# The Concept of Progress and Characteristics of Traditional and New Technologies:[1]



## Hans Lenk



"In any case, progress implies that it looks much greater than it really is". This statement by the Austrian poet Nestroy became famous after Wittgenstein had chosen it as the motto of his *Philosophical Investigations*. Is it true, however? Certainly it seems to be true for the problems, methods and methodologies of philosophy itself (maybe even for Wittgenstein's investigations – in the light of Lichtenberg, Schopenhauer, Mauthner and other forerunners). But it certainly does not seem to be true any more for technical and technological progress. Instead, we might state: "Technical progress implies that it is at times much greater than it seems". But technical progress is not identical with cultural or moral progress. Discrepancies between the different kinds of progress were time and again highlighted and epitomized as well as made responsible for some untoward effects (e.g., by Albert Schweitzer, Lord Snow, Daniel Bell, Arthur Koestler and many others, especially by intellectual critics). *The* one and only, the unique progress as a general social phenomenon without any differentiation does not even exist. However, there are systems interlockings and systems effects which had been discovered already in the twenties by Von Gottl-Ottlilienfeld in his classic on *Economics and Technology: Foundations of Social Economics* (1923, 2nd ed.). Here, the author already stressed the "interlocking of all individual progresses towards a total movement of technology itself": creative analogies from different fields, combination of results from earlier progresses are preconditions of genuinely innovative technical progress in general which has to be relevant for the fulfilment of demands. Technological progress has to be distinguished from technical progress or from advance in technics or even techniques, because it is progress in *knowledge* about and of technologies without necessarily an extant technological development or implementation to occur. However, technological progress and knowledge is very important for the mutual interlocking of subsystems. Von Gottl-Ottlilienfeld mentioned already series of continuity, technological and technical mutations (the jump to another basic idea of a problem solution) as well as the systematic contexts of all technical problems and their individual development (which he even calls "proper life" ("*Eigenleben*")) and the derivation and "filiation" of problems which eventually lead to an unitarian system of technical questioning and probing, i.e. to a kind of methodological unity. The "self-

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[1] Originally, the first part of the paper was presented as an invited lecture to the XIXth World Congress in Moscow, 1993, the second part to the section "Philosophy of Technology" at the XXth World Congress of Philosophy in Boston 1998. (No proceedings at all were published for the Moscow Congress and there was no volume in the Proceedings on philosophy of technology (!). Part II and the postscript were published in an abbreviated form in Lenk - Maring 2001, 93ff.) There - as well as in the Appendix of my *Grasping Reality, 2003,* - a list of characteristics of the so-called New Technologies was presented , however containing too many - actually 30! - features, indeed overlapping in part.- I would like to thank Prof. Dr.-Ing. Guenter Ropohl for his respective helpfull and some critical remarks. Ropohl presented a very thoughtful and differentiated, at times critical discussion of the mentioned features of new technologies in 2000 during the summer conference of the more or less invisible College of Philosophy of Technology at the Academy of Philosophical Studies at Sant 'Abbondio (Lago Maggiore) thereby opening a new discussion on the structural features and tendencies of modern technology from a methodological and philosophical point of view. The debate will presumably go on for some time

advancement ('*Selbststeigerung*') of progress", an *eigen*dynamics is clearly seen under systems aspects. This later on led Kurt Huebner (1968) to the idea that modern technology would be "coming to itself" and its intentionality in the ideas and applications of cybernetics.

What are now the new characteristics of technological development and the ever-accelerating technical progress and its overall situation in our society? Certainly it lies not only – but also – in the fact that particular moral and legal concepts do not easily avail themselves to applications without further concretion. Sachsse, e.g., showed that concepts like "property", "theft", "just", "exchange" and maybe also "consumption" cannot be simply transferred to the concept of information as a goods gaining ever more prominence, but they where somehow developed in view of the classical concept of possession of goods with respect to some kind of underlying substance or philosophic category of substance, which cannot be multiplied.

Fast changes in the circumstances of life in modern dynamic and pluralistic societies as well as the accelerating dynamics of social, political and economic and technological conditions in the shifting orientations require also some respective changes in the applicability conditions and even the scope of fundamental ethical convictions and opinions. Quantitive acceleration, systemic cross-area interactions and interpretations, in short: systems effects, engender a kind of shifting of accents and changes of the respective systems themselves. Omissions however can especially nowadays be ethically speaking much more important than in earlier times. Collisions of values – even if not fundamentally new ones – can be dramatized or even lead to a new kind of social harm of social origin (when we think, e.g., of the results of the implementation of scientifically successful medicine, the overpopulation problem as well as regional economical, ecological and other social traps – as sociologists would call them – which might lead to a kind of new "tragedy of the commons" (G. Hardin 1968)).

In any case, the most decisive point of view for a new interpretation of ethics in view of technology and technological progress is beyond any doubt the immense technological power of man which has grown to an extension and intensity where some sort of systems backlash or a kind of overkill effect of a self-destroying dynamics might occur or might have even already been developing – particularly in view of the ecology and the imbalance of ecosystems in highly industrialized or over-industrialized regions or even globally. We seem not to be aware or not be able to implement the respective responsibility for the overall functioning of the eco-systems in general.

Let us start with some remarks about the concepts of "*technical progress*", without being able to develop a whole theory of technical and technological progress here. At first, it is clear that the concept "technical progress" has a normative hue. It is always in comparison to an "is-state" or with respect to a state of the system to be aimed at which motivates the technical solution or operation to be called "better" in view of a potential technical progress. This is the case, whenever the same accomplishment can be achieved by less cost or effort or when we succeed in getting a higher output or a better achievement with the same input or effort. The criteria of the assessment refer to the advancement of quality, longer endurance of product, safety, reliability, greater precision, feasibility, better control, higher speed, simpler or better surveyability and improved economic efficiency, particularly pertaining to costs of production and maintenance (in terms of the input-output relation). Economists define even the existence of what they call "technical progress" simply by the increasing output in comparison to equal or less investment of capital and labor. This would even imply increases of production stemming from higher motivation as for instance found and supported by the famous Hawthorne experiments in social science and an improved organization of the work process in view of constant investment of capital and labor. This, however, cannot be dubbed "technical progress proper". Friedrich Rapp (1978) distinguishes between potential and realized or materialized technical progress taking up again Von Gottl-Ottlilienfeld's distinction between technological progress in knowledge and genuine technical progress in social reality. Gottl-Ottlilienfeld indeed restricted his analysis to the so-called "real technology" ("*Realtechnik*") consisting in the production of material artifacts, the application of respective operations and "the clearing of the totality of operations and means of actions to dominate nature" (1923, 9). If one adds the embedding in social contexts one has to extend the concept of progress to perspectives which imply social, economic, and other factors, notably nowadays ecological ones. With the introduction of a concept of *socio-technical* progress however, the specific traits of the concepts of technical and technological progress in the narrower sense might easily lose precision. Therefore, this terminological shift is not generally to be recommended. Generally speaking, the overall direction of technical development to be called "progressive" cannot be understood purely as an outcome of just economical or technological details by themselves, but as a complex systemic interplay between different kinds of factors without just obtaining linear causality of one factor only.

Many authors stress that there are mutual dependencies to be taken into consideration for the explanation of technological development which can only be grasped in a multidimensional analysis. That means, generally speaking, that the concept of a general or an overriding cumulative and ever-escalating progress with a kind of proper or *eigen*dynamics of its own ("*Eigendynamik*") turns out to be an integrative interpretative construct which can only occur from a permanent interplay of and with all the mentioned fields of influence and agents engendering the rather great complexity of contributions, interconnections, and factors. What we can call "the societal state of progressiveness or progress" is thus a complex integration of many detailed factors and processes as well as subsystems of different kinds. The fact that the probability of improvements and advancements is always to be increased and to be assessed in terms of and/or dependent on the respective previous state of development in technology, science and other societal factors of influence also determines the quasi lawlike basic form of an exponential growth of technical (including technological) progress. This is particularly true with respect to the acceleration phenomena.

With regard to moral assessments and judgments of responsibility it is difficult, if not impossible, to attribute in rather complex realms of synergetic and cumulative effects, in view of the mentioned systems effects, the responsibility for the application and implementation of detailed aspects of progress to just one individual technologist or researcher. If the development and acceleration do indeed depend on a multiplicity of mutually escalating interconnections and interplays, it is not possible just to attribute the responsibility to just one person or single institution. However, in the wider perspective of responsibility for prevention (preventing of accidents, disturbances or even catastrophes) and for the attitude of trust or stewardship for eco-systems etc. (as stressed by Hans Jonas in his book *The Imperative of Responsibility*), certainly individual persons partaking in contributing, namely technologists, engineers and, generally speaking, many members of the technological intelligentsia do bear a certain co-responsibility, although they cannot always actually or grossly be attributed the total moral responsibility for the implementation and application of their discoveries and developments, if the respective harmful effects could not even possibly be foreseen by them or anyone in advance. (This is the problem of individual responsibility of the technologist or engineer and the scientist in applied research which cannot be dealt with here in detail.) Generally speaking, however, the splitting of individual responsibilities and the contribution of different kinds of responsibilities to different bearers as, e.g., collectives or persons as role or position-holders, moral agents etc. would pose real and difficult problems which have not yet been analysed in a detailed manner and certainly not been solved to date. It is true, that there is collective responsibility for the implementation and application of technical operations, procedures, and enterprises which has to be borne by human beings unless a thesis of a quasi "natural" technological developmental process with a kind of proper dynamics of its own could be defended. Technology is an outcome of human activities and initiatives and can only be dealt with in terms of responsibility and moral duties etc., if we refer the pseudo-collective systematic responsibilities to the human decision-making beings themselves. It is the acting human being who develops technology, if in a multiramified and a synthesized accomplishment of combinations and collective activities as well as networks of accomplishments. This has certainly consequences for the extension of the concept of responsibility which cannot be deductively reduced, but has to be referred to the respective individual responsibilities of the acting and partaking persons in an operational manner. In particular, one has to take into account the responsibility of prevention and stewardship with special regard to misuse and ommission or neglection etc.

In technology and industrialization many technical progresses without the adequate social progresses have become problematic as we know very well. Can we say, then, that technical or technological or even "*the* progress" (whatever this interpretational construct may mean) can be responsibly attributed to somebody? Apparently not. However, knowledge in science and technology and the respective technological progress is certainly posing a problem which grows in parallel with the increasing power of technology in many realms of our society. In an age of pervasive technology, responsiblity for technological progress(es) does pose a much more pressing problem than just armchair-science did in earlier times. Together with the increase of dispositions and range of effects of technology certainly the responsiblity grows considerably. Cannot even knowledge be misused? Is the separation between pure science and technical application still to be neatly carried through? Certainly not in view of an ever-growing technicalisation of science and simultaneous scientification of technology. The differences between basic research and applied research or technology are amounting just to differences of accents; the borderlines between these realms become more or less fluid. Has not any knowledge whatsoever, any technological development and discovery a certain kind of ambivalent characteristic with respect to implementation (as the Roman god Janus would have insinuated)?

Generally speaking, the moral and ethical problems of applying technological procedures are certainly not new. Any knife could already be misused in earlier times. Only the range of effects, the magnitude of risks have vastly grown – up to the danger of selfdestruction of humankind. In addition, the unforeseen side-effects have grown with the range of actions, of technological effectiveness to such a degree that the traditional ethical regulations of behavior to which man has accustomed himself within the sociobiological evolution of group organisation etc. seem frequently or even notoriously to be overcharged or overstrained. The ethics of "love thy neighbor" does not any more suffice in an age of global pervasive technology with remote interconnections, instantaneous interactions and even remote effects to or in other continents. If just pressing a button can kill hundreds of thousands of humans or deprave or harm millions or even humankind in total, traditional regulations of actions and their respective motivating concepts having been developed from face-to-face group situations in our sociobiological evolution will certainly fail. It is not only the solution of technical problems and just the increase of technological and technical progress (though they are necessary indeed insofar as we are dependent on them) which literally determine our future, but also notably and prominently the social, political, and ethical problems which have to be solved and have been so much underrated in the last decades. Certainly, we are dependent on technical and technological progresses, but we have to apply them and to implement technical developments in a wise manner. This wisdom to be sought or searched for is still the traditional task and asset of philosophy. Philosophers to the front! We have to meet this mundane challenge, i. e., to develop a comprehensive ethics including individual and collective agents in an age of pervasive and ever-accelerating technology.

In proportion with this progress and the power of technology, again *technologically* multiplied to the extreme, mankind's responsibility would grow if not even explode. Today much more than hitherto, large-scale ethical and moral problems usually evolve in connection with the extended technological power of man to dispose of our non-human environment, of nature, the power to manipulate and temper life, even human life itself. Because of man's tremendous technological efficiency and huge power of technological action, a rather new situation for ethical orientation seems to be evolving which apparently requires some new rules of behavior. Even if the basic principle of goodness may remain constant, the executive rules applying ethics to the conditions of today must be developed further, must be adapted to new possibilities of behavior, action and side-effects, including also extended institutional settings and new institutional responsibilities, all of which would pose very tough questions to tackle with. Eventually we discover, and at time suffer from, limits, paradoxes, natural and social traps, phenomena of overcharging resources, overburdening systems, overworking capacities, etc. Technology assessment thus becomes a matter of necessity and, which I deem very important, of anticipation. Technology assessment has to be anticipatory - and, indeed, also participatory, i.e. "democratic" so to speak.

But, relating to ethical questions of responsibility, what is a viable new characteristic description of the overall situation? Let me only shortly mention six faxtors.

First, the number of people affected by technological measures or their side-effects has increased tremendously, as everybody knows. Second, natural systems are now an object of human action, at least in a negative way: Humans can permanently disturb or destroy them by their technological measures. One might think of the problem of the ozone layer and the one of human-made carbon dioxide overproduction. Third, man does not only seem to have a common object of technology in the traditional sense of the term, but he has become an object of collective and individual technological manipulation, not only by pharmacological means and in terms of mass suggestion and subconscious influences, but potentially also by genetic encroachments on human hereditary stock by genetic engineering. Fourth, moreover, we seem to observe a progressive trend which might be called a systems technological or informational technocracy, or, for short, *systems technocracy*. This would be a technocratic trend in combination with bureaucracy or red tape and progressive development of microelectronics, data information, data retrieval and processing, etc., in administration, in handling computer aided-systems, organizations, information systems, etc. Personal privacy seems to be endangered by all these developments if widely implemented, and all the phenomena of data protection and other problems related with the information and systems revolution emerge. Fifth, a new kind and extension of technocracy also seems to display another very important component.

Edward Teller, the so-called father of the hydrogen bomb, stated in an interview that "the scientist or technologist ought to apply everything he has understood and should not put limits on that. Whatever you understand you should also apply". This statement constitutes, to my mind, an overstated ideology of technocratic feasibility. It turns, so to speak, Immanuel Kant's old dictum "*Ought implies can*" into a reverse technological imperative, "*Can implies ought*". Whether or not humans are allowed to, or even ought to make, apply, produce, initiate, carry through everything they have been able to make , or they can make and do in the future, certainly comprises a specific and precarious ethical problem, indeed.

Sixth, in view of the increased possibilities of effects of manipulation in the biomedical as well as in the ecological context, the problem of responsibility for unborn individuals and generations for the future of humankind, of natural and partially manmade ecosystems and even for natural species is getting new and even dramatic emphasis.

For more than a dozen years I used to be member of the respective working group of the German Engineers' Association (*Verein Deutscher Ingenieure*) in the subgroup "Man and Technology: the engineer in profession and society" which developed a guideline, the so-called "*VDI-Richtlinie*" VDI 3780 of the German Engineers' Association, which had been officially accepted in 1991, after twelve years of cooperation and dedicated committee engagement. The title of this guideline is "Technology Assessment: Concepts and Foundations" ("*Technikbewertung: Begriffe und Grundlagen*"). The thrust of this work consists in highlighting and defining the significance and function of various socio-technical and social systems including non-technical values for technology, for technical decision-making, technical acting, etc. The idea and task is to instruct, to sensitize and help the practitioner in planning and technological decision-making, but also the reflective engineer on the job with regard to the role of values, notably social values, to goals, aims, attitudes, needs and specific interactions of these mentioned topics in technological planning, acting and decision-making. The idea is certainly not to give "ex cathedra" decrees. We cannot relieve the engineer or politician of technology or the manager or entrepreneur of his or her responsibility of deciding, but it was first of all necessary to see the characterisic traits of the traditional technologies. The German Guideline VDI No. 3780 did not explicitly deal with the new functions, features, and trends of the so-called New Technologies getting into relief ever more prominently.

## II.

What are now the very new developmental characteristics of modern New Technologies and of their ever more encompassing impacts?

Surveying the classical interpretations of technology, e.g. as extension of human organs (Kapp, 1877), as "realization and reification from ideas" ("*aus Ideen*"; Dessauer, 1956) and as productive self-realization by working on and encroaching into nature (Marx), one gets a whole bunch of aspects, pertaining to what has occasionally been labelled "*Realtechnik*" ("real technology" and/or material technics) which does not seem to be readjustable to just one main fundamental trait but opens up a whole spectrum of diverse elements. All of these would appear only together grossly to characterize or comprise the multilevel phenomena of modern technological and sociotechnological development. It seems fair to state that not just one unique trait characterizes techniques and technology or even "the essence" of technology, but that only a pluralistic description and theory of technology can cover all the general fundamental traits. That would mean that philosophy of technology has to be a pluralistic discipline or to choose a pluralistic approach. Just one-factor theories of technology, only highlighting just one trait (e.g. "the domination of nature") is but a much too global and skewed interpretation hardly sufficient to cover all the different levels and aspects of modern technology and technological societies.

This is true all the more since in our "informations- and systemstechnological era" (Lenk 1971) regarding its ever narrower enmeshment of systems and relationships within systems as well as regarding the connection by handling and controlling information in worldwide networks, by growing scientism and industrial comprehensive organisation and management technologies, by rather abstract procedures and generalizations and formal and functional approaches.

This is a general and quasi law-like trend covering increasingly comprehensive outlooks. Thus, an interdisciplinary theoretical description of technical objects, operations, procedures, and systems (including sociotechnical structures and technological action systems as well as environmental, cultural and political conditions or influences (not to mention economical ones)) has to be taken into consideration by a pragmatic and reality-oriented philosophy of technology. Therefore, a pragmatic philosophy of technology has to identify and distinguish all of the intriguing practical trends within the different fields of technological and socio-technological development supplying a certain kind of total view of the phenomenon of technology and historical trends as well as cultural traditions and new, rather revolutionary outlooks caused by technological breakthroughs (like the information "revolution" or systems engineering and systems technology management as well as bio-technologies).

In what follows I would like to give a characterization of rather new traits and features of modern technology, in particular the so-called New Technologies, which have recently gained considerable weight and are still getting relief in the overall technological development, but concerning particularly pioneering areas thus shaping our technological future.

By the way,I do not pretend or claim to have discovered totally new structural characteristics of technologies, but my aim was to highlight the importance of tendencies, aggravated impacts and describing the ever-enlarging influences as well as penetrating trends of notable features of technics and technology which have gained much weight in the last half century. I am not interested in a clean or meticulous definition of a concept of new technologies, but in describing and emphasizing a newly dominating trend of in part maybe "old" characteristics and features or as well as trends. (The phenomenology of talking about "characteristics" may be a bit misleading invoking some essentialist connotations – which is not my aim, indeed; it might be better to talk about new important tendencies getting relief or even taking over or overarching traditional trends and phenomena.)

In the rest of this paper, I would like to present the following ***10 characteristic traits or feature syndromes*** of the modern technological world and techno- as well as social systems particularly dominating and gaining outstanding relief in and by the ***New Technologies***.

### a) Proceduralization and Operationalization

*Operations, procedures and comprehensive processes as well as concentration to operational essentials in technology*: Technology does not only consist of machines, instruments and other technical products, but there is a growing and accelerating importance of and orientation at technological *processes, operations, procedures* etc.

In short, operations technologies, process control and procedural phenomena are outstanding features of modern technological and industrial production and development (see my 1971, 133f)[2]. The procedural has gained weight and is still getting more and more leverage, whereas the systems of artifacts ("*Sachsysteme"*) do not lose any importance whatsoever. These phenomena would now be as important as energy-transforming machines and assembly-line production when they became widespread.

Essential are not only procedures, processes, and methods, but also, increasingly, *methodologies*: this trend is to be found in all science-based technological developments as well as in administration (led by systematic, methodical or even methodological process control, systems engineering, operations research etc.).

To be sure, artifacts and their systems can be differentiated and divided up according to some qualitative and quantitative aspects like automatization and robotization (see g) below), miniaturization or even nano-technicalization, pertaining to horizontal and vertical expansion and interaction as well as interpenetration, according to higher levels of abstractness and universal management procedures (see above a)) as well as regarding so-called new technologies (e. g., information technology), computer modeling, simulation, and controlling (including robots and nanosystems), as well as biotechnology (notably gene technology) etc. It has to be emphasized (Ropohl in Lenk-Maring, eds., 2001, *102f*) that the development of artifacts and their integrative systems would require much more *technological* knowledge and ability as, e. g., science-based and just operation-oriented approaches, simulation of prototypes and models (prior to materialization).

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[2]. By this, I would not like to insinuate that processes and procedures take priority over artifacts and real technology ("*Realtechnik*"), though - I admit - the quote of Häussling's ( 1995,1998) rather pointed statement "the *real* nowadays is the procedural" might be irritating in that respect. I certainly agree that artifacts and machines as well as "real technology" in the traditional sense is necessary. Indeed, there is no formalization, proceduralization and algorithmization nor "virtuality without reality" (Ropohl), i. e. without artifacts, objectification and reification in technology. However, robotics or robotization, automatization and formal or ever more formalized procedures as well as organizational, so to speak meta-level technologies, of structural management systems, information systems and systems technology are gaining much more momentum these days (which I myself, by the way, predicted in 1971).

Ropohl puts in extra categories the special field of the *application* and study of *utilization* of „artifacts" and their systems („*Sachsysteme"*) in everyday connections and the respective consequences regarding growing one-sided as well as mutual dependencies, and alienation as well as invisibility and lacking penetrability and lacking spontaneity or human intuition. But this just means that the mentioned consequences would indeed obtain with respect to general systems technocracy, the endangering of privacy regarding data retrieval and, frequently, the degradation of noticeable and operative responsibilities for collective and secondary, i.e. institutional and corporate, actions.

**b) Informa(tiza)tion, Computerization, and Modellization**

It is by way of abstraction, formalization, computerization, and informatization, as well as by the use of formal and functional operations technologies (e.g., flow charts, network approaches etc.) that the increasingly comprehensive processes, organizations and interrelations of different fields and subfields are integrated. *Information technologies lead the way*.

Universal machines like the computer provide a certain abstractness, the software-determined use of programmed processing and control. Universal machines and technological as well as techno-organizational systems are advancing fast, progressively maximizing all the mentioned features of flexibility, speed, "intelligent" machine autonomy, adaptivity (if not "learning"), exchangeability of parts etc.

## c) Multiple Application, Interdisciplinary Interaction and Flexibility, Modularity

Interfering by and intermingling by way of interrelations and the wide interdependence of technological products and processes: Indeed, by way of the interdisciplinary, formally systematized, functional integration and interrelation of generalized operations and by systems engineering in all walks of life, we are getting a texture woven together by mutual dependencies between all the realms of life that are susceptible to systematic technological, informational, and operational manipulations (including economical ones). Interdisciplinarity is frequently led by spill-overs between different sciences and technological developments, innovation, and implementation – as well as to society at large. It characterizes the embedding of the interdisciplinary interactions (*stimulation or even "interstimulation"*) within the overall developmental purview. Systems technologies by themselves require interdisciplinary approaches in theory and practice.

Computerization and software models allow a somewhat risk-free and inexpensive simulation and/or the testing of the models of technological constructions and developments in advance. This is a feature of a rather general, if not universal, scope for adapting models in science, planning, and administration; systems organizing and management endeavors are rendered much more flexible and easily variable than hitherto.

Model simulations indeed provide flexibility, adaptability, risklessness: Computer models, software programming, and other successful attempts at improving and optimizing the relevant models by way of computer programming and visual computer-graphic construction usually provide and render efficient, inexpensive and fast solutions to many design and construction tasks of all kinds (including scientific modeling, technical construction and development of new machines, procedures, and systems in the narrower sense). (This goes even beyond the analytic solubility of mathematical equation systems.) The computer has turned out to be a universal, easily feasible and employable representative "*can-do-anything*" instrument providing extreme variability, easy detours and enormous energy- as well as cost-savings posing virtually no physical resistance or obstacles, since the respective model improving is conducted in advance and without real risks.

In all state of the art technologies there is a comprehensive trend towards these modules, functional building-blocks, and functionally integrated microprocessors, which can be inserted, by way of adaptable connections and exchanges of chips, within other modules and systems – and even in sets of new constructive elements.

