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A Philosophical Analysis of Its Subject-Matter and Methods

Stig Andur Pedersen
Johannes Witt-Hansen

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IMFUFA ROSKILDE UNIVERSITETSCENTER
INSTITUT FOR STUDIET AF MATEMATIK OG FYSIK SAMT DERES FUNKTIONER I UNDERVISNING, FORSKNING OG ANVENDELSER

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af Stig Andur Pedersen & Johannes Witt-Hansen

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Abstract:

Futures research is delineated as a normative and constructive activity aiming at determining the direction of the process of development. Its methods are discussed, and the role of scientific reationality in studies in futures research is criticized. The posibility of transgressing a given epistemological structure or theoretical framework which characterizes the development of natural science is an important problem for futures research. The tension between scientific rationality and transgression (Schritte über Grenzen) is emphasized as a main problem for futures research.

FUTURES RESEARCH. A Philosophical Analysis of Its Subject-Matter and Methods.

Stig Andur Pedersen and Johannes Witt-Hansen.

1. The subject-matter of futures research

The reader of books, treatises or journals dealing with futures research look, generally speaking, in vain for a thorough investigation of the problem concerning the subject-matter of futures research. The negligence or unawareness of this problem has had a prejudicial or even damaging repercussion on the discussion of the methods of this discipline, which often bears the stamp of one-sidedness or distorsion. We are here confronted with problems which are not so easily solved as might seem at first sight.

In the first place it would seem that the common sense contention that the subject-matter of futures research is "the future" or "the future as such" is void of meaning as is the suggestion that the subject-matter of historical research is "the past" or "the past as such".

Of course, it is not the exclusive privilege of futurologists to deal with the future. Astronomers and meteorologists do so as well. But one one could not be serious and maintain that the subject-matter of astronomers and meteorologists is "the future". Roughly, we may agree in saying that the movements of celestial bodies are the subject-matter of astronomy, and atmospheric phenomena that of meteorology. Nevertheless, there is a strong inclination for saying: "Since futures research deal with the future, its subject-matter must be "the future". This propensity is supported by the use of terms like "futurology", "future studies", and phrazes like "alternative futures", or by book titles like "The Year 2000". The same propensity is encouraged by loose talk of "predicting the future", as if "the future" were a special interesting event.

Naturally, it is not our intention to challenge the position that predictions, forecasts and prognoses play an important role in futures research. But since the Delphi-method attacks problems of the form "when will this or that be the case", its application arouses easily the impression that "the future" is a special fascinating event or object of investigation which,

apart from the time parameter, is fundamentally different from the object of historical research. Uses of the Delphi-method ask, for instance, the following questions:
When shall we have airfields placed on the Ocean? Answer: 1982.
When shall we have all-weather-take-off-and-landing-control for aircrafts? Answer: 1987.
When shall we have nuclear fusion plants? Answer: 1987.
The questions were asked in a Japanese Delphi-investigation from 1971.(1)
A critic of the common sense view that "the future" is the subject-matter of futures research has remarked scornfully: "Since the future does not exist, future studies are logically, and from the point of view of theory of science, impossible". The anti-critic replies of course by return:" Since the past does no exist either, historical research is logically, and from the point of view of the theory of science, likewise impossible". If such arguments were valid, the objects of the research of futures, and the objects of historical research as well, would be "empty sets". And of course they are not! The historian will have no difficulties in outwitting his opponent in such debate. He needs only to refer to the fact that historical science is a well-established science with a rather well-defined field of application. The futurologist's position is more difficult. His science is as yet not well-established since even the debate concerning its subject-matter has not yet come to an end.
Let us start with the time-honoured counterpart of futures research: historical research!
Even though the historian better than the user of the Delphi-method, and with greater success can ask and has asked questions beginning with WHEN, one of the founders of modern studies and critique of sources, Leopold von Ranke, has maintained, in his Geschichten der romanischen und germanischen Völker (2), that historical science should not foremostly find out WANN ES GEWESEN, but rather ask WIE ES GEWESEN, emphasizing the HOW at the expense of the WHEN.
In his Philosophie der Geschichte (3) Hegel takes a similar, but still more radical position. It is not the past as such that is

the subject-matter of history, but RES GESTAE, that is, "historical events" or "what happened in history". The events in question are of course events in economics, politics, war, law, morals. They are events in art, religion, philosophy and science, described in the different historical disciplines from history of economics, politics and war to the history of art, religion, philosophy and science.

Today this is trivial! But in Hegel's time it was an important discovery that there are historical disciplines different from dynastic history and history of wars. The interest in chronological and exact dating was put into the background at the advantage of what is called the historical process and the division of this process into periods.

In Hegel "the historical process of development" is the process which the human spirit in a broad sense (that is, as subjective, objective and absolute spirit), so to speak, traverses. This process is essentially a development of human consciousness of freedom, manifesting itself as a development of forms of state in the direction of still greater freedom. "The past" as such is not mentioned.

In Marx this point of view becomes still more articulate. The subject-matter of historical research is here human productive activities, that is, sexual, "material" and intellectual production, the corresponding products and the social relations implied by the productive activities in question. The products are human beings, "material" goods of any sort whatsoever, and art, religion, legal and moral rules, philosophy and science. The social relations take the form of family, state, classes, church, military institutions, and so forth. And the conflicts to which they give rise lead to wars, class-struggles, revolutions etc. This whole complex of productive activities, products, social relations and conflicts are elements of the historical process, of the historical development, whose driving force in the last analysis is "material" production. This whole complex, centered around the "material" relations of production is in Marx the subject-matter of historical research. "The past" as such is not mentioned. (4)

