

Basalla, Chap. 6

[Square brackets indicate comments by Dr. Roe]

The Cross-Cultural Imperative: It is easier to deal with tech. & culture cross-culturally: "Technology is so intimately identified with the cultural life of a people that it is difficult for an indigenous observer to gain the objectivity necessary for critical appraisal" (p.169).

Chinese Culture: China represents a well-studied alien culture to ask the question: "How may culture affect the selection and replication of technological novelties?" (p.169).

3 Key Renaissance European Tech. Items All Come From China: "The three inventions that Sir Francis Bacon identified as the source of great changes in Renaissance Europe—printing, gunpowder, and magnetic compass—were products of Chinese, not European, civilization" (p.169).

The Chinese Elite: Why These 3 Items did not revolutionize Chinese History?

Paper: @200 A.D., a pressed product like felt, a nomadic invention for yurts to the northwest of China. Paper was not to be made in Europe (velum, or rags, was the local media) for another 1,000 yrs=@1200 A.D. (p.170)! **Printing:** Xylography, invented @ 750 A.D., was block-printing, an entire page being carved, in reverse, on wooden blocks which were then rolled with ink & printed, created a surge in literacy in the Sung dynasty (960-1279). Typography=movable type, was not invented until @ 1050 A.D. & didn't have the same effect as it did in Europe because of the cumbersome nature of Chinese part ideographic/part phonetic "characters." It was not to make its appearance in Europe until @1440, some 400 years later! In Europe, "Recent historians have credited printing with the emergence of modern consciousness, the secularization and commercialization of printed matter, the Protestant revolt against the authority of the Roman Catholic Church, the rise of modern science, and the growth of literacy and education" (p.170).

Gunpowder: (see "Chinese.Tec")

Compass: (see "Chinese.Tec")

Mark Elvin & "The High-level Equilibrium Trap": Basalla cites it as an "ingenious, if not always convincing" economic argument (p.174). To the problem of (1.) sheer scale can be added (2.) no bottlenecks to internal transport (inland canals + road systems), (3.) hierarchical market towns which made "putting-out" easier, (4.) financial inventions like paper money, "cash," "bank drafts, checks, double-entry accounting & the **abacus**" proto-computer, that made liquidity more attractive than investment in factories & machines, (5.) abundant cheap labor, which again mitigates against machines, and (6.) a declining personal income, related to population

growth, that robbed merchants of a vast potential consumer market.

Joseph Needham uses a socio-political argument, "Asiatic bureaucratism" in place since the 1st unification of China in the 3rd cen. B.C. with the end of the Warring States period until the 20th cen. [This was the rise of the **Literati**, steeped in the classics, particularly of Confucius [a secular religion based on "filial piety" for the Emperor as the ultimate Father Figure enjoying the "Mandate of Heaven"] & recruited on merit in the 1st written exams, but of literature & philosophy, not technology--in fact, they despised manual labor & wore their fingernails long to signify that]. Needham suggests that the literati occupied the role of "middle management" to the Emperor & the power élite & mitigated against the rise of a Chinese mercantile class, which in the West shaped social & political institutions to favor scientific & tech. progress (Basalla, p. 174).

[**A Comparative Political Argument**]=centers on the "stability" Needham, as an apologist for Chinese civilization, notes, versus the West's "instability." Note that China was a **centralized** land-focused, self-sufficient Empire ruled by an **alien & conservative cultural élite, the Manchus**, therefore non-disposed to accept innovations, whereas European polities were mini-nation-states locked in mutual competition & therefore always looking for a "technological edge" which military technology gives. It helps to start late & small, ethnically-homogeneous & competitive with equivalent-sized & organized units! In Basalla's words: "The answer is that Western culture was not monolithic; Europeans were eclectic, open to new ideas, influences, and things" (p.176) & soon forgot about the triumvirate's alien origins & claimed it for their own.

Basalla adds a complementary "ideological" argument: "Even Needham, who offers a strong defense of the socioeconomic approach, admits that hitherto unexamined ideological factors may yet prove to be crucial in explaining China's failure to match the scientific and technological achievements of the Western nations in modern times and its reluctance to adopt the results of those achievements" (p.175). [He cites "ethnocentrism," "xenophobia" & "conservative, antiquity-fascination" as values that acted against the progressive fascination with the new characteristic of the West: "The steady-state society that Needham praised can be seen from another perspective as a conservative one bound by traditional Confucian principles, convinced of its superiority over the rest of the world [the Chinese name for themselves is "Han," the "Middle Kingdom"=central in the earth], and suspicious of technological innovations, primarily those coming from the West [classified as "barbarians" by the Chinese]...the Chinese scholar-officials were men of letters [& remember what trouble we got into under our own "Mandarins" like Robert MacNamara in the Vietnam War!] with little interest in, or sympathy for, science,

commerce, and utility. Furthermore, the focus on ancient Chinese authors [as unimpeachable "authorities"] as a field of study was not conducive to an acceptance of the ideas of novelty and progress that had come to the forefront in Renaissance Europe. A Jesuit traveler in the late seventeenth-century remarked that educated Chinese were more attracted to antiquities than they were to modern things. He observed that the Chinese predilection for the past directly countered the European's love of novelty for its own sake" (Basalla, p.175).

