Basalla Chaps.1-5

Notes on Basalla Chap.1

Diversity=There are 1.5 million species of Flora & Fauna, as an imperfect analogy, in the U.S. alone more than 4.7 million patents have been issued since 1790, therefore tech. diversity is very high

e.g., Hammers, in 1867 Karl Marx was surprized to find that 500 different kinds of hammers alone were manufactured in Birmingham, England

Necessity=The traditional explanation for the diversity of the made world

But, "necessity" is more cultural than we think

e.g., Aesop's fable=the Western concept, a crow is dying of thirst, tries to drink from a tall pitcher, can't & then insight occurs & it drops nearby pebbles in the pitcher causing the water level to rise via Archimedes' principle & successfully gets a drink=**absolute necessity & "basic" needs**

e.g., the auto=we are told is absolutely necessary, but it's only a century old, Nikolaus A. Otto, a traveling salesman, devised his 4-stroke internal combustion engine in 1876 in Germany, thanks to no grave horse crisis; in fact, during its 1st decade of existence, 1895-1905, the auto was just a **toy** of the rich.

e.g., the truck=adopted even more slowly than the auto; WWI use of trucks was the result of intensive lobbying effort from the manufacturers

Post-hoc Need=(my term) for in both cases the need arose after, not before the invention; that is, "invention is the Mother of necessity" not "Necessity is the Mother of Invention" as the adage goes!

Utility=The other traditional explanation for artifactual diversity, but, again, utility for what purpose?

e.g., the wheel=the best candidate for necessity since it is listed as the most important invention since fire (in comic strips both attributed to the Stone Age, erroneously); fire is at least 1.5 million years old as an invention, the wheel only 5,000 years! Most people take the use of the wheel=civilization, a major index of progress; there is no wheel in nature. It came from sledges with smoothed logs as rollers. Basalla says appears in 4th millennium, first in Mesopotamia, then in Europe, but earliest evidence is from the steppes of Russia far to the north! 1st wheels were either solid or tripartite planks fastened with cleats. Oldest were god-cars (carry effigies of deities), important persons & in war (the 4-wheeled "battle wagon" & the two-wheeled "straddle car"=a

precursor of the chariot, both used for hurling javelins); by the 3rd millennium it had passed to India; the spoked wheel comes in the 2nd millennium for war chariots & also appears for the first time in Egypt & northern China; its use in transporting goods is 1,000 years after its invention, circa 2,400 B.C.! Wheel absent in all the rest of the world until recently & especially in the Amerindian New World. 1st appears there in Western Mexico from 300-1400 A.D. for toys or votive objects only & continued by Aztecs (may be diffusion from Asia?). He ascribes the wheels' lack to mountainous terrain (debatable) & lack of **draft animals** (agreed--only camelids in S.A., not Mesoamerica. & aren't draft animals); -from 350-650 A.D. the wheel actually disappeared from Near East & North Africa with the adoption of the camel over the bullock; only the Western Imperialists reintroduced the wheel there! There is a **Western bias** for the wheel because (I argue) it is an old Aryan invention! Basalla, in contrast, asserts that it was not until the late 19th & early 20th centuries that Western writers elevated the wheel. It is <u>not</u> a **necessity**!

Functionalist Fallacy=(my term);he critiques functionalist anthropologists who trace every aspect of culture to some basic need (e.g., Bronislaw Malinowski), but this has obvious diffiulties: art, religion, magic and science have tenuous connections to human survival. "a skysraper is not simply a structure to protect people from the vagaries of the weather"!

Biological Necessity=operates negatively; it determines what is impossible, <u>not</u> what is possible; his argument that we don't need any tech. to survive, like animals, however, is incorrect given the fossil record and our current anatomy. "[A]nimal tool behavior is so rudimentary and limited that it can scarcely be compared with the technology of the simplest of human cultures (false). There are no fire-using animals (true) nor are there animals that routinely fashion new tools (partly true), improve upon old tool designs (true), use tools to make other tools (true), or pass on accumulated technical knowledge to offspring (false)."-p.13

Alienation from Nature=(my term), Basalla approvingly quotes Karl Marx who asserted that "the worst human architect is superior to the best insect nest or hive builder because only humans are able to envision structures in their imagination before erecting them". -p. 13; this early Industrial Revolution worldview would contrast with modern

Biomemesis=imitate nature as the "master builder & inventor" "Production of the Superfluous"-José Ortega y Gasset=technology

Evolution=a metaphor (not just an ornament of rhetoric, "Metaphors or analogies are at the heart of all extended analytical and critical thought", not just poetic discourse). Basalla sees it as useful to apply this concept from organic evolution to evolution in technology.

Organic-Mechanical Analogies=(p.15) Initially these analogies flowed from technology to biology. Structures & processes in living organisms were described & explained in mechanical terms [the "mechanical metaphor", present since the Industrial Revolution & applied also to human society, as in "social forces", "social inertia", "social masses"]. In the middle of the 19th cen. the analogy went in the opposite direction [technology was described in organic terms, as in technical evolution embedded in the "Victorian Chronology" which began in the 18th century Enlightenment:

1748 A.D.=Montesquieu, The Spirit of the Laws, protoevolutionary (savages=hunters/barbarians= herdsmen, based on subsistence strategies)

1848 A.D.=The birth of modern "ARCHEOLOGY", the Dane C.J. Thomsen, "Victorian Chronology"

I: "Stone Age"

II: "The Bronze Age"

III: "The Iron Age" (human technology evolves), Copenhagen, 1st Natural History Museum

Social Darwinism=Herbert Spencer (nature "red in tooth & claw", Darwinian "reproductive fitness" was misunderstood as "power=physical might") & he noted a **teleology**, evolution went from:

a.) the simple to the complex

b.) the generalized to the specialized

(but evolution is adventitious; it has no "goal" except adaptation to current conditions; all goals can only be reconstructed **post-hoc**, except, perhaps, for cultural evolution & "apical choices" in a technological "style")

-The Birth of "**Science Fiction**" (the "organic metaphor" for tech. enters lit.) Samuel Butler (his novel Erewhon & essay "Darwin Among the Machines", machines developed like organic beings & rapidly evolving machines would supplant humans.

Developmental Sequences for Tools=General

General A. Lane-Fox Pitt-Rivers, who in 1852 assigned to test a new rifle, gradual

& progressive modification in weapons, traditional & otherwise, which he arranged formally into developmental sequences (typology)-classify & collect, the "Museum Approach".

The Marxist Perspective=S.C. Gilfillan, an American sociologist influenced by Marxism, in the 1930s battled the popular belief in "Titulary Inventors" like Leonardo da Vinci, to suggest inventions were inevitable and heros were cultural fabrications. Published a study of just ships.

-The problem was the steamship powered by paddles, which seemed to be a radical invention & break with the past-he emphasized continuity & traced it back to a Byzantine ship of the early 6th cen. A.D. that used oxen to turn a windlass connected to paddle wheels [but that was just precocious tech.]

The Cumulative Synthesis Approach: the economic historian Abbott P. Usher who used Gestalt psychology (the enemy of Marxism's tabula raza epistemology)-p.23:

1.) Perception of the Problem
2.) Setting the Stage (data collecting)
3.) Act of Insight
4.) Critical Revision

Basalla-Chap.2
PRECOCIOUS TECHNOLOGY

Continuity versus Discontinuity (Basalla)

Popular Culture=Belief in the "Heroic" ["Titular"] Inventor, e.g., Alexander Graham Bell & Telephone, Thomas A. Edison & the Electric Light, Henry Ford & the Assembly Line; a **conservative approach** featuring "Social Agency" & the importance of the individual

Scholarly Approach=Belief in the Role of Society, the "Anonymous" Inventor, e.g., metallurgy, a **liberal approach**, often rooted in Marxism, the "social mass", not the individual, "labor" not "work".

-but, these authorities cannot deal with Leonardo da Vinchi or with Tesla

The Philosophical Debate="Revolutions" in Science (the Thomas Kuhn approach), major **disjunctions** & **paradigmn shifts** (like Gould's "punctuated equilibrium" in evolutionary biology) versus the Karl Popper approach to slow, cumulative growth like Darwinian evolution & the "uniformitarianism" that came out of Lyell's new "pre-Diluvialist" geology.

Thomas Kuhn="The Structure of Scientific Revolutions". 1962

Edward W. Constant="The Origins of the Turbojet Revolution". 1980, again, tech. is modeled after science. But, while a turbojet appears to be a revolutionary idea, since no propeller was involved, the inventors were not part of the aeroengine community, & new theories (assumes technology=knowledge) from aerodynamics & thermodynamics were involved, it may have drawn on preëxistent ideas out of a 200 year-old history of water turnbines, turbine water pumps, steam turbines, internal combustion engine gas turbines, piston engine superchargers & turbo-superchargers (i.e., same principle, whatever their uses or energy sources, therefore "innovations" not "inventions").

130 B.C.- Hero of Alexandria-"aeolipile"=principle of "reaction" & heated gas expands [precocious gas turbine]

@1630 A.D.-Giovanni Branca-principle of "deflection"-a jet of steam spins wheel with blades shaped like water wheel [like Norwegian vertical water wheel]-steam boilers couldn't produce pressures

1883 A.D.-Charles Parson abandons work on gas turbine, shifts to steam, "atmospheric," low pressure engines moving piston not turbine blade

1884 A.D.-Charles Parson-"turbogenerator", 1st practical steam turbine

The Priority=Centrality of the Artifact=Basalla's principle, the goal is some novel tangible thing, not a delivered paper, publication or idea; it exists before the revolutionary act (theory). Humans think **haptically** (Eugene Ferguson's point about engineers & Carol Link's about the **act of making an artifact=an act of "communication" with raw materials).**

Science & Technology=the modern belief that technology is "applied science", but metallurgy came in at 6,000 B.C. just out of **iterative** learning, trial & error, & **play**; most metallurgical processes could only be understood "scientifically" (via chemistry) in the late 18th century & even today there are processes that defy chemical explication.

The Priority of Technology=my example from Hero of Alexandria & the Aeolipile, Greek materials science (technology) was not up to the levels of its speculative thought (science); other examples show the opposite.

Industrial Revolution=in textiles in 18th century had more to do with craft processes than with science (even in computer science the 1st computer was not the "Difference Engine" of the speculative science, Charles Babbage's Mechanical Computer; but Jacquard's loom which was the 1st to use punched-card input, which came out of the trades!

Case Studies in Continuity=

Stone Tools, 2.5 million in humans, existent as "chimp-ports" before that
-but this is debateable, his historic examples are better=

Eli Whitney & Cotton Gin=The problem was short staple Inland cotton; it took a slave 3 hrs. to produce 1 pound of cotton by hand, therefore cotton was not a major crop in the south until after Whitney; before it was rice & indigo. The occasion was trip of Whitney's to Georgia in 1793 heralded the "inspiration", but Basalla says the preëxistent artifact was the Indian charka-type of gin which was already in widespread use, therefore continuity; The B.C. Indian charka was used to process long staple, or Sea Island cotton, & that was limited in distribution, but Whitney must have known of it (it goes back to the even-earlier sugar cane roller press). The social context was a demand for cheap cotton cloth is a world dominated by wool & linnen-but is also required genius!

The "Titular" or "Heroic" inventor=James Watt & steam engine-fell asleep & dreamed based on steaming kettle (folklore). In actuality, there was the Newcomen steam engine already around (continuity again).

1712-Thomas Newcomen's working atmospheric steam engine, which utilized the condensation of steam to create a partial vacuum under a huge piston in a lever arm (a beam), as it was lowered a pump rod on the other end raised to its maximum height, then the steam condensed & weight of the pump drove the lever arm up for another cycle-used as a pump in coal mines

1763-Watt begins haptically, by repairing a studying a model Newcomen engine; he realized efficiency could be improved by keeping the piston hot, which he did by insulating it & condensing the steam in an adjacent cylinder kept cool; he abandoned the atmospheric "single-acting" Newcomen pump by applying steam to both ends of the piston to do work, a "double-acting" pump.

1784-James Watt's double-acting steam engine with a separate condensor, thought at the time to be revolutionary (and it was in terms of transport, if not in design).

Seminal Innovation=like the Steam Engine, spawns a whole set of "branching developments" like the railroad steam engine & the Stanley Steamer

1860-Jean Joseph Lenoir's (a Belgian) internal combustion engine, fueled by illuminating gas & based on double-acting steam engine based on explosions of mixture of fuel & hot air, produces **1st internal combustion engine** that, like Watt's, drives the piston on both ends

1876-This leads to Nikolaus Otto's refinement of the gas engine to produce the 4-cycle internal combustion engine!

Precocious/Canonical Tech., the latter because of "technological coherence", can be built upon by other tech. and/or science=turbojet ex. from Basalla by W.H. Constant

"The Inherited Prototype"; the "Seminal Machine"

What of the Role of Science? (the Electric Motor)

-Even tho electricity was revolutionary the machines that employed it were **evolutionary**

Discovery of electromagnetism by Hans Christian Oersted in 1820 stimulates American physicist Joseph Henry in 1831 even, in later machines, using a "piston" and "cylinders"!

Equally "analogical thinking" was present in brand new transistor! An "emitter" and

"collector" from vacuum tubes even tho no "emitting" or "collecting" were taking place!

Even whole new industries were patterned after existing industries, e.g.,

Edison's lighting system, 1882 establishment of 1st power station in NYC as a centralized facility feeding electricity for lighting to homes was based on private gas light industry feeding to houses via tubes underground (electric industry had to apply as "gas" industry since they were the only ones to get permission to bury cables under streets!), down to the power of weak yellowish light of 16 "candlepower" (note: atavistic like "horsepower")=12 watt bulb modeled after gas burner, and not after the public arc-light industry (consumers would need their own generating plant!)

Biomemesis (the Origin of the 1st thing made=the unbroken "chain" has to begin somewhere), e.g., "Barbed Wire", on "naturfacts" (p.50)

It could have been made much earlier (inventions not "inevitable"), possibly as early as the 1st wire-drawing machines in the Renaissance!

Instead, it occurred **simultaneously** in late 19th cen. America (1st fences based on English experience from the Old World=stone fences, wood fences or hedge-rows)

But, the movement into the prairies where none of these materials were available created a crisis of cost (in 1871 the combined cost of fences equaled the national debt!)

However, "Osage Orange", a short tree, did exist with its barbs & people grew it for hedge-rows, "living fences", but it grew slowly, could not be moved, cast shadows & formed refuges for "pest" species

1868-Michael Kelly's "thorny fence", straight wire with diamond sheet metal "thorns"

1873-DeKalb, Illinois County Fair, on the edge of the prairie, Henry Rose exhibited a primitve device of a strip of wood on smooth wire with brads, but this "inspired" Jacob Haish, a German-born lumberman, & two Americans independently, who formed separate companies within a year

The Role of Fantasy="Dream Tech.", e.g., Jonathan Swift in "Gulliver's Travels" of 1726, on an automated "Book-writing machine", based on children's alphabet blocks, recently introduced, but now set in square arrays operated by cranks with words glued on their surfaces--an act of satire, ridiculing notion that machines could emulate humans!

The Origins of the Discontinuous Argument (Evolutionary versus Revolutionary

ideas of Technical Development)

1.) lose memory of precursors (cars came from bicycles; Henry Ford called his car a "quadracycle" as the cart had earlier come from the travois, or drag-car!

2.) confuse tech. with its social consequences, as in the "Industrial "Revolution", seems to imply the tech. that made it up was revolutionary. Instead, it was evolutionary!

3.) the patent system promotes idea of single idea as property of a single creative individual; the concept of progress

4.) the "cult of the heroic inventor"=Samuel Smiles wrote books celebrating the lives of famous inventors in the Industrial Revolution Age, thus beginning the new genre (to add to artist's lives from the Renaissance)

5.) The 1st International Industrial Exhibits, like the British "Cystal Palace" Exhibit of 1851 promotes novelties

6.) nationalism, even Russia touted its own "inventor" of Edison's incandescent light bulb!

Notes on Basalla Chap.3

Why are some societies more innovative than others?

-U.S. currently issues 70,000 patents annually, others, like Tikopia, studied by Raymond Firth in the 1920s exhibit greater stasis

-Borrowing & "artifactual isomorphism", selecting a better material for a similar traditional artifact or artifact component, e.g., the Tikopia fitted Western steel carpenter planes into their traditional stone adzes

-Borrowing & a sub-class of the "transformed object", the "aesthetic transform", i.e., turning something that was technical (effective tech.) into affective art, e.g., the Tikopians shaped the handles of discarded toothbrushes into earrings!

"Homo faber"="Man the Maker", emphasizes the physical necessity argument,

"Homo ludens"="Man the Player" is utilized by Basalla instead, the "game" of innovation/invention/novelty (pleasure from solving puzzles, over-coming challenges, beating nature or human competitors", the role of make-believe, or fantasy:

Technological Dreams

-the proposals & dreams of the technological community, their propensity to "go beyond what is technically feasible"="The Technical Imperative" (Roe)

-this contradicts the "conventional depiction of the technologist as a rational, pragmatic, an unemotional person dominated by a utilitarian outlook" (p.67)

-Technological Extrapolations

consevative ventures well within the realm of possibility, just a step or two beyond current practice (imaginative exercizes or elegant variations [of "theme-and-variations"])

-e.g., the "Machine Books" of the Renaissance (1400-1600) published in Germany, France & Italy, hundreds of novel machines extrapolated from current practice; because of their entertainment function they were called Theatrum machinarum="Theater of Machines")=a clear case of novelty.

-most popular by the French military engineer, Agostino Ramelli, 110 water pumps alone! Not a product of necessity.

-Patents, better representations of technical potentiality rather than actuality; in 1869 only 10% of patents had practical potential, again, the rest are novelties;

market economic incentives don't explain them, "psychic rewards" do. They are "technological dreamers" (p.71)

-Technological Visions

-bold and fantastic, ideas that really push the envelope (but not a literary genre like science fiction); earliest date to the 15th century

-e.g., Conrad Kyeser's **Bellifortis**, fantastic war machines ["military enfatuation"] or Leonardo da Vinci's 1452-1519 unpublished (until the 19th century) personal notebooks, all "precocious tech." like flying machines & gliders, parachutes, helicopters, armored tanks, gigantic crossbows & catapults, multibarreled guns, a steam engine & steam-powered gun, paddle boats, diving suits, a self-propelled spring-powered wagon [in old age he deplored war]; never upscaled from models to prototypes!

-Impossible Machines

They can never be actualized because they violate fundamental scientific laws like:

-perpetual-motion machines, a self-rotating wheel as early as the Sanskrit treatise **Siddhanta Ciromani** (400-500 A.D.), reaching an apogee, again, in the Rennaissance (all closed-cycle operations)

-reached a peak in the 19th cen. as steam power became evident, would free industry from dependence upon imported raw materials & fuels (500 patents in energy-poor England from 1855-1903)!

-["cold fusion" in the U.S. as late as the end of the 20th century!]

-Popular Fantasies

of the public, outside of the technological community, can be traced back to the "precursor" Roger Bacon, the 13th cen. English philosopher who prophesied that large ships, without oars or sails, would navigate the oceans, or flying machines with beating wings like a birds that would fly thru the skys, or diving bells that would allow people to investigate the bottom of the seas! [technological prophesies]

-"unfindable objects", like the "staircase cycle", a bicycle for climbing stairs with "X"-shaped wheels!

-science fiction, from the 19th cen., Jules Verne's submarines, H.G. Wells's time machine or Carel Capek's robots

-[technological critiques], e.g., cartoons like Rube Goldberg who highlighted the absurdity of technological civilization that creates complex machines toward trivial ends & naively believes all human problems have a "technological fix"

-[Francis Hsu's (an American anthropologist) "externalization of affect"; rather than teaching people not to steal we put up surveillance cameras]

-popular science journalism (the concept of progress in Popular Science, Science and Mechanics, Mechanix Illustrated, Popular Mechanics (for the low-brow, Omni and Scientific American, Discover Magazine for high-brow readers

"Progress"

-[the concept of "progress" J.B. Bury & its relationship to the Western Linear Time conception

-widespread fantasization of technology is primarily a Western phenomenon [with the addition of modern Japan] & may be related to Western hegemony

-may exact hidden cultural costs, e.g., enthusiasts of nuclear energy as a fantasized solution to energy problems, may persuade governments & the public to embark without a full consideration of its problems [waste storage]

Technology Transfer

-Borrowing, or "diffusion", is a cultural universal, no society completely isolated & self-sufficient

-cultural contact via:

a.) Exploration

1543 3 Portuguese Adventurers bring 2 matchlocks=arquebuses with them

1560 Japanese matchlocks used routinely in the field

1575 Matchlocks prove decisive in the great battle of Nagashino

b.) Trade

Legal exportation of tech. In 1748 no steam engines operated in America, altho they were common in England; When Colonel John Schuyler of New Jersey wanted to drain water from his copper mines he contacted the Hornblowers, an experienced family of English mechanics who sent a son with the machine, thus inaugurating the Age of Steam in the USA by 1755. Similar mechanics went all over Europe, including Russia & Italy, two of the least advanced regions technologically; Development & Commercialization can be Undertaken by a country that lacks the industrial and scientific base to originate an item of

technology, e.g.,

-the Japanese legal purchase of the rights to the transistor from Western Electric to transform Tokyo Telecommunica-tions into SONY with the birth of the small transistor radio in 1955 (Americans concentrated on the pure science, developing better & different kinds of transistors for the military market while commercial companies were reluctant to adopt the new technology because it would compete with their vacumum tube sales [& they needed to be replaced often due to heat failure, making them lucrative] & thus lost the market)

-Illegal exportation of tech. English traders illegally exported textile tech. to America; to protect its industry England had made exportation of machines & plans illegal by 1781; in 1783 several machines are smuggled to Philadelphia, but no one could be found to assemble them & they had to be shipped back! Early machines (up to 1812) had no "manuals" nor were they even pictured or drawn! This hampered trans-mission as they needed the experienced mechanic to go along with the machine, assemble it, and teach locals to use & repair it. (the role of "practical knowledge")

c.) Travel & "Environmental Influences" to spur Innovation:

-First settlers to New World in 1600s brought with them axes from Germany & Britain, both of which lacked "polls"=the counter-balanced mass on the back of the haft; they were suitable for shaping timbers but not felling the huge trees of American virgin forests, by 1715 the first hint of a poll appeared & by 1780s it was fully developed; by 1863 one manufacturer listed 13 kinds of axes! All save 2 are gone today, axes being replaced by chain saws

-or, the classic flat-bottomed American steamboat from deep-hulled, keeled English protoytpes by 1850.

-or, the American steam locomotive that defeated the river steamboat; the 1st one imported from England in 1829, resulting in the unique American "leading truck"; the English had rigid driving wheels because they had a

smaller country & therefore could prepare the track better, with straighter runs, tunnels & bridges that did not require those wheeels to turn; the rougher American steep hills, sharp curves & low-cost crude track made it necessary to have a forward set of turning wheels on its independently-turning truck [also, immense distances eventually produced some of the largest & most powerful steam locomotives in the world], or, modern car (micro cars in Europe & Japan, not in USA)

Relation of Technology to Science (often over-emphasized in Basalla's views):

(1.) Connection between the 2 is complex & seldom hierarchical

(2.) Science that spurs tech. need not be the latest or the purest

(3.) Science dictates the limits of the artifact's physical possibilities, but not its physical form

-The atmospheric steam engine (vacuum not part of tech. traditions, but of speculative science of pneumatics); a French scientist Denis Papin @ 1700, also a skilled mechanic who built his own devices. He discovered the atmospheric steam engine & predicted several uses, like draining mines, but did not implement it; the working-class ironmonger of little education, Thomas Newcomen of Dartmouth, England, was more successful precisely because of his lack of education & his trade contacts! He probably indirectly heard of Papin's discoveries & made a real workable machine from a simple lab apparatus (not a mere translation of theory into practice=both equal; his pivoting beam was original)

Eugene Ferguson's theory of non-verbal "visual thinking" that characterizes the innovative stage of engineering (+ models)

-Marconi's 1st true radio, of little formal education, and far inferior in his knowledge of physics than Maxwell, Hertz & other scientists, he was obsessed simply with getting better range, highly empirical by tinkering with antenna design, with the help of wealthy British relatives he founded the Wireless Telegraph & Signal Company in 1897 after having moved to England; first sold to British army & navy, technology went in <u>advance</u> of science

Importance of "intermediaries"

-Papin was close to those scientists doing pure pneumatic research, yet his wider experiences & abilities led him to a successful lab apparatus,

that, in turn, inspired the mechanic Newcomen (more so than were pure scientists like Torricelli)

-Hertz turns Maxwell's pure theory into electromagnetic transmission into a lab demonstration, where Marconi completes the process as a marketing and empirical system [chains of communication]

d.) War

e.) Migration (voluntary or forced)

1685 Louis XIV revokes the Edict of Nantes, ending a century of limited religious tolerance in France; the French Huguenots (Protestants), many of whom were skilled craftsmen, were forced to migrate to England, Ireland, Holland, Germany & Switzerland; transferring tech. in the textile business (silks, velvets & laces, and in related apparel=hats, stockings, ribbons & gloves) + they improved the technology of fine papers & blown & cast plate glass

f.) Missionization*

g.) Technology Missions*

h.) Industrial Espionage

Silk industry in England dates to arrival of the French Huguenots, but the English were still hampered by irregular hand-thrown thread & needed to copy superior water-powered machine-thrown Italian thread to make more regular cloth, <u>but</u> the latter had turned that into a state secret; they even permitted a book illustration of their machine, but so much was not (and could not be) conveyed in the drawing that the secret was safe until 1715 when a mechanic was sent to Italy to secretly observe the machine in operation and learn its secrets! Modern companies make employees sign "restrictive covenants"; the recent case of 3 Chinese who worked for Argilent exporting to China new phone patching software!

i.) Intellectual Property Infringement*

j.) Imperialism 1740-1947, the 200 year rule of the British rule of India (the role of steamship & railroad)

1801 Age of steam propulsion in England begins with the steam tuboat "Charlotte Dundas"

1819 1st steamboat in India, a small British-built pleasure craft for an Indian prince

1824 River steamboats proved decisive in defeating Burmese in the Anglo-Burmese War

1840 Ganges steamers built but local level of income so low that it could not generate sufficient revenue & service curtailed, nevertheless, steamboats were a potent symbol of English might (magical tech.=they sailed upriver without use of sails or oars, as if by magic!)

Railroad in India=1 of the largest tech. projects by any Colonial power

1845 Huge source of funds invested, 95 million pounds sterling from this date to 1875 alone!

1863 2,500 miles of track by this date

1936 43,000 miles by this date, the 4th largest system in the world! It was accompanied by a telegraph system, very important in transfering information (paradoxically, India exposed to Western tech. earliest [25 years before Japanese railroad], but utilized it less)

1947 Indian independence (industrialization lags due to the utilization of a socialist model, until nearly the present)

Notes on Basalla Chap. 4

(*) indicates ideas or examples not mentioned by Basalla, but which pertain

Socioeconomic explanations, currently based on the pervasive use of Marxism in technology studies, cannot be exhaustive & so broad-based cultural explanations must be included

"Variation is inevitable in the made-world", in the quoted words of the American anthropologist Homer Barnett, "All imitation must entail some discrepancy", even manufactured items. By themselves random, they can become guided by intent as artisans see their consequences & capitalize on them.

A "random-walk", like "genetic drift"*, can explain divergent technological evolution as the anthropologist Richard Anderson has argued-yet another parallel between biological & technical evolution

George C. Homans, an American sociologist, divided innovators into 3 classes based on ability & economic position: (1.) the highest class innovates because they want to maintain their position of superiority, (2.) the middle ranks of mediocre producers tend to be conservative since their violation of traditional mores can lead to their fall, especially considering their limited abilities. These journeyman producers tend to be in the majority, hence the resistance to large-scale innovation in traditional societies, (3.) and the lower ranks, economically so marginal that they have nothing to lose, and hence can innovate with impunity. Ashanti woodcarvers are an example: the highest stay within the confines of the style for the "internal market", the middle produce copies and the lowest branch out into other styles (of neighboring tribals or even primitivist "fantasy" carving of interest to Westerners (external styles, external markets)

Removal of Economic Risk=In Latin American folk (peasant, not tribal) production, when owners of a studio remove all risk by providing a salary regardless, potters become quite receptive to innovation, answering novel requests from shops and others.

Skeuomorphs="An element of design or structure that serves little or no purpose in the artifact fashioned from the new material but was essential to the object made from the original material". We have cited the photo-laminate fake "walnut" on the modern foam dashboard as an example; it is the skeuomorph of a time when the only cheap material to mount guages in was wood!

Basalla cites the dentil, the ends of wooden roof joists were transformed into stone when the Greeks shifted to marble architecture, producing the ornamental spaced reflief cubes under the eaves of the roof of a Greek-style stone building; the ancient Egyptians did the same thing. The "ribs" in their columns came from the bundles of totora reeds that composed their original reed columns, but now carved in stone! This is a case of "**technological atavism***"=Humans innovate something new by looking backward; treating stone as a new kind of reed, not for its totally new aspects of "inherent perfectability of form" that a new material would yield. That is only discovered later.

Design (reconciling form with function) can be divided into 2 types by the design theorist Christopher Alexander: (a.) **unselfconscious design**, that of traditional societies whereby generations of artisans keep refining a design with little thought of self, (b.) **selfconscious design**, the modern process whereby self-aggrandizing designers spend a short time, aided by information technology like CAD/CAM design, to generate fashionable, but not very functional items.

Traditional/Modern Solutions*=this means that the objects refined by many generations of artisans tends to respect the "inherent perfectability of form" of the raw material and enter into more of a dialog with the raw material, modifying intent accordingly, whereas a modern designer engages in a monlogue, making the object transparently reflect his intent, because he wants the resultant object to be clearly "his" (a "signature" creation).

Basalla=This means that, **given their level of technology and avaiable materials**, it is hard to improve on traditional design (tho this does not mean they are perfect), while 5 minutes spent will usually allow one to improve on a mass-produced item!

The Capitalist Revolution (1830-)=the first society to commit itself to change, not stasis, via the doctrine of "Progress" and unceasing (nay, geometrically accelerating) technological change. The invention of the modern Corporation as an "artifical legal person" diverted the onus of responsibilty for debts or damages from the members of the Mercantilist Joint-Stock Company to the Corporation. Secondly, it emancipated control from the élite classes to the merchant class itself, the bourgeois.

Machines to Combat a Militant Proletariat=Along with the Industrial Revolution came a "working class" of unskilled factory workers apart from peasants & traditional artisans. The machines, however, were 1st used against the

artisans.

Technological Unemployment=New technology causes the unemployment of old skilled hand-workers by machines, for the benefit of capitalists & consumers, but at the loss of craft.

E.g., The "Automatic Spinning Mule"= Early non-automatic mules were used to spin cotton thread but required highly skilled "spinners", who only accounted for 10% of the work force at a mill, but were essential. Therefore, they bargined for quasi-managerial positions & salaries & used strikes to obtain them. Mill owners resented this & sought help of inventors like Richard Roberts, the 1st to complete a successful machine after the catalyst of a 3 month strike at the mills at Hyde. Such machines "controlled" the spinners & phased them out.

E.g., The "cylinder Printing Machines". Before "printers", an old craft union, used square wood blocks to print designs on calico, very labor-intensive, production=slow. After a series of 18th cen. strikes a cylindrical metal roller automated the printing process, the printers losing their power & employment.

E.g., The mechanization of wool combing; before wool can be spun into thread, its tangled fibers had to be aligned in parallel strands; done traditionally by "wool combers", an old trade union, using heated combs & skill. They were noted for militancy; acts of paliament passed to curb their influence beginning early in the 18th cen., by 1850 machines were perfected, egged on by strikes in 1820s-1830s. The combers begin to decline.

Heightened Commercial Activity=>Increased Innovation=A contributing factor during this time since excess profits can be spent on tech.

Scarcity=>Efficiency in Raw Material Usage=Caused by tech. innovation, ex., in 20th cen. coal more expensive for electricity production, efficiency of steam generating plants went up from 7Lbs=>1kilowatt hr in 1900 to .9Lbs in 1960! Same for fuel efficiency in cars after 1970s Gas Shortage! The latter, in part, a response to **Governmental Mandate**

Artifical Scarcity=>Increased Efficiency=That scarcity was a result of OPEC's cartel slow-down to drive up prices; Public & Governmental pressures on Nuclear Energy; no new construction since @1970, yet the production of energy from nuclear plants has been accelerating! A result of increased efficiency in the plants themselves.

The "Narcotic" of Raw Material Availability*=A parallel development that **depresses** innovation in countries with excess raw materials that <u>produce</u>

them, in contrast to the above, which deals with consumption. An ex. is the Middle east, where incomes have been going down in Muslim countries like Saudi Arabia, leading to militancy, as industry & technology are ignored in response to easy money from oil. The same can be said, at a more moderate level, for the U.S., which has many resources, albeit declining in oil, regarding low efficiency vehicular design (SUVs & Trucks) compared with energy/raw materials poor Europeans & Japanese!

Scarcity=>Outright Substitution=Brand new materials (synthetics) are developed when scarcity ("natural" due to resource exhaustion or "artificial" produced by boycott or war).

E.g., Coal replaces wood as a fuel in England due to laws, as early as 16th cen., protecting wood (English oak=much required for navy); in charcoal form was used to produce iron, the substitution of coal led directly to many innovations in iron-working & the industrial revolution in general!

E.g., Artificial rubber from natural rubber* In WWII, as the japanese took the British & Dutch rubber plantations of SE Asia, US led to invent synthetic rubber

Economic Inducements to Innovation (Market Demand)=Jacob Schmookler, "Invention and Economic Growth", argues innovations come from (a.) the "push" of accumulated knowledge=supply side, and (b.) the "pull" of market demand. He syas the market is the most powerful factor, using # of patents issued (only 50% of all patents will have commercial potential). He looked at **capital goods**=goods that produce others like machine tools, buildings, transporters & the rate of **capital investment**, the hope of monetary reward, are statistically correlated. The general fund of knowledge is important, but for accelerating overall trends, not specific innovations or inventions. But, a time-lag occurs, between high investment & high # of novelty due to the experimental phase. Note, he didn't cover **consumer goods** like audio-visual or cars, a high % of modern post-industrial economies.

Economic Inducements to Innovation (Labor Scarcity)=That a scarcity of labor leads to labor-saving machines (which can also cover the "artificial scarcity" of strikes*) was 1st articulated by John R. Hicks in 1932, based on mid-19th cen. comparisons of tech. in U.S. versus Europe (higher novelty in US a product of labor scarcity in a young & expanding country), & in Europe (in comparison to Asia) or to Empires in antiquity*

"World Expositions", like the one in England in 1851, provided a forum to glorify, & hence promote, novelty*, & showcased the "**American System of**

Manufacturing" that economized on labor, in contrast to England's then superior, but old-fashioned, style. It used a series of special-purpose machines used in series to make the components of manufactured items.

E.g., the "Blanchard Lathe" of 1820 that made copies of irregularly-shaped wooden objects, like gun stocks (general purpose machine-tools, like lathes, drill-presses [m-t brought to raw material] & planer-shapers [raw material brought to m-t] had been invented in England, but Americans innovated "special-purpose", "sequentially-arranged" machine-tools (precursor of the "assembly-line")* + more complex turret lathes & milling machines

The Role of the Gun-note the example above was for gun stocks, this led to increased emphasis on "standardized" & "interchangeable parts" used by US armorys, then spread to civilian tech. like sewing machines, typewriters, bicycles, etc.="Military=>Civilian" cycle

Abundance of land+private ownership of land=Scarcity of labor (in 1st 1/2 of 19th cen. in America) where ag. production was high & profits went directly to farmers who owned & worked their own land. Industry thus forced to offer salaries commensurate with those obtainable in agriculture (up to WWII America was agrarian)=high-priced labor=>adoption of labor-saving machines. Farmers, also, bought labor-saving machines to allow them to cultivate more land [the McCormick Reaper] for same reason, help was hard to find (why work for someone when you could own your own land?)! Not so in England where land was scarce & labor cheap.

"Elasticity" of Labor=Less elastic in America, Industry found it difficult to get additional labor when it was needed (concentration/sparseness [how geographically dispersed, widely in US] + attraction (for wages or opportunity) + mobility [costly transportation]); with concentrated (poor) labor surplus & cheap transport [railways]=more elastic in England, thus less innovation

18th Cen. England=Start of Industrial Revolution, a time of greater dearness of labor (lower population) + less elasticity before railroad net, produced labor-saving devices, thus starting the revolution. By 1840 the locus of the Industrial Revolution had shifted to the US (English complaining that all new innovations come from abroad), which repeated this pattern in 19th cen.!

Skilled/Unskilled Labor=Skilled are "machine makers", unskilled are "machine tenders", - skilled labor, no machines. Skilled more expensive than unskilled in both US & England, but due to labor scarcity in US, that raised unskilled workers' wages more rapidly than it did for skilled workers, thereby making

the unskilled "scarce", while the skilled were relatively plentiful. Thus when demand rose there were enough skilled workers working at wages sufficient for them to invent machines to replace the scarce unskilled laborers!

Expensive, Inelastic, Unskilled labor Scarcity=>entrepreneurs + available capital=replace unskilled with "capital intensive" machines in 19th cen.

Economic ("Business") Cycle & Novelty=In times of economic expansion ("Bull Market"=high investment=capital cheap & available, interest rates high, labor elastic, skilled & expensive [supply of unskilled labor=low]), the relative abundance of skilled labor=>makes it reasonable for entrepreneurs to invest in capital-intensive, labor-saving machines/ the opposite for times of business contraction=recession, depression="Bear Market"=low investment=capital expensive & scarce, interest rates low, labor inelastic (nobody can afford to move), unskilled & cheap (unemployment high), machines not invested in (-stocks + bonds). This poises no threat in US where unskilled labor was scarce & did not resist new machines, but it did in England, where surplus workers emigrated or opposed the machine via strikes & machine-destruction (Ludditism)

"Industrial Cycle" & Novelty*=Agrarian (peasant)=3rd World=> Manufacturing (Industrialization of cheap & elastic unskilled labor)=>

Increased education=>skilled labor, less elastic + more expensive=> 1st world "information & service economies"=>"hollowing-out" of industries, exportation of unskilled jobs & manufacturing abroad=> increasing inter-dependence of economies=>World System

Slave Economies Show Lowest Rates of Novelty*=A corollary, as historians have argued for the Roman Empire (especially its populous south, around the Mediterranean, versus the labor-short northern frontier--e.g., ox-driven threshing machines in Gaul, not Italy!).

Indentured Labor (Share-Cropper) Economies Next Lowest Rates of Novelty*-like the American South after the civil war, or in Ireland

Monetary Rewards=Western societies, for last 400 yrs have used first (a.) "money prizes", since the Middle Ages, and then "patent protection" to spur novelty. The 1st is good for the early, primitive state of a tech., like the Kremer Prize, since they can be directed at a specific problem (e.g., man-powered flight="**dream tech**"), spuring a solution by dramatizing its urgency, but do not ensure security for innovator, hence are less useful for generally stimulating tech. ingenuity. (b.) Patent Office & patent Law, the intervention of the state, to foster general tech. ingenuity by protecting innovator, his

"intellectual property" & resultant income. In 1790, based on the English system, the US institutes the patent system, no longer at the whim of a Monarch, but shaped by democratic & industrial forces. But while it is assumed that patents lead to economic growth, the 2 are not closely correlated; since 1930 in US the GNP (Gross National Product=All Goods & Services Produced Nationally & Internationally by an Economy/GDP=Gross Domestic product, only in US) has maintained a lead over patent frequency.

Corporate versus Private Ownership of Patents=1 big reason why the 2 don't correlate is that most patents no longer go to the individual inventor but to the corporation that employs him, therefore the incentive to create & exploit it is no longer there, & the corporation can now become a monopoly thru patent control & manipulation, thus quashing novelty (i.e., tech. receives a "H.I.T."*). originally the 17 year monopoloy was there to protect the individual while he got his product to market, now it is used by corporations to stifle the competition of rivals & encroach upon their rival's monopolies, given more & more employment to lawyers to settle the resulting disputes, not inventors. Lawyers are a singularly non-productive segment of the economy, highly rewarded via prestige, money & political access, but non-productive in terms of innovation; the more lawyers an economy has, the more it falters in the production of wealth.

Industrial Research Laboratories=1st established in the late 19th cen. (&* now increasingly abandoned, Bell Labs created many technologies, but failed to capitalize on them; its dead, replaced by the independent & competitive "Lucent technologies" Corporation).

1st research labs were organized in Germany in 1870s-80s by synthetic dye manufacturers, also the 1st time when "technology becomes applied science!"

1st one in US was the private one of a key individual inventor, Thomas A. Edison's private lab at Menlo park, New Jersey in 1876, associated with the incandescent light bulb, later made corporate by General Electric, the successor company in 1901. In 1902 DuPont followed suit as did the Parke-Davis pharmaceutical company, bell Labs in 1911 & eastman Kodak in 1913 (within 20 yrs there were over 500; now there are 11,000!).

"Offensive" versus "Defensive" patents=The "patent shield" of 1,000s of little defensive patents to forestall a rival's developments & to be held, not developed, as "counters" destined to be bargined away in other strategic market decisions, is a very conservative approach to patents adopted increasingly over time, replacing the earlier "offensive" use of patents to stake

a claim to explore new directions. This is why early Research Labs were more successful than their later incarnations!

"Non-technological Reasons for research Labs"=(1.) Maintained to bring an "aura" of science & prestige to a firm, (2.) To keep fresh scientific talent on tap within the corporate structure, (3.) To erect a bulwark against change & secure monopolies to markets by defeating competition.

Scale of Corporation=Only big companies can afford Research labs, & they tend to be precisely the least flexible & prone to explore new technologies/small companies & individuals innovate more; where big companies lead in exploration it tends to be in new domains of science such as genetic engineering or pharmaceuticals, & not in "mature techj. like cars.

Of 70 of the most important inventions of 1st 1/2 of 20th cen., more than 1/2 were produced, not by Research Labs with all their resources, but by individual inventors! Research Labs are not the "Invention Factories" (whether in industry, government or universities) that their advocates assert they are.

The Priority of Cultural Explanations=Mono-cultural historical or sociological studies of novelty in the west have tended to stress economic factors (*probably because of our materistic bent since the late Middle Ages), Basalla is unique, as a historian, to consider cross-cultural (comparative) cultural factors in creativity (p.129) "Discussing economic and institutional incentives to innovation is much easier than dealing with the connections between cultural attitudes and values and artifactual change. Although such connections may appear to be vague and tenuous when compared with the arguments emanating from the economist's camp, they are more useful in explaining why entire societies vigorously engage in technologically innovative activity over long periods of time. The cultural approach is especially relevant to understanding Western domination of the production of technological novelties for the past five hundred years".

Western Preoccupation with tech. (p.124)="No other cultures have been as preoccupied with the cultivation, production, diffusion, and legal control of new machines, tools, devices, and processes as western culture has been since the eighteenth century". Note* the association of this beginning with the Enlightenment, the beginning of rationalism and the triumph over the "Savage Mind" of the sacred (closed) world view, but it goes back even further to the Renaissance of the 15th century!

The Renaissance & the Origin of the "Cult of the Titular Inventor"*=(p.129)

"As is the case in so many other aspects of modern life, Renaissance culture appears to mark the turning point in attitudes toward the technological innovator".

Why, of all Western cultures, is the US so preoccupied with Tech. since 1830s?

Non-Economic (Ideological & Social) Reasons for Novelty=Of course, all these economic arguments don't explain all novelty, ideological aspects such as American values of "personal autonomy"*, "cultural [national identity] assimilation"* & "manifest destiny", as well as social reasons such as mass emigration & migration=>multi-ethnic societies=>"melting pot" (if only 2 big ethnic blocks, like Guyana, that produces a "Plural Society" harmful to tech. growth via cooperation & shared markets)

Why is Islam, now a Non-Western culture (since the 15th cen.) a non-techno-logical society? (p.131) "In the Muslim tradition, innovation or novelty is automatically assumed to be evil until it can be proved otherwise and applies to innovations made by believers in Islam as well as those imported from other cultures. The Arabic word bid'a has the double meaning of 'novelty' and 'heresy'. The worst kind of bid'a is the imitation of the ways of the infidel for as the Prophet has warned: 'whoever imitates a people becomes one of them'."

This(*) leads to situations in Sunni societies, like Saudi Arabia & Pakistan (among the Taliban), where the only education people get in Madrasas, religious schools funded by the Saudis, is a Koranic education by rote, thus ensuring high unemployment among young men who are technically unsuitable for the 21st century, who then fall prey to fundamentalism!

Progress=human history does not follow a cyclical or a declining trajectory (from a lost "Golden Age", "historical **devolution**"*), but ever upward, uniquely Western as of the 17th cen. Via "instrumentation"* ("rulers" versus "guages") on micro-macro scales=microscope & telescope, with the latter discovered new stars (Novum), which the Biblical world-view declared immutable. Therefore, everything is new thru science, can control nature. The Greeks & Romans had not known of the compass or gunpowder, therefore the present is superior to the past, especially philosophy, the "science" of the ancients, became replaced by modern science. Inventions now became proof of the "improvement of humankind".

The Conquest of Nature=(p.132) "The domination of nature joined novelty and progress to form a triad of ideas that emerged in the culture of Renaissance Europe and became instrumental in stimulating techno-logical change". But it

is much older.

The English Historian of Technology, Lynn White, Jr., traces it back to biblical myth from Genesis (1:26-30); God made humans in his image & then gave them "dominion" over nature (every plant & animal) & commanded them to "subdue" the earth & fill it with their progeny. In the "Desert Religions"* God thus established a hierarchy, unlike Eastern & new World religions where nature & humans coexisted on equal terms. White believes that the cultural preoccupation with technology 1st seen in the Middle Ages stems from this notion that the domination of nature was sanctioned by religion & thus a form of worship, i.e., an institution that "facilitates worship".

a.) A double-edged sword(*): leads to objectification of nature=science & technology, why we are successful

b.) but also leads to ecological disaster, 1st recognized in 1960s by the beginning of environmentalism

c.) versus animists "praying to the trees" & "Master of Animals" ("primitive ecology")

Basalla, Chap. 5

"Excess of Novelty"=American locomotive smokstack 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)

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