If we return to the research of futures as carried on, since Kant and Marx made their important contributions to this field of study, we discover that the subjects are, at large, the same as those of historical sciences. In future studies one deals for instance with war, that is, with military strategic problems. Indeed, modern futures research started, as a matter of fact, with problems of that sort (Herman Kahn, A.J. Wiener, Thomas C. Schelling)(5) And it was not until later that economic, political, moral, religious, philsophical and scientific problems were included. Art was not forgotten either. Congresses dealing with futures research since the end of the sixties and the beginning of the seventies bear witness to this effect.(6) Ecological problems are, moreover, problems to which futurologists have no privileged access. In 1847 the German botainst, Nicolaus Fraas, published a book with the title: Klima und Pflanzenwelt in der Zeit, ein Beitrag zur Geschichte beider.(7) However, in spite of this comprehensive community concerning subject-matter, the time parameter in the two sciences is of course different, and historical science and future studies are, in spite of the community in question quite different. RES GESTAE or historical events are unsubvertible. What has happened cannot be undone, notwithstanding the different interpretations of historical data. On the other hand, future events have aspects which are often overlooked. However, these aspects are of fundamental importance for the understanding of the special character of futures research as a scientific discipline. For even if an enormous development of methods and technique of prediction, forecasting and prognostication has taken place, certain future events, of special interest to futurologists, are in principle unpredictable. It is news to nobody that scientific discoveries and technological inventions are of ever increasing consequence as conditions for human life on our planet. We are direct eyewitnesses of this process. In the present context, however, it is crucial to realize that precisely scientific discoveries and technological inventions are in principle unpredictable. And that is true whether futurologists use the Delphi method, System Dynamics or the method developed by Marx. Examples of such discoveries or inventions are: the elementary quantum, nuclear energy, the double helix and the genetic code; the transistor solar cells, etc. Here it is important to know that futurologists in the " East" and in the "West" as well univocally acknowledge the impossibility of predictions of that sort. The Soviet futurologist, Beztuzev-Lada, for instance, points out that "it should be clearly understood that scientific and technological forecasting is not an attempt to predict scientific and technological discoveries which are essentially unpredictable (otherwise they would not be discoveries!), but an examination of possible variants of future developments in science and technology, by means of which scientific research, the allocation of the requisite capital, the deployment of scientific workers, and so on, can be organized more efficiently. The same is true of other aspects of forecasting".(8) And he makes this statement in spite of the political slogan concerning "the inevitable victory" of communism on a world scale.

Francois le Lionnais, science adviser to the French Institute of Advanced Scientific Studies, says in unison with his Soviet Russian colleague that "futurology must give up absolutely any pretensions at predictions as soon as it is a question of fundamental research aimed at crossing a frontier beyond which stretches completely unknown territory. One cannot, at the same time, know and not know. The illusion to the contrary (and we should not be led astray by the error of those who are victims of it) from the application of a philosophy, or intuition, or unscientific convictions, to a field which science regards as uncharted - whether temporarily or for all time - and which it is trying, or perhaps will try, to explore. Such intuitions and convictions may merit our respect, but any futurology worthy of the name should not take them into account".(9) This is perhaps such essential feature of future studies that is may used for delimitation of this discipline from other disciplines using forecasting and prognostication methods, for instance, meteorology. We may even venture the seemingly shocking and paradoxical contention that the subject-matter of futures research is "the unpredictable". Let us look a little closer into this paradox! If we listen to the criticism levelled at explorative forecasting, we have to admit that intrinsic in any explorative forecast is either the incitement to act in its favour, or the impulse to act directly against it. Since a forecast usually is heard by people ready to act, it carries within itself the seeds either for its realization or its rejection. Such prognoses are either self-fulfilling or self-denying, and are, consequently, essentially different from, say, weather prognoses or waterlevel prognoses, which can neither be expedited nor debarred. But of course they can be taken into account by definite precautions or preventive measures. Forecasts concerning the victory of socialism in this or that country furnish examples of what may happen to explorative forecasts, as do forecasts concerning the use of hydrogen in cars and aircrafts, or forecasts concerning disentanglement or even resolution of international or class controversies by non-military means.

Whatever may be the role of forecasting and prognostication in futures research, it should be understood that it cannot be its task to "predict the future" or to "have a look into the future". Consequently, it is not primarily the task of futures research to deliver predictions or forecasts of events to come; it is rather its task to construe them in thought as possibilities and promote their realization - or, conversely, to prevent these possibilities from coming into being. Here, again, it is worth while to consider and reconsider the possibilities presented for analysis in "Blueprint for Survival", "Limits to Growth", and in the flood of books and papers in the same vein, published since 1972. These publications have, by the way, nothing in common with the so-called Doomsday prophesies.(10)

To the futurologist it is a matter of course that "the future", that is, "future events", do not come into being in accordance with laws that can be described in terms of differential equations, exemplified by Laplace's "world formular". Futures research is, therefore, not essentially a foreshowing, predictory or prognosticating science, but foremostly a normative, constructive and regulative discipline.

A number of future events arise as a result of human decisions. Some decisions are necessary: If they are not made, then our existence is threatended (starvation, war, etc.) Other decisions are not necessary in the same strong sense. They are made because of human wishes. Futhermore, some decisions are of benefit to certain classes but a disaster to other classes. And some decisions lead to deep human insight and improve our lives, while other are degrading and impair our capacity for judging. The human future is shaped by a complex interaction among nature, society, and culture. Natural laws, social forces. as well as human desires and goals enter into this interaction as inseparable elements. And thus, the interaction of these elements constitutes the process of development. The subject-matter of futures research may, therefore, be defined as a comprehensive hybrid process: the process of development.

We may assume, then, that the subject-matter of futures research is the process of development in its hybrid totality - a process which has formed our past and present and is going to form our future. This process is not a finished and limited object in the same way as for instance, a cup can be said to be so. We are not more able to step out of it than we are able to step out of the universe. The universe manifests itself through material objects, animals, plants, forces, human beings, ets. The process of development manifests itself in an analogous way through natural objects (including technical constructions), animals, plants, human beings with their desires, projects and decisions, social classes with their demands and goals, etc. All this forms the raw material available to us as researchers. They can be studied and used as starting points for our thoughts about the future, about the direction in which we want the development to run, about the unavoidable features, etc. But there is no Archimedean point outside the process of development. We are part of the process and are forced to form our conceptions of it in its totality if we want to influence its course. As a consequence of this, futures research has to be a synthesizing discipline in contrast to the special sciences, say, physics and biology which are studying highly idealized objects such as elementary particles and genes.

Starting with reality as it appears today and with the traces which past development has made, that is, with history, our task is to estimate not only what we want future development to be like and what our possibilities are of attainning our goals, but also the likelihood of various consequences for ourselves and other people arising as a result of our attempt to influence future developments. As was noted above, our estimates, visions and arguments cannot be made from an Archimedean point. On the contrary, they will unavoidably and necessarily be partial or incomplete. It is our task to put together these partial results so as to create the best possible picture of the situation.

History, or the traces of development, constitute the basis of our subject of research. The future, however, is a fiction, a fictive artefact. There is nothing peculiar about the fictive character of the future. Every science makes constant and indispensable use of fictions: In physics we talk about mass points, in biology about genetic codes, etc. All these things are theoretical entities and, therefore, in a way artificial abstractions from reality.

