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INTRODUCTORY THEORY AND OVERVIEW[1]

Prior reading

Winner, Langdon (1986). *The whale and the reactor: A search for limits in an age of high technology.* Chicago and London: The University of Chicago Press. Preface, ix-xi; Chapter 1 "Technologies as forms of life"
Teich, Albert H. ed. (1997). *Technology and the future*. 7th. ed. New York: St. Martin's Press. Preface iii-viii; Thinking about technology, 1-2.; Corlann Gee Bush "Women and the assessment of technology." p.157-179.

Why a course on Technology in Society?

Let Bill Gates, President and CEO of Microsoft, offer an answer:

"I think this is a wonderful time to be alive. There have never been so many opportunities to do things that were impossible before. It's also the best time ever to start new companies, advance sciences such as medicine that improve the quality of life, and stay in touch with friends and relatives. It's important that both the good and the bad points of technological advances be discussed broadly so that society as a whole, rather than just technologists, can guide its direction."[2]

In this introductory chapter I lay out the key theoretical issues and, in the section headed "Problematique", some of the key practical issues, raised in studies within the broad field of "Science, Technology and Society". The most important issues, such as the debate on determinism, the criterion of efficiency, the idea of technology as a system, and many others, have separate chapters devoted to them (the names of the chapters are indicated in distinctive type) and therefore receive only brief mention here. The reader should bear this in mind and not conclude that the lines devoted to a topic in this chapter are proportional to its importance: indeed, the reverse is nearer the truth.

The title "Technology in Contemporary Society" is purposely rather vague because the content has evolved over a period of years, and continues to evolve. The meanings of both "technology" and "society" are themselves very fluid. A separate chapter (What is technology?)is devoted to the various meanings of the term "technology".

"Society" is so contentious a term that some neo-conservative politicians such as Margaret Thatcher have even denied its existence ("There is no such thing as society, only families and people."[3]). A 1992 Encyclopedia of Sociology[4] has no entry for "society" as such. I shall expand on the topic of Society in the section headed "Technology and Social Structure".

For the time being, let us assume that *technology* refers to the application of rationally derived means to control matter and energy for practical ends and that *society* refers to the structured interaction of human populations sharing a common existence in time and space.

"Technology in Contemporary Society" addresses the set of problems (see "problematique" below) centered around the reciprocal relations between technological change on the one hand and individuals, societal structure (with an emphasis on relations of power), and culture on the other hand. By "reciprocal relations" I refer to the way in which individuals, institutions and culture determine the form taken by technological change and the consequent effects, impacts and influences that technological change exerts upon those entities. (See the chapters on Determinism, Technological Change, Innovation and Trajectory.)

One purpose of the lectures is to heighten awareness of some of the more important practical and moral issues facing us today - especially those which seem to arise out of very rapid technological change. Too many people walk through our technological world as if they were asleep - as somnambulists. Given time, human beings can probably adapt to almost any technological regime. But that raises some very important questions. Do we *have* the time? *Should* we adapt to technology or would it be better to make technology adapt to us? Do we, for that matter, have that choice? And can nature adapt, or will certain technological regimes destroy it? The answers are not self-evident and for that very reason they generate passionate debate.

The essence of technology

Rather than expound the formal problems concerned with definitions of technology, it is appropriate, at the outset of our study of Technology in Society, to try to capture its essence in a few words. By "essence" I mean those properties that are intrinsic and indispensable as opposed to coincidental or accidental.

In essence, technology is a system dedicated to the mastery of nature through the mediation of devices which -- albeit with ambivalent results -- extend and amplify the powers of humankind. ***Technology is a universal amplifier.***

Explanatory notes for the idea of "essence".

We find the idea of technology as a **system** already implicit in the German philosopher Martin Heidegger's word "Gestell" (1954)[5] which he used to describe the essence of "Technik". . It was made explicit in Jacques Ellul's "Le système technicien" (Paris, 1977). I insist however that technology cannot be divorced from economics and, whether or not I enunciate the whole phrase, it may be assumed that I am always talking about "The Techno-Economic System". Of course technology is also embedded in a broader social system of which economics is a part. I expand on this in the section "Technology in Society". How one classifies the systems and subsystems is a matter of perspective[6], or "the way we look at things". No one way is "correct".

The **mastery of nature** is the overt or covert purpose of technology. It can be done gently or harshly but the end result is always to transform the world of nature into the world of artifice. The essence of technology, said Heidegger, is that it confronts every aspect of the world as a resource or "standing reserve" as the word *Bestand* is usually translated.[7] Technology harnesses the Faustian Spirit "to bring to fruit the most exalted plans". The story of Faust that we associate with the Faustian Spirit is that told by Johann Wolfgang von Goethe, Germany's greatest poet. In Act IV of Part II of Faust the protagonist makes plans to reclaim land from the sea in an ambitious megaproject. (see discussion in The Technic Frame of Mind).

The **mediation** of devices, which are interposed between the human operator and the object of his work, is an essential aspect of technology. Every technological device from a spear to a computer is a medium. So are other expressions of "technique" in the broad sense used by Ellul (See Chapter What is technology); language would be a prime example. Media both distance and transform or refract our experience of the world. Marshall McLuhan made this concept a commonplace with his *Understanding Media: The Extensions of Man* (1964[8]) and thus founded what has come to be called "medium theory"[9]

Mediation can be either deliberate or unconscious. The idea is readily grasped from an example of deliberate mediation - the Claude Glass[10]. This was a wallet-sized mirror held up at special vantage points by 18th Century aspiring artists and tourists to reflect the perfect scene. With their backs to the view they would paint or sketch its reflection. The idea is as old as Socrates who, in *Phaedrus*, referred to the observation of an eclipse by looking at its reflection in water or some other medium.