China, 1st in Archaeology!--indeed, powerful independent confirmation of that position comes from the discipline of "archaeology," defined as it originally was by the English antiquarians, as "backward-looking curiosity," that shows the Chinese to be much earlier in their creation of archaeology than the West & more persistent in their antiquarianism via the collection of antique bronzes.

@750 B.C.=Feng Hu Tzu, an Eastern Chou philosopher, notes that first weapons were made of stone, then of jade [the first two buried with the dead], followed by bronze and then, in his day, iron. But this is from a later quote.

@250 B.C.=Han Fei Tzu, a historian of the Warring States Period, outlines in the Shih kuo (with an interest in reconstructing history using artifactual patterns) that in Yao Dynasty [culture] times people used clay containers only, the Yü made ritual vessels with the interior painted black and exterior painted red! and the Yin people engraved their bronze meal utensils and incised their wine vessels! He must have seen excavated specimens to make such a vivid description.

@100 B.C.=The greatest Chinese historian of antiquity, Ssu-ma Ch'ien, of the Western Han dynasty, actually precociously inaugurated "historical archaeology" by actually visiting abandoned cities and examining ancient relics to verify them first hand before putting them in his great Shih chi (Historical Memoirs).

52 A.D.=A Chinese compilation set out a sequence of Stone, Bronze and Iron ages, but may be result of "folk memory" [my term] according to Glyn Daniel. Thereafter Confucianism takes over and developed an ideology of a Golden Age of 3 Dynasties and legendary predecessors, thereby reducing archaeology to "the studies of bronzes and stones" from an antiquarian perspective. It will never undergo the scientific alteration that happened to Western archaeology starting in the Renaissance (in 1586 A.D.=William Camden, an academic in the College of Heralds, a kind of Elizabethan antiquary center. He traveled widely in England to visit archaeological sites & defended his "back-looking curiosity" as a mark of the cultured mind. His "Britannia" was the first guide to British Antiquities and remained in print (revised & reedited) for 200 yrs! In addition, he was a careful-observer of crop marks!

Attitudes Toward Nature: [Moreover, the Chinese differed in their Taoist identification with nature, rather than the Western Judeo-Christian attitude of the domination of nature, placed here by an interfering humanoid deity for human use, an attitude that directly impacted eagerness to alter the earth for the worse in the pursuit of profit].

Fads & Fashions: [in my terms a "fashion" is a short burst in popularity, assuming the shape of a "battleship curve," of a cultural item, most easily recognizable once it has ended, within an ethnographic (living population) entity--its archaeological (dead population, "bounded=closed" corpus) equivalent is a recognizable "phase" of a "tradition," "horizon" or "series." "Fads" are even on a shorter cycle than fashions. While fashions may last decades or even centuries, fads usually appear & disappear within months or years--Fads have no archaeological equivalent since we currently do not have a means of resolving that short a period of time & the patterns of artifact popularity within them, in antiquity]. Basalla notes something similar: "At certain points in the development of technology [or art] the selection of an innovation is motivated not by widely shared cultural values but by short-lived fads that sweep through a region for a decade or so and are gone...[he opposes them to the enduring & shared cultural values]...where the impulses are associated with a naiveté, fancy, or whimsy [I would say the "ludic" or "play impulse"], we may conclude that the choice was made on the basis of a passing fad or fashion" (p.176)--[note, he uses the two terms synonymously].

Sub-Cultural Affiliation: [We may add that if the "shared cultural values" include the majority of a culture, then the "fads" or "fashions" usually afflict regional, racial, religious, occupational, gendered or otherwise differentiated sub-cultural groupings within the larger over-arching culture.]

Example: The "Atmospheric Railway": The 1st steam-powered railroad began operating in 1830 in England, then came the "mania" of the 1840s when speculators issued dubious stock to gullible investors seeking to make it rich & all sorts of schemes originated, including the bizarre "atmospheric" railway, ex. of which were built in England, Ireland, Scotland, Wales, France, Belgium, Austria-Hungary, Italy & the West Indies in the period from 1844-47 (p.177). Power wasn't supplied by the locomotive, rather it simply carried a piston fastened to its undercarriage. The piston fit

into a track-level laid-cylindrical tube with a slot in its top for the sliding piston, sealed with leather flaps to keep the pressurized air in that drove the piston & the train. It was like a big "air-pressure message- tube" container of the sort once used to shuttle bills in department stores or still utilized in drive-in tellers in banks to get car-patron transactions to-and-from the distant teller. Unlike a steam traction locomotive "...the atmospheric railway was its use of the pressure of the atmosphere, and not the expansive power of [heated] steam, to force the piston through the cylindrical tube. Steam-driven air pumps stationed at two- or three-mile intervals along the rail line were to evacuate air from the cylinder just prior to the arrival of the train, thus causing the piston, along with the train to which it was attached, to move in the direction of the lower pressure" (p.179). Unlike dirty, coal-fire smoke-belching trains, it was quiet & clean, could locate the dangerous boilers on solid ground away from passengers, did not have to waste weight & space hauling coal & water & needed to be on only while the train approached each station, conserving fuel. On the negative side, it required lots of pumping stations & the leather of the time aged & cracked & could never form a very good seal. Moreover, there was no controlling engineer on the locomotive & the trains had to be controlled & shunted from one track to the other, via uncertain brakes, from the pumping stations miles away & in the absence of telegraphy! It could not be upscaled based on greater passenger demand by simply adding a larger engine; the whole line had to be rebuilt; moreover, it was unidirectional. To have bi-directional traffic a whole second opposite-oriented line would have to be installed. Water & snow leaked into the tubes & they projected over crossings! The tracks were, accordingly, very short (only 1.75-20 miles & short-lived, the longest surviving for only 12 yrs! [Its legacy was not in transporting people, but in furnishing the inspiration for the zipper!]) Why did so many competent engineers, including the most famous of them all, the diminutive but brilliant and charismatic Isambard Kingdom Brunel, the creator of the world's largest ship, the equally ill-fated "Great Eastern," invest in such a scheme with so many obvious problems? "...we are dealing with a fad and that those caught up in it were incapable of seeing its many disadvantages. Brunel and other promoters...believed that its serious technical problems would ultimately be resolved. They never were." (p.181)