This does extremely increase technical progress and development as well as render possible and support the exchangeability of obsolete parts or modules. Thus, *modularity* of parts and elements provides a universa(lizabi)lity of applications of the respective parts and modules also within other processes and instrument systems, ("flexible production systems", Ropohl, 1971). Interfaces are relatively open and guarantee a full spectrum of options, possible ramifications, and modifiable applications. Thus, connectivity, flexibility, and the dynamics of development – as well as multiple and tendentially universalized applicability of partial technical solutions – are enhanced.

## d) Comprehensive System(atization)s and Megamachines

The mentioned three trends lead to a comprehensive systems interlocking effect - even to a kind of positive feedback amounting to systemic interaction and generally to systems acceleration of interactions across different fields, notably of different technological developments including those in economic and industrial realms. (This is a trend which had already been predicted by Gottl-Ottlilienfeld (1923): "mutation", "filiations" and intensification of different progresses across traditional realms: a sort of mutually interactive spill-over effects and of what we nowadays would call positive feed-back processes).

There is a tendency to conceive of the whole world as technology-dominated, manipulated, organized, and shaped by technosystems. Even ecosystems and social systems become artificially encroached-upon eco-technosystems or socio-technical systems, respectively. The trend towards a „mega-information-system“ and even „mega-machines“ is enhanced by the functional overarching and by meta-levels of the mentioned technological and operational processing and the multiple applicability of processes, machines, and programs. Systemic methods and methodologies and science-based as well as abstract and formalized strategies are certainly getting headlines, ever more importance and impact on planning and construction processes. Indeed, automatization, formalization and such abstract strategies attain relevance, momentum, and importance together with the refined "real technology" of the artifacts and technical bases. There is no "either ... or" nor "neither ... nor", but an important mutual interaction and interpenetration of both tendencies, whereas the meta-level formalization of many systems approaches is indeed a rather new feature like informatization and automatization or robotization in general. To be sure, the discussion of characteristic features here is, philosophically or epistemologically speaking, a methodological one (this does not mean that engineers themselves always are intentionally using philosophy of science methodology or so).

In addition and by contrast, there are intriguing trends towards *miniaturization* and now even the development of *nanotechnology* as a special field of its own which favor ever more miniaturized technological subparts, elements, and building blocks (in the figurative and literal sense). This might eventually produce another kind of „danger": the „chipification" of almost everything. If combined with an ever-increasing miniaturization, micro-systems technology, and nanotechnology will not only extend the technological availability and manipulability of all sorts of information-management and systems-regulation processes, but also engender dangers of the spilling-over of minute faults and failures etc. from the respective micro-levels.

## e) Multimedia Technologies, Techno-globalization, Virtuality, and Artificiality

There are systematic and accumulating combinations of the technomedia (*"multimedia"*) booming indeed. All these processes and developments of the technicalization of the symbolic, of virtual representations and their respective interpretations, lead to a kind of co-action and co-evolution of different and diverse information technologies and media. Moreover, there is an ever-increasing generalization, even a tendency towards universality, and a common or joint impact as well as systems integration of these information technologies and media; we seem to be living already today in a multiply-mediated technogenic world impregnated by multimedia, in a *multimedia technoworld*.

We nowadays even find a *technicalization of the virtual and fictional*: The virtualization of the artificial and symbolic worlds in information technologies as well as in technology-based images and models including imagery-modeling superimposing themselves take on real life characterization and the respective interpretations[3].

"*The real*" and the virtual *cyberworlds* overlap rendering a*rtificial environments and the partial worlds widely made up of artifacts and informations*, notably by technogenic relationships, properties and technological systems, processes and objects. We would nowadays metaphorically, if not virtually, talk of an "*artificial world*" we are living in. (The "*second nature*", the "*symbolic universe*" mentioned in the last century by the philosophical anthropologists Plessner, Gehlen and Cassirer has in fact turned out to be a rather *technological* world now gaining primacy almost everywhere on this planet.)

It is a comprehensive *globalization of technology* and at the same time a *technological globalization* of the world. The overwhelmingly global success of technology and the technicalization of almost everything leads to a new unity of the world – engendering a new "technogenic world", a technologically integrated, informational and, consequently, interactive one on a planetary scale. Indeed, to a large extent we seem to live in a *media-electronic global village*.

## f) Telematization, Techno-reality, and Systems Historicity

Telematization of almost everything being (re)presented at all, the world-wide ubiquitous „electronical“ presence ("*hic et nunc et potentialiter ubique*") will make the idea of a *global information village* come tendentially true - not only in passive attendance or ubiquitous media coverage and (pseudo-)presence. But there are also already locally separated, but functionally coordinated teams working on giant „delocalized“ or separated projects or abstract "dissipated“ systems enterprises, designs, or networks (e.g., *via* the Internet). The "second nature", the technology-enacted "reality" engendered by information networks takes on relief and will be

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[3] The technicalization of the virtual and virtual world is a very noticeable fact everywhere in highly industrialized media & technology systems and in information and communication technologies we all now use and and more or less "live by. There is the problem of gaining "secondary reality" of information systems, e. g., most notably the Internet and other information and electronic systems technologies impinging more and more even on economic and political as well as "real life" decisions. In particular, real-time and online decisions have nowadays worldwide impact on this planet (see stock rates) as well as economic and social reverberations.

getting ever more impact[4]. The media technicalize (a kind of) reality, indeed constitute a techno-enacted reality. This second-hand informational reality gains momentum and social impact, has already become a "*socially real* reality", a "socio-(information-)technological" one, an *IT-reality*, so to speak.

Moreover, a characteristic *information-technological historicity* has been developing in complex systems: Not only comprehensive information systems, expert systems, and computerized decisionmaking systems which are designed, developed, operated on and controlled by many programmers and agencies take on a certain "history" of their own and history-dependence („*historicity*") that mirrors the development of "the system" thus far, but also a representation of world history by and in the media systems seems to display a peculiar historicity for this "media-ted" virtual reality: "*quod non in systemis non in realitate*": Ironically, but really it seems to come true that "everything that is not in the very systems is not (any more to be considered) real".

## g) Robots and Remote Control, "Intelligent" Technology and Systems autonomy

New electronic and multimedia technologies allow remote control and intelligent sensing at a distance or in unaccessible environments (e.g., robot manipulation in nuclear plants, in nano compartments and environments, or in outer space technology), thus multiplying manipulative and technological power in extension and scope; it also allows us to speak of reactions of the technological instruments and systems as "intelligent". *Robotization* will proliferate and be widely disseminated in all fields of future technology-guided production.

Again, we may in fact improve the manipulation of far-reaching information systems and remote effects (including in interplanetary unmanned spaceships or satellites and in nuclear plant chambers) as well as in chemical reactors and regarding chaos technology for manipulating the state or phase space orbits of complex dynamic systems etc. Here, thus far unapproachable constituents and components as well as processes seem to come into the reach of technological manipulation – and even some kind of control, though maybe of a very indirect provenance.

Not only in sensing and remote control instruments and systems are feedback loops built in, but in a plethora of instruments and systems more and more sensitive feedback control and "intelligent" "decision-making" techniques and "learning"

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[4] I am not denying thereby the extant phenomena of degradation and decay in information storage via electronic systems, but I claim that very complex information systems take on a quasi life of their own insofar as no individual person or programmer can survey any more *all* the developments of a very complex distributed net functioning by co-operation and via all or, rather, practically innumerable parallel influences of millions of interactive users and programmers. Certainly, we should - in view of the acknowledgement of this "secondary", primarily social or human-made, "reality" of the information systems and networks - not forget about the technology-enacted and -based "artifactual" reality in the rather traditional machine-oriented and material sense. However, the secondhand information reality has indeed become a "real" effective reality by now – at least socially speaking (see also below).

procedures are progressively gaining momentum. This provides a kind of flexible systems autonomy or, at times, error-correcting ultra-stability.

Even in the designing, building, checking of machines, programs, technological and organizational systems there is a tendency to eliminate human interference: Machines build machines, machines check machines, programs control and check machines, programs supervise programs... In effect, this involves a meta-level technicalization in terms of a higher-order self-applicability of overarching abstract procedures, programs etc. amounting to a sort of "reflexive" or "self-referential" self-applicability – a meta-feasibility and metafunctionality of sorts or even a *meta-autonomy.*

## h) Artificial Technological Needs and Problems-generation

There is an outstanding trend towards artificial technological needs and problems-generation engendered on the basis of potential solutions produced by *system(at)ic searches for multiplying and exhausting the options* including possible utilization (Klages 1967): Even for R&D in technology the *social systems character* became obvious already some decades ago: There is a signifcant tendency systematically and methodologically to sift and exhaust potentials, possibilities, and options[5] (e.g., by the so-called "morphological matrix" after Zwicky, see Ropohl 1975, 1978). Frequently, only *after* having detected several products, processes, or procedures in a systematic search an application will be launched or even a new "need" might be discovered, created, or even manipulated now to be satisfied by the technological development already completed. Sometimes, the technological solution or invention would precede the need or the problem to be solved (as, e.g., Marx had already predicted in his philosophy of technology).

## i) Socio-systems Technology and Systems Technocracy

Systems orientation as mentioned, systems engineering and the managing problems of social systems lead to interlocking socio-techno systems (Ropohl). Even in technology *per se* an intrinsically inseparable, indissoluble *social systems syndrome* is provoked by the ever-growing, ever-accelerating, ever more encompassing technological measures intrinsically embedded in social contexts (cf. Lenk and Ropohl 1975, Lenk 1982, Ropohl 1996). (We should even extend the systems perspective to include ecological factors and talk of ***s***ocio-***e***co-***t***echno systems, "SET" systems for short, see Lenk 1994, Lenk-Maring 2003.)

As predicted by the author already twenty-five years ago (1973), *systems-technocratical tendencies* will gain impact and importance. This means that many different political, cultural, and human(itarian) problems of modern societies will tend to be conceived of and discussed, as well as attacked – and maybe partially solved – by *systems-technological* means. Systems-technological administrations are currently gaining momentum everywhere. The computerization of almost everything runs wild (including the „booming“ grey zone of computer crimes). Systems-technocratic dangers seem to be intimately integrated with the encompassing

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[5] Gehlen deemed a new paradigmatic feature of the most modern technology the tendency "to vary (or modify), probe all the means of representation and thought, the very kinds of procedures and processes ("*Verfahrensarten*"), to invoke all possibilities until exhaustion and to look for the consequences" (1986, 169), i.e., systematically to test all possibilities and options - technologically speaking, but also in terms of utilization.

systems-technological approaches raising the intriguing (and in part new) problems of *personality- and data protection against informational tapping, information invasions, and encroachment*: With respect to information technologies, social and legal problems of data protection and privacy, as well as protection of the integrity and dignity of the human person and aspects of *human(itarian) values* and humaneness, even of what it means (and when the embryo starts) to be human – all these problems are now getting a particular urgency – notably in applied information technology and biotechnology.

Systems-technical and information-technological multiplication of impacts, whether of technological success or failure, are extant. With the nearly unimaginable explosion of human technological power in the vast extension of energy technologies and systems as well as information technologies, the respective direct and indirect consequences both of success (domination and manipulation) and of failure ("catastrophes", "accidents", "normal" after Perrow or otherwise) will pose extraordinary problems to deal with. Indeed, they seem to grow beyond any potential human grasp (in the literal as well as in the figurative sense).

Another variant of systems-technocratic dangers is highlighted by the *susceptibility to sometimes unnoticeable risks*: The encompassing intertwinement of systems components within all-comprehensive socio-technological systems in general implies a certain susceptibility or proneness to risks as could be experienced several times by electric blackouts of whole metropolitan areas etc. Risk susceptibility of highly developed and densely intertwined systems is a kind of very "real" systems-technocratical dangers, too. Some technically engendered dangers (e.g. radioactivity) may even go unnoticed by the affected beings. (The sociologist U. Beck even coined the expression „Risk Society" („*Risikogesellschaft*") – somehow a misnomer as a *general* characteristic.) Comprehensive information systems are particularly exposed to risks as by, e. g., viruses, cyber-terrorism etc.

## j) Socio-eco-technological Systems and Social Responsibility

Ever-extending systems-technological trends and the exponential enlargement of the power of encroachment by multiply distributed technological systems, "big technologies", "big (applied) science", or even worldwide technological systems) pose tough ethical and legal questions of responsibility. What are requirements and limits of individual and collective or corporate responsibilities and of their distribution? There are intriguingly new responsibility problems for the (still human-made) technological world,the socio-eco-techno-systems and events therein (cf., e.g., my 1979, 1982, 1992, 1994). These hard problems come up and often amount to real moral, political and social conflicts or even "social traps"; they seem to present insoluble tasks of how to deal with and divide up, distribute, or share responsibility bearable in practice. Technology at large appears to take on the histori(sti)cal characteristic of a fate or destiny. At the same time, the survival of humankind, essentially and cumulatively, appears to depend on a rather smoothly increasing technological, social, political, economical and ecological („susttainable") progress. However, the auspices of the ever-accelerating technological progress on a worldwide systems scale (including "globalization" effects of and in international organizations and in the world-wide economy seem to take on a vast and accelerating expansion and momentum. Consequently, the responsibilities not only for the onset and development of the general systems phenomena, but also for the detailed consequences of the respective technological intertwinements, even for individual decisionmaking at strategic points, can hardly be borne by individual persons, given current legal and moral responsibilities. Large realms of socio-technical developments seem to evade responsible decision-making and any willingness to accept such a responsibility.

We have to develop new strategies for identifying and handling as well as distributing not only individual responsibilities in complex socio-(eco)-techno- and socio-economic systems, but also to cope with the notorious problems of *collective and corporate* responsibilities (French 1984, Maring 2000) and the respective conflicts between different types of responsibilities (Lenk in Mazour-Chumakov-Gay 2003 and in Mitcham, in press, Lenk-Maring 2oo1a). All these responsibility problems are especially characteristic for the New Technologies in all dynamically interacting complex social and socio-technical systems. The New Technologies have indeed multiplied the worldwide extension of systems technologies and information as well as communication systems. Priority rules, relevant legislation and law enforcement, associations-based Ethics Codes and international political requirements have to go hand in hand to hopefully guarantee practice-orientation and operationalization of ethical and humanity-oriented value concepts (see my 2003a)

Concluding my list of structural characteristics of modern technologies I would like to summarize: These traits, especially those pertaining to so-called new technologies seem clearly to oblige us to extend descriptions of the structural features of technology and technologies beyond any of the traditional accounts and characteristics of classical technologies.

It may be an interesting task for the near future to analyze combinations and conditional relationships among these characteristic features, and to allocate them to particular technologies, technological fields, and engineering disciplines – as well as to socio-technical contexts and problems. But that remains a task for future studies. The present attempt to the systematize the features is as yet far from being complete and comprehensive. However, it is worth going on to work on such a systematization in the future - maybe in an improved and expanded cooperation by younger philosophers and social scientists of technology and applied science from the East!

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