. By the 1970s an integrated circuit had *millions* of transistors on a microprocessor chip. Nanotechnology, the science of the nanometer range, thus had a large influence on this process.

This high computing capacity enabled the computer to link itself to display technology (television display). Edward Lorenz, who studied weather patterns on such a computer, realized that slight deviations in conditions for solving equations, when reiterated, cause enormous differences. This led to the development of Chaos Theory. Later, Benoit Mandelbrot, who had spent time both at the Institute for Advanced Studies as well as at the computer giant IBM, was able to study iterative systems of equations while studying noises on telephone networks. With computers it became possible to repeat iterations millions of times, which when combined with plotting complex number graphs produced the famous Mandelbrot set and opened the door to the study of fractals. Self-similarity was its key feature. Combining these two qualities—self-similarities and tiny deviations causing huge results—one obtains the properties of *irrational numbers*. These are both self-similar (with infinite series or infinite fractional definitions) and cause large deviations under iteration (1.9999^{20} can become very different from 2^{20}). Until the 1970s, the assumptions made nearly 50 years earlier to neglect irrationals and transcendental numbers could not have any effect as there was no sufficient number of calculations for those decimal positions to have an effect. But now, it was possible.

Hence these developments, which can be studied only with the help of a computer, resurrected the interest in the beauty of irrational numbers which had lain dormant since the extensive study of *phi*, the Golden Ratio. All the numbers that were neglected when considering symbolic logic and Boolean algebra made a reappearance in the ’70s in the study of fractals, but as approximations. Irrationals, complex numbers, and even quaternions made a comeback when computers were used for creating graphics. The very same ideas neglected a century ago resurface as approximations (as they are represented by 0s and 1s) within the digital world. What was eliminated in computing logic by removing the notions such as infinity was now being pursued by increasing iterations and computing speeds relentlessly.

Since the motto of *smaller and faster* has to deal with limitations of technology, the only possibility of enhancing the power of computers was to combine them with existing technologies. This happened in the reverse order, i.e., the latest technology was incorporated first into the computer, then the one before that, and so on. As already described, the most recent technological development before the computers was the cinema and television, which were incorporated by the rise of computer graphics and video games. The next available technology was the earlier development of the telephone. Hence computers were now linked together, like a telephone network. This culminated in the 1990s and determined the rise of the internet. When the internet connection was made wireless, it meant a connection to radio technology and therefore to wireless telegraphy. This determined the rise of Wi-Fi. It is possible to map out the developments in computing which, almost like clockwork, swallowed up the existent technology into themselves to generate a new gadget. The full development of each type of technology can be represented in waves, like this:

1960s-1970s:	Computer + Television	=	Computer graphics
1970s-1990s:	Computer + Telephone	=	internet
1980s-2000s:	Computer + Radio	=	Wireless internet (Wi-Fi)
	Radio + Telephone	=	Mobile phone
2000s-2010s:	Computer + Radio + Telephone	=	Smartphone

As this trend continues, it is easy to see that the computer will increasingly be linked with all gadgets ever devised by man. Anything that can be operated upon can be automated by a computer: watches, calculators, light switches at home, cars, etc.

Meanwhile, the idea of the brain being similar to computers took a greater hold upon popular imagination, and the idea that computers can "learn" and "think" proved very attractive. Not realizing that no combination of standing or falling dominoes can ever "think," a type of animism has arisen in computer culture, where, by using human words like "think," "learn," "understand" and "figure out," a sort of consciousness is attributed to the computing process itself. For example, consider this segment of an interview:

> *Omni Magazine* (1987): Do you find it depressing that chess computers are getting so strong?
> *Claude Shannon:* I am not depressed by it. I am rooting for the machines! I have always been on the machines' side. Ha-ha!

This exchange highlights the anthropomorphic ideas attributed to the computer, which have gained in popularity with every successive decade and every successive rise in computing power. There has been very little focus on the fact that the actual thinking process is a far richer field than that which is described by rote repetition. Even the pioneers in computers who were right in the middle of developing the structure appear to have missed this connection. For example, Norbert Wiener was a member of Veblen's circle in World War I who developed the ideas of *cybernetics*: that biological cells and electronic circuits have similar behavior when feedback loops are included. His theory formed the basis for not only computers but neuroscience as well for a large part of the 20th century. Yet, he made the following statements:

> The nervous system and the automatic machine are fundamentally alike in that they are devices, which make decisions on the basis of decisions they made in the past.