However, it should not be overlooked or ignored that the fictions of futures research are basically different from the fictions of physics, biology and sociology. For whereas the latter have an explanatory and possibly predictory function, the fictions of futures research are directive, regulative or normative. Classical particle mechanics provides an explanatory model which includes many fictions. "The future", on the other hand, is a regulative idea, which may or may not come into being, and which cannot, without much ado, be used as explanation of the past or the present time.

Art as well as science contribute to the understanding of the process of development. Both provide visions of "the future" in the form of utopias or constructions for the realization of their elements. Although scientific discoveries and technological inventions are in principle unpredictable, science has, as part of the total process of development, a special impact on the shaping or development of "the future". Moreover, science is our most eminent institution of systematic knowledge. It is not only our most productive source of new knowledge, but is also in control of the knowledge at hand. An evaluation of our possibilities of control must, consequently, take this institution and its functions into account. This is the context in which the theory of science, conceived as a systematic reflection on science in all its aspects and meanings, is relevant to the research of futures.

2. The methods of futures research

Above, the Delphi-method and various methods of forecasting and prognostication were only loosely touched upon. We do not intend, on the following pages, to deal with these methods, but want to concentrate on the scenario method. This method has not only a central place among the methods of futures research, but is also, in definite respects, essentially akin to the experiments and, in particular, to the thought experiments, known from physics and biology, or known from Marx's analysis of the pre-capitalist and capitalist commodity production societies in "Capital". If we define scenarios as fictive situations related to the future, it becomes understandable that the scenario method is at the center of methods used by the investigation of the fictive processes of development to which we called attention above.

a) Counterfactual situations, constructions and propositions

In the experiments and thought experiments which play such dominating role in the construction of classical and modern physics, the so-called counterfactual constructions or situations have a central place. Propositions concerning counterfactual constructions or situations are called counterfactual propositions. In the planning of an experiment, for example of Michelson's experiment, aiming at the ascertainment of an "ether wind", a non-existing situation is imagined or constructed in thought; and it is described in conformity with the general requirements of science, and in accordance with available scientific knowledge (Maxwell's equations, the classical principle of relativity, etc.) When this is done, it is decided whether or not the experiment in question should be performed. If it is decided to carry out the experiment - and that was decided in Michelson's case - a great laboratory work concerning the materialization or realization of the counterfactual situation is outstanding. In other cases analysis of the counterfactual situation leads to the result that the experiment should not be carried out. For example, for reasons which he stated in detail, the Russian physicist, P. Kapitsa, abstained from the experimental investigation of the dependence of the velocity of light on the strength of a magnetic field.

In the case where the counterfactual situation is not materialized, the experiment is completely or to some extent performed in thought. Such experiment is a thought experiment. Sometimes a thought experiment is sufficient for the achievement of a crucial or even definitive result. In Newton's famous thought experiment with the moon (Principia III, Proposition IV, Theorem IV) the counterfactual situation is established that the moon is at rest at a definite point of its path. And with point of departure in available knowledge (Galileo's law for freelly falling bodies, the law of the inverse square, the second law of motion, the distance of the moon from the center of the Earth etc.), it is investigated what happens in such situations. In this case the counterfactual situation cannot be materialized or realized. In Galileo's thought experiment with two bodies tied together, the counterfactual situation is easily materialized. Only it is superfluous. The Aristotelian law for freely falling bodies is falsified without further "real" experiments. These examples of counterfactual situations or constructions in physics are important because, in futures research, analogous counterfactual situations are constructed (low energy societies, industries without pollution, economic equilibrium between industrialized and developing countries etc.). Precisely such counterfactual situations, similar to thought experiments in physics, are called scenarios.

In the formulation of scientific arguments and in attempt to provide a foundation for a definite scientific outlook, the class of implicative propositions plays an important role. An implicative proposition is expressed in a sentence of the form, "if ...then...". Now, it is important to point out that there are many forms of implication. The usual material implication, $A \Rightarrow B$, characterized by the truth table below[x]), and being logically equivalent with $\neg(A \vee B)$, is consequently only one among several forms of implication.

A counterfactual implication is an implication of special significance. Often it is expressed in a constriction of the form,"if it were the case that ..., then it would be the case that ...." . It is important to understand, how one argues in favour of or against counterfactual implications. The following example should illustrate the situation.

Look at the following counterfactual implication:

(1) If Denmark had not joined the EEC, there would have been full employment today.

Let us investigate the structure of an argument for the validity of this implication.

In order to enter upon such argumentation, one has to imagine what Denmark would look like if it had not joined EEC. This implies that a proper conceptual alternative to the actual situation should be constructed, viz. an alternative involving that Denmark is not a member of the EEC. This is precisely a conceptual alternative which is in conflict with the fact that Denmark actually <u>is</u> a member. If one's opponent in the discussion of (1) accepts that the conceptual alternative provides a proper picture of Denmark today, then the argumentation can continue with the demonstration that the consequent in (1) follows logically from the conceptal alternative.

It is now plain, how one can argue against (1). The argumentation may have two targets: (a) One can argue that the suggested conceptual alternative, on which a foundation of (1) should be based, is not a proper picture of the conditions (Denmark could not possibly have looked like that, if it were not a member of the EEC!). (b) Or, provided that the conceptual alternative were accepted, one could challenge the logical deduction of the consequent. Usually, it is not possible to argue against the deduction of the consequent, since it is a logical deduction according to accepted logical rules. The most ticklish point is the question concerning the propriety of the conceptual alternative or the question, whether or not it is sufficiently close to reality. Estimation or appraisement will here play an important role.

In the study of his own work and his own thinking, any scientific investigator can easily persuade himself that counterfactual propositions are rather frequent. The planning of an empirical experiment provides a good example of the application of counterfactual constructions. They play a role in the design of an experiment and in the provision of a basis for the dicision concerning the performance of an experiment. For illustration let us return to P. Kapitsa's problem: In "The future problems of science" he gives an account of his situation when he succeeded in producing very strong magnetic fields. According to his report, Einstein tried to persuade him to carry out an experiment for the purpose of showing the influence of a magnetic field on the velocity of light. Kapitsa refused to make the experiment, and did so arguing: "If this experiment had been carried out, it would have given an effect of a second order, but the result could not be forecast. The experiment would have been extremely difficult because experiments up to 30.000 Gauss had been conducted which indicated that magnetic fields do not influence light, and this followed from contemporary conceptions".(11)

The situation described by Kapitsa is very characteristic. By the planning of an experiment, one imagines a non-existing situation, describes it with the highest possible preciseness on the basis of available scientific knowledge, and then one decides whether or not one should materialize the situation. If one decides to carry out the experiment, then a great work aiming at materializing the counterfactual situation in the laboratory in usually outstanding. In the example quoted, the job consists in constructing, technically, a situation where changes in the velocity of light, as a consequence of a magnetic field, can be recorded.