Flying Cars: [like water-going cars, a fad, but less successful] America's "technological infatuation" with the airplane (1900-1950) led to attempts to build flying cars that could utilize the highway or the skyway. In 1926 Henry

Ford began to manufacture a cheap airplane called the "Ford Flying Fliver" & in the 1930s the Federal Bureau of Air Commerce financed the design of aircraft prototypes that it hoped could be mass-produced like cars; one, the Plymacoupe, was powered by the Plymouth car engine, but WWII put a stop to all this experimentation. Many models were promised after the war, but none came to pass given the greater skill levels required to pilot a personal plane, and the greater expense & hazard. "Postwar Americans did take to the skys but not in privately owned planes. They flew as passengers in large aircraft piloted and maintained by the professional crews of big orporations" (p.181). [The dream remains & several, both planes, helicopters & hybrids, are still in design & appear from time to time in the magazines of tech. infatuation, Popular Mechanics & Popular Science].

Nuclear propulsion Space Vehicles: [the success of the atom bomb & atomic propulsion reactors for submarines led to a very costly fad in the postwar years. The Federal government spent billions of dollars on nuclear rockets & aircraft & over 1 million for a nuclear merchant ship [at the time that the U.S. merchant marine was rapidly shrinking!] (p.182). The Nuclear Energy Commission finally had to terminate these projects in 1972 because there was no way to neutralize the radioactive exhaust gases of nucelar-powered rockets & jets (either at take-off or in flight, not to mention the inevitable crashes, or to provide shielding for the pilots-p.184).

Project Orion: (1958-65), a 10 million dollar project to produce a nuclear-powered space craft to cruise at 100,000 mph, based on timed explosion of atomic bomblets acting against a pusher plate protected by springs! Once again, space pollution was an inhibiting factor.

The Savannah: The nuclear-powered merchant ship was more feasible because it utilized a marine reactor (from a submarine), but it was not economically feasible [the cost constraints do not apply to aircraft carriers, cruisers or other warships, of which a number are now afloat]. President Eisenhower's "Atoms for Peace" program led to the savannah as the 1st of a fleet (never built). Launched in 1963, cost over-runs & a high operating cost cancelled out any money the ship made from cargo & it was decommissioned in 1971.

Technological Extinction: "The long-standing bias among historians is to examine the origins of innovation and not their ultimate extinction or discard [rejection]" (p.185).

W.H.R. Pitt-Rivers's Study of "Disappearing Oceanic Artifacts": The canoe, pottery & bow & arrow disappeared from a number of islands [by a process

of "culture-loss"]. In the former case wood was always available, "...but there is evidence that skilled canoe makers simply died out without leaving any one to carry on their craft" (p.186)-[like the "founder principle"]; [pottery may be related to lack of suitable clays-a similar "devolution" happened in the Bahamas in the Caribbean]. The bow & arrow is a more interesting case since here cultural factors may have acted: "The bow and arrow never entirely disappeared from Oceania; however, it was put to debased uses, such as target practice or the shooting of rats and birds, instead of serving as a prime military weapon. In warfare the club replaced the bow and arrow, which indicates that the latter's demise may be related to new battle tactics, a different view of the goals of war, or changing attitudes toward death in battle" (p.186) [but there too wood limitations thru over-cutting may have played a role as not all trees are suitable for bow manufacture & stone may serve for clubs-as in New Zealand].

George Kubler's "Invention [Creation]/Replication/[Rejection]Discard": This American archaeologist emphasized a cycle for the "made world" [both "invention" & "discard" have a different technical definition; "discard" means an object thrown away at its use-site in situ, perhaps because it became broken or worn-out, or for some other reason like too great an effort of transport; it is useful in reconstructing "activity areas or loci" versus "refuse" which, in being carted away, destroys the spatial context, but in its final depository can still be useful in reconstructing "material cultural inventories"--(whether in a "midden" or a "dump") both are classes of "garbage," disposed-of items. This is different from "rejection" which implies a cultural decision to no longer use, therefore I will alter the terminology]. "[Creation] breaks stale routine, replication makes the [creation, whether a novelty, an innovation or an invention] widely available, and [rejection] assures that there will be room for newly [created] things in the future" (p.187).

Long Duration Technology: "The lack of extensive artifact diversity and the absence of technical progress in preindustrial societies lead one to assume that the retention of artifacts there is high and that consequently their lifespan, or duration, is long. In a culture where a great deal of effort is expended in making relatively few items, there is an incentive to retain and repair broken things, make do with what one has, and generally preserve the status quo. The pursuit of the untried and the novel is less attractive in these settings in which a great deal of time and energy must be devoted to producing such new things. Because it is far better to accept existing

artifacts than it is to innovate, the relative lack of novelty in traditional societies may be due to an understandable reluctance to part with the old instead of an inability to create the new" (p.187).

Throw-Away Technology: "If long durations characterize the artifacts of traditional societies, a trend toward shorter duration is what one might expect to find in modern cultures that promote novelty, endorse the doctrine of progress, and cultivate and apply science. To these three powerful factors should be added the techniques of mass production... [which]...encourages the discard of individual artifacts (creating a throw-away culture), and the replacement of entire classes of things. This is perpetuated by the ability of those engaged in mass production to replicate an innovation quickly and flood the market with its copies, an act that simultaneously satisfies a craving for novelty, creates a feeling of satiety, and prepares the way for the next innovation. In many cases this process operates at the level of fashion, as with annual automobile model changes" (p.187)

[Coexistence of Technological Alternatives]: "When one class of artifacts replaces another one, the displaced artifacts do not vanish from the scene. For a time there exist overlapping generations of different artifacts capable of filling, to a degree, the same function. So it was in the 1920s and 1930s when lighter-than-air craft (dirigibles) were being superseded by the airplane, and so it is with the generations of computers that have succeeded one another so rapidly in the late twentieth century. Not every company immediately buys the latest computer, and if it does the older models are not destroyed but are passed on to other users" (p.188) [usually ones lower on the "technological food-chain"]. [this happens for longer than it does in natural evolution].

No Mass Extinctions in Technology: "Technological evolution has nothing comparable to the mass extinctions that are of interest to evolutionary biologists...Only in the apocalyptic visions of science fiction does one encounter the wholesale destruction of an entire technological civilization and its forced retreat to an earlier, usually paleolithic or medieval, stage of development" (p.188).

Intermittent [Staggered] Duration; Kubler-"An artifact that has been discarded is revived and reinstated at a later date" [or at a different place/by a different culture] (p.188). [this is not archaism, which is done for nostalgic reasons, but out of sheer practicality]. "Steam locomotives, [long] supplanted in the West by electric and deisel engines, flourish on mainland China [due to their vast reserves of coal] where seven thousand of them are in use daily and three hundred new ones are manufactured each year. The revival of the

wood stove and solar-heating methods in the 1970s' energy crisis is another example of discarded artifacts given a new life at a later date" (p.188).

Japanese Adoption/Rejection of the Gun is an ex. of "intermittent Duration": (see "Japanese.tec")

"There are several reasons why the Japanese did, and could, renounce the gun. Japan's élite and influential warrior class, the samurai [far more numerous as a class than the knights of Europe], preferred to battle with swords [indeed, were defined by their right to wear two: the short and the long sword]. The Japanese sword possessed symbolic, artistic, and cultural values that transcended its role as a weapon. It was the embodiment of the warrior's ideas of heroism, honor and status [the code of bushido, the "way of the warrior"] and was linked to aesthetic theories specifying the proper movements of the body. The gun, on the other hand, was an [intro- duced] alien instrument, devoid of these rich associations [and, instead, was linked with outlaws and ronin, outcast "masterless" samurai]. Finally, Japan's insular position and its reputation as a nation of fighters made it possible for the country to rely upon the sword at a time when it was surrounded by gun-using neighbors" (pp.188-189).

-----proof-read up to here Alternative Technological Paths (technological Evolution is not Unilinear: "...when the United States decided against funding the supersonic transport... [it was]...choosing an alternative possibility-the jumbo jets. All too often it is assumed that the development of technology is rigidly unilinear, that at no point could other choices have been made" [usually by the vested interests in the selected technology] (p.189). "The evolutionary perspective on technological change reveals that there are a diversity of paths open for technological exploration and exploitation..[with]...many alternatives avail- able...And the study of artifact selection has made clear the arbitrary nature of the decisions made. Again and again neither biological nor economic necessity determined what was selected. Instead decisions were made on the basis of these two elements combined with a large measure of ideology, militarism, fad, and current conceptions of the good life (p.190).

-----Assign Separately-----

Edward T. Hall-Kinesics & Proxemics-"Kinesics" is based on "kinetic energy," or the employment of the body in motion, Lemmonier would call this "gesture," & it is culturally-modifiable "Proxemics" is based on the same root as "proximity," the closeness of human to tools & raw materials.

Pull Kinesics & Ground-Level Proxemics (Japanese Pull-Saw=Ryoba-Nokogiri, 1st recognized as embodying "styles in technology" by the American anthropologist Edward Spier. The handle is grasped by 1 or 2 hands & the teeth are raked toward the body to cut on the pull stroke. It is double-sided, so the rip teeth can be on one side & the cross-cut teeth on the other. Steel is stronger under tension (pulling) than under compression (pushing) so the blade can be thinner, cutting a narrow kerf & saving wood that would otherwise be reduced to sawdust (p.190-191). [it is also more precise, being narrower, which lends itself to complex joinery, a technological trait that the Japanese are famous for. Complex joints interlock & hold a work-piece together without the need for glue or fasteners. These joints also flex, so movement is possible with changing external conditions like heavy winds or earthquakes. The result is where everything is treated like complex cabinet-making; in essence, a house is a cabinet you live in. All this requires skill, so that it is also an élite form of housing.

[Tools Exist as "Suites"]-[Tools do not exist in a vacuum, but as parts of interrelated sets or "suites" that all obey, or will increasingly seek to obey over time, the same stylistic principles]. "For example, in China and Japan the wood plane is pulled toward the body [just like the saw] rather than pushed away" [as it is in the West] (p.191).

Ground-level proxemics-[Basalla's fig. VI.3 (p.191) shows the work-piece being held by the foot & cut on the ground, just raised on a board. This places the worker on the same level as his work-piece & the debris created from working; surrounded by woodshavings & saw-dust the worker is thus "identified" with his raw materials in contrast to the "aloof" Western woodworker].

The Western "Push" saw only dates to Roman times (p.190), [its best example is the "backed mitre saw" with its strong, thick, reinforced blade to resist bending & producing a thick, wide kerf that biases the worker who uses it to simple joints like the lap-joint (rabbit joint) or the tongue-in-groove. It comes with a sturdy pistol-grip designed to cut on the push stroke. The fasteners (which exist in great profusion: bolts, staples, screws [themselves in 6-8 varieties], nails, rivets, etc.) produce rigid structural elements like the truss that defy the elements & resist bending (but break catastrophically when their strength is exceeded). [Due to their simplicity these joints & fasteners lend themselves to a commoner "carpentry" tradition which, again, in typical Western style produces a "democratic" form of housing & wooden artifacts

accessible to all.

Western "raised dias" style:

Moreover, both the work & the raw materials are done & housed on a Greek-style raised dias, the work-bench & dimensional lumber storage shelves. This further alienates the worker from the raw materials & their by-products in true Western "domination of nature" format].

Diachronic Paradigmatic Completion [Styles Diachronically Select Against Items That Contravene its Basic Precepts:]-[this is a structuralist position, see Eugene Hammel "Lévi-Strauss & the Three Bears" (1972), that over-time greater syntagmatic perfection will be sought. Basalla mentions the data but does not draw the conclusions="Evidence also suggests that in the recent past [during the analogous-to-the-Orient "post & beam" carpentry tradition with its greater dependence on joinery than the "stick-built" "balloon-frame" construction of the 19th cen. to present period] even Europeans and Americans made a greater use of pull tools-for example, drawknives, spokeshaves, scrapers, adzes, and scorps to shape chair seats-than they do today" (p.191). [& some of these were, of course-because of the kinesic pattern, highly skilled, such as the adze-workers who were the highest paid carpenters prior to, and during, the early 19th cen.]. [Cultural Styles of Work]="There is more at issue here than opposing motor-habit patterns. The tools themselves are different (p.190) [and] "...the two saws are distinct enough so that a worker accustomed to using one of them must be retrained in the operation of the other" (p.191). "If the ancient and simple tools fashioned to carry out the basic operations of woodworking can be designed and used so differently, we can expect to find alternatives for the more complex and adaptable artifacts of industrial cultures" (p.191).

Block Printing East/West (Xylography/Typography):

Xylography: The carving of the entire page of a text in reverse on a block of wood; each page, of course, must be custom-carved, therefore very labor & time intensive, making books expensive. It was regarded as a poor precursor of typography. But "In the Orient it was xylography that sparked a printing revolution and typography that was tried and then dropped because of its shortcomings" (p.192)-just the opposite of the Western experience!

@750 A.D.=The Chinese invent xylography.

953 A.D.=The publication, via xylography, of the Confucian Classics, some

130 volumes, fixed the corpus & restored it to a central place in Chinese thought, fomenting a revival of interest in classical thought comparable to the revival of interest in the Greek & Roman classics in the later Western Renaissance.

983 A.D.=The finishing of the most monumental xylographic publishing program of ancient China, the printing of the entire Buddhist canon, the Tripitaka in some 5,048 volumes covering 130,000 pages (each engraved on a separate wooden block)!

1368 A.D.=The apogee of the Chinese xylographic printing program in works of exquisite artistry, which now begins to decline, particularly by the 15th cen., altho the quantity continued to increase (p.193).

1500 A.D.=By this date "more printed pages existed in China than the rest of the world combined!"

Typography: In the West, Gutenberg's invention using mass-produced, interchangeable letters, allowing books to be printed quickly & cheaply & therefore suitable for the diffusion of knowledge. Sir Francis Bacon in the 17th cen. regarded this invention "as one of the great forces shaping Western thought and life" (p.192).

@1050 A.D.=Typographic experiments began in China. "Initially the characters were [incised] on pieces of soft clay, which was then hardened by [firing]" (p.193).

@1250 A.D.=Wooden type was tried in China 1403 A.D.=The Koreans are casting metal type by this date, but typography continues to make little impact, in part due to aesthetic attitudes ("As an art form, typographic books never achieved the excellence of their xylographic competitors. This difference meant a great deal to a people who cultivated calligraphy as an art and who were sensitive to the nuances of book design" (p.193). On a practical level "...those who espoused typography had to handle at least five thousand different Chinese characters in printing" [which would have made a set of individual character type very cumbersome to organize & interchange] (p.193).

@1850 A.D.=Westerners reintroduce typography into the land of its origins! [Experimental History-the analog of experimental archaeology]-[the methodological problem is the same in both disciplines, tho the same tools may be used, the disparity in skill levels makes any direct comparison of time & effort difficult between modern replicators & ancient originators]. "A modern student of printing commissioned a contemporary wood engraver to carve a block for a single, small, page measuring five by seven inches. The

engraver took thirty to thirty-five hours to complete the task. Yet, the sixteenth-century Italian missionary to China, Matteo Ricci [an excellent ethnographic source], who was well acquainted with Western printing techniques, noted that a Chinese artisan could carve an entire page in about the same time that it took for a European typesetter to set a folio-sized [large format] page with metal type" (pp. 193-194).

[The Xylography=>Typography Evolution is not documented in West]= "...no Western block books predate Gutenberg. The earliest xylographic books date from 1460, at least two decades after movable type is said to have been invented. And block books continued to be printed in Europe for about a century" (p.194). [Instead of being a precursor, they appear to have functioned as a cheap imitator used only for religious propaganda "...to popularize biblical stories, relate simple moral tales, reprint common prayers, and summarize the rudiments of grammar. Instead of serving as the highest artistic model of the art of bookmaking, block books in the West were cheap, crudely printed and illustrated, and usually very short" (p.194)!]

[The Linguistic Argument Cannot Explain This-tho the Artistic One May]="The wide discrepancy between Eastern and Western xylography cannot be explained in terms of the written languages of the two regions. If Chinese artisans could engrave some five thousand intricate ideograms for very high quality books why could not European craftsmen learn to engrave the twenty-six simple letters of the alphabet with proficiency and artistry?" (p.194)-[the answer may be that from the more utilitarian Western perspective artistry was not essential; the need for cheap methods of religious proslet-ization overwhelmed any aesthetic impulse.] "The block book could have met the needs of Renaissance Europe just as it did those of Sung Dynasty China" (p.194) [again, necessity is illusionary], at least for several centuries.

Railroads versus Canals [spurious necessity again]-"Between 1840 and 1960 journalists, economists, and professional historians agreed that the railroad was the single most influential determinant of economic growth in nineteenth-century America. The railroad revolution was credited with the westward advance of agriculture, the rise and form of the modern corporation, the development and siting of industry, the establishment of patterns of urbanization, and the structure of trade between the major regions of the country" [but the modern cliometrician, or quantitative economic historian, Robert W. Fogel created a counterfactual model of 19th cen. America's

economy without the railroad & discovered that "The absence of the railroads...would not have greatly affected economic growth between 1840 and 1890 because canal and river boats, with the help of horse-drawn wagons, could have moved goods normally carried by rail and because the railroad was not of vital importance to the market for manufactured items or as a stimulus for technological innovation" (p.195) [but that, of course, depends on the accuracy of his post-hoc reconstructions. He does show that the canals & horses were about 1% less efficient, hardly enough to credit the railroad with all its benefits. Indeed, had additional canals & roads been built, all within the technological capability of the U.S., even greater demand could have been handled without the railroad (pp.196-197)].

Steam, Electric & Gasoline Cars: [The railroad may have slowed the development of the car by some 40 yrs (p.197)]. [it is hard to pick winners from among viable alternatives]="At the turn of the century, it was by no means obvious that the modern automobile engine-the Otto four-stroke cycle internal combustion engine-would win over its competitors," [but in 1900, 4,192 cars were manufactured in the U.S.: 1,681 steam, 1,575 electric & only 936 gasoline, & by 1905 gasoline models outnumbered the others 7 to 1!] despite the fact that "...each of the power plants had advantages and disadvantages; none had a clear-cut technological superiority" (p.198).

Electric Vehicles & [Limiting Technology]: The 1st commercial electric vehicle was produced in 1894. "The electric car appeared to have all the [advantages]...It was noiseless, odorless, and very easy to drive. No other motor vehicle could match its comfort and clean-liness [reasons why women favored them] or its simplicity of construction and ease of maintenance. Its essential elements were an electric motor, batteries, a control rheostat to regulate speed, and simple gearing. There was no transmission and, hence, no gears to shift" (p.198). [but] "It was slow, unable to climb steep hills, and expensive to own and operate. Above all else, it had a limited cruising range. Its heavy lead and acid storage batteries had to be recharged every thirty miles or so [hence it was limited to the city the batteries were the "limiting technology & they are to this day. Electric delivery trucks, the ideal medium for this technology, were initially successful] "...but by the mid-1920s they were displaced by delivery vehicles powered by gasoline engines, which were less expensive to purchase" (p.200).

Steam Vehicles [a Viable Alternative?]: "Steam automobiles enjoyed intense popularity at the beginning of the century. To understand this phenomenon,

we must set them apart from the cumbersome steam carriages of the previous century. The power plant in an early twentieth-century Stanley or White steamer was a trim twenty to thirty horsepower unit, about the size of a gasoline engine...and fueled with a petroleum product...The steam car was not as quiet as the electric but its purchase price and upkeep were considerably less and a powerful engine enabled it to handle all road conditions without strain. The first self-propelled vehicle to reach the summit of Mount Washington, New Hampshire, was a Stanley Steamer (1899), as was the first car to travel over two miles a minute (1906). The steamers of the 1900s could outstrip the electric car but did face competition from the best of the gasoline engine automobiles ...(t)he steam engine's ability to deliver maximum power as it revolved at a slow and steady rate was an important factor in its success. Whereas the reciprocating internal combustion engine in gasoline-powered cars ran at 900 revolutions per minute (rpm) when idling and 2700 rpm at maximum efficiency the engine on the steamer at a speed of sixty miles per hour revolved at a slow 900 rpm. On internal combustion engines an elaborate set of gearing (transmission) was necessary to transmit and transform this rotative power so that it could move the wheels at an acceptable speed, but the steamer had no need for a transmission, clutch, and gearshift... the steam engine had far fewer moving parts than the gasoline engine, which meant less engine wear and easier maintenance. Finally, the use of proper fuel was critical for the gasoline engine, but low-grade petroleum distillates could be burned to heat the water of the steamer. [but] "The steamer did have a number of important drawbacks. The limited cruising range that plagued the electric also proved troublesome for the steamer. Because steam was exhausted to the atmosphere, and not condensed for reuse, the steamer needed a water refill every thirty miles. Another problem was the time it took to generate steam for the car's first run of the day, altho the standard half-hour wait was eventually reduced to a few minutes with the introduction of pilot lights and flash boilers... Steam-automobile manufacturing lasted thru the 1920s" (pp.200-201). Gasoline-engined Cars: "Early gasoline motor cars were rather clumsy and complex machines. To start their engines, a hand crank and muscle power were necessary [limiting the drivers to males-the crank frequently broke wrists & arms]; their successful operation depended on a series of recently fashioned mechanical systems for ignition, cooling, lubrication, and transmission of power, and they were noisy and emitted unpleasant exhaust gases. On the positive side the gasoline motor car did have an extended

cruising range of seventy miles [the key here, the technological advantage]...and could climb most hills and travel at a good speed on the road" (p.201).

[Technological Atavism Yields Similarities of Form Regardless of Power Plants in Early 1890s Cars]=Figure VI.4, p. 199 [because all were essentially "horseless carriages"-a Baker electric, a Stanley steamer and an Autocar]. "These automobiles are remarkably similar in appearance yet their powerplants differed radically."

Selection from among Technological Alternatives Isn't Rational: "The selection of the gasoline engine was not the result of a rational appraisal of the merits of the competing power plants. There were no automotive experts at the turn of the century" (p.201). [but that does not mean that the common tinkerer was incapable of intuitive correct selection since later "...the study of theoretical and actual heat engines indicates that the Otto cycle engine is superior in thermal efficiency to a steam engine...a gasoline engine yields more miles per gallon of fuel than a steam engine. Here, at last, is solid evidence that the promoters of gasoline engine were on the right track. Consciously, or intuitively, they had backed the most efficient engine." A Geographic Argument: [In conjunction, I argue, not as an alternative, to the Great Man theory] "Some historians have cited geographical factors as the cause of the rise of the gasoline automobile. Steam and electric cars were primarily built and sold in the eastern United States [where their range limitations were vitiated by the greater regional urbanization]. The gasoline car, on the other hand, was particularly well-suited to the rural areas of the midwest [due to its greater range]. [This] ...coincided with the industrial and natural resources of the region. Its ample supply of hard woods had earlier made the Midwest a center of carriage and wagon production [& the frames & wheels of these early cars were made out of wood using carriage-builder techniques], and its farm power supply needs had attracted makers of stationary gasoline engines [& therefore helped build an infrastructure of gasoline stations + Henry Ford was from the Midwest-Chicago- & built his factories there]" (pp.202-203).

A "Great Man" ("Titular Inventor") Argument: Tho rejected by Marxist historians, the "Titular Inventor" model, a variant on the "Great Man" theory in history, does, in fact, retain considerable merit in some cases. No better example of the power of this idea exists than the triumph of the gas over the steam-powered car. Despite the fact that "...one hundred or more makers of steamers did little to overcome the steam engine's negative images

and thereby popularize their vehicle...[even the most successful of these lacked the personal traits needed]..."The Stanley brothers, the most successful of the steam car builders, lacked the ambition and managerial skills needed to produce cars in quantity and distribute them across the nation. Nor were they quick to incorporate existing technical improvements that would have made their vehicles more attractive to customers." [with the result that while] "The Stanley company weathered the restrictions placed by the government on the American auto industry during World War I, ...it emerged in a weakened condition. Shortly after the war, the company closed its doors; it had failed to meet the competition of the inexpensive Detroit motor car" (p.202).

The Seminal Role of Henry Ford: [In contrast,] "In 1914 Henry Ford visited the Stanley factory, which was then turning out 650 cars annually; Ford was manufacturing that many of his Model Ts in a single day. While skilled craftsmen slowly built and hand-finished a few Stanley steamers, unskilled workmen on Ford's innovative assembly lines were mass-producing thousands of gasoline automobiles." (p.202) [Altho, as in the case of many Great Men, the strength of his character & determination, which were the key to his initial success, were later to almost ruin the Ford company as he stuck too long with the Model T.]

The "Best" Technology Does Not Always Win:[but]...the diesel engine is far more efficient than the gasoline engine. Under actual driving conditions, the average thermal efficiency of the Otto cycle is about 10 percent and a diesel 18 percent. Therefore, if the early Detroit entrepreneurs forsook the inefficient steam engine, why did not later, and better informed, automotive engineers lead the country to more efficient diesel power [as, in fact, they have in Europe]? The answer, of course, is that the selection of automobile engines, whether in the early or the late twentieth century, is made on other than purely technical and economic grounds" (p.203). [specifically, the dirty particulates discharged in exhaust by diesels which are more resistant to environmental cleaning-up]

Industrial Societies Are Uniquely Capable of Generating Technological Substitutes: "It is not an accident that two of the three examples of alternative technologies surveyed here are taken from modern industrial societies. Nathan Rosenberg has noted that such societies are not utterly dependent on a single innovation because, if necessary, they are capable of generating substitutes for it...Alternatives can be found not only for railroads and gasoline engines but for almost any major modern invention. The production of [creation] is so great that clusters of related

innovations, waiting to be selected, exist to fulfill virtually any of our wants, needs, or whims" (p.204).

"Winner" Fixation Fixation on the "Winners"-Simplifies History by Ignoring Contemporary "Loser" Alternatives: "The history of technology would be written far differently if, instead of concentrating on the "winning" innovations perpetuated by selection and replication, we were to make a diligent search for viable alternatives to those innovations" (p.204).

["Social Agency"-a concept by the American anthropologist Terrence Turner/in contrast to Roe's concept of "Mythic Agency")=[Societies lodged in history, that is, believers in the "Commutable Space/Time Matrix." A belief in social agency is the product of what the modern American historian George Basalla calls the "voluntaristic outlook."

Voluntaristic Outlook="...the assumption that the selecting agents [among technological alternatives & other creations] are active, productive individuals capable of making the choices and changes needed to shape the material [and the spiritual/artistic] world as they see fit. The selectors do not represent all segments of society nor are they necessarily concerned with the public's welfare. However, they have the freedom to decide which of the competing [creations] will be replicated and incorporated into cultural life. Some restrictions [ideological, social, technical or systemic] are placed on this decision-making activity, but opportunities for change are plentiful." "This [is a]...voluntaristic approach to technological [and other] change" (Basalla 1988:204).

Deterministic Outlook=The opposite of a voluntaristic outlook based on social agency, the "ultimate" cause can be any "prime-mover" such as geography ("geographic determinism" à la Diamond) or "economic determinism" (à la Marxism & Cultural Materialism) or "technological determinism" (à la "autonomous technology" of "mega-technical systems" of Langdon Winner) (Basalla 1988:204). [in its emphasis on the passivity of individuals it is not unlike "mythic agency" & reveals that these systems are but the manifestations of "secular religions," all expressions of the modern "savage mind"].

a.) **Early Figure**=Lewis Mumford, 1930s-1940s, the metatechnical "Technics" that encapsulates us (the anxiety of the rise of Modernism)

b.) **Middle Figures**=Jacques Ellul, 1950s-1960s, believes we are all technological slaves (the anxiety of the rise of Fascism & other totalitarianisms like Communism & its linkage with the

military-industrial complex & the Cold War)

c.) Recent Figures=Langdon Winner's terms, 1970s-1980s, we all technological accomplishments—we have our eyes open & can make choices, but only within the megatechnical system that encapsulates us (the disenchantment of the Vietnam War).

Autonomous Technology & Megatechnical Systems=of Langdon Winner, an American historian of technology at M.I.T. (now at R.I.T), and, most recently, author of the collected writings: The Whale and the Reactor & "technological somnambulism." "The impossibility of self-determination is not the result of the machinations of a powerful ruling elite but is due to the nature of twentieth-century technology [itself]. The leading question is not who but what governs society? Winner's answer is 'autonomous technology,' technology changing in accordance with its needs and not the needs, desires, or wants of humankind" [a sort of neo-Hegelian approach]...The freedom to develop technology primarily to serve human needs was lost with the spread of industrialization and the growth of modern megatechnical systems in communications, transportation, power production, and manufacturing. These gigantic, complex, interconnected technological systems overwhelm human values and defy human control. Change is possible in the system only if it does not conflict with primary technical values such as efficiency or large-scale integration. Hence, the way we live, work, and play is structured by the monolithic technological order that rules modern industrial society" (pp.204-205). [but does this work as well in the current decentered information-service society?]

Attenuated Determinism-Basalla's critique reconfering social agency on modern society filled with active social agents. "This modified or attenuated determinism is similar to what was found in the case of the supersonic transport [or the modern nuclear power industry]. The aircraft industry's half-century drive for increased airspeed was deflected by social, economic, and political forces; at the last moment, a decision was made that overrode the purely technical demand. In sum, for the purposes of a theory of technological evolution, the selecting agents need not enjoy total freedom of action [indeed, they never do if culture is real], with all possible choices equally available [rather, known choices are the relevant factor]. It will suffice to have a narrower range of choices from competing [creations] and a restricted field of operation [determined largely by "stochastic processes" from ancient "apical choices" within given "cultural styles of technology"] for the selector (Basalla 1988: 205-06).