> Let us remember that the automatic machine is the precise economic equivalent of slave labor. Any labor which competes with slave labor must accept the economic consequences of slave labor.

The logical conclusion from these two statements is that the working nervous system must accept the mental consequences of slave labor! It is interesting to see that Wiener never made this connection and reconsider his ideas on the thinking process, but remained convinced of the identity of the thinking and automatic machines.

However, consider this question from the ideas developed previously with regard to the will-element of human thinking. It is seen that the greatest application of inner effort is necessary for creating a new thought structure, and repetition has a role only so far as the necessary strength has to be developed. In addition, the inner effort applied by our mental process was seen to be a vastly accelerated version of physical bodily exertion. Hence, repetitions and mental calculations have their exact counterpart in gymnastics of the body, where a certain degree of repetition and effort is necessary to develop strength and flexibility.

However, restricting the body to only compulsory repetitive activities tires and wears out the body, as was done with slaves for many centuries. Consequently, all artistic and meaningful movement of the limbs gets neglected. At the same time, the opposite extreme of avoiding the repetitive strength-building activity in the prime of life is also harmful. For example, if a child never learns to walk as it is *always* helped by a walker, or if an adult *always* moves in a machine and never moves his legs, the legs atrophy and decay. Looking between these two extremes, it is possible to identify how to navigate between slavery and atrophy. It is to encourage strength-building activities, even repetitive ones, when the body is growing, in order to generate the strength to last a lifetime. Similarly, repetitive calculations and mental exertions are a necessary part of human education, and it is vital to develop the necessary strength of mind and inner effort before one begins to use any "aids to calculation." It is also important to realize that further increase in mental effort can only be accomplished when creating new ideas. Hence, all technological aids to physical or mental activity will not have a detrimental effect, only if both the body and mind are engaged in activity which is entirely non-repetitive, fresh, and *creative*. Just as a modern-day person may spend the entire day in a cubicle and yet keep the body fit by exercise, dance or social activity, the strength of the thinking capacity which uses computers and calculators all day long can only prevent atrophy if through focus, concentration, and creativity an independent thinking process is developed.

Unfortunately, it is precisely with regard to the development of will-element in thought, that there has been very little understanding. By the *belief* that thought is mechanical, inner shackles have been placed on the thought process which tend to direct it more and more toward atrophy. Even if a few people display a lot of ingenuity in making computers work, the net effect of using these machines is detrimental to the general populace as long as the will-element in thought goes unrecognized. This gives rise to several repercussions seen in the thought life of people today: unable to calculate without using a calculator, unable to write without using a word processor, unable to remember without using reminders, alarms and search engines, unable to navigate without using the GPS, a sharp rise in attention disorders, etc. Unless this fact is recognized, like the unused limb, our individual thinking capacity and ability to focus will degenerate. Just as the arm or leg loses strength when unused, the thinking process loses its strength as well. Since mental processes occur at a much faster time scale, the deterioration can be very rapid as compared to a physical atrophy.

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It is not necessary to subscribe to any particular belief system, especially when dealing with technological matters. The belief of identity of mechanism and thought process, invoked by Boole and his contemporaries in the Industrial Era and virtually unchallenged until today, has had the powerful effect of crippling the will-element of thought. The Modern Olympic games have the motto: *Higher, faster, and stronger.*

However, modern thinking has retained the first two and eliminated the need for strength; it is left only with higher density of mechanical components (*smaller*) and *faster* speeds of operation as its mode of expression. This cripples thought quite effectively.

It might be argued that development of computers in the past few decades have not hindered creativity, but helped develop it. For example, like the printing press of old, the internet allows every user to express thoughts in as many ways as possible. This, however, does not get to the root of the situation, because creativity by definition cannot be bounded. Creativity creates the rules of the game, alters and shapes them; not obeys them. If creativity were truly included right at the very core of computing technology, then a large variation in the types of computers can be expected. But what is the situation in reality?

> According to Bigelow, "Von Neumann had one piece of advice for us: not to originate anything." This helped put the IAS project in the lead. "One of the reasons our group was successful, and got a big jump on others, was that we set up certain limited objectives, namely that we would not produce any new elementary components," adds Bigelow. "We would try and use the ones which were available for standard communications purposes. We chose vacuum tubes which were in mass production, and very common types, so that we could hope to get reliable components, and not have to go into component research." (George Dyson, *Turing's Cathedral*, p. 143)

> The basic architecture of the computer has remained unchanged for six decades since IBM developed the first mainframe computers… it was named after John von Neumann. (Darrel Ince, *The Computer*, p. 117)

> The basic functions of modern computers haven't really changed much since John von Neumann's "stored program concept" and Alan Turing's "universal machine" propositions of the 1930s. Although the technology functionality has increased exponentially, the process of binary computation (XOR, NAND, and so on) remains basically unchanged, as do the fundamental concepts of the architecture. (Russell D. Vines, *Wireless Security Essentials*, p. 4)

It is intriguing to see that in spite of the rapid changes in the world of computers, the basic architecture has remained the same for nearly half a century. In fact, that is the imbalance introduced into technological development, where the basic structure remains unchanged, while the surface structure changes much more rapidly than one could keep up with. Even if some variations in architecture are tried out, they do not challenge the digital basis of computing or the notion of counting neurons. Finally, even if there is some interest in analog computers, or a different architecture (e.g., parallel vs. serial, or quantum architecture), the application of symbolic logic itself is not challenged. These developments are perfectly in line with the structure of the logic, and the notion of creativity and novelty being attached to number (*smaller and faster*), making that the only change possible within the rules of the system.

The connection between development of formal logic and physical exertion has been identified quite well by Shenefelt and White:

> In fact, one of the chief aims of logic in its systematic development is to render logical judgments as close to brute reflex as possible. This is why we study forms. Forms leap out at the eye. But once we spot them, the thought required is immediately reduced because we know what to do. We know which rules to apply. To say this isn't to say that logic makes us unthinking, but only that it saves our thinking for other matters, not for determining the mere cogency of arguments, but for anticipating where the arguments are going or why they exist at all. In this respect, then, logic is like walking. The better at it we get, the less we need to think about it and the farther it takes us—to the contemplation of new vistas. (Shenefelt and White, *If A then B*, p. 232)

However, what new vistas are possible if vision itself is impaired? The authors mention new vistas, but do not identify what those vistas might be, or how they can be accessed. This is the most important topic to be addressed at the end of this analysis: Where to go from here? Are there any alternative paths that could have been taken? How can the strength be brought back into the thought process? These are the questions that will be addressed in the final chapter.

The Road Less Taken

But small is the gate and narrow the road that leads to life, and only a few find it.
– Matthew 7:14

A recap of the full sequence of developments up to this point is now in order. In the first place, thinking was seen to have an aspect of pure thinking (such as logic), an aspect of skill (feeling) and an aspect of willing, involving internal effort. The inner effort involved in repetitive mental tasks could be done mechanically as well, which led to interest in calculating machines. In the second place, the idea that thinking and logic could also be mechanical processes started gaining ground, leading to the works of Boole and his contemporaries. The difference between the logic of the Greeks, which had its roots in geometry and arithmetic, and the logic of Boole, which had its root in algebra, was identified. It was also mentioned that a re-evaluation of Euclidean geometry which was happening at the time, made all mathematicians and geometers question their assumptions. The path taken by some of them was to abandon assumptions and axioms based on real life experience (as was the case with Euclidean) and to construct an entire consistent system of abstract axioms. They reasoned that, since "common sense" had turned out to be misleading to justify the axioms of geometry, the best course was to abandon the common-sense axioms and to allow abstract axioms to form the basis, and shift the focus to the mathematical consistency of this abstract system. As a result, logic was restricted by mathematics.

In this process, a different "common sense" could have been identified, that of the *eye*. While it is true that parallel lines never touch one another as far as the sense of touch goes, they *do* meet as far as the visual sense is concerned. Two railway lines do meet, according to the eye. However, as already pointed out, an understanding of the visual process and the mathematics associated with it (laws of perspective and projective geometry) was a newcomer on the scene, as opposed to Euclidean geometry and solid laws of construction and geometry. This led to an abandonment of this line of thought, and logic was instead guarded from the intrusion of non-Euclidean or non-algebraic ideas.

Abandonment of non-mathematical ideas, as well as "infinity" within mathematical ideas, enabled the development of logic that could be mechanized. And finally, it was shown that mechanization using only digital changes also restricted the mathematical scope to the integers instead of the continuous geometric line. This had an effect, which was even predicted:

> Banish the infinite process, and mathematics pure and applied is reduced to the state in which it was known to the pre-Pythagoreans. (Tobias Dantzig, *Number: The Language of Science*, p. 139)

This has been found to be an exact prediction, as the digital design of the computer has more in common with an elaborate and intricate abacus than any other prior machine. The effect of this development on the thinking faculty was described in the preceding pages, and it was found that the restriction of the logic, as well as neglect of the element of inner effort (willing) have led to a decline in thinking capacity.

If a different alternative is to be found, the threads of thought must be traced backwards to find the fork in the road. Backtracking to this point in the 1850s when *The Laws of Thought* was first published, a different path can be identified: non-Euclidean geometry. This subject was born during the time of Renaissance with the introduction of perspective in painting, and treated mathematically for the first time by Girard Desargues and Blaise Pascal (contemporaries of Descartes and Leibniz in the 17th century). Carl Friedrich Gauss, who coined the term "non-Euclidean," actually downplayed the effect of this geometry, as it contradicted Immanuel Kant's dictum in *Critique of Pure Reason* that Euclidean geometry was the only valid path. Nevertheless, talented mathematicians like Gauss, Janos Bolyai, Nikolai Lobachevsky, and Jakob Steiner investigated the new geometry and helped non-Euclidean geometry come to the foreground in the beginning of the 19th century.

What is the essence of these investigations? It was Euclid's postulate that parallel lines never meet. However, in non-Euclidean geometry, parallel lines were said to meet: at *infinity*. While at first glance this might seem as absurd as saying that one can calculate something provided infinite time is allowed, non-Euclidean geometry went one more step ahead. With a series of transformations, it was possible to map this point at infinity onto any other point, thus making it have as solid a foundation as Euclidean geometry. Hence, non-Euclidean geometry was the first attempt, since the time of Euclid, to grapple with infinity and treat it mathematically.

Around the same time, what non-Euclidean geometry did to geometry, imaginary numbers did to arithmetic. Introduction of complex numbers, such as "i" (and later "j" and "k" by William Hamilton, in "quaternions") proved extremely confusing for mathematical thinking, as one could no longer attribute qualities of "greater than" or "lesser than" to imaginary numbers. It was one thing to deal with irrational and transcendental numbers, which could still be identified on a number line, and quite another to deal with $i=\sqrt{-1}$. Arithmetic and Algebra were completely altered. This is, then, the transformation that occurred in the middle of the 19th century:

Geometry => Non-Euclidean geometry
Arithmetic => Imaginary (complex) numbers

Both these transitions met with violent opposition at the time. Non-Euclidean geometry was involved in "Textbook Wars" (whether or not Euclidean geometry was fundamental), while Hamilton's introduction of multiple complex numbers was embroiled in the "Quaternion Controversy" (whether or not complex numbers were practical). However, if that thicket is crossed somehow, a new question opens up. Since Greek Logic was founded on geometry and arithmetic, the natural question to ask is: "What happens to logic now?" As identified earlier:

Quantifiers: Arithmetic (All, some, none)
Copulas: Geometry (is, is not)

Reversing this for the 19th century:
Complex Arithmetic: New Quantifiers?
Non-Euclidean Geometry: New Copulas?

