

Basalla, Chap. 5

[square brackets indicate an interjection by Dr. Roe]

"Excess of Novelty"=American locomotive smokestack spark arrestors (a whole 1/2 page figure of some 60 attempts to keep sparks from coming out of the smokestacks of wood & coal-burning locomotives) [**--a good illustration of the play factor in tech.**]

Selection in technology is like artificial selection in biological evolution, not natural selection.

[It is not so much that rates of creation are greater in a society in times of crises (necessity), as the rates of the acceptance of creation]

Ideology to creation="...the belief in the idea of progress stimulates the invention of novel artifacts. That belief also influences the subsequent selection of the novelty for development by creating a cultural milieu in which new things are welcomed as a sign of betterment." (p.137)

["Cross-fertilization in technology"]="Different biological species usually do not interbreed, and on the rare occasions when they do their offspring are infertile. Artifactual types, on the other hand, are routinely combined to produce new and fruitful entities" (p.137).

a.) e.g., the internal combustion engine was merged with the bicycle & the horse-drawn carriage to produce the automobile (p.138)

Alfred L. Kroeber's distinction between the "family trees" of organic & inorganic evolution, with the merged lateral branches of technology due to diffusion & cross-fertilization are contrasted with the spreading, & ever-widening branches of organic phylogeny (p.138:Fig.V.2).

Evolutionary analogy as heuristic="I...use the evolutionary analogy because of its metaphorical and heuristic power and caution against any literal applications, not the least, the process of speciation" (p.138)

Evolutionary parallels in tech.="...the parallel worlds of organisms and artifacts...exhibit a rich diversity of types and a continuity based on antecedent related forms...organisms and artifacts share a tendency to produce an excess of novelty [creation], reproduce by means of copying with variations, and spread their innovations over a wide geographical area" (p.139).

In creation: "Trial and error [iterative tech.] predominates as a method [an analog of mutation in evolution], and the small number of men and women who participate in it are subjected to, among other things, economic constraints, military demands, ideological pressures, political manipulation, and the power of cultural values, fashions and fads" [note the emphasis on the multi-causality of tech. change] (p.139)

["Problematic Functionality"]=[The ultimate function for a new device/process is problematic, or hard to foresee="]...the potential, as well as the immediate, uses of

an invention are by no means self-evident" (p.139), [e.g., Thomas Edison invents the phonograph in 1877 & in 1878 has to publish an article listing 10 ways it may prove useful to the public (p.139), but only picking music as 4th because he thought it trivial; "A decade later when the inventor entered the phonograph business, he still resisted efforts to market the phonograph as a musical instrument and concentrated upon selling it as a dictating machine. Others, who saw the entertainment possibilities of Edison's invention, modified phonographs to play popular musical selections automatically on the deposit of a coin. The coin-operated machines, displayed in public places, soon gained popularity. In 1891 Edison was unwilling to accept these early jukeboxes, because he believed they detracted from the legitimate employment of the phonograph in offices...[but]...by the mid 1890s even Edison agreed that the primary use of his talking machine was in the area of amusement" (p.140).

The same fate later happened to the tape-recorder; it was developed by Germany during WWII, but was made into a consumer item by the Japanese [Tokyo Telecommunications=later "Sony"] in 1950; but they 1st tried to market it to the government to record court proceedings or for scientists to record data, a next move proved more productive by introducing it to schools to teach a foreign language but it was "Not until the 1960s was the tape recorder finally advertised and sold as a device for recording and playing music, at which point sales began to soar" (p.140).

[New Inventions Start as Novelties]="Clearly the phonograph and tape recorder were not developed to meet some identifiable, pervasive, and pressing need or want. When these machines appeared on the scene, neither the technologists nor the public knew what to do with them."