However, counterfactual implications play a role not only in situations where one is interested in materializing the antecedent. In many cases it would be absolutely impossible to materialize the antecedent of the counterfactual implication. This situation is illustrated by Newton's thought experiment, mentioned above:"...if we imagine the moon, deprived of all motion, to be let go, so as to descend towards the earth with the impulse of all that force by which it is retained in its orb...", then.. "the force by which the moon is retained in its orbit becomes, at the very surface of the earth, equal to the force of gravity which we observe in heavy bodies there" (Prop.IV. Theorem IV, Scholium). The proposition: "The moon is deprived of all motion" is a counterfactual proposition and consequently false. However, from this proposition does not follow that the implication in question is true. Nevertheless, having recourse to the laws and facts in question, and by the use of <u>regulae philosophandi</u> <u>1</u> and <u>2</u>, Newton is capable of arguing so convicingly in favour of the-close-to-reality of his counterfactual construction that he can furnish the proof that the inertial and the heavy mass are proportional (Prp.VI, Therorem VI). This proof becomes a sufficient condition for the discovery and construction of the law of gravitation, and serves as example of the important role played by counterfactual situations in the sciences. (12)

b) scenarios

In perspective planning and in futures research counterfactual constructions have got their special name: <u>scenarios</u>. Since the scenario method is placed in the center among the methods used in the investigation of fictive processes of development, it is an important task for futurologists and perspective planners to develop systematic methods for the development and logical foundation of scenarios. It is important to have the richest possible spectrum of scenarios and capability of arguing

in favour of the close-to-reality of the scenarios. A rich spectrum furnishes the greatest possibilities of action and the greatest innovative effect. Close-to-reality, on the other hand, is a presupposition for the decision-makers to make a point of or to be in earnest with scenarios.
Furthermore, it is important to realize that the twofold task in the application of the scenario method - the development of a rich spectrum and the foundation of the individual scenarios - pull in different directions, and often enter into conflict with one another. This is quite analogous to the situation known from well established sciences like physics and biology, where one can observe the conflict between the innovation or cognitive effect, which is a consequence of new hypotheses or theories, and the foundation or justification of such hypotheses or theories.
It is important to take heed of the fact, that the dominancy of the innovational part over the foundational part of the process may lead to fantasticality and remoteness from reality ("utopias far from reality"); whereas the dominancy of the foundational part, on the other hand, may lead to repression or suppresion of new theories or viewpoints. The claim of foundation may, in other words, lead to restraint or suppression of the innovative effect. Now, arguments in favour of the nearness to reality of counterfactual constructions is an essential element in a scientific foundation process. There is a difficulty, however, because there are no fixed rules according to which such foundation can be established. Here we have arrived at a point in the process of science, where logic in the form of fixed rules ceases to function, and where scientific assessment or evaluation becomes a link in the chain of argumentation. Cp. Newton's application of regulae philosophandi 1 and 2. Such estimation or evaluations are heavily dependent on the attitude or basic conceptions that dominate the scientific milieu. Such basic conceptions manifest themselves typically in the ontological view at the basis of a definite science. For instance: the Aristotelian conception of the nature of "being" is fundamentally different from Newtonian ontology: teleology contra causality; continuity contra discontinuity (atomicity); different conceptions of the properties of space, etc. The so-called crucial experiments

may have fatal consequences for a given theory. This does not imply, however, that such experiments, for instance Michelson's experiment concerning "the ether wind" can decide, which of definite basic assumptions is correct, and which is wrong. It is rather the other way round that the experiment, so to speak, is orientated or adjusted toward a definite ontological conception or basic conception of reality. For instance, the outcome of Michelson's experiment was a catastrophy for classical physics, represented by Lorentz. For relativistic physics or Einsteinian kinematics Michelson's experiment precisely showed what should be expected as being the case.

The important conclusion is that the fundamental part of a scientific theory, especially its ontological foundation, turns out to be almost immune to <u>direct</u> empirical control. Fluctuations in the basic structure of a scientific theory develop in quite a different way. It is <u>indirect</u> and with clashing tendencies. Such fluctuations take place through deep breaches in the cognitive situation, through the development and overcoming of scientific crises, through the discovery and solution of troublesome paradoxes, through the transgression of intellectual barriers, through changes of the structure or pattern of thought.

3. Scientific rationality

In the part of scientific argumentation that aims at foundation or justification, the so-called scientific rationality plays a central role. Scientific argumentation is built up around imagined or construced situations, whose realization or materialization is considered possible. Scientific rationality consists in excluding situations which, from the point of view of a definite attitude, cannot possibly be materialized. Furthermore, it deals with the systematization, control and verification of the situations which are within the compass of possibilities defined by the science or scientists in question. It is its task to mark out the limits between what is considered necessary and what is regarded as possible.

Scientific rationality has the function of supervising these limits, whereby it offers a guarantee that scientific works are in harmony with the prevailing attitude to scientific problems and methods.
A thorough, painstaking and honest investigation and control of scientific ideas, discoveries, propositions and contentions, on the highest possible level, is, consequently, **the core of** scientific rationality. It is hardly possible to discover other forms of human activity in which systematic control is so rigorous and relentless, as in the case of scientific work. In no other field are the requirements for systematic and critical behaviour or bearing stricter. It is well known that scientific fitness or suitablity, for instance as a basis for technology, is highly indebted to the exceptionally strict requirement in the sciences for validity, control and preciseness.
On the other hand, it has often been overlooked that, in between, the sciences strangulate themselves in their own honesty and thoroughness, and that they, in virtue of their rationality, unwittingly suppress or paralyse new tendencies emerging in science. In other words, they become repressive.

The repressive character of scientific rationality manifests itself, in particular, in the demands made by scientific rationality to counterfactual situations constructions or thought experiments. Here it suggests itself to ask: how remote from reality or from the scientific ideas accepted by or dominating the scientific community can such situations or constructions be? Repression manifests itself in particular in the criteria constituting the line of demarcation between "wild ideas" and a balanced scientific assessment. Cp. Bohr's "crazy ideas" concerning "the mixture of Planck's ideas with the old mechanics. Bohr's "crazy ideas" were criticized by Rutherford (1871-1937) from quite a proper scientific position. (14)
There are definite ties or fastenings that are quite necessary for scientific rationality. These ties are called ties of rationality. Such ties, and the forms of repression which

they imply, are necessary features of the process of science and are to a certain extent unavoidable. The conflict between foundation or justification and innovation is therefore an inextricable relation of adversity, which is a condition for the dynamics of the process of science.
The ties of rationality are a)ties of inertness, b)social ties of rationality, c)ontological ties of rationality.
Below we give some examples of the ways in which these ties of rationality function in the research of futures.
b) Ties of inertness
In a given age, for instance in Western Europe, a definite scientific behaviour, deportment or "ideology" will be dominating. This has not only bearing on the requirements of exactitude or preciseness in science, but also on the problem, whether a definite research activity or trend in the field of science is relevant or legitimate, or whether it is in conformity with the principle of simplicity, to the demands for coherence. Such deportment imposes a series of more or less hidden ties on the current trend in science and the corresponding research activity. If the barriers which the ties impose on scientific activity are broken, the new activity in question will be considered non-exact, unreliable, irrelevant, unsufficient and without foundation. The mathematics which came into being in the Renaissance, in Galileo's time in particular, bears the imprint of laxity or lack of preciseness, a circumstance being incompatible with the requirements of precision and harmony demanded by the geometers of Antiquity.

In 1635 the jesuit, Bonaventura Cavalieri (1598-1647), professor in Bologna, published his famous "Geometria indivisibilibus continuorum nova quadam ratione promota". Cavalieri was a pupil of Galileo, and his "geometry of indivisibles" caused a sensation. However, foul fiends intimated that he should be awarded the prize of obscurity, in particular since his basic concept of "indivisible elements", that was the foundation of the whole structure, was nowhere defined. Cavalieri compared figuratively planes with tissues, and bodies with books. And the development of infinitesimal reflections which Cavalieri started were successful merely in virtue of his and other mathematicians' sharp intuitive understanding of physics. As well known, the strife about "infinitely small magnitudes" continued until the end of the 19th century.(15)

The scientific deportment or carriage in demand in a given age or in a given scientific environment confers on this environment an inertness, which, on the one hand, ensures efficiency and intrinsic coherence; on the other hand it confers repression and restraint. Such ties are called of inertness ties. Berkeley (1684-1753), for instance, in his "The Analyst", called Newton's "fluxions" "ghosts of departed quantities". (16)

In the 19th century, a strife arose between physics on the one hand, and geology and biology on the other. Physics was represented by Lord Kelvin alias William Thomson (1824-1907), and by his calculations concerning the age of the Earth, based upon geophysical data and theories. Geology and biology were represented by Charles Lyell (1797-1875) and Charles Darwin (1809-1882). Lord Kelvin corrected or rectified continually his calculations concerning the age of the Earth. In the sixties he was of the opinion that the sun had illuminated the Earth for at most 300 million years. "In 1862 the uncertainties of his data led him to admit at least the possibility of a 400 million year old earth.

By 1868, he was convinced that sufficient evidence existed to justify limiting the assumed duration of life in earth, if not the earth's total age, to no more than 100 million years. In 1876 he was willing to accept an upper limit of only 50 million years for the earth's age, and in 1881 a limit of 20 to 50 million years. Finally, in 1897 he declared that the earth's age was nearer 20 million than 40 million years, and embraced Clarence King's estimate of 24 million as the best available".(17)

He based his calculations on the following assumptions:

1. all of the energy in the universe is gravitational in origin, that is, its energy stems from the sun (and other stars).
2. the sum total of energy is limited and calculable in quantity.
3. it is constantly being dissipated according to the second law of thermodynamics, in the direction of "thermal death".

According to Charles Lyell and Charles Darwin the age of the Earth exceeded by far Lord Kelvin's estimates. In "Principles of Geology" (1830-32) Lyell set forth a view of the development of the Earth that not merely conflicted with Cuvier's cataclysmal theory, but also with Kelvin's geo-physical conceptions. The formation of geological strata was, according to Lyell, not the outcome of a series of catastrophies. It took place <u>gradually</u> in conformity with known physico-chemical laws. In order to understand, how natural selection might take place Darwin had to presuppose that certain geological processes should have a duration of more than 300 million years. From Kelvin's geophysical point of view this was absurd.

The strife between Kelvin and the uniformitarians and evolutionists continued through the whole century. The problem concerning the age of the Earth gave rise to a conflict between geologists and physicists, a strife that, owing to the high prestige of physics, turned out to the advantage of the physicists. The geologists were obliged to revise their conception of the speed of geological processes. The outcome of this conflict was, <u>negatively</u>, that the development of geological theories was directed by a different science and by persons which only had a sporadic or superficial knowledge of the basic results and theories of geology. The outcome <u>positively</u>, that the geologists were obliged to work out more precise quantitative formulations and statements concerning the duration of geological periods.

b) Social ties of rationality

The physicist John Ziman has developed a science of science, in which the mechanism of consensus in the scientific environment is a crucial feature of the process of science. This mechanism is, above all, rooted in the validity of scientific theories, in their good agreement with experience and, consequently, with physical reality. This agreement, in natural science, is so good that modern technology can be raised on a scientific foundation without breaking down. However, if we are interested in the repressive and reactionary function of science, there are other factors of human and social nature, which, in the given context, should not be underestimated.

The sociologist Charles Fischer has examined a mathematical theory, the theory of invariants, which prospered in the 19th century. He showed how this theory, for social reasons, disappears from the sphere of the mathematician. The most important event in this connection was David Hilbert's (1852-1943) attitude to the theory. In the period preceding Hilbert's analysis mathematicians worked with methods of calculation which were technically difficult, involving complex constructions. Hilbert put an end to these constructive methods. The general problem was "to show that for a quantic of any number of variables of any degree there is, in some sense, a finite basis for all of the invariants belonging to it (i.e., that there are only a finite number of independent invariants). The real difficulty will arise in establishing an affirmative solution to this problem when the quantic is made up of more than two variables". Now, in 1888 Hilbert proved "that a finite system of independent invariants existed for quantities in any number of variables". The point was that Hilbert - after he had furnished this proof - could maintain: "With this, I believe, are attained the most important general goals of a theory of functional fields of invariants". (18)

Hilbert and other outstanding mathematicians, for instance Hermann Weyl (1885-1955), turned their back in the theory; and the interest or concern of younger mathematicians was directed toward other objects of study. Consequently, the theory did not have the innovative power, necessary for the survival as a mathematical theory with an identity of its own. The conception of mathematics which Hilbert and Weyl stood for pervaded the field of mathematics to such extent that all alternative theories were suppressed. They killed the theory of invariants. However, the theory of invariants did not die for objective mathematical reasons; but rather because "the ruling class of mathematicians" discarded it. A constructivist trend in the development of mathematics might have given the theory of invariants new opportunities. Admittedly, the present sketch does not confer the whole truth about the theory of invariants. Social factors are, indeed important and central elements of the development. But of course, a change in attitude and a different "ideology" should be taken into consideration as well. Our example is, therefore, also an illustration of another type of rationality ties: ties involving ideological repression.

c) Ontological ties of rationality

Finally some ties of rationality concerning a given structure of science may be worth mentioning. They are called ontological ties of rationality because they concern assumptions related to the properties of "being" (on - being). Since these assumptions deal with essential or inherent features of objects investigated by a given science, it is important to use the old distinction between essential or inherent and accidental or contingent properties of the objects in question. For instance, it is an essential or inherent property of a material particle in Newton that it has inert mass, whereas it is an accidental or contingent property that it has a given velocity. In Descartes, the heavy or inert mass of a particle is not an essential or inherent property of the particle. This property is generated or produced through the state of motion of the particle which, here, precisely is an essential property.

This outlook plays a role in the erection and disposition of

scientific arguments around ideal, counterfactual situations or constructions of the sort discovered in physics, biology, sociology or future studies in connection with experiments thought experiments or scenarios. One imagines typically definite ideal objects or some selected and essential relations between them, eliminating or "thinking away" irrelevant or accidental reciprocal effects and properties of the systems picked out for investigation. A well-known example from physics is the mathematical pendulum. And a well-known example from sociology is a capitalist society, consisting of two classes: the class of industrial capitalists and the class of wage-workers: the capitalist society investigated by Marx.
If the inherent or essential properties of the objects are eliminated, they lose their constitutive features. And you do not know, what you are talking about or dealing with.
In our example of the mathematical pendulum, you can easily "think away" the extension of the pendulum, and still know what you talk about; but you cannot "think away" the heavy or inertial mass of the pendulum. In the capitalist society described by Marx, you can "think away" the class of merchants, the class of interest bearing capitalists; but you cannot "think away" the class of industrial capitalists without forfeiting the constitutive features of the object called the capitalist society. Our dependence on the ties of rationality in scientific work manifests itself in the circumstance that we cannot construe abstract, ideal situations, clashing with inherent, constitutive and individuating aspects of the scientific field of investigation, without stirring up serious conflicts. Such constructions are acceptable only in situations where existing scientific behaviour or carriage has taken us so far that it clashes with itself. In situations like that a given science is in crisis; and it is a situation of a sort that requires a transgression of barriers to thought or a change of the structure or pattern of thought.
It is easy to illustrate or exemplify the function of the above mentioned ontological tie of rationality though cases from the history of science. It is regrettable, however, that

the history of science mainly has been the chronology of great deeds. For this reason the best elucidated cases are those where ontological rationality-ties were broken. In this light the repressive character of the ties of rationality are put into the background. The repressive situations are mostly described only in cases where "premature" scientific theories, which later have a prominent seat in the Pantheon of the sciences, became the subject-matter of the history of science. The numerous cases where a theory completely vanishes from the system are rarely analyzed from the point of view of the history of science.

A short description of Micheal Polyanyi's theory of adsorption may serve as exaple of ontological ties of rationality. Polanyi developed in the years 1914-1916 a theory of adsorption, that was based on the following principles: "....(i) that the adsorption, of gases is **due to an** attraction that derives from a potential which is uniquely determined by the spacial position of the gas molecule and therefore independent of the presence of any other molecules in the field of the adsorption potential; and (ii) that, when subject to the field of adsorption, the gas behaves in accordance with its normal equation of state".

The theory was further developed and strongly underpinned through empirical experiments. However, in spite of the overwhelming empirical confirmation of the theory, it was soon discarded. The reason for this was that it clashed with the dominating conception of the molecular world, involving that the inner atomic forces are electric of nature.

"This view of atomic forces made my theory of adsorption untenable. Electrical interaction could not be derivable from a spatially fixed potential; they would be screened off by the presence of other molecules in the field".

A theory which is in conflict with predictions obtainable on the basis of a dominating conception in science will have very poor chances of survival, even in the case of empirical verification of the theory; or in the event that alternative conceptions were in conflict with empirical facts. Polanyi describes the ontological bond as follows:

"Could this miscarriage of the scientific method have been avoided? I do not think so. There must be at all times a predominantly accepted scientific view of nature of things, in the light of which research is jointly conducted by members of the community of scientists. A strong assumption that any evidence contradicts this view is invalid must prevail. Such evidence has to be disregarded, even if it cannot be accounted for, in the hope that it will eventually turn out to be false or irrelevant". (19)

3. The argument of transgression

In the years 1800-1820 the wave theory of light was erected on a sound theoretical and experimental basis. It came into being in the works of the British physicist Thomas Young (1773-1829), and the French physicist Augustin Fresnel (1788-1829), who showed that polarization phenomena could be explained only on the assumption that light waves are transverse waves. However, at the basis of the wave theory of light lay the the ontological assumption that waves must propagate in some medium that vaguely was called "the ether". As it turned out, by closer analysis, an ether that should be the conveyor or the vehicle of transverse waves would have very strange properties. In the first place, it involved that the ether should occupy all otherwise "empty" space and penetrate all matter. Secondly, it should be like a solid body with highly elastic properites. These assumptions led to a serious paradox, however. For since it was well-known that all planets move freely in space as if they were going through a vacuum that offered no resistance at all, how could one believe that the ether really existed. This paradox was solved through the application of a viewpoint which we come across again and again, and which involves "eine Anderung der Denkstruktur" or "a change of the structure or pattern of thought". Werner Heisenberg, who coins this phrase, talks about "Schritte über Grenzen". Here we introduce Heisenberg's "Across the frontiers" as "the argument of transgression".

Very often it happens in the sciences that a theoretical structure is applied or tentatively applied in a field for which the theory or the viewpoint in question is not constructed. Often it happens at unawares! For example, the classical theorem of addition of velocities was tentatively applied to optical phenomena. As we know, this approach led to logical difficulties which took the form of serious paradoxes. It is an important job of the scientist to identify, formulate and solve such paradoxes. Sometimes the solution offers itself in an analysis of the key concepts of the conceptual frame within which one is working, and by the extension of the conceptual framework in question in such a way that, within the new framework, there is room for new and already known facts, and for old and new theories or theory fragments at that. Through such procedure mathematicians and physicists transgress constructively the limit which the prevailing theories have fixed for the description of definite subject-matters. Consequently we talk about "the argument of transgression". Before this jargon was used, mathematicians and physicists talked about "rational" or "mathematical" generalization or extension of concepts or theories. This modus loquendi is discovered in Bohr's classical treatises of science of science in particular. [20] In social sciences the argument of transgression is brought into focus in connection with the discussion of Hegel's philosophy of history and Marx's social science. The term "dialectics" refers to this point of view. The following example from the history of science is quite illuminating. In the sixth century B.C. the Pythagoreans discovered a paradox that caused the breakdown of the Pythagorean world picture. The paradox which Aristotle quotes in his Analytica priora amounts to the following assertion: if it is assumed the side and the diagonal of a square are commensurable, then one arrives at the absurdity that an even number is an odd number. Hence, if one attempts to express the length of the diagonal of a square in units of natural numbers, produced through the division of its side into parts, one ends up in a self-contradiction. This, again, implies that the number system or the conceptual frame is too narrow for the description of definite interesting geometrical relations. We know that the paradox is solved through an extension of the number concept, that is,

through constructive "transgression" of the limit for mathematical description fixed by natural numbers.
It should rather not interest us here that a complete solution of the paradox was not delivered until the 19th century.
However, it may be important to emphasize that similar paradoxes within the frameworks of futures research could not wait 2000 years for their solution. The obvious reason for this is that the solution of global political and economical problems are on the agenda, and that definite troublesome global problems should be avoided or eluded. Perhaps we cannot even wait for their solution until the year 2000.
The problem is: are we in our research of futures able to identify and formulate similar paradoxes - similar in the sense that they block up the path leading to prolific developments of futures research, or hamper the solution of troublesome global problems; and also similar in the sense that the argument of transgression can be applied to them. As illustrated by our example, the argument of transgression has to do with the relation between a definite description or theoretical structure and its object, or - as the saying goes - the relation between a theory and its field of application. In the definition of the subject-matter of a theory definite ontological assumptions, that is, assumptions concerning fundamental properties of the object, are always included. According to Pythagorean ontology being as a whole is "number", i.e., a structure built up of relationships that can be described mathematically. On this foundation rests the interesting and epoch-making requirement that nature should be described in mathematical terms. All propositions concerning nature should be propositions concerning relations between numbers. As our paradox shows, this program was impracticable, an insight that caused a deep crisis in the science of Antiquity. As it turned out, the equalization of things and numbers made this program impracticable because "numbers" in Antiquity were natural numbers.
Concerning the light-ether paradox, there were two possibilities: either the abandonment of the ontological idea that light for

its propagation in space requires a specific medium, or the construction of a non-contradictory "ether model". To the physicists the attempt to abandon the idea of a medium for the propagation of light-waves was so absurd that, for more than 50 years, they tried to improve the "ether model". The outcome was negative. The "ether model" at hand remained inconsistent. The contradictory character of the "ether model" became explicit in the principle which, so to speak, was built into Maxwell's equations: the velocity of light in vacuum is constant independent of the state of motion of the emitting body.
Physicists like Henri Poincarè (1854-1912), H.A. Lorentz (1853-1938) and Albert Einstein (1879-1955) attempted in different ways to bring this surprising fact into harmony with classical kinematics. Einstein pointed out the conflict between the principle of the constancy of the velocity of light and the classical theorem for the addition of velocities. Einstein's solution, contained in the special theory of relativity, made the "ether model" superfluous, and it disappeared slowly from the textbooks in physics. The light ether ceased to be an essential feature of the phenomenon light. The electromagnetic field replaced the ether as ontological entity, because "field" and "matter" were more appropriate in the attempts of physicists to furnish a consistent description of the phenomena at hand. As Einstein and Infeld observe in "The Evolution of Physics" (1938), "our first attempts to go beyond the mechanical view and to introduce field concepts proved most successful in the domain of electromagnetic phenomena. The structure laws for the electromagnetic field were formulated; laws connecting events very near to each other in space and time. These laws fit the frame of the special relativity theory, since they are invariant with respect to the Lorentz transformation" (22)
The use of the field concept in the construction of the special relativity theory by Einstein is an instructive example, illustrating how the structure of thought ("die Denkstruktur") changes when the argument of transgression is applied. Subsequently, the ties of inertness as well as the social and ontological ties are disrupted. Some examples of breaks or

possible breaks in social sciences having the character of being research of futures are presented below.

4. The ties of rationality and modern research of futures

Although terms like "study of futures", "futures research", "futurology" etc. are of rather recent date - they appear at the end of World War II - the subject itself is not new. Modern research of futures was inaugurated by Leibniz (1646-1716) and continued by Kant and Marx (1818-1883). Kant is not only the most outstanding representative of the science of science in modern time, but his achievements in the field of social philosophy and futures research are unique. Kant obtained this position because he, like his Scottish twin-brother Adam Smith (1723-1790), was able to use Newton's "universal" mechanics as a model of research.

In a small treatise from 1784, "Idee zu einer allgemeinen Geschichte in weltbürgerlicher Absicht", Kant advances the following point of view: since human beings not only act by instinct like animals, but are rational beings, one might expect that they, from a global point of view, act according to a fixed plan. However, all knowledge of the history of humanity points directly in the opposite direction. Although human beings in definite situations are able to act and in fact act according to plan and with wisdom, their actions as a whole bear the imprint of foolishness, malice and mania of destructiveness. It is strange that certain animals - Kant mentions bees and beavers - which, guided by their instincts, act, as it were, according to a plan. On the other hand, human beings are the only beings that are capable of expecting or anticipating "events to come". [23] Or, as one would say today, human beings are the only beings capable of establishing counterfactual situations or constructions. Nevertheless, they are, according to Kant, on the whole without plan and object in view. This situation urges Kant to take into consideration the possibility that in human history there might be a hidden purpose or hidden plan of nature. All this sounds so phantastic in our ears today that we are inclined to refer to it as belonging to the past. However, if we turn the pages of a book published 190 years after Kant's little treatise, we read: "In nature organic growth takes place according to a "plan of nature". The size and function of the different organs are determined by the spezialization within the organism as a whole, and also their growth takes place within this frame. The general plan for the growth of an organism comes sometimes into being through evolution, through "natural selection", and is deposited in the genes as a code; from the very beginning it (the plan) is inherent in the growing organism: plan and organism are inextricable connected. Our world system has no such "general plan". (24) The quotation is from "Mankind at the Turning Point" (1974).

Through anthropological and historical studies Kant arrives at the conclusion that it is inherent in the plan of nature to establish republican states all over the world. The states can not settle their disputes or solve the international conflicts through non-military means until this happens. When this fundamental problem has been solved, it is finally possible for human beings to unfold all their predispositions and abilities. A guiding thread to political action in accordance with the surmised plan of nature is discovered in the small treatise of eternal peace, "Zum ewigen Frieden" (1795). (25)

It was often believed that Kant was a pacifist in a trivial sense. That is not so! He calls expressly attention to the circumstance that humanity, in as far as it abides on such low stage of civilization as in fact it does, wars are not only an evil, but sometimes a useful factor of civilization. On the other hand, wars are of historical or transient nature. They can only "for the time being" be means of solving international conflicts. When the different states arrive at a higher stage of development, that is, have a republican constitution, as is the case in some European states and in the United States of North America, wars cease to be something occasionally positive. They become the greatest of all evils.

If it is in accordance with the plan of nature to subdue the greatest of all evils, then the following questions have to be asked and answered: what social forces can motivate politicians to refrain from the use of military means for the solution of international conflicts? Whatever can motivate them to look for an alternative to such means? Kants answer is: only economical forces can have such effect. The situation is the following: if we do not discover an alternative to the military solution of international conflicts, the economic systems of the states will break down under the burden of armaments. The expenses or the drawbacks of military solutions or preparations for such solutions will have predominance over the revenues or advantages of war.

Hence, if you make it a universal law that conflicts between states should be solved by military means, you land, as it were, in a self-contradiction. This is the core of Kant's rationale, inherent in the categorical imperative. As is well-known, the overwhelming costs and dwindling benefits of armaments and war have not prevented states or governments from considering or attempting a military solution of international conflicts or conflicts between states.

None the less, the Kantian point of view or the Kantian veto against military solutions of such conflicts has not been without influence on the most outstanding military-stratigic theorist of modern time, general Carl von Clausewitz (1780-1831), the author of "Vom Kriege" (1832-34). Although Clausewitz did not do futures research in the Kantian style or in a modern sense, he has, nevertheless, an important place in the history of futures research, because the phenomenon of war has a central place among the problems of our modern world. It may be added, that one of the most quoted authorities in the field of futures research, the co-author of "The Bible of Futurology", Herman Kahn (b. 1922), is one of the most prominent contemporary Neo-Clausewitzians.

Clausewitz is no historian either. His subject-matter is not the analysis of this or that battle in the European history of wars. It is something different. Using the theory of science

inherent in classical mechanics as a model-pattern, that is, in accord with the ideal of science of the 19th century, Clausewitz analyses the phenomenon of war in a way similar to that in which Newton analysed celestial and terrestrial mechanical phenomena. What Napoleon expressed in cannonades and aphorisms, Clausewitz presented as a coherent system of thought. No one before Clausewitz had asked and answered the question: What is war? Clausewitz had, in a word, the essential features of the phenomena of war in view. Consequently, he used the procedures of abstraction and idealization, known since the foundation of classical mechanics. He investigated, so to speak, war "in empty space". Thus, local or accidental circumstances of historically known wars were left out of consideration. As Clausewitz observes, "the scientific form is based upon the endeavours to investigate the essence of the phenomena of war, and to show their connection with the nature of the things which are their constituents".
"We do not plan to furnish new principles and methods of warfare, but intend to investigate what was already in existence long ago concerning intrinsic connections, and (intend) to trace it back to its simplest elements".[26] Although Clausewitz is not a researcher of futures in a modern sense, his presentation of war as a social-political phenomenon is a model-pattern of a scenario in social science, an exemplar of a fictive social situation, yet near-to-reality.
Clausewitz' conception of war as a social-political phenomenon may be summarized in the proposition: war is a rational instrument of national policy. "War belongs ... to the province of social life. It is a conflict of great interests which is settled by bloodshed, and only in that is it different from others. It would be better, instead of comparing it with any Art, to liken it to business competition (Handel), which is also a conflict of human interests and activities on a great scale (Handel in grösserem Masstabe). Besides, State policy is the womb in which War is developed, in which its outlines lie hidden in a rudimentary state, like the qualities of living creatures in their germs".[27]

Whereas the rationale in Kant is expressed in the veto against the solution of conflicts between states or nations with military means, the rationale in Clausewitz is contained in the rejection of 'war for war's sake. War is ultima ratio regum, the last reason, or the last resort of kings. This device was engraved upon the cannons of Louis XIV, and upon the Prussian guns since 1742. Warfare aims at definite political goal that cannot be attained through other political means of coercion. War as an instrument to national policy is eo ipso subordinated politics.

As Clausewitz point out, "war had admittedly its own grammar, but not its own logic". This means, presumably, that in war there are other rules of the game than in commercial or political negocations; but that, none the less, its logic is the same as the logic of commerce and politics. The question is: what is the core of this logic? In so far as nations or governments communicate commercially or politically, they solve their conflicts in writing or speech. War is a sort of substitute for linguistic communication of nations or governments (eine andere Art von Schrift und Sprache ihres Denkens), which, as ultima ratio is used if writing or speech do not lead to the result wanted. (28)

In contradistinction to Kant, Clausewitz does not open the prospective that a situation might arise in the future where war does not only not pay, but where war becomes superfluous or even impossible. In his conception of war Clausewitz does not take into consideration to develop a scenario or to postulate a counterfactual situation from which an alternative to the military solution of international conflicts between states is derivable. Clausewitz was not motivated by circumstances, or by arguments derived from a theory of science, to intimate or even to point out or emphasize that the coherent conceptual frame he had created might be exploded because new or neglected scientific or technological theories or economical-social facts had to be taken into account and made the subject-matter of analysis.

Thus, Clausewitz did not take the possibility into consideration that the barrier to thinking about war which he erected in his work some day might be or had to be transgressed. And that his conception of war had to be replaced by a new theoretical structure, a theory for solution of international or interstate conflicts with non-military means. For Clausewitz it was a matter of course, a presupposition that could not be a matter of controversy, that weapons were constructed in order to be used in military operations. That the paradoxical situation might come into existence that weapons were constructed and produced in order NOT to be used in military operations, but exclusively in order to be used as silent arguments in political negociations on a great scale, lay outside his scope of vision. Since this paradoxical situation is close to being a reality, since the military use of nuclear weapons involves total self-destruction of the contending parties according to the slogan 'MAD' for 'mutually assured destruction', we are confronted with a situation of transgression of extraordinary and far-reaching charater. If nuