Art, Science & Technology
Part I: Causality by Design

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Index

Introduction

Every organism lives in an active environment consisting of: (i) invariants, *e.g.*, the river, the ocean, the sky, the mountains, the seasons, *etc*., and, (ii) affordances presented by predator, prey, possible mates and/or symbionts (Grene & Depew 2004). Environmental invariants become subsidiary or 'tacit' to focal awareness of affordances. In this view, 'knowledge' is orientation in an environment resulting from the tacit integration of subsidiary and focal awareness into a gestalt whole (Polanyi Oct. 1962) called 'knowing'.

Walter Lippman (1922) observed that humanity lives in a *pseudo*-environment created by the complexity of its self-created world. One's immediate Space/Time presented by the five physical senses of touch, taste, smell, sight and sound defines but a small part of the active environment in which one lives, loves and works. For the rest one relies on what Lippman calls 'the pictures in our heads', *i.e.,* collective representations of 'our' world conveyed through codified knowledge, *a.k.a*., the media.

Grene & Depew (2004) similarly identify three forms of indirect perception unique to the human species. They are all cultural inventions: tools, language and pictures. [1]

> From birth, the perceptions of the infant, then of the child and of the adult are saturated by these human and cultural ingredients. But the fundamental structure of perception [*HHC*: gestalt-knowing] remains the foundation of these accomplishments… if not the foundation, at least the analogue, of all knowledge. (Grene & Depew 2004, 357-8)

Codified knowledge is fixed in an *extra-somatic* (Sagan 1977), *i.e.,* out-of-body, media that in Law is sometimes called a matrix. This conveys knowledge from one human mind to another, usually distant in Space/Time, assuming the Code is mutually

[1] I classify them differently. For my purposes, language and pictures both constitute codified knowledge while tools constitute tooled knowledge, *a.k.a.,* physical technology, with which the human species enframes and enables Nature thereby introducing more and more invariants into its environment (Chartrand July 2006).

understood by sender and receiver (Chartrand July 2006). Today, codified knowledge takes the form of the written and spoken word, the still and moving image, recorded sound & music and, experimentally at least, recorded odour and touch. In effect, codified knowledge fixes *meaning* into Matter/Energy. As noted by Husserl, about writing (but arguably all codified knowledge) "makes communications possible without immediate or mediate personal address; it is, so to speak, communication become virtual. Through this, the communalization of man is lifted to a new level" (*quoted* in Idhe 1991, 46).

Codified knowledge is, however, different from tooled and personal & tacit knowledge. Tooled knowledge, *i.e*., physical technology, is fixed as *function* into an extra-somatic matrix. It enframes and enables Nature to serve human purpose (Heidegger 1955). Most organisms do not just adapt to their environment they also adjust the environment to serve their purpose, *e.g.,* the ant hill, bird's nest and beaver dam. Personal & tacit knowledge, on the other hand, is fixed as neuronal bundles of memories and reflexes of nerve and muscle in what the Law calls a 'Natural Person'. Ultimately, however, all knowledge is personal & tacit. Without a Natural Person to decode a work or push the right button both codified and tooled knowledge remain sterile artifacts without meaning or function.

In this panel of a triptych of articles I will consider 'the pictures in our heads', or more formally 'representations' about Art, Science & Technology within our shared intellectual environment – the noösphere of theoretical biology. In the <u>first</u>, I will define my terms and establish the causal relationship between Art, Science & Technology.

In the <u>second</u> – *Epistemes* of Arts, Science & Technology, I will trace the co-evolution and co-construction (Kauffman 2000) of these concepts using mathematical 'epistemes' (Foucault 1973). For my purposes, an episteme is a dominant theme characterizing an era or epoch of history. It is a symbolic expression of an historical 'way of knowing'. Let me, however, immediately assuage the reader: No equations will be presented. The math will be intuitive, not formal. In doing so, however, I will demonstrate that the Present is an overlapping temporal gestalten (Emery & Trist 1972) woven out of five epistemic strands - four actual and one emergent:

(i) *Harmony* in the Ancient and Medieval periods of western European civilization supported by animal, human & water power (600 B.C.E.-1400 C.E.);

(ii) *Perspective* in the Renaissance & Baroque (the Age of Discovery) boosted by gunpowder and wind power (1400-1650 C.E.);

(iii) *Motion* from the Enlightenment through the first Industrial Revolution fueled by steam power (1650-1850 C.E.);

(iv) *Probability* in the Modern period beginning with the second Industrial Revolution fueled by electrical, chemical and nuclear power (1850-2000 C.E.); and,

(v) *Adjacent Possible* in the contemporary Post-Modern period (2000+ C.E.) including the third Industrial Revolution initiated by genomic and nano- technologies.

In the <u>third</u> panel – *Return to the Garden*, I will conclude with *Dr Faustus' Tour of New Atlantis and the Garden of Eden*. These are three of the most powerful and conflicting artistic & literary icons in Anglosphere culture (Bennett 2000) Christopher Marlowe's *Dr Faustus* sells his immortal soul in return for dominion over the Earth, here and now, granted by a Devil arguably called Science & Technology. Francis Bacon's

New Atlantis sums up our utopian hope for a rational, secular, scientific world in which knowledge is power. No soul or God is, however, required. The Garden of Eden is where our ignorance (innocence to some) and immortality dangle on the Trees of Knowledge and of Life.

In our tour we will slip passed the Cher'-u-bims, and flaming sword turning in all directions set up by God to stop us re-entering (*Genesis* 3.24) and eat again of the fruit of the Tree of Knowledge but this time also of the Tree of Life – the DNA helix. Northrop Frye's *Great Code* (1981) [2] still rules Anglosphere culture even if the alphabet has transmutated into amino acids and nucleotides – the building blocks of the new Art, Science & Technology of Life.

Terms [3]

Michael Polanyi's theory of personal knowledge extends beyond focal/subsidiary use of tools to language. Polanyi argues language is a pointer "to attend to what it points at and this is its meaning". What language points to and its associated meaning becomes "a gestalt-sign". Due to psychological displacement or "partial transposition of this experience to a distance", the object of our attention becomes what we mean (M. Polanyi Oct. 1962, 605). [4] When we attend to the pointer, however, we lose the gestalt. Or, as noted by Martin Heidegger: "All ways of thinking, more or less perceptibly, lead through language in a manner that is extraordinary" (Heidegger 1955, 3). In the case of our terms – Art, Science & Technology – the extraordinary point is that their contemporary Anglosphere meaning confusingly derives from a mixture of Greek, Latin and early French sensibilities. I begin with Science.

Science

Since the beginning of Western civilization, logic has been accepted as the preferred path to knowledge (Dorter 1990, 37). It distances us from our passions; it frees us from the distracting world of sensation and emotion. In the hands of the Romans the Greek *logos* – logic - became 'reason' derived from the Latin 'ratio' as in to calculate (OED, *reason*, n 1). In this sense one can speak of 'calculatory rationalism'. And from the Romans we derive Science from the Latin *scire* "to know" which, in turn, derives from *scindere* "to split" (MWO). Science today is accepted as the epitome of reason deriving knowledge by splitting or reducing a question into smaller and smaller parts or elements until a fundamental unit or force is revealed, *e.g.*, Newton's gravity.

Until innovation of the experimental instrumental scientific method in the 17th century, however, such splitting and reducing was restricted to words. The critical epistemological difference between ancient and modern Science, leaving aside for the moment mathematics, is the scientific instrument forcing Nature to reveal her secrets. Epistemologically Idhe calls this 'instrumental realism' (Idhe 1991). It is the design, development and operation of instruments of ever increasing sensitivity that has allowed

[2] Frye, N., *The Great Code: The Bible and Literature*, Academic Press, Toronto, 1981.
[3] This article and its companion pieces represent an unhappy acceptance of analytic philosophy: We are limited by the language we speak - English, French, mathematics – no matter the form of codified knowledge.
[4] As will be seen, on another plane, Polanyi points to a similar displacement when we "indwell" in our tools and toys that become existential extensions of ourselves, *e.g.*, computer games.

humanity to pierce the veil of Nature, of appearances, and establish human dominion. Such instruments are not verbal constructs; they are tangible works of technological intelligence that measure and manipulate Matter/Energy.

To the degree such instruments measure above and below the threshold of our natural senses, they realize a Platonic ideal: "belief in a realm of entities, access to which requires mental powers that transcend sense perception" (Fuller 2000, 69). Furthermore, the 'language' of sensors [5] realizes the Pythagorean ideal by reporting Nature by the numbers.

There are three primary natural science disciplines – biology, chemistry and physics. Each breaks out into an ever widening range of sub-disciplines and cross-disciplines, *e.g*., biochemistry. In each there are distinct engineering specialties, *e.g*., chemical, genetic, mechanical and, electrical. It is from these that, today, most physical technology flows. Price argued that the relationship between Science and Technology is that of the research-front of one relating to the previous generation or archive of the other. Thus Science operates with the previous generation of Technology while Technology operates with the previous generation of Science (Price 1965, 568).

Knowledge in the Natural & Engineering Sciences (NES) is fact-based and subjected to objective, value-free testing in which replicability of results is the test. It is concerned with objective truth, understanding and manipulation of the physical world. It exhibits decreasing tolerance through Time for difference and error as old knowledge is progressively and reductively displaced by the new, *i.e.*, NES knowledge progresses vertically up the ladder of Time. [6]

When applied for utilitarian purposes, NES knowledge generates physical technology, *i.e.*, the ability to manipulate Matter/Energy to satisfy human want, needs and desires. In twenty-five generations we have literally enframed our planet with hundreds of artificial satellites enabling ourselves of planetary riches, making them ready at hand to serve our purpose, from the deepest oceans to the outer reaches of the solar system.

Reductionism extends to epistemology, *i.e.*, the theory of knowledge. Knowledge itself has been split into domains, disciplines, faculties and forms with an inevitable increase in incommensurability (Kuhn 1962, 1977, 1996). Reductionism has, however, significant advantages. <u>First</u>, it strips away secondary phenomena distinguishing cause from effect revealing in the natural & engineering sciences underlying 'laws of nature' (Taylor 1929, 1930; Zilsel 1942). As will be seen, its metaphysical legitimacy rests on the testing of cause and effect, or *when-then* causality with Time's Arrow moving out of the Past into the Present then into the Future by way of prediction.

<u>Second</u>, the knowledge gained through reductive testing becomes embodied in new sensors (and subsequently tools and toys). The epistemological importance of such sensors is the consistent objective evidence they generate about the state of the physical world – at the normal (mesoscopic), below (microscopic) or above (macroscopic)

[5] My term 'sensor' corresponds to Baird's 'measuring instruments' (Baird 2004).
[6] This assumes 'normal science' within an established paradigm not a 'scientific revolution' leading to a quantum leap in understanding even with a 'Kuhnian loss' (Kuhn 1962, 1970, 1998: Fuller 2000).

sensitivity of our native human senses. Such evidence is objective in that collection is not mediated by a human subject. Once calibrated and set in motion a clock – atomic or otherwise – ticks at a constant rate per unit time until its energy source is exhausted.

It is important to appreciate that sensors pattern our modern way of life. The simple household thermometer is an example. It tells us when we have a fever and when to seek medical intervention. In turn, a medical thermometer is used to monitor the progress of such intervention (Shapin 1995, 306-307). Put another way:

> By encapsulating knowledge in our measuring instruments, these methods minimize the role of human reflection in judgment. They offer a kind of "push-button objectivity" where we trust a device and not human judgment. How many people check their arithmetic calculations with an electronic calculator? ... Putting our faith in "the objectivity" of machines instead of human analysis and judgment has ramifications far and wide. It is a qualitatively different experience to give birth with an array of electronic monitors. It is a qualitatively different experience to teach when student evaluations – "customer satisfaction survey instruments" - are used to evaluate one's teaching. It is a qualitatively different experience to make steel "by the numbers," the numbers being provided by analytical instrumentation. (Baird 2004, 19)

The effects of new sensors on human life can be profound, for example, "the idea of a world governed by precise mathematical laws was transmitted… through Galileo's and Huygen's conversion of the mechanical clock into an instrument of precision" (Layton 1974, 36). Or, consider our "image" of the world (Boulding 1956) resulting from Galileo's innovative use of the telescope and its "artificial revelation" (Price 1984, 9). Put another way, once upon a time a Pope or King would say it *is* cold and ordered the windows closed. Today everyone looks at the thermostat which reads 20 degrees Celsius. Put yet another way, it is no longer God or Man that is the measure of things physical; it is the Machine.

Pure reductionism, however, chiefly characterizes traditional Physics and, to a lesser degree, Chemistry. These deal with the 'geosphere', *i.e.*, the world of inanimate matter and mechanical motion, not the biosphere of living things or the noösphere of human thought including Art, Science & Technology.

Art

The word 'Art' derives from the old French meaning 'Skill; its display or application' (OED *art*, n, I, 1). It is, in this sense, a generic term referring to application and practice of knowledge in any field including law and medicine (and other self-regulating professions) as well as the Mechanical and Liberal Arts, *e.g.*, a Bachelor or Master of Arts. It has, however, acquired additional meaning through Time [7] so that Art in aesthetic terms refers to "A pursuit or occupation in which skill is directed towards the gratification of taste or production of what is beautiful" (OED, *art*, n, II, 10). Thus we can distinguish Art in which "the hands and body are more concerned than the mind"

[7] In Part II I will examine the role of Baumgarten and Kant in development of what was originally proposed as the science of sensuous knowledge called Aesthetics to balance the science of intellectual knowledge called Logic.

contrasted with the Fine Arts; *i.e.*, “those in which the mind and imagination are chiefly concerned” (OED, *art*, n, II, 11). [8]

The contemporary Arts consist of four primary disciplines and their sub-disciplines including: the literary, media, performing and visual arts. Each uses a distinct medium of expression: the written word; the recorded sound and/or image; the live stage; and, the visual image, respectively. Each discipline is composed of distinct sub-disciplines and schools. Each has a five stage production cycle: creation, production, distribution, consumption and conservation. And each takes on five distinct functional forms including: the amateur, applied, entertainment, fine and heritage arts (Chartrand April 2000).

There are four essential differences between Art & Science. First is the use of concepts versus precepts.

> Whereas Art begins with desired effects and finds causes to create these effects and no others, Science starts with presumed causes and seeks effects to confirm or negate these causes. Art organizes ignorance by precepts while Science organizes knowledge by concepts (Nevitt 1978, 7).

A second difference is that new knowledge in the Arts does not necessarily displace the old. Rather King Tut still sells; Shakespeare is still performed; Bach is played more today than in the 17th century. New works are, however, being added through Time to the inherited repertoire or patrimony - if they pass the test of Time. Thus artists, unlike scientists, face competition not just from their peers but also from their long-dead predecessors. At the same time, forms such as Egalitarian Realism or poke-in-the-eye art including such icons as Mapplethorpe’s homo erotica photographs and Andres Serrano’s ‘Piss Christ’ found an audience during the Culture Wars of the 1980s and 1990s (Chartrand 1991) corresponding to the so-called ‘Science Wars’ of the same period (Fuller 2000). [9]

Third, analytic psychology recognizes four distinct ‘ways of knowing’ – thinking, intuition, feeling and sensation. [10] For my purposes, I renamed these, respectively, Reason, Revelation, Sentiment & Sensation (Chartrand July 2006). In the NES Sensation is subject to Reason; Sensation is restricted to ‘what is’. In the Arts, Sensation is dominant and an *avant garde* has existed since the mid-19th century that seeks change-for-change’s-sake; it seeks novelty (Scitovsky 1976). The Arts embody the impulse toward the new and original, a self-conscious search for future forms and sensations to the point that the idea of change and novelty overshadows the dimensions of actual change. As will be seen, the artist no longer, as in the past, simply affirms a moral-philosophic tradition but rather searches for a new sensibility, a search which society actively encourages. It has been said that what is imagined in the mind of the artist today

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[8] The French ‘les beaux arts’ or ‘the beautiful arts’ conveys a sense not easily accessed in English. Another example of how knowledge is limited by language.

[9] The co-evolutionary relationship of these Anglosphere wars will be explored in Part III.

[10] Beyond its descriptive power, analytic psychology has spawned arguably the most widely used psychological testing instrument in the English-speaking world: *The Myers-Briggs Type Indicator* ®. Used extensively in North American business and education it attempts to identify and measure the faculties of knowing possessed by an individual. The mix or ‘type’ reveals how each individual learns best, *i.e.*, acquires knowledge and best makes decisions.

becomes the reality of tomorrow (Bell 1976, 33-35). It is in this sense that Revelation or intuition is the secondary dominant in the Arts.

Fourth, the role of Reason as dominant in the NES made entry into the university natural. In the case of the Arts, however, with the exception of music (as will be seen due to its Pythagorean connection with mathematics) and literature (in the guise of rhetoric and grammar), the Arts were not part of the ancient or medieval liberal arts curriculum (Cantor 1969, 66-67). As will be seen, the Arts were and still are considered 'crafts', *i.e*., they involve experiential learning. This is epistemologically critical – knowing by doing.

Artistic knowledge is concerned with subjective truth; a search for *kosmos* or the right ordering of the multiple parts of the world (Hillman 1981). It is holistic in aesthetic distancing and contemplation of the gestalt. Testing is personal and subjective: 'It works for me!' It tends towards increasing tolerance of differences, styles and tastes. It is value laden, not value free. New knowledge emerges as from a helix that as it rises up the ladder of Time dips up, down and across its axis – back to the Past, across to the Present and forward into the Future.

When applied, artistic knowledge generates aesthetic or design technology, *i.e.*, the ability to manipulate Sensation through Sentiment or how we 'feel'. The Arts provide the 'technology of the heart'. The arts industry itself is made up of all profit, nonprofit and public institutions including incorporated and unincorporated enterprise as well as self-employed individuals that: (a) use one or more of the Arts as a primary factor of production, *e.g*. advertising, fashion, industrial and product design; (b) use one or more of the Arts as a tied-good in consumption, *e.g.* home entertainment hardware, magazines and newspapers; and/or, (c) produce one or more of the Arts as their final output, *i.e*. create, produce, distribute and/or conserve goods and services in the literary, media, performing, visual and/or heritage arts. Using this inclusive definition, I have elsewhere estimated that the American arts industry accounts for between 6% and 8.5% of Gross National Product, *i.e*. all goods and services consumed in the United States but not necessarily produced there (Chartrand April 2000).

Unlike physical and organizational technologies, [11] however, design technology primarily affects the demand-side of the economic equation. In effect, design technology involves the use of the Arts to manipulate the aesthetic or emotional responses of the audience/consumer/reader/viewer. It is thus more sensitive to culture, custom and tradition than physical technology. This fact, together with the injunction against the study of consumer taste – "De Gustibus Non Est Disputandum" (Stigler & Becker 1977) – Taste is Not Disputable - explains why there has been little investigation by mainstream economics and why Art is simply ignored in the Standard Model of economics.

[11] Physical technology emerges out of the NES; organizational technology emerges out of the humanities & social sciences (HSS) and design technology from the Arts. The Practices, or self-regulating professions, apply knowledge from all three primary knowledge domains to answer practical and pressing problems of daily life. (Chartrand July 2006)

Technology

The word 'technology' entered the English language in 1859 according to the Merriam Webster Dictionary deriving from the Greek *techne* meaning Art and *logos* meaning Reason, *i.e.*, reasoned art. The Oxford English Dictionary, however, says it was re-coined at that time by Sir Richard Francis Burton to mean "Practical arts collectively" (OED, *technology*, 1 b). Burton was an infamous Victorian explorer and translator of such oriental erotica such as the *Kama Sutra* (1883), the *Arabian Nights* (1885) and the *Perfumed Garden* (1886). [12]

When we refer to 'technology' today we generally speak of physical technology, *i.e.*, knowledge tooled into Matter/Energy as function. Tooled knowledge takes three forms: sensor, tool and/or toy. The purpose of a sensor is measurement of Matter/Energy; the purpose of a tool is manipulation of Matter/Energy; and, the purpose of a toy is pleasure (Chartrand July 2006).

For Michael Polanyi, tools become, through 'indwelling', extensions of our bodies "forming part of ourselves, the operating persons. We pour ourselves into them and assimilate them as parts of our own existence" (M. Polanyi 1962, 59). For Martin Heidegger, technology is the means by which Nature is enframed and enabled to serve human purpose. As a species, we order things in our environment into standby mode as a 'standing-reserve' (Heidegger 1955, 17) awaiting activation – the furnace, TV, computer, car, train, airport, *etc*. Whatever is part of this standing-reserve, however, "no longer stands over against us as object" (Heidegger 1955, 17). It is no longer 'other'. It becomes an existential phenomenological extension of our human *being*.

Works of technological intelligence are recognized or 'known' by their purpose or intent (Polanyi 1962, 175), not by their meaning. Put another way, in another context, by another author: "technology is about *controlling* nature through the production of *artifacts*, and science is about *understanding* nature through the production of *knowledge*" (Faulkner 1994, 431).

The term 'work' illuminates features shared by Art and Technology. Thus Aldrich (1969), like Kant and Aristotle before him, uses the term 'work' inclusive of works of aesthetic and technological intelligence. However, the term also confabulates their differences: Art carries meaning while Technology carries function.

'Work' is a very old English word. It is both a noun and a verb. As a noun it has three branches with thirty-five meanings and over sixty sub-meanings. The first branch refers to something to be done, something being done, or something already done by an agency – divine, human or mechanical (OED, *work*, n, I). The second branch refers to the thing done or made or constructed including works of art, machines and buildings (OED, *work*, n, II). This sense also reflects 'the effect or consequence of agency' (OED, *work*, n, II, 9 b). The third branch involves 'work' in phrases such as workplace (OED, *work*, n, III).

As a verb, work has three branches with forty meanings and over 100 sub-meanings. The <u>first</u> branch, as a transitive verb, refers to construction, creation, design, direction, execution, herding, making, management, manufacturing, performing or

[12] In a perverted Victorian inversion of the Indian practice of *sati*, his wife burnt much of his unpublished and highly erotic work after his death and edited his published works to veil the naughty bits.

producing anything from works of art and books to buildings and miracles. The second, as an intransitive verb, refers to the action, agitation, effect, fermentation, influence or other operation of an agency – divine, human or mechanical - in doing or making something. The third deals with work in relationship to adverbs such as work in, work with, work off, *etc*.

Four additional definitions are required: philosophical, biological, mechanical and economic. First, Heidegger defines work as "that which brings hither and brings forth into presencing, and that which has been brought hither and brought forth" (Heidegger 1954, 160). He etymologically links both the English and German for 'work' with the Greek *ergon* from which 'energy' derives. That which is brought forth out of concealment into our presence by work Heidegger calls 'reality'. In this sense 'work' means 'making real' that which was concealed or implicit. [13]

Second, the biological concept of work as expressed by Kauffman (2000, 49) is 'the constrained release of energy'. Thus,

> the coherent organization of … constraints on the release of energy … constitutes the work by which agents build further constraints on the release of energy that in due course literally build a second copy of the agent itself…" (Kauffman 2000, 72)

This also applies to works of aesthetic or technological intelligence which require the constrained release of energy for their creation, use or appreciation. In fact the constrained release of energy regulates the working of all instruments. Arguably, as constrained release of energy, work also links with Heidegger's technology given his interpretation of *energeia* as the Greek "enduring-in-work" (Heidegger 1954, 161) rather than the Latin concept of energy as efficient cause. In this sense, Technology fixes energy in physical structures (static or dynamic) enabling them, making them ready at hand to serve human purpose, to work for us.

Third, in physics and mechanics 'work' means "the operation of a force [energy] in producing movement or other physical change, esp. as a definitely measurable quantity" (OED, *work*, n, I, 8). Fourth, in economics, work is labour or "human effort, physical or mental, used to produce goods and services" (Mansfield & Yohe, 2004, A6). In the Standard Model, work is disutility, *i.e.*, pain, for which a worker is compensated by a wage used to buy goods and services from which to extract utility, *i.e*., pleasure. Work is rewarded according to its disutility, *i.e.*, the greater pain, the higher the wage. But if work is not just disutility then 'psychic income' must be earned, *i.e*., a worker receives satisfaction above and beyond the real wage. This helps explain why self-employed artists & entertainers are second only to pensioners as an income class recognized by Revenue Canada (Chartrand 1990).

Causality by Design

Among his many contributions Immanual Kant (1724–1804) established as a law of nature that the notion of the *if-then* relationship corresponds to the concept of cause and effect and that there is but a single direction to causality, *i.e.*, Time's Arrow only

[13] This concept is reminiscent of Polanyi's concept of 'reality' in Science as "a thing that may yet manifest itself inexhaustibly, far beyond our present ken" (Polanyi 1967, 192).

moves from cause to effect, from Past into Present into Future by way of prediction (Grene & Depew 2004, 93-4). This law, however, was limited by Kant to matter defined as lifeless stuff or objects pushed or pulled by measurable forces through Space/Time, *i.e.*, the geosphere. This limitation was required because it was clear to Kant that material and efficient causes (cause and effect) were insufficient to explain living things, *i.e.*, biology as well as Art & Technology.

Aristotle identified four causes of things to be the way they are: (i) material cause: that out of which a thing is made, *e.g*., economic inputs; (ii) formal cause: the form or shape of the final thing, *e.g*., economic outputs; (iii) efficient cause: the initiating agent, *e.g.*, the entrepreneur or firm; and, (iv) final cause: end purpose or *teleos*, *e.g.*, satisfaction of consumer wants, needs & desires plus a normal profit.

Kant addressed the question in his *Critique of Judgement* (1790) which is divided into two parts. The first is the "Critique of Aesthetic Judgment"; the second, the "Critique of Teleological Judgment". The ordering is important. While works of technological intelligence, or artifacts, have purpose, works of aesthetic intelligence have purposiveness or meaningfulness but no purpose, *i.e.*, no utilitarian function, *e.g.,* Art.

Biological forms display both purpose and purposiveness. There are three aspects of living things demonstrating teleological or final cause: ecology, metabolism and ontogeny. First, Kant saw the web of mutually supportive relationships between various species of plants and animals constituting an ecology or ecological community as so complex that linear *when-then* causality was simply insufficient. Second, in the metabolism of living things "each part is reciprocally means and end to every other. This involves a mutual dependence and simultaneity that is difficult to reconcile with ordinary causality" (Grene & Depew 2004, 94). Third, in ontogeny, or development of the individual, the future mature end-state guides successive stages of development. This is a clear case of formal and final cause at work.

Having found teleological processes in living things Kant was concerned to distinguish between Design and Designer. This is, of course, a question that continues to trouble contemporary society. To do so, Kant distinguished between works of technological intelligence and living things. Quite simply, parts of a machine are put together by people and parts do not bring other parts into existence, *i.e.*, a machine is not a self-organizing entity. By contrast: an organism is "a product of nature in which everything is both an end and also a means" and in which the parts are "reciprocally cause and effect of [one another'sl form." (Grene & Depew 2004, 98-99). For Kant all works of technological intelligence are finally caused by human purpose. Living things, however, do not require human or divine purpose but rather reflect a 'natural purpose'. Kant called this *purposiveness*. [14]

It should be noted, however, that Kant priorized these two forms of causality - mechanistic and purposive – always allowing mechanistic explanations, when available, to trump purposive causation. Thus he restricted the term "explanation" exclusively to mechanistic causality (Grene & Depew 2004, 107).

Kant's view was extended in Heidegger's interpretation of Aristotelian causality. His is radically different from the conventional deriving from Latin translation rather than

[14] In Part II I will consider Kant's aesthetics in the context of the 'personality theory' of copyright.

Greek original. Thus 'cause' comes from the Latin verb *cadere,* "to fall," meaning "that which brings it about that something falls out as a result in such and such a way" (Heidegger 1955, 7). The original Greek, *aition*, however, means "that to which something else is indebted" (Heidegger 1955, 7). Roman linguistic imperialism should not be forgotten.

For Heidegger the four causes – material, formal, efficient and final - are "all belonging at once to each other, of being responsible for something else" (Heidegger 1955, 7). This is similar to Kant's view of living things in which "each part is reciprocally means and end to every other" (Grene & Depew 2004, 94).

Similarly, Heidegger interprets final cause, or *telos,* in an unconventional manner. Usually translated as 'aim' or 'purpose, he argues *telos* originally meant in the Greek that "which gives bounds, that which completes" (Heidegger 1955, 7). For Heidegger, technology thus represents "modes of occasioning" in which all four causes are at play "bringing-forth" something - natural or human-made – to completion (Heidegger 1955, 10). And it is "through bringing-forth, [that] the growing things of nature as well as whatever is completed through the crafts and the arts come at any given time to their appearance" (Heidegger 1955, 10). As will be demonstrated, this is reminiscent of Kauffman's 'adjacent possible' (2000).

Art, including 'reasoned art', in contrast to Science, involves putting things together so that they work, *i.e.*, it involves construction or making rather than reducing to first principles. On the one hand, a work of art 'works' by successfully conveying meaning from creator to audience, *e.g.*, as a novel or a painting. Within the patrimony it takes the form of codified knowledge transferable generation onto generation. On the other hand, 'reasoned art' takes form as a device or machine. Technology involves tooling knowledge into Matter/Energy to perform a function. It enframes and enables Nature to serve human purpose even on stage and in film as stage craft or special effects. It too - as roads, sewers, generating plants, housing, *etc*. - can be passed down generation onto generation. Both have 'vintage'.

All this happens, however, only 'By Design' (Chartrand July 2006). At root 'reasoned art', *i.e.*, technology, remains Art. In fact, the earliest expression of engineering knowledge in the West takes the form of design portfolios and the "natural units of study of engineering design resemble the iconographic themes of the art historian" (Layton 1976, 698). There is, however, a Western cultural bias towards 'the Word' and away from 'the image' – graven or otherwise (Chartrand 1992). This has contributed to the epistemological suppression of tooled knowledge relative to 'scientific' knowledge which is usually presented in a documentary format (the article or book) while tooled knowledge appears first as an artifact which must then be transliterated into written formats that "savour of the antiquarian" (Price 1965, 565-566). The result has been "semantic ascent" (Baird 2004) within Anglosphere culture - up and away from the instrumental experimental realism of modern science. One is left with words, not empirical science.

The idea of 'Design' in both Art & Technology is eternally linked to a form of causality rejected by traditional physics and the positivistic philosophy of science – teleology: "the doctrine or study of ends or final causes" (OED, *teleology*). Physics as well as a positivist philosophy of science gets along quite well with only material and efficient causes (cause-and-effect). Formal causes are questionable and final causes denied entirely. Put another way: "The physical world that Newton envisaged was a world that could be described in terms of material and efficient causes, in terms of particles of matter that exist in space and time and are moved by force" (McLeod 1957, 478). This can be called 'billiard ball' science involving inanimate matter and energy that has no will or volition of its own.

With the discovery (or re-discovery) of perspective in the visual arts in the Renaissance, a new word entered the English language – design. The word derives from the Latin *designare* "to mark out, trace out, denote by some indication, contrive, devise, appoint to an office" (OED, *designate*, v). In Renaissance Italy 'design' assumed its contemporary aesthetic sense of geometric composition (Aldrich 1969) as distinct from its social sense of planning with a purpose. In French, these two are expressed by separate words: "*dessein* meaning 'purpose, plan'; and, *dessin* meaning 'design in art'" (OED, *design*, n, etymology). In English, however, both senses are combined in the single word 'design'. What they share is *intent*, specifically the intent to make as opposed to understand the world at the disinterested distance afforded by Science. Design involves making patterns out of Matter/Energy and/or Imagination, *e.g.*, ships of clouds sailing across the living skies (Aldrich 1969, 381). The word 'design' itself entered the English language in 1588 followed fifteen years later in 1603 by 'causality' (OED, *causality*, 1), a word that arguably lies at the heart of the Scientific Revolution and the conceptual foundation of the experimental method.

As a verb, 'design' means "to create, fashion, execute, or construct according to plan; to have as a purpose" (MWO, *design*, v, 1). As a noun, it means deliberate purposive planning; the arrangement of elements or details in a product or work of art; the creative art of executing aesthetic or functional designs (MWO, *design*, n, 1a). Critically, engineers use the word design "in framing membership criteria for the professional grades of engineering societies" (Layton 1974, 37). More generally, however, in Design

> we have come to recognize the processes which bring about creative advances in science, the new paradigms as processes of human design, comparable to artistic creation rather than logical induction or deduction which work so well within a valid paradigm... the norms of artistic design (are) "inherent in the specific psychic process, by which a work of art is represented" and thus in the creative act, not in the created object - in the process not the structure . (Jantsch, 1975, 81)

From the dictionary definition I extract the terms 'arrangement' and 'purpose' in order to contrast tooled knowledge as Technology and codified knowledge as Art. Both are extra-somatic, *i.e.*, fixed outside a Natural Person. The purpose of codified knowledge, however, is transmission of knowledge between Persons while the purpose of tooled knowledge is measurement and manipulation of the natural world.

With respect to arrangement, codified knowledge involves manipulating an alphabet, grammar, syntax and vocabulary, *i.e.*, a language including images – still and moving, sounds and mathematics, to communicate with other human beings. Arrangement of tooled knowledge, however, involves the coordination of different forms and types of Matter/Energy to subsequently and artificially manipulate or animate the natural world. This may include synthesizing bits of biological, chemical, cultural, economic, electric, electronic, ergonomic, mechanical and/or organizational knowledge into a single working device or instrument.

Arguably, however, Technology represents the ultimate in human Design. As Heidegger (Heidegger 1955) suggests technology enframes and enables human life. In effect, it constructs a distinct human ecology growing ever more distant from Nature as the knowledge explosion continues to expand. An extreme example is space travel during which humans cannot live in the natural environment, nor on any off-world destination of which we know. Even on Earth, the average Canadian spends 94% of one's life cocooned within a human designed environment (Leech *et al* 1997). Consider coming home from the office in a car, unlocking the door to the house, turning on the lights, making supper using appliances, watching television, checking one's email then driving to the local mall to shop. All is technology. Technology enframes and enables us, defines and patterns activity in the human ecology. And this is all the result of Causality by Design. Whether or not *kosmos* – a right ordering of the multiple parts of the world – has been achieved; whether or not our brave new world is beautiful is the question laying at the heart of *Dr Faustus' Tour of New Atlantis and the Garden of Eden* in Part III.

Conclusion to Part I

In this first panel of a triptych of articles, I have defined Art, Science & Technology. These words are pointers to a gestalt world of knowing. Art is codified knowledge conveying *meaning* from one human mind to another. Some Codes are alphabetic, some aural, some visual, some kinetic but always sender and receiver must share and understand the Code if a 'work is 'to work'. [15] Technology is tooled knowledge, *i.e.*, knowledge fixed in Matter/Energy as *function*. The subject of both Art & Technology is the Natural Person. Their work is the result of Design, of human purpose, of formal and final causes. Codified and tooled knowledge, however, have no meaning or function without the intermediation of a Natural Person.

Science, on the other hand, is both codified and tooled knowledge. It began as an abstract mental exercise of reducing things through logic in the ancient and medieval worlds. It became, with the Scientific Revolution of the 17th century, committed to the design, construction and operation of instruments to force Nature to reveal Her Secrets. She did. The subject of Science, however, is Nature; reductionism based on controlled experimental conditions is its primary methodology. Invariants are established; one change (cause) is allowed and its effect metered. Material and efficient causes are sufficient. Nonetheless, modern Science too is the product of Design – of tacitly integrating subsidiary (controlled or invariant conditions) and focal awareness (effect or affordances) into gestalt knowing.

[15] Elsewhere I distinguish between human-readable and machine-readable Code. Human-readable is codified knowledge protected in Law by copyright, trademarks and registered industrial designs. Machine-readable Code is 'soft-tooled' knowledge intended as instructions to a machine or molecule more appropriately protects by patent (Chartrand Sept. 2006).

Reductionism, however, is inappropriate in the world of human-made things – of Art & Technology - where "the sciences of the artificial" rule (Herbert Simon quoted in Layton 1988, 91). Similarly, Michael Polanyi recognized the artificial nature of Technology when he observed a machine can be smashed but the laws of physics continue to operate in the parts. He concluded that: "physics and chemistry cannot reveal the practical principles of design or co-ordination which are the structure of the machine" (M. Polanyi 1970). This is, of course, also true of a work of aesthetic intelligence.

Reductionism is also insufficient in biology where today we can design living things with human purpose, *i.e*., biotechnology. In effect, we can now combine human with natural purpose. One implication is that biology can, for the first time, join physics and chemistry as a 'technoscience'" (Grene & Depew 2004, 345). Our visit to the Garden of Eden must, however, await *Part II: Epistemes* of Art, Science & Technology.

Toute a l'heure

References

Aldrich, V.C., "Design, Composition, and Symbol", *Journal of Aesthetics and Art Criticism*, 27 (4), Summer, 1969, 379-388

Baird, D., *Thing Knowledge: A Philosophy of Scientific Instruments*, University of California Press, Berkley, 2004.

Bell, D., *The Cultural Contradictions of Capitalism*, Basic Books, NY, 1976.

Bennett, J., "Civil Society, the Anglosphere, and the Gateways to Prosperity", *Outlook*, Hudson Institute, Spring 2000.

Boulding, K.E., *The Image*, University of Michigan Press, 1956.

Cantor, N.F., *Medieval History - The Life and Death of a Civilization* (2nd Ed.) Macmillan, NYC, 1969.

Chartrand, H.H., "The Hard Facts: Perspectives of Cultural Economics" in *Transactions of the Royal Society of Canada 1989/Fifth Series/Vol. IV*, University of Toronto Press, Toronto, 1990.

Chartrand, H.H., "Context and Continuity: Philistines, Pharisees and Art in English Culture", *Journal of Arts Management, Law and Society*, 21 (2), Summer 1991.

Chartrand, H.H., "Towards an American Arts Industry" in *The Public Life of the Arts in America*, Joni Cherbo and M. Wyszomirski (eds), Rutgers University Press, April 2000.

Chartrand, H.H., *Ideological Evolution: The Competitiveness of Nations in a Global Knowledge-Based Economy*, Dissertation, University of Saskatchewan, July 2006.

Cwi, D., in conversation with the author, Cultural Policy Institute, Baltimore, November 1985.

Dorter, K., "Conceptual Truth and Aesthetic Truth", J*ournal of Aesthetics and Art Criticism*, 48 (1),Winter, 1990, 37-51.

Emery, F.E., and Trist, E.L., *Towards A Social Ecology: Contextual Appreciation of the Future in the Present*, Plenum, London, 1972.

Foucault, M., *The Order of Things: An Archeology of the Human Sciences*, New York, Vintage Books, 1973.

Frye, N., *The Great Code: The Bible and Literature*, Academic Press Canada, Toronto, 1981.

Fuller, S., *Thomas Kuhn: A Philosophical History of Our Times*, University of Chicago Press, 2000.

Grene M.,& Depew, D., *The Philosophy of Biology: An Episodic History*, Cambridge University Press, 2004.

Heidegger, M, "Science and Reflection" [1954], in W. Lovitt (trans.), *The Question Concerning Technology and Other Essays*, Harper Tourchbooks, 1977, 155-182.

Heidegger, M, "The Question Concerning Technology" [1955], in W. Lovitt (trans.), *The Question Concerning Technology and Other Essays*, Harper Tourchbooks, 1977, 3-35.

Hillman, J., *The Thoughts of the Heart,* Eranos Lectures 2, Spring Publications Inc., Dallas, Texas, USA, 1981.

Ihde, D., *Instrumental Realism: The Interface between Philosophy of Science and Philosophy of Technology*, Indiana University Press, Bloomington, 1991.

Jantsch, E. *Design for Evolution*, Braziller, NY, 1975.

Kauffman S., *Investigations*, Oxford University Press, 2000.

Kuhn, T.S., *The Structure of Scientific Revolutions*, Third Edition, University of Chicago Press, Chicago, [1962, 1970] 1996.

Layton, E.T., "Technology as Knowledge", *Technology & Culture*, 15 (1), January 1974, 31-41.

Layton, E.T., "American Ideologies of Science and Engineering", *Technology & Culture*, 17 (4), October 1976, 688-701.

Layton, E.T., "Science as a Form of Action: The Role of the Engineering Sciences", *Technology & Culture,* Vol. 29, No. 1, January 1988, 82-97.

Leech, J.A, *et al*, "The Canadian Human Activity Pattern Survey: Report of Methods and Population Surveyed" *Chronic Diseases in Canada*, 17 (3), 1997.

Lippman, Walter, *Public Opinion Introduction - The World Outside and The Pictures in Our Heads* [1922], MacMillan, NYC, 1960.

MacLeod R.B., "Teleology and Theory of Human Behavior", *Science*, New Series, 125 (3246), March 15, 1957, 477-480.

Mansfield, E. & Yohe, G., *Microeconomics*, 11th Ed., NYC, W.W. Norton, 2004.

MWO, *Merriam-Webster Online Dictionary.*

OED, *Oxford English Dictionary*, Oxford University Press 2004.

Nevitt, G., "Futures past and present", *Canadian Futures*, 1(2), 1978.

Polanyi, M., *Personal Knowledge: Towards a Post-Critical Philosophy* [1958], Harper Torchbooks, NYC, 1962.

Polanyi M., "Tacit Knowing: Its Bearing on Some Problems of Philosophy", *Reviews of Modern Physics,* 34 (4), Oct. 1962, 601-616.

Polanyi M., "Science and Reality", *British Journal for the Philosophy of Science*, 18 (3), Nov. 1967, 177-196.

Polanyi, M., Transcendence And Self-Transcendence, *Soundings* , 53: 1, Spring 1970, 88-94.

Price, D. de S., "Is Technology Historically Independent of Science? A Study in Statistical Historiography", *Technology & Culture*, VI (4), Fall 1965, 553-568.

Price, D. de S., "The science/technology relationship, the craft of experimental science, and policy for the improvement of high technology innovation", *Research Policy*, 12 (1), February 1984.

Robinson, K. (ed.), *The arts and higher education*, Guildford, UK, Society for Research into Higher Education, 1982.

Sagan, C., *The Dragons of Eden*, Balantine, NYC., 1977.

Scitovsky., T. *The Joyless Economy*, Oxford University Press, London, 1976.

Shapin, S., "Here and Everywhere: Sociology of Scientific Knowledge", *Annual Review of Sociology*, 21, 1995, 289-321.

Stigler, G. & Becker G., "De Gustibus Non Est Disputandum", *American Economic Review*, 67, 1977, 76-90.

Taylor, O. H., Economics and the Idea of Natural Laws, *The Quarterly Journal of Economics*, Volume 44, Issue 1, Nov. 1929, 1-39.

Taylor, O. H., Economics and the Idea of Jus Naturale *The Quarterly Journal of Economic*, Volume 44, Issue 2, Feb. 1930, 205-241.

Toffler, A., *The Culture Consumer: Art and Affluence in America*, Pelican Books, Baltimore, 1965.

vom Busch, W. (Ed. in Chief), *Art education and artist's training in the Federal Republic of Germany*. Bonn, Inter Nationes, 7-8(e), 1985.

Zilsel, E., "The Genesis of the Concept of Physical Law", *Philosophical Review*, 51 (3), May 1942, 245-279.