[Famous Uses are Not 1st Uses]"Each invention offers a spectrum of opportunities, only a few of which will ever be developed during its lifetime. The first uses are not always the ones for which the invention will eventually become best known. [e.g.,]

- [1.] The earliest steam engines pumped water from mines,
- [2.] the first commercial use of radio was for the sending of coded wireless messages between ships at sea and from ships to shore [actually to inform the port when ripe bananas were scheduled to arrive!], and
- [3.] the first electronic digital computer was designed to calculate firing tables for the guns of the United States Army" (p.141).

[Prototypes Can't Predict Success]"...even when there is general agreement about how [a new invention] is to be used, we cannot assume that it will operate as promised. Initially inventions are likely to be very crude models embodying new ideas in need of further refinement. What decision makers often base a selection

on is not a fully developed [invention]...but the first [badly] working prototypes." [e.g.,]

[1.] "Edison's 1877 talking machine, with its tinfoil recording surface and hand crank, was just barely able to reproduce the nursery rhyme the inventor shouted into its mouthpiece" [& could only record for 2 min.] (p.141).

[Faith-Based Selection]=[Signing up for a new technology is an act of faith in the eventual perfection of superior principle]. "The selection of novelty involves risk and uncertainty. It rests upon an act of faith and the judgement that an invention will prove useful to some segment of the public and that it can be developed into a reliable device" (p.143).

[Rejection of New Tech.]=[just considering the automobile, the rejection of:]

- [1.] "the combined airplane/automobile (late 1930s)
- [2.] the gas-turbine-powered car, truck, and bus [1950s),
- [3.] the rotary internal combustion (Wankel) engine (1970s)

[Why Rejection?]- "Economic Constraints"-**[Market "pull"/innovator "push"]**

The "market pull" explanation has difficulties, since demand can be assumed for many items before they ever enter production (if ever); it cannot be a sufficient cause, perhaps just one of several proximate causes (p.144).

[Systemic Causation]=[in many key inventions] "we will find that economic forces interacted with technological, social, and cultural factors in determining their selection. The selection of none of these novelties was controlled solely by economic demands" (p.144).

[Case Study #1=the waterwheel]=the central distinguishing mark of Western tech as of the 12th cen. was its dependence upon waterpower. The vertical waterwheel was originally a Roman invention of the 150-100 B.C. period, used to grind grain into flour (a modern East Indian woman will spend 2 hrs grinding flour on a hand-mill for just 1 meal, therefore its advantages are obvious). Animal (donkey) mills require more care, but less initial investment, [which may explain why it wasn't until the 5th or 6th cen. A.D. (500 yrs later!) that the vertical waterwheel came into its own (p.145).

[Roman Inhibiting factors:]-according to the historian Terry S. Reynolds:

Attitudes Toward Nature:"These were people who believed that nature, ruled by a panoply of gods, was sacred and not a realm open to casual human intervention and exploitation; the diversion of rivers and streams for waterpower might be interpreted as interference with the natural order."

Attitudes Toward [Effort]:"...members of the wealthier and educated classes held manual labor in contempt and were reluctant to embrace technological innovations as a solution to their problems."

Attitudes Towards Economics: "There was no tradition in antiquity for investment in technological improvements. Landowners were likely to hoard their money instead of putting it into a speculative venture involving an untried technology."

[Abundant labor=Cheap, a Detriment to Machine Tech.] "Hand and animal mills were less expensive than waterpowered ones to construct and they had one advantage- in slack times horses, donkeys, or slaves could be readily sold and the money invested in them recovered. The argument that an abundant labor supply acted as a deterrent to the diffusion of waterpower is reinforced by evidence that in the fourth century A.D. water mills were recommended to Roman estate owners as a substitute for those run by human labor, because that labor was then becoming scarce and expensive [the empire then being on the defensive-- no conquest wars to generate captives to be made into slaves] (p.146).