This is the fork in the road that has not been well recognized conceptually, even though there was a lot of controversy surrounding these ideas. The road taken has been the one that abandons both these developments, and introduces more axioms into the logical structure, while limiting the existing copulas to just one. However, what if that is not done, and the other path is pursued?

Naturally, one will have to consider that other verbs can serve in place of "is" and "is not." This means that the law of contradiction can be overcome, therefore, it is not something absolute for all things in the world. While this statement, that contradiction is possible in the newer avenues for logic, may seem heretical to mathematicians and philosophers today, it is nevertheless the natural next step in the development of logic. The consequences of this are elaborated in a little-known essay by Carl Unger: *The Philosophy of Contradiction* (written in the 1920s). In this he systematically considers what is obtained by overcoming this contradiction, i.e., it gives rise to *logic of becoming* instead of logic of *being*, thus generating a new copula "becomes":

A is not (not A) => A *becomes* not A

As described further in the essay:

> The concept "seed" involves what is other than it is—that is, it should form roots and a stalk; equally is it part of the concept "stalk," that it should issue in leaves and a blossom. The contradiction in a concept, including what is other than it, is justified when we figure the time relationship as an essential part of the concept. The true concept of a seed is not that it should be equal to itself… The emergence of a contradiction is not, in itself, evidence of a false enquiry. (Carl Unger, *The Philosophy of Contradiction*)

If A is a finite set, not-A is necessarily everything else, i.e., infinite. Hence, this "logic of becoming" *includes* infinity in the same way that projective geometry includes the points at infinity.

This insight is a completely different approach, as it actually modifies the way in which thought is structured, giving a new fruitful basis for logic. As seen with the example of the seed, this opens the door for thinking with concepts which are not repetitive like calculations, and hence require a fresh infusion of inner effort in order to sustain them. This can be contrasted with the current attempts at creating "living automata" under the assumption that with enough complexity, networks, rapid calculations and feedback loops, life would spontaneously manifest. Unless the very form of thinking is altered, there is no way to get out of this dead-end path and understand living phenomena.

Unger continues this analysis further, which need not be elaborated at this point (but is definitely worth studying), except to emphasize that this understanding passed by virtually unnoticed by the logicians of the period. All the attention was focused on making the fortress of axioms impregnable. Even the eventual discovery of paradoxes by Gödel and Turing, coming as it did in the middle of World Wars, did not deter the use of this logic but rather made it more rigid.

Taking a different turn opens-up worlds of possibilities. To get an idea of it, consider all the verbs that could have taken the place of "is/is not"! All of these form possible alternatives to the copula in logic, enabling a real extension of it. It also provides the vital clue to solving the problem posed in the beginning of this work: Does a machine affect the way one thinks, and if so, how to tackle the problem? This can now be addressed properly. Thinking has an aspect that has to do with inner effort, and this grows strong with novelty and originality. Rote repetition alone does not allow this, and can hence be safely outsourced to the machine. Thinking using symbolic logic alone requires some effort, but it does not allow one to change the rules of the game, crippling its limits. Thus, the only option is to proceed to strengthen thinking by contemplation of new forms of logic, so that one can treat every event as a fresh situation instead of trying to force-fit situations into a mechanizable model.

It also provides a guideline for providing access to technology while learning. Just as a toddler is not given outer support at the moment it is learning to walk, but instead is provided with encouragement to walk on its own, no technological aids to calculation must be used until one knows how to calculate on one's own. Just as no harm is done when a physically fit person uses a motorbike, it is safe to use calculators, for example, only when one can conveniently calculate in one's own mind. There can be individual variations in the process, but the principle holds. If technological aids are introduced before the corresponding strength is built up in the thought process, it would act as a permanent crippling factor, and be very hard to overcome in later life. While particular care is to be taken with all aids to the thinking process while a young adult is growing up, a similar principle holds for adult life as well. For example, if memory is not cultivated inwardly by taking an interest in events and retaining them in the mind due to the force of will, all aids to memory would have a crippling effect on individual memory. If there is a tendency to simply search for answers to questions, then it would become apparent that not only memory, but logic suffers as well, and it would become more and more difficult to actually engage in thinking, and easier to simply play by the rules. Additionally, if it is not clear that true creativity and originality involves thinking that is not mechanical or repetitive, then it is possible for thought itself to become automatic, making man more machine-like in nature.

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Thus, following this path from the fork offers a way to not only come to terms with logic and thinking in general, but provides the knowledge based on which safeguards can be identified for the use of computing technology. It is also possible for the Craftsman to embark on technology of a different sort than the ones generally used, and to consider entirely different architectures for machines. So far, the early pioneers in computer technology had obtained their motivation either from religious impulses, or from greed and war impulses. The identification that inner effort can be cultivated independently, and that it can be strengthened along specific ways, offers a new route: the impulse born of the desire to help, which is a human trait worthy of cultivation. The path which had been blocked so far, due to the rigid nature of the assumptions that the Philosophers had inculcated into technology, can be cleared for Craftsmen having this motivation behind their work.

Strengthening the thinking process also provides a balance between thinking and willing, so that skill and art from the realm of *feeling* can once more enter into the thought process. Individual and cultural differences can enter once more both into technology and ideas, rather than one uniform pattern being applied over the entire world (an inevitable consequence of adherence to mechanical logic alone). This would allow individuals to build on the successes of their predecessors, by remembering, understanding, and carrying forward the impulses of the older cultures in a new form. It is time that novelty no longer means simply a smaller, faster, or more powerful re-packaged version of the old, but is genuinely new. It is only then that instead of facing a future shock, one can look the future in the eye, go forward and *create* it.

Conclusion

It has been shown that the central theme underlying the analysis of computing and thought is the notion that thought contains an element beyond logic alone in the internal effort or will. This opened the door to identify that the developments in logic and computations of the past century have focused entirely on the logic itself, rather than seeking the origins of it or elements beyond it. It has also been shown that the major transformation that occurred at the end of the 19th century served to restrict logic to that which can be mechanized; a decision that has had massive repercussions in the way one understands thinking, and consequently, the way one views the human being.

A look at the origins of logic showed its dependence on physical experience and mathematics, as elaborated for nearly two thousand years since the Greek era. When the basic tenets of Euclidean geometry came to be questioned, it was time to revamp logic as well as to remain true to this way of organizing thought. However, the opposite course of action, that of restricting logic even further to only that which can be mechanized, was carried out, leading to the phenomenal importance given to computing in today's world, over and above that given to new ways of thinking. This caused a sort of re-inventing the wheel, where all the paradoxes of the Greek logic came back to haunt developments in symbolic logic and computation as well.

Once it is *assumed* that thinking is identical to a mechanism, it leads to several repercussions, the first of which was already mentioned as a marked decrease in mental will power, and a resultant drop in memory, attention spans, focusing ability and creativity. However, this is not the only effect of mechanical logic over-reaching its boundaries. Human nature becomes increasingly rigid, as phrases like "I can't help it, this is the way I am wired" or "It is in his DNA" become prevalent. This undercurrent of belief, that a human is as programmable as a computer, changes the personalities of people, making them increasingly resistant to new ideas at a rate greater than ever before. At no point in history has mankind's thought been linked with machines to the extent that it occurs today, and there is a very real danger of jettisoning the very essence of thought from everyday behavior.

When symbolic logic, which is at home in the domain of logistics, penetrates thoughts relating to human relationships, it would have the natural effect of determining if people fit together like cogs in a machine or not. Relationships are retained only as long as the gears and hooks connect, and abandoned and replaced when they are not. This is the only type of thinking possible with this logic, and naturally, as relationships do not fit the box of symbolic logic, either the logic has to be abandoned or the relationship. Thus, misplaced application of this form of thinking can lead to significant tearing of relationships, and devaluing of human worth.

However, when it is accepted that this form of machine-logic is a small subset of the full range of capacities of the thought process, then it would be possible to prevent harm and actually use it for relieving the mind of rote repetitive work. In addition, the independent development of internal effort of thinking can take up its rightful role in preventing the atrophy of thinking and invigorating it in new artistic and creative directions, rather than making a smaller and faster version of the old. The Philosopher can once more shake hands with the Craftsman, as well as with the Artist that brings the two together.

Metropolis (1927)

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