The idea of technology as **extensions** of man was already being spoken about by German philosophers a hundred years before McLuhan.[11] Samuel Butler (1835-1902) made reference to the idea on his novel *Erewhon*[12]. They have been called "prostheses" as a generalization of the term used in surgery.[13] Sigmund Freud (1930[14]) wrote: "Man has, as it were, become a kind of prosthetic God. When he puts on all his auxiliary organs he is truly magnificent; but those organs have not grown on to him and they still give him much trouble at times." Arnold Gehlen (1957) saw the history of technology reflected in the successive replacement of motor faculties, sensory faculties and brain by technical means. A.J.Lotka[15] referred to the "exosomatic" evolution of man in contrast to the biological or endosomatic evolution which had been reduced to minor importance. Philip Slater (1974)[16] regarded many technologies as projections into the material world of elements of man's psyche (psychic excretions). He wrote:

> Our psychic excretions... show an annoying tendency to become part of our real environment, so that we are forced to consume our own psychic wastes in physical form. Instead of being recycled, as they are in emotional exchanges between people...their materialization leads to increasing poison accumulation..

As examples we can think of fantasies of superpotency embodied in fast cars; or paranoid fears focused on bugging devices.

Recently (1994) Arthur Kroker and Michael Weinstein, two Canadian thinkers, commented: "Crash theory, however, abandons the notion that media are 'extensions of man'. Far from it. They are humiliation of the flesh, which remains an embarrassment after 'man' dies."[17] What they are describing is the end term of the virtualization of

reality. It is possible that our strong emotional reaction to changes in technology is conditioned by our subconscious impression that technologies are extensions of ourselves.

Amplification

The central aspect of the essence of technology is that it amplifies human action, **it is a universal amplifier, both for good and for bad**[18]**:.** This idea has important consequences for technology's claim to novelty. The novelty of technology as a phenomenon tends to be exaggerated[19] -- partly because its rise was coincident with the total reorganization of the way in which goods are produced and distributed (economics): that is to say with the capitalist mode of production. By far the greatest effects of technology, at least until very recently, have been in the amplification of powers already existing in the pre-technological era. As McLuhan observed[20] "The potter's wheel, like all other technologies, was the acceleration of an existing process." Going back further into prehistory, Colin Tudge showed how the ability to make weapons and thus magnify the power of their aggressive drives laid down a blueprint for the development of our ancestors *Homo habilis*.[21]

The Engels Effect

Novelty within the technological system arises in two ways. Firstly, as a result of "the Engels effect" by which cumulative quantitative changes result in a qualitative change. This effect, named after Karl Marx's collaborator Frederick Engels[22] has been elevated by some scholars to the status of a "Law" and described as "the transformation of quantity into quality". Folk wisdom recognizes the principle in such phrases as "more is different"[23] or "you can have too much of a good thing." To illustrate: there is a qualitative difference between smoke signals and the Internet - not merely a difference in channel capacity. Another example is provided by automobile transport. More cars move more people but, after adding still more cars, the whole can gridlock. A physical analogy is provided by the heating of water. Add heat at a steady rate to a beaker of water. It gets hotter and hotter but, at a certain point, it changes state into steam.

This rather simple idea which is central of Ellul's thought, should not be confused with the much more subtle analysis of dialectical logic from which it is derived (by Engels out of Hegel). John Wilkinson[24] points out that any concept of a threshold quantity is alien to the dialectical logic and that the transformation of quantity into quality is mirrored by the transformation of quality into quantity -- a topic that I have treated separately under the heading "quantification" in the chapter on The technic frame of Mind.

New powers

Secondly, novelty arises when technology enables actions to be performed which were completely beyond human powers (though not beyond human imagination) without technology -- when we cross new thresholds of possibility. For an example consider manned flight. Icarus imagined it but the Wright brothers achieved it. Scientific technology amplifies our powers by introducing novel ways of achieving ancient objectives such as blowing up one's enemies and "improving the breed".

The significance of the "amplification" aspect of technology is that, while we may be able to stand an infinite amount of good, we can stand only a limited amount of bad. Technology tends to raise the level of harmful action above the threshold of moral tolerance.

Ambivalence

Since the essence of technology lies in amplification, we are always getting more of something and, very often, perhaps inevitably in the long run, the result is the opposite of what we intended. Technology thus amplifies a tendency in human affairs which has been observed for centuries -- the tendency of all human action to produce results which are unintended or undesired or both. Technology has been accused of producing "perverse effects" (from the French "effets pervers")[25] but, as Ellul pointed out, they are part and parcel of any technological activity. They reach their climax in Accidents (see chapter with that title).

"What we look for does not come to pass. God finds a way for what none foresaw."

Euripides (~480-406 B.C.E.)

Carl Jung, the psychoanalyst, revived a Greek term *enantiodromia* to describe this phenomenon. Marshall McLuhan, the Canadian communications genius, referred to it as the "reversal potential" of a technology[26]. Ellul called it **ambivalence.** - that is, having two outcomes at the same time which we value very differently.

There are always unexpected consequences flowing from human actions and they always include at least some bad effects. We burn coal to get electric power but at the same time we add carbon dioxide to the atmosphere. Those who built the power plants did not expect the CO_2 to alter the earth's climate, but now we fear that it may.[27] The move to the paperless office by means of computer technology has caused such a demand for paper that the price has sky-rocketed.

Of course, not all unexpected consequences are ambivalent or undesirable. The introduction of the bicycle transformed rural life in England and, by encouraging marriage outside the village, improved the genetic constitution of society. James Tanner[28] attributed the increased height of the population of the United Kingdom at maturity at least in part to the bicycle (though the assumption that tall is beautiful is a cultural fossil from more physical times). It would be interesting to study the unexpected consequences of the introduction of the Model T Ford to the prairie farmland.

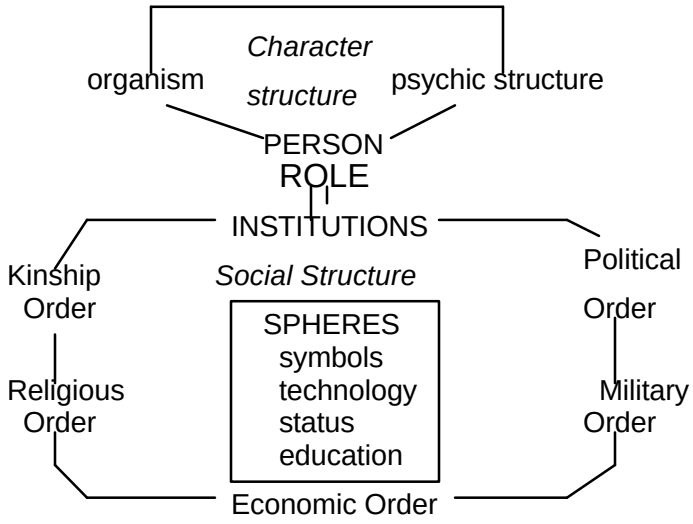
Both amplification and ambivalence are key concepts in technology.

Technology and Social Structure

The inter-relationships of technology and the society in which it is embedded can be looked at in many ways. There is no agreement amongst scholars as to which is the best. I have chosen one illustrated below (Fig. 158) derived from the classic text by Gerth and Mills [29]. This is concerned with the structural, that is to say mainly institutional, aspects of society. Another axis is represented by "culture" which interacts both with technology and with the structures, particularly with the economy in our model (see below).

Gerth and Mills observe that each of the institutional orders of society (kinship, religious, military, economic and political) has a technological sphere (as well as other spheres with which we are not here concerned). Clearly, the role of the technological sphere varies from order to order, being greatest in the economic and military orders, though far from negligible in the other orders. The interdependence of the social and the technological is emphasized in particular by the constructivist school who speak of "socio-technical assemblages".[30]

fig.158
(After Gerth & Mills)



Economic order

General Eisenhower, on leaving the presidency of the United States, warned of the "military-industrial complex" which drew attention to the interdependence between the military order and the producers of its technological hardware. From my point of view the tightest association is with the economic order and I often speak of the "techno-economic system" to emphasize the point.

Jacques Ellul, the French sociologist and theologian, on the other hand, gave technology the status of an autonomous order in 1963, although later he called it a system (1977). (The distinction between "order" and "system" is not of any great practical importance in the present context.) In contrast to my view, and that of the authorities I shall quote later, Ellul emphasized the independence of the technological and economic orders. He writes:

> And then there is the even more frequent confusion between technology and economy. The instant one tries to differentiate them, Marxists accuse one of diversionary manoeuvres and anti-revolutionary idealism. And yet, so long as we fail to study the technological phenomenon beyond its economic implications and the problems of the economic system and the struggle, we are doomed to ignorance of contemporary society (and hence, impotence for any revolutionary action). Economic progress and technicization are not synonymous. Technicization does not have an economic aspect *from the very outset*. Today, if there really is a potential and debated kinship between technological and economic growth, there is no kinship between technological growth and economic development, as we shall see.(Ellul, 1977, p.28)

Further on in the same text, Ellul stresses the need to isolate the concept of technology "from untold connected phenomena that are not in the realm of technology". Frankly, it is not clear to me why Ellul is so insistent on this point - unless it is to protect the principle of autonomy on which he has staked so much intellectual capital. The work of Solow on the contribution of technological change to economic growth has not to my knowledge been refuted by Ellul (although it was challenged by Rosenberg many years

after Ellul's writing). Ellul admits that "No technology, however autonomous it may be, can develop outside a given economic, political and intellectual context" (*ibid.* p.31). Recent work published by the Organization for Economic Cooperation and Development (OECD)[31] emphatically links technology and the economy and the authors state that technological change cannot be treated as an exogenous [outside the economic system] factor.

Actor Network Theory

I have begun to make use of Actor Network Theory[32] in my interpretations but confess that my grasp of it is still imperfect. Readers' comments may help me to correct this. The idea follows from the concept of technology as a system in which everything is interconnected. It is misleading to depict influences as single vectors; no person or social group acts alone, action is always reciprocally balanced by reaction, and non-human agents play as important a part as persons. Lee and Brown put it this way, "For us to recognise this coconstruction of machines by humans and of humans by machines, we must be prepared to grant machines the status of active actants rather than passive objects which are simply present-at-hand...."[33] A practical example of the human elements of an actor-network is presented in the chapter on Technological Change, using the market diffusion of the post-coital contraceptive RU486 as an example. This example is, at the present time, defective in being limited to humans.

Person-machine Systems

The Gerth and Mills diagram (Fig. 158) is surmounted by *the person*. Neither the techno-economic system nor individual technologies in the form of devices have any significance considered in isolation from the human beings who create them and make use of them. The concept of devices as prostheses has been mentioned above. The trend is for ever more intimate associations between person and machine -- a move toward the "cyborg", defined as the entity resulting from the application of attachments to the human body of any mechanical or electronic device to extend or enlarge the performance of its physical or mental faculties.[34] On the other hand, as the technologically privileged enhance their performance with electronic extensions, the class at the bottom of the employment heap might regard themselves, and certainly be regarded by others, as mere extensions of the machines that they serve. It is significant that in 1820, in response to the activity of the Luddites in the previous decade, the parliament of England made the destruction of a machine a capital offence, thus giving a machine the value of a human life.

Smart machines

The counterpart of the cyborg is the "intelligent" or smart machine[35]. Automation and cybernation (automation plus feedback -- see Appendix to chapter Techno-economic System) gradually transfer the intelligence of the operator to the machine. The ultimate aim of the designers of smart machines is to surpass and even supersede human intelligence. There is an ongoing and passionate debate on the meaning of the term "artificial intelligence", its possibility and desirability. This is beyond the scope of these lectures but the phenomenon of the smart machine offers at one and the same time the greatest hope for the liberation of humans from toil and the greatest threat to the traditional role of employment as the means by which society allocates its product.

The "threat" of the smart machine was discussed with great insight by Samuel Butler in his novel *Erewhon*. It was this threat that caused the Erewhonians to destroy their machinery.

Technology and Culture

"Culture" is another of those words whose meanings vary with context and with country[36]. I use it here to indicate the way of thinking, beliefs and patterns of behaviour of a specific society or social group.[37] Note that human behaviour, of which the practice of technology is an important part, occurs within a culture and at the same time reconstructs the culture[38]. Technology as genus (i.e. comprising all specific instances) never stands alone. It is always embedded in a society with its distinctive culture and is affected by it just as it affects it. The technology can be as simple as eating utensils or knitting needles: contrast knife and fork to chopsticks or to folded roti or the German way of knitting a pullover to the English way. Anthropological studies have revealed that older technological systems had a stronger cultural component than modern systems. I see this as a phase of transition between magic and science. Once the scientific basis of a technology is established, the scope for variation in practice in response to cultural pressure is diminished. For instance, the metallurgists of Africa who, until very recently produced large quantities of iron, steel and bronze, surrounded the business of smelting with a complex ritual connected with giving birth, the crucible being seen as a womb[39]. With the introduction of modern technology the process is the same as it would be in Canada.

Technological activities are carried out within social groups whose distinctive cultures influence the way in which the technology is conducted. As an example of the culture of a contemporary social group the **corporation** has attracted most recent research[40]. Within the oil and gas business for example, one can contrast the lean and efficient corporate culture of Anderson Exploration Ltd., to that of Home Oil Co. which Anderson took over. In 1994, Home's office expenses (including executive dining room, art collection etc.) worked out at $2.00/barrel while Anderson's were $0.72![41] Cultural differences of this kind give rise to serious problems when one firm is taken over by another and functions have to be combined. Novell Inc.'s acquisition of Word Perfect Corp. was a case in point. Robert Frankenberg, CEO of Novell said "The cultures were very very different. Melding those two was interesting and difficult..."[42]

The following study shows how the entire business culture of one society can differ strongly from that of another:

> Managers were asked whether they agreed that the bottom line should **not** be the only real goal of a business, but that the other stakeholders should be taken into account....
> 96% of Japanese agreed, and 86% of Germans: but only 53% of Americans.[43]

Another example shows how culture affects the organization of production and thus "the economy". The economist Robin Murray claims that culture is **the** most important factor in productivity[44] and gives many examples from which I have chosen one, the production of Parmesan cheese. As a background to this example I should mention that small sausage makers in France are being forced out of business by the decision to forbid slaughtering outside the large central abattoirs and many of the over

three hundred varieties of French regional cheese are threatened by similar regulations, both on the grounds of sanitary standards. In contrast, there are 980 cheese factories clustered around the city of Parma. They are governed by an ancient guild that enforces extremely high standards of cleanliness before allowing the official stamp to be used. This very decentralized arrangement combined with a central coordinating body reflects a particular cultural history. It enables cheese production to be continued in an artisanal manner in the midst of a modern economy.

Further examples of cultural influence are provided in the discussion of "one best way" in the chapter on Determinism. These examples show how specific technologies can be influenced as much by culture as by the pure engineering concept of efficiency.

Up to this point I have emphasized the way in which different cultures affect the practice of technology. But the influence is reciprocal. Technology, especially advanced technology, infects every culture in which it is embedded and thus transforms it, like a virus carrying an alien gene[45]. This is particularly the case in the transfer of technology to developing countries; we do not transfer just a technology, we inevitably transfer large elements of culture.[46]

The degree to which the transfer of culture occurs is very controversial. Before the word "convergence" was associated with the functional convergence of telecommunications, entertainment and business systems, it was the name given to a phenomenon supposed to characterize the transfer of technology from the capitalist to the socialist economies. Convergence theory held that as the Soviet economy adopted North American production methods it would be forced to adopt American political democracy, while, at the same time, America would adopt some aspects of socialism (planning, welfare state etc.) This thesis was vigorously resisted by Soviet theorists such as Enokh Bregel.[47]

In hindsight, it appears that the most successful transfers of technology between cultures take place in the military sphere and it is no accident that this sphere was marked in both the USA and the USSR by secrecy, hierarchy and insulation from market forces. Hampered by the refusal to accept American "culture", the Soviets were markedly less successful in accepting the technology necessary for the production and distribution of consumer goods.

These consideration may give one cause to doubt Samuel P. Huntington's thesis that the successors to the "evil empire" required by American ideology -- which he identifies with the Islamic and Sinic spheres -- will be able to import a full range of American technology while preserving their culture. My belief is that only military technology can be successfully transferred under these conditions. Military culture is already global.

Symbolic content of technology

Many cultural anthropologists have observed that symbolic content or "meaning" is attached to various aspects of technology. The practice of technology is often accompanied by ritual; the tools and implements of a trade may have a sacred character (e.g. as preserved in Masonic rites); even static artefacts (US: artifacts) such as a Coke bottle or its contents may be imbued with symbolic meaning by the skilled manipulators of the advertising trade. The question is whether such symbolic "meanings" are part of the "meaning of technology". Francophone sociologists[48] have made the study of "objets

techniques" a distinct discipline, but many anglophone critics intersperse comments about technology as practice with observations about the symbolic meanings of artefacts as such.[49]. The difficulty of this question is illustrated in the movie "The Gods Must be Crazy" where a "static"[50] artefact (a Coke bottle) from one culture is dropped into another culture where it becomes an implement and thus enters the realm of active technological practice.

Socio-cultural system

It follows from the foregoing discussion that when we speak about the context of technology in action we are really referring to socio-cultural systems i.e., systems comprising both the institutional orders of society and the cultural patterns of daily life. We find a constant attempt by technophiles to decontextualize technology - to wrench it out of its culture and treat it as an autonomous entity. If they could only succeed, they could attribute the ills of society to society itself and exonerate technology. The other side of this debate is the attempted decontextualization of technology by the technophobes[51] who wish to attribute all the ills of society to technology and thus to exonerate society.

To sum up: society, in both its structural and cultural aspects, constructs technology but it is a society continuously transformed by technology. Society and technology are thus mutually related in a way that may be called "dialectical". A neat comment was offered by Moses Znaimer, head of CityTV who said "..if you build $20 million studios on the tenth floor of that building, you'll make the Tommy Hunter show for the rest of your life. Your ideology commits your hardware and once you've spent the money, your hardware determines your ideology. If all you've built is atom bombs, that's all you can drop."[52]

These rather general ideas about the relations between technology and society are brought into much sharper focus when we address the problem of determinism which runs like a thread throughout this book. In fact Determinism is the central theoretical issue in studies of technology in society and I have therefore devoted an entire chapter to it.