[High=late Middle Ages=1st Power Revolution]=[British historian Lynn White]. The numbers of watermills in Europe was in the tens of thousands & "The energy available in most large European streams was put to use in the Middle Ages" (p.147). Not only was the design of the machines improved, but they utilized them for a far-greater range of functions than had the Romans. "The Romans used waterwheels to grind their flour and lift water for irrigation purposes. By contrast, there were few aspects of medieval life that were untouched by waterpower technology. Wood was sawn, drilled, and turned by waterpowered tools; grains were ground and olives were pressed in water mills; the tanning of leather, the making of paper, and the finishing of cloth employed waterpowered equipment; and mining and metallurgy depended on hammers, lifts, pumps, and bellows driven by waterpower.

[Medieval Era="Proto-Industrial Revolution"]-"The water mill, along with the windmill and more efficient harnesses for horses [in addition to their simple constituent devices like the crank and gears] are said to have constituted a power revolution that set medieval civilization apart from all earlier ones. For the first time in human history, a great civilization was built upon nonhuman [non-slave] power." While using a true industrial revolution to denote this development is an "overstatement, we can still agree that in the Middle Ages the first decisive steps were taken. Medieval waterpower technology in large part laid the foundations for late eighteenth-century industrialization" (p.147).

[Technology alone is not the answer]="The unimproved ancient waterwheel could have been used to transform the life and economy of Greece and Rome" (p.147).

[Religion as Contributing Cause]="...the influence of Christian tenets and institutions..[i.e.,]...the establishment and spread of Western monasticism. According to the sixth-century A.D. Benedictine rules...religious houses were to be secluded places [the "sacred tech." principle of physical isolation] where the

monks could work and pray undisturbed. [but Buddhist monks, the comparable group, weren't on the forefront of tech., so it had to be something in the Christian "attitude toward effort"=>]. The Christian belief in the dignity of manual labor, a belief not common in antiquity, was central to monastic life. The brethren were expected to do most if not all of the work necessary to provide themselves with food, shelter, and simple material comforts. Given these circumstances, water mills served admirably. [+ the "sacred tech." principle of "institutional completeness"=>]. The use of the waterwheel ensured that the monastery would be a self-sufficient community with no need to traffic with the outside world, and left the monks with more time for their devotions. The monasteries of western Europe made early and extensive use of waterpower, not only to grind flour but to make beer, iron, leather, and cloth, among other things. The spread of masteries in regions where it was hitherto unknown or little utilized." (p.148)

[Scarce=Expensive labor=>Expediter of Machine Tech.] "Monastic water mills also provided examples for [feudal] lay landowners [aristocratic robber barons] faced with labor shortages and in need of new revenues...The supply of labor, so abundant in the antiquity, began to shrink in the turbulent late Roman era [up to the fall in 476 A.D.]. By the early Middle Ages, labor scarcity had become a serious problem. Because much of the demand was in the agricultural sector, water mills proved useful in replacing a diminishing and more costly labor force. **For that reason economic factors must be given equal weight with religious ones in explaining the growth of waterpower technology** [emphasis, mine]."

[Political Decentralization="feudalism" essential to machine Adoption]

[Capital-Ownning Groups, with incentives for labor-saving, Essential] "Medieval water mills, especially in some of their more elaborate manifestations, required the investment of a considerable amount of money. The feudal aristocracy was willing to make the investment because water power reduced labor costs and because the mills could be made into a source of additional profits. Exercising their rights over the serfs who worked the land, the feudal lords compelled them to use the manorial grain mill and pay in kind for its use." (p.148).

[Urbanization Contributory to Machine Adoption]

"At the end of the Middle Ages, another wealthy social group, merchants living in urban trading centers, were also in a position to invest in waterpower. Because this new group could not rely on a manorial monopoly of income, they used the waterwheel in pursuit of their commercial interests, thus bringing it to new industrial and manufacturing applications" (p.148)

[new Tech. Replaces Old Tech. Gradually]="The reign of the waterwheel was ended by the selection of the stationary steam engine, but the emergence of this

new source of power was not as abrupt as we are sometime led to believe. For many decades the two coexisted in European and American industries. The eventual triumph of steam occurred more than a century after the appearance of Newcomen's [stationary steam] engine" (p.149).

[Successor-induced Hypertrophism]=[the most elaborate ex. of old principle appears, paradoxically, after its successor principle has already appeared] "After 1750, under the dual impact of heightened industrial growth and competition by the steam engine, the waterwheel was transformed into a much more efficient and modern power source. . Systematic experimentation with various wheel designs, the theoretical analysis of the waterwheel in terms of the hydraulic principles on which it operated, and the substitution of iron for wood in the construction of the wheels led to a more sophisticated waterpower technology. The improved water-wheels could easily compete with the typical early nineteenth-century steam engine" (p.149).

[Case Study #2=the Steam Engine]=[A Niche-Need Facilitates the New Principle] "The first working Newcomen engine was erected in 1712 and used for a very specific purpose-pumping water from mine pits. Mining was one industry that could not accomodate itself to the limitations of waterpower. Textile factories could be sited next to good waterpower sources but not coal or tin mines. At best canals might be dug to carry water to the mine's waterwheel or power generated by a close-by stream could be transmitted by a system of linked rods (called Stagenkunst [note the use of a German word because Germans were then in the forefront of European mining tech.] to operate pumps at the mine. Neither method was completely satisfactory, consequently, the Newcomen engine, often burning the fuel mined on the spot, first found a place in mining regions" (p.149).

[Combining Principles Prolongs the Life-Span of Old Principle]="Many of the industrial applications of waterpower relied upon the smooth, constant, rotary motion of the waterwheel. The motion generated by the Newcomen engine was a reciprocating, or back and forth one, well suited to operating pumps but not factory machinery. The problem then was to obtain rotary motion from a steam engine. The immediate and ingenious solution was to use a steam engine to lift water for the continuous operation of a waterwheel. In this way, two disparate sources of power were joined to create the rotary motion needed to turn the machinery in the factories or the grindstones in flour mills. Steam engine-waterwheel combinations were quite popular in late eighteenth-century Britain, especially in the textile industry" (pp.149-150).

[The "Curse" of Natural Resources]=[They may delay the adoption of a new tech.] "In France and the United States, where there were many new waterpower sites that could be easily developed, the steam engine was

adopted later than in Britain, a country with few such sites...the waterwheel survived and managed to offer stiff competition to the Newcomen and [rotary-power] Watt machines for over a century" (p.150).

[The Eventual Waning of the Old Principle]="The water wheel...could not meet the power requirements of heavy industry after 1850. Ironically, the very success of the Industrial Revolution [caused by waterpower] created power demands [in the long run] that could only be met by the steam engine" (pp. 150-151).

[The Individual Inventor-Entrepreneur--This Supports the "Titulary Inventor"] "In nineteenth-century America the creation, selection, and development of a technological novelty was often carried out by a single figure-the inventor-entrepreneur. People like Robert Fulton [Steamboat], Samuel F.B. Morse [the morse Code], Cyrus H. McCormick [mechanical reaper], and Thomas A. Edison [the light bulb, the record-player] were as active in their workshops as in business circles where they raised the capital needed for the manufacture of their inventions" (p.151).

[Machines 1st Emulate Hand Labor, Then Fail]="The English were the first to attempt the mechanization of reaping and tried to duplicate the [walking human] harvester's swinging [scythe] action with machines equipped with rotating scythe blades (1790s). When those failed, they built mechanical reapers with scissor-action cutting blades. The latter had a limited success and, in the 1830s, were soon supplanted by McCormick's machine whose cutter employed a serrated or notched blade in a sawing motion" (p.151).

[Machines Require Their own Environment to Succeed]=McCormick invents the mechanical reaper in Virginia, but its stony, hilly, small and irregular fields limit the applicability of his horse-drawn mechanical reaper. Altho it will cut 10-15 acres in a day compared with human scythe operators at 1-2 acres, it required big, flat stone-less and regular fields to succeed (the adoption point was 46.5 acres & above). These were found in the open Midwest, not the east, so he moved his factory to Chicago, where it became the dominant force (& would later merge to create International Harvester, now Navistar) (pp.152-153).

[In Capitalism, Marketing is Essential & Even beats Superior Principle]="McCormick was a pioneer in the creation of new business techniques [marketing]. He made good use of field trials that pitted his reapers against those made by rivals...and offered special financial incentives to purchasers of his machines" (p.152).

[Synergy in Tech.] [one tech. may reinforce another] "The introduction of the mechanical reaper also coincided with other technical improvements in agriculture and with the extension of the rail system. Railroads were crucial to the growth of agriculture in the Midwest and West. Surplus grain was shipped by rail to the populated urban centers, and manufactured goods and

finished lumber were transported to the rural areas" (p.153). [both reaper & railroad facilitated Westward expansion, p.154].

[Selecting against a Technology]=not all technologies are selected, some are selected against, e.g., the abortive 1970s American titanium-aluminum Mach 3 SST. The sellers of the new tech. always tend to over-estimate the economic benefits (210-250 commercial aircraft, 50,000 jobs) [p.155]; whereas the competitive Anglo-French Mach 2.2 aluminum Concorde, which was actually built, merely yielded a handful of planes & proved uneconomic even at record fares; it was only kept flying out of national prestige and even then was just cancelled for good in October of 2003!

[the Soviet competitive TU-144 made its maiden flight at the same time as the Concorde, but could never be brought to production, p.156]

[The 1st Defeat for the Concept of Progress]

Concerns over the sonic booms & the damage such aircraft might do to the upper atmosphere were coupled with fiscal problems to force congress to cancel the project in 1971. "The proponents of the SST were surprised by the intensity and effectiveness of the public criticism of their pet program...[but]... the late 1960s and early 1970s were marked by both organized and spontaneous public protests over the war in Vietnam, civil rights issues, and the destruction of the environment. The SST symbolized big government [which was to bear 90% of the costs with the private companies only shouldering 10%] acting in behalf of big business and unbridled technology without regard for the rights and well-being of ordinary citizens...yet never in modern times had there been such a clear and concrete public challenge to the belief that technological change was progressive and inevitable...In reviewing the many reasons for the SST failure, one might well ask why the friends of supersonic travel were so oblivious to them. The answer is twofold. First, they were enthusiastic believers in technological progress. We had always built faster aircraft in the past and given the chance we would do so again, especially if the government was footing the bill. Second, they had not considered that the public, through articulate, concerned activists, would enter what they supposed would be a restricted debate. According to the prevailing rules, elites in business, the military, and the government should handle these matters" (pp.157-58).

Military Necessity="A concern for costs and adequate returns from an investment is overridden by urgent military necessity during wartime" (p.158) [i.e., here "necessity" should work, at least some of the time]

[From Tactical to Practical]="In the modern era, military imperatives have affected the selection of key technological innovations that eventually found a place in the civilian world" (p.158). e.g.:

1.) the "Peaceful Atom" "The scientific knowledge and technical expertise

that enabled the Manhattan Project to accomplish its military mission could, to an extent, be transferred to peacetime nuclear power production. The isolation of the uranium U-235 isotope, the one best suited for fission, presented a formidable technical barrier that was overcome by building very large and costly industrial plants for isotope separation. Uranium-235, originally employed as an explosive in the Hiroshima bomb, also served as a reactor fuel in postwar power plants. The world's first nuclear reactor, the graphite and uranium pile erected by Enrico Fermi at the University of Chicago in 1942, was built under the sponsorship of the Manhattan Project" (p.162). Other reactors produced plutonium, another bomb material (for hydrogen bombs).

2.) jet-propelled airplanes

3.) spacecraft

4.) radar

5.) computers [& computer networks=WWW]

6.) numerically-controlled machine tools

7.) miniaturized electronics (p.168)

[The Military Model for Industrialization]=> "For [some historians war]...is an essential element in the establishment of industrial capitalism. The latter argue that nineteenth-century industry modeled itself on the military using factories instead of barracks, laborers instead of soldiers, and corporate planning and strategy instead of military planning and strategy" (p.159)

The Association of the Military With Advanced Technology in the West=

"...is found in the Renaissance machine books, which portrayed fantastic engines of war. Somewhat later military demand for large quantities of standardized clothing, foodstuffs, and weaponry did prefigure...the creation of mass markets fed by mass production. The metal industry was often closely tied to weapon manufacturing, as was the explosives industry. And wartime profits did launch many new industrial enterprises" (p.159).

The Age of "Automobility" in the U.S.="...the beginnings of the age of automobility in the United States...[happened in]...1905, when the annual New York Automobile Show became the nation's largest industrial exhibit; [in] 1907, when the car was perceived by Americans to be a necessity; and [in] 1910, when 485,377 automobiles were registered in America making it the world leader in car ownership" (p.159).

Example #1=The Motor Truck=But in that same yr. only 10,123 trucks were registered [because of the competition with horse & wagon]."Motor trucks, in America and elsewhere, lagged behind automobiles" (p.159).

General "Black Jack" Pershing was the 1st to use trucks militarily in his fruitless

1916 pursuit of the Mexican raider Poncho Villa (who used horses). As leader of the U.S. Expeditionary Force entering France in 1917 he called for 50,000 more (in 1915 the U.S. Army had only had 1,000).

WWI Spurs Truck Development & Adoption="The battlefields of World War I served as proving grounds for truck engine, transmission, and body designs; military requirements helped to bring uniformity and standardization to truck manufacturing; wartime uses...demonstrated its dependability and adaptability; and government contracts financed the expansion of truck production facilities...In 1914 America's truck makers produced 24,900 units; four years later [in 1918 at the end of the War] their production figure was 227,250 units" (pp.160-61).

[Pork-Barrel Politics Aids Post-War Truck Production]="Despite enormous problems in the postwar years [of adjusting to the civilian market], American truck production thereafter never fell below the wartime record set in 1918, except for the economic depression year of 1921. National defense was invoked in the years immediately following the war to gain federal money for nationwide highway construction programs. General Pershing, in testimony before Congress (1921) argued that the country's defense depended upon a network of good roads, and a year later the Army produced the 'Pershing Map' showing the main arteries that were vital to American security in wartime. These so-called national defense roads conveniently coincided with the principal routes already designated by the states for incorporation in a federal-aid highway system...The Army's endorsement...aided the nascent motor-truck industry's attempt to become a major transporter of goods over long distances, in direct competition with the railroad" (p.161).

Example #2=Nuclear Power=[a direct outgrowth of the military] "Unlike the motor truck that was in existence before the Army made it popular in World War I, the nuclear power reactor was a direct outgrowth of the military uses of nuclear energy. America would not have a nuclear power industry today had the atomic bomb not been developed during World War II. Indeed, military necessity has been enormously influential in shaping international nuclear power production for nearly fifty years" (p.161).

[Forced Immigration in Tech. Transfer]="Hitler's rise to power in Germany during the 1930s forced some European and American scientists to conclude that the German dictator might be the first to manufacture an atomic bomb for military purposes...One of the key figures in the [defensive] promotion of the military aspects of nuclear energy was the Hungarian physicist Leo Szilard who had fled Hitler's Germany in 1933...

in October 1939 he drafted a letter to President Franklin D. Roosevelt, to be signed by Albert Einstein [another refugee from Germany], informing the American leader that recent developments in nuclear physics made it possible to

construct a new type of extremely powerful bomb."

[The First Giant Governmental Research Project]="Within three years of the Szilard-Einstein letter, the U.S. Army was given the responsibility for directing the Manhattan Project to create an atomic bomb [the largest governmental research program up to that time]...employing more than a hundred thousand men and women, spent over two billion dollars and eventually developed the bombs dropped on Hiroshima and Nagasaki (in August 1945)" [that ended the Pacific War] (pp.161-62).

[The "Great Man" Model, Critiqued under the "Titulary Inventor" Rubrick by Marxist-Influenced Historians--because it championed the heroic individual over the collective, is Sustained by Naval Atom Uses]=

"Whereas the Army was spending billions of dollars producing atomic weapons, the navy had not been given an opportunity to enter the atomic age. Once peace [after WWII] was declared, the navy, determined not to be bested by rival Army, turned its attention to nuclear energy as a means of propelling surface and underwater craft...Given its aims, the Navy was understandably far more concerned with reactor technology [as a source of power] than it was with the design of nuclear weapons ...Admiral Hyman G. Rickover...more than any other individual, can be credited with making that idea a reality. Moreover, the engineering decisions Rickover made as he developed his nuclear propulsion systems [where the principal problem was shielding the crew from the heat]...were to have an impact on the international nuclear power community. Rickover, an engineering officer who, in 1947, rose to head the Navy's nuclear submarine program" (p.164) & made the conservative & successful choice of light water (ordinary H₂O) cooling-the "Nautilus," the 1st nuclear submarine, was launched as scheduled in 1955, sailed around the world, breaking all records in the process.

[1st Working Prototype Fixes the Species-for good or ill]=A nuclear carrier scuttled by budgetary concerns diverted Rickover into a shore-based prototype (if he couldn't get the carrier, at least he could test its power plant, albeit on dry land!-p.164), the 1st civilian reactor (Westinghouse) to feed power into the grid on the Ohio River at Shippingport, PA, came on line in 1957 at 60 megawatts (& served as the prototype for all reactors, in the U.S. & those it sent abroad, for decades to come), p.165. of "...the nearly 350 reactors operating in the world, about 70 percent of them are of the light-water type" (p.166). But, being a hasty redesign of the naval unit, where efficiency was secondary to crew safety, it was the least efficient for land power generation & therefore not competitive against civilian coal-powered steam plants. In the late 50s a coal plant could produce electricity at six mills per kilowatt, whereas it took Shippingport some 64 mills! Efficiency improved, but after 30 yrs coal-fired plants are still cheaper, the

industry being saddled with a model doomed to forever remain uneconomical! (p.166). "The nuclear power industry was not born out of a desperate need of the electricity producers to find an alternative to [cheap & reliable, if environmentally dirty] traditional energy sources" (p.167). [Indeed, due to fears already present before 3 Mile Island in 1978, no new reactors have been commissioned since 1973 (& none have come on line since the ones in the pipeline were finished in 1976!).

All current reactor models are tied to the military, tho used for civilian power="At the time that the Shippingport plant was being planned, the Soviet Union, Great Britain, France, and Canada were developing reactors for electrical power production. These nations had different social institutions and political traditions, yet their power reactors were all closely tied to military programs. The Soviet reactor [very unreliable as Chernoble showed] was adapted from a naval propulsion unit [in imitation of the U.S.], the British and French models were based on reactors originally built to produce plutonium for bombs, and the Canadian reactor had been indirectly and heavily subsidized by the American government through its purchase of Canadian plutonium for the making of weapons. Without the pressure of military necessity, and its accompanying largess, there would be no nuclear power industry today" (p.167).

The Present Age is that of the "Warfare State"=In the second half of the twentieth century the distinction between the economic and military factors affecting the selection of technological novelties has been blurred. Earlier, the military was in ascendancy as a selecting agency only in wartime and during the preparation for war. At other times it made few demands on technology... After World War II came the Cold War, the arms race, the space race, and [now the War on Terror and] the belief that national security required an ever higher technological level of military [& security] preparedness. In the warfare state that now exists in the more powerful industrialized nations, innovations are constantly examined for their military potentiality and major industries are devoted exclusively to serving military markets. Many of the most exciting new technologies of the late twentieth century bear the stamp of their military origins...The extraordinary role played by the military in deterring technological choices makes our age unique in the history of technology. Never before have so many important innovations arisen and been developed largely because of their potential use in waging war ...From the perspective of the late twentieth century, it appears that the military's association with innovative technology may well be one of the hallmarks of our age" (p.168).