The current "problematique"

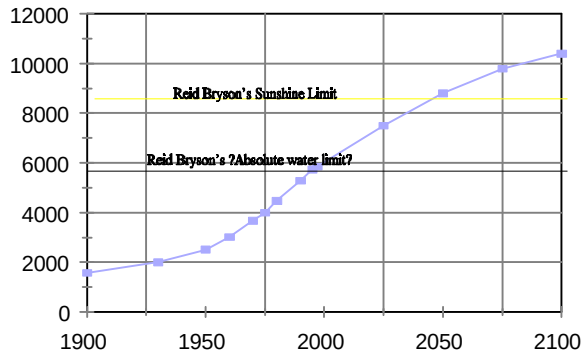
Technology is generally assumed to have brought wonderful benefits to humankind. Freedom from want through industrial agriculture, freedom of choice through the cornucopia of consumer products, freedom from disease through the wonders of medical scientific technology, and now freedom from ignorance through the marvels of the Internet. Even those totally fascinated by technology admit that these wonders, apart from being very unevenly distributed amongst the peoples of the world, have a downside, or negative aspects that we treat as problems. Together these problems constitute a "problematique".

The term "problematics[53]" was introduced by the American sociologist R.K.Merton in 1957 to embrace the principal problems, conceptual, substantive and procedural in a given discipline. The variant "problematique" is favoured by the Club of Rome (an international group of influential persons who commissioned "Limits to Growth"). It is preferred to "crisis". By definition, a crisis is something we pass through. No such guarantees are offered by a problematique[54]. Interested readers may compare my

version of the problematique with the "World Scientist's Warning to Humanity" with which it has much in common.[55] The main components of this problematique are frankly *extrinsic* to technology, although they have come about through the power of technology to amplify human actions. In the opinion of scholars such as Jacques Ellul and Albert Borgmann[56], factors *intrinsic* to technology itself, pose a greater threat. While I do not share this view, the section below labelled "Other problems", clearly includes some Intrinsic Characteristics of technology.

Population

One of the dominant elements of the world problematique is the growth of population. A principal cause of this growth is improved technology in the areas of health, agriculture and water-supply which have greatly reduced mortality (most of the technology involved is low-level)[57]. The diagram shows the population of the world from 1900 to the 1997 based on published data and extrapolated to 2100 using the latest estimate of the United Nations Population Division. During the second half of the 20th Century, the rate of increase was exponential. Towards the end of the century a decrease in birthrate has been observed leading to a reduction of future estimates and producing an S-shaped curve. Across the diagram are two lines representing possible limits to further expansion (with current technology) suggested by Reid Bryson, Director of the Center for Climatic Research at the University of Wisconsin. The lower of the two limits is based on the supply of water for drinking and agriculture. The upper one is determined by the amount of sunlight needed to supply the base of the food chain.



WORLD POPULATION HISTORY AND PROJECTION

Environment[58]

The second most dominant element of the world problematique concerns the macro-effects of people on the environment under the interlinked aspects of: resource exhaustion; amenity destruction; global atmospheric change; sink overload; and possible loss of the war against infectious microorganisms. The impact of a society on the environment is sometimes expressed by the formula PAT (the product of population, affluence and the level of technological development. However, technological development can either increase the impact (e.g. by mechanization, or by offering hitherto unavailable services) or it can reduce the impact through increases in efficiency. Hence the PAT relationship is very complex. It is well known that the total energy demands of the advanced industrial countries (AICs), with a population of about 4% of the globe, equal something like 80% of the total global consumption. The danger ahead of us results from the passionate desire of the "developing" countries to emulate the affluent life style of the AICs -- a thrust which the AICs actively encourage in order to "open up markets". Note that these figures relate to energy, not to a standard of living

based on purchasing power which is much less skewed[59], although, of course dangerously inequitable.

Demographic theorists postulate that increasing affluence will eventually cause the developing countries to reduce their birth rates to the level of the developed countries. However, this may be a very lengthy process as there is a strong religious and cultural dimension to the issue [60]-- particularly where women have not been emancipated. Meanwhile, during the demographic transition, the Earth will be subjected to an unsustainable, and possibly even fatal, combination of high population and high consumption. The effects will be focused first on water supply; then on energy and food production. It is very doubtful whether there is a purely technological solution to this: it is a deeply cultural problem and hence will have to be addressed with social measures. But technology will have to be part of the solution.

Work

The third most dominant element, in my personal view -- not featured by the Club of Rome --is structural unemployment due to technological change and the opening of the global market -- itself made possible by Communications Technology. This is part of the general problem of "work" and "allocation" in an increasingly automated society. In brief, I ask two questions: first, whether work is an absolute good, in which case, how is it to be allocated justly when it is no longer necessary for sustenance?; second, if work becomes unnecessary, what will replace it as an allocation mechanism for goods and services? This topic receives extended treatment in a later chapter (Work). At this point I want merely to point out two of the many contradictions inherent in this aspect of the problematique. The first is that capitalism depends as much on consumption as on production and the wholesale destruction of jobs also destroys purchasing power. The second is that the "official" solution to all these problems -- increasing economic growth -- is ecologically unsustainable. Solutions that do not result in an equitable distribution of the output of the techno-economic system cannot be socially sustained.

Economy

"From the economic point of view, the major criticism of modern technology is that it tends to magnify inequalities between countries, and within countries (including developed ones!). Thus it plays a crucial role in making inequality recursive and increase with time."[61] Within countries, the result is expressed in the polarization of market earnings. In the Canada of the 1970s, for instance, about 25% of men were in the "rich" category and an equal number in the "poor" category. By the 90s each category comprised 30%, with a corresponding decline in the middle class. John Richards (1997)[62] wrote "Probably the most important factor in the increased polarization of earnings is that, over the past generation, technological change has almost certainly polarized skill requirements among employees." He points out that the jump in the earnings premium associated with higher education has been dramatic. Polarization has been avoided in France and Germany at the cost of increased unemployment. The economic system finds itself in contradiction with many other desired ends (see chapter on Efficiency) and cannot be accepted as a "given".

Other problems

Additional specific ills that have been attributed to technology are:

- hazards to health and life, the threat of catastrophe (See chapters Management of Technology; Accidents.). In this context I note with particular concern the growing resistance of bacteria to antibiotics and the return of diseases like tuberculosis that were thought to have been conquered.
- alienation from the work process. There is a debate as to whether alienation is due to the technology or to the organization of the workplace as a result of the division of labour (which certainly preceded modern technology).[63]
- anomie[64] - a lack of social standards or values. This leads to crime on an increasing scale. One argument is that technology alters the structure of social institutions such as the family; and it introduces new moral choices for which no standards have been evolved. Anomie also describes the gap that people feel between their wants and the means society provides for their satisfaction. Societies that lay great stress on 'success' encourage deviant behaviour in those that cannot attain it. This is more of an economic than a technologic problem, but the two are very closely entwined. The Club of Rome refers in general terms to new factors in the world problematique "such as changes in human behaviour, the emergence of seemingly irrational movements, including terrorism, and the growth of individual and collective overt selfishness thrown up by our materialist society".
- over-complexity leading to technology appearing "out of control"
- growth of bureaucracy, technocracy and State intervention owing to the need to regulate increasingly dangerous or socially dysfunctional activities. There is now a backlash against this trend, spearheaded by neo-conservatives who fail to understand that intervention is a *necessary* condition for the operation of a complex techno-economic system (Adam Smith was not so naif!).

A more general ill that has been pointed out by numerous authors is the ubiquitous presence of technological devices between the subject and the direct object of experience or action. The device acts as a distorting or refracting medium and weakens our hold on reality.

In summary, it is very clear that the problematique comprises both intrinsic technological and extrinsic social and ecologic problems.

Aspects of the "resolutique"

The final chapter in this book of lectures is devoted to a discussion of the "resolutique", a term coined by the Club of Rome to describe the set of solutions that they proposed in response to the "problematique". The key concept in the resolutique is sustainability, the principle that nothing we do today should jeopardize the survival of future generations. This is not a self-evident moral imperative; indeed, some philosophers[65] have taken the view that, "It is absurd to conduct politics as an indefinite set of sacrifices of present generations for the future. If the present had no value, neither could the future have value **B** because when the future arrives it will (at that time) be present." This should act as a moderating influence on the push to sustainability.

There is, of course, a strong biological urge for parents to make sacrifices for the preservation of their gene-carriers but to extend this principle outside the kinship group has to be justified on either religious or utilitarian grounds. The utilitarian argument is

that local actions will have future global consequences and one should not "ask for whom the bell tolls; it tolls for thee." We cannot escape by building islands of affluence in a sea of misery. The photograph[66] reproduced hereunder is symbolic of this: it shows a curtain of smog generated by Hong Kong's industries drifting across the hilltop on which the palaces of the entrepreneurs are located.

Both technological and social sustainability have to be achieved. It is obviously pointless to find technical solutions if the social fabric disintegrates. Of course we can have no expectation that a final set of solutions will be found. Experience shows that the implementation of any technological or social remedy creates new problems which have to be addressed in a new frame of reference. This is the dialectic of political action.

In the material world, "energy is the only absolute". Some partial solutions to this problem are presented in the chapter on Sustainable energy. A redirection of effort, notably away from armaments and the cult of luxury; a technological transformation away from a dependence on fossils fuels to current solar sources; and a satisfactory solution to the population problem, are parts of the energy resolutique. In the social world, discussed in the chapter on Work, new ways of using labour, new ways of justifying entitlement to a share in the products of industry, and new ways of achieving self-esteem, are all necessary for the resolutique of the labour/product disjunction brought about by labour-saving technology.

At this time, and accepting the fact that I shall be repeating myself, the following conclusions are offered as a general summary of the stance that I have adopted.

Some conclusions

1. "In each lived moment of our waking and sleeping we are technological civilization." (George Grant). Technologies are forms of life. (Langdon Winner)[65]

2. Technology is a universal amplifier, not differentiating in this role between good and bad effects. Technology sometimes extends and amplifies the powers of humankind so powerfully that the change is qualitative and not merely quantitative. It thus presents us with choices never before open to us and forces us to make new kinds of moral decision.[66]

3. Technology is never neutral, neither is it simply deterministic. Each technological system has a bias resulting from the resolution of many forces acting within the network of actors or agents including inanimate objects whose properties set bounds on human action.

4. The consequences of all human actions, however benign their intention, are often unforeseen and not infrequently malign. The amplification brought about by technology not only enhances the benefits of human action but multiplies the opportunity for disbenefits and disaster.

5. Power over nature always means the power of some people over other people with technology as the instrument.[67] Technological change alters the power relationships of society.

6. All the transformative acts that we carry out on matter, on energy and on symbols are mediated by technologies that impart a bias to our actions.

7. The technic frame of mind sees all problems as technical problems that can be fixed.

8. Technology has an intrinsic fascination for human beings - sometimes intensifying into an addiction. The power of this fascination sometimes overrides all rational calculations.

9. Technology is smoke and mirrors. I use the metaphor of smoke, because technology hides itself from us -- the phenomenon of the black box. But it is also a mirror that reflects its technicity back to us, thus reinforcing our technic frame of mind.[68]

10. Contemporary technology -- SciTech --is a cultural construct inseparable from economics. They are co-products of specific historical circumstances: the rise of a new way of producing and distributing things which we call capitalism -- a way vastly more productive of material goods than any other system devised before or since. Technological change is the driving force of the economic system and the economic system establishes the constraints within which technological change occurs.

11. The capitalist system is driven by the will to accumulate wealth and power. In competition for that wealth and power a player either wins the game or has to drop out of the game. The techno-economic imperative drives one to install the most productive machinery regardless of the social consequences; just as one is forced to advertise in the talk show with the highest rating regardless of one's repugnance for its content.

12. The Achilles heel of the techno-economic system is its need constantly to expand. In a world of finite resources, that must eventually result in crisis and collapse.

13. The success of automation in doing away with the need for human labour and much of routine mental activity has resulted in the permanent destruction of "jobs" - the traditional social arrangements by which workers become entitled to a wage, status and self-esteem. The problematique of technology is centered on our response to this new situation.[69]

14. Heilbroner in his *Visions of the Future*[70] sees our age as one of apprehension, following an age of hopefulness. But Sam Florman[71] says:

> "But for all our apprehensions, we have no choice but to press ahead....We cannot stop while there are masses to feed and diseases to conquer, seas to explore and heavens to survey."
>
> "By saying that I espouse the tragic view of technology I mean to ally myself with those who, aware of the dangers and without foolish illusions about what can be accomplished, still want to move on, actively seeking to realize our constantly changing vision of a more satisfactory society. I mean to oppose those who would evade harsh truths by intoning platitudes. I particularly mean to challenge those who enjoy the benefits of technology but refuse to accept responsibility for its consequences."

Given the current socio-economic paradigm of possessive individualism operating within a globalized economy, what else could he responsibly say? But, for me, the real challenge is to the paradigm, not to the technology which is an inescapable part of it.

[1.] ©P.Fitzgerald-Moore
[2.] *The Road Ahead*. Viking 1995, p.276.
[3.] A view shared by George Gilder, a speech-writer for Ronald Reagan (*Microcosm*, p.). I think it possible that Thatcher derived her saying from C.S.Lewis who, in the novel *That Hideous Strength* (1945), has a character say, "There is no such thing as Man .... there are only men."
[4.] Borgatta and Borgatta.
[5.] The translation of "Gestell" as "technological system" was offered by Michael Heim, the translator of Heidegger's "The metaphysical foundations of logic". I have identified at least seven different translations of "Gestell"in the literature.
[6.] The concept of perspective is developed by Ortega y Gasset.
[7.] Heidegger, M. (1977). *The question concerning technology and other essays*, (Translated by William Lovitt). New York: Harper & Row.
[8.] McLuhan said that extensions of man are also auto-amputations.
[9.] Meyrowitz, Joshua (1994). Medium theory. In *Communication Theory Today*. David Crowley and David Mitchell eds. Stanford CA: Stanford University Press, p. 50-77.
[10.] Paul Evans "Pretty as a picture". *Manchester Guardian Weekly* 23 June 1996, p.32.
[11.] Kapp (1877) pointed out that technological tools are "projections", extensions and reinforcements of the human organs according to Freidrich Rapp (1985) *Interdiscliplinary Science Reviews* v.10, no.2
[12.] *Erewhon or Over the Range*. 10th Revised Edition. London: A.C.Fifield, 1919. p.270-272.
[13.] "An artificial replacement for a part of the body." (OED).
[14.] Freud, Sigmund (1961) *Civilization and its discontents*. Trans. James Strachey. New York: W.W.Norton, College Edition, 1962, p..38-39.
[15.] Lotka, Alfred J. (1945) The law of evolution as a maximal principle. *Human Biology*. v.17, no.3 (Sept), 167-194 (See especially pp.188-192)
[16.] *Earthwalk* (1974). Chapter 1 "The extensions of man or say hello to the nice fist."
[17.] *Data Trash: the theory of the virtual class*. Montreal, 1994.
[18.] An early statement by Elting E. Morison (1966) is specific "Since the launching of the Wampanoag we have gone on to refine a whole system of technical invention that has created a whole new kind of world for us. The inventions have amplified our physical energies, our powers to sense, detect, and communicate, and our powers of thought, often by means of language and other symbol systems, and, more recently, in the computers which expedite and supplant, in certain areas, if they do not actually amplify, our powers to think." (page 119). Earlier, Gehlen (1957; English translation 1980, pp.17-19) had used an expression translated as "facilitation" which "implies a small effort and a large effect". The term "leverage" is apt in this context.
[19.] Barry Cooper, in his *Action into Nature* (1991) devotes a whole chapter to the novelty of technology. Neither Cooper nor I are referring in this context to the "novelty" of specific technical solutions but to the

novelty of the technological phenomenon.

[20.]McLuhan, Marshal (1964). *Understanding media: the extensions of man*. New York: McGraw Hill Paperback, 1965, p.184.

[21.]Tudge, Colin. *The day before yesterday: Five million years of human history*. Cape

[22.]See The *Dialectics of Nature* by Frederick Engels. London: Lawrence and Wishart Ltd., 1941.

[23.]Title of essay in *Science* (1972) by Philip W. Anderson, Nobel Laureate.

[24.]Translator's introduction to *The Technological Society* by Jacques Ellul, p.xv.

[25.] Tenner, Edward (1996?) *Why things bite back: technology and the revenge of unintended consequences*. New York: Alfred A. Knopf.

[26.] This idea seems to come from the French philosopher René Thom (Derrick de Kerckhove *The Skin of Culture*. 1995 p.78) but was made into a Law by McLuhan et al.. *Laws of Media*.

[27.]The Technological Order, in *Technology and Culture* v.3, no.4 1962.

[28.]Tanner, James Mourilyan (1989). *Foetus into man: physical growth from conception to maturity.* 2nd. Ed. Ware, England: Castlemead Publications.

[29.]Gerth, Hans and C. Wright Mills (1953)*Character and Social Structure*, New York and London: Harcourt Brace Jovanovich, 1964, p.32.

[30.]Bijker, Wiebe E. (1995). *Of bicycles, bakelites and bulbs: toward a theory of sociotechnical change*. Cambridge: MIT Press. [see excellent review by Steven Woolgar in *New Scientist*, 9 Dec. 1995, p.48-49].

[31.]OECD (1992). *Technology and the economy: the key relationships*.

[32.]There is a growing but rather scattered bibliography: key names include Michel Callon, Bruno Latour and J. Law. I shall just give one reference and make the suggestion that the basic concepts are to be found in Friederich Hegel's Phenomenology. See Nick Lee and Steve Brown "Otherness and the actor network." *American Behavioral Scientist*, v. 37, no.6, May 1994, 772-790.

[33.]*op. cit.* 775.

[34.]J.M. Johansen. This theme has been further developed by Arthur Kroker in a book *Data Trash*. Peter Cochrane, Head of advanced Applications and Technologies at British Telecom describes the "office you wear" in *New Scientist* 5 August 1995.

[35.]Zuboff, Shoshana. *In the Age of the Smart Machine*. Excerpt reprinted in *Technology and the Future*, 7th ed. 370-379.

36.Edward O. Wilson cites Alfred Kroeber and Clyde Kluckholm (1952) who distilled no fewer than 164 prior definitions of culture into one. *Consilience: the unity of knowledge* (1998, p.130)

[37.]The Society for the History of Technology, in launching their journal *Technology and Culture* in 1960 adopted the definition of Edward B. Tylor: "Culture is that complex whole which includes knowledge, belief, art, morals, laws, custom and any other capabilities and habits acquired by man as a member of society."

[38.]Jennings, Ann & William Waller (1995) Culture: core concept reaffirmed. *Journal of Economic Issues*, v.29, no.2, 407.

[39.]Schmidt, Peter R. ( ) *Culture and technology of African iron production*. University Press of Florida. Review in New Scientist, 20 April 1996, by Jonathan Beard. Also Video

[40.]That corporations have distinctive cultures only recently became apparent to academics and consultants. See Charles Hampden-Turner, *Corporate Culture*. London: Hutchinson, 1990. Also "Decoding Corporate Culture" by Eileen C. Shapiro, *ROB Magazine* Sept 1995.

[41.]Article by Scott Feschuk in *G&M* 17 Oct 1995 B8.

[42.]Don Clark in *Globe and Mail*, 12 Jan. 1996.

[43.]Charles Handy *The Empty Raincoat* p.147.

[44.]Interview with Bissoondath on Vision 1996 05-07.

[45.]This metaphor was suggested to me by Carlo DiStefano

[46.]E.F. Schumacher

[47.]"Two Economic Systems: Theory of Convergence." (Moscow, about 1972)

[48.] Such as Jean Baudrillard, Gilbert Simondon and Yves Deforge.

[49.] Caroll Pursell's British TV series White Heat seems guilty of this.

[50.]The concept of static components of technology was introduced by Lewis Mumford to refer to things like hearths, pits, houses, pots, sacks, clothes, traps, bins, byres, baskets, bags etc. *Technology and*

Culture, v.7, (Summer, 1966) p.306.
[51.]"Haters of technics"; sometimes erroneously called "Luddites". The Luddites were early 19 Th. c. machine breakers who were trying to protect their livelihood.
[52.]In an interview with Evan Solomon in *Shift*, v.3, no.1 (Fall 1994)
[53.]OED Supplement Volume III.
[54.]"... the tangle of contemporary problems -- political, economic, social, cultural, psychological, technological and environmental -- for which the Club of Rome adopted the term 'the world problematique'." Alexander King and Bernard Schneider *The First Global Revolution*. London: Simon & Schuster, 1991.
[55.]Web site: http://www.hhh.umn.edu/archives/pubpol/pubpol-d/9511/0042.html
[56.]Borgmann, A. (1984) . Technology and the character of contemporary life: A philosophical enquiry. Chicago & London: University of Chicago Press.
[57.]The role of medical technology in the great population explosion of the Industrial Revolution is debatable. See McKinlay, J.B. & McKinlay, S.M. (1977) The questionable contribution of medical measures to the decline of mortality in the united States. *Health and Society*, v.55, 405-428. The influence of the labour movement in the industrialized countries may have been of even greater importance.
[58.]A useful summary of the environmental problem is provided by Amulya Kumar N. Reddy in "Technology, development and the environment: A re-appraisal." United Nations Environmental Programme (1979)
[59.]The output of the AICs represents about 54% of global production on a purchasing power parity basis (Handy, 1994, p.222).
[60.]Important evidence for this is provided in an article by P.R.Ehrlich, A.H.Ehrlich & Gretchen C. Daily in *Mother Jones*, Oct. 1995.
[61.] Amulya Kumar N. Reddy in "Technology, development and the environment: A re-appraisal." United Nations Environmental Programme (1979), p.6-7.
62.*Retooling the welfare state: what's right, what's wrong, what's to be done?* Toronto: C.D. Howe Institute.
[63.]Gendron, Bernard (1977). *Technology and the Human Condition*. New York: St. Martin's Press.
[64.]Term originally described in 1897 by Emile Durkheim and enlarged by Merton in 1957.
63.Simone de Beauvoir as interpreted by Trudie Govier in *Socrates Children*. Peterborough ON: Broadview Press, 1997, p.227.
64 Courtesy Rupert Spicer Esq. Hong Kong.
65.[65.]*The Whale and the Reactor.* Chicago & London: University of Chicago Press, 1986, 11-16.
[66.]Mesthene (1970) stated this clearly (though in terms of "values"). I am not sure who first did so. (Reprinted in Teich, 6th ed. p.81)
[67.]C.S. Lewis (1945) *That Hideous Strength.* London: John Lane, the Bodley Head, p.217. Filostratr "You know as well as I do that Man's power over Nature means the power of some men over other men with Nature as the instrument. There is no such thing as Man. It is only a word. There are only men."
[68.]This idea is adumbrated in Jean Baudrillard's *Miroir de la production* and, not quite so clearly, in George Grant's essay "Thinking about technology" In *Technology and Justice.* Toronto: Anansi, 1986, p.33; David Pollack (*Clio*, 1988) expressed it with particular clarity.
[69.]There is a rapidly growing literature on this topic e.g. Aronowitz, S. & DiFazio, S. (1994). *The jobless future*; Rifkin, J. (1994). *The end of work.* There is a listerver on the Net: futurework@csf.ucolorado edu.
[70.]Heilbroner, Robert. *Visions of the Future: the distant past, yesterday, today and tomorrow*. New York: New York Public Library/OUP, 1995, p.69.
[71.]Florman, Samuel C. *Blaming Technology: the irrational search for scapegoats*. New York: St. Martin's Press, 1981, p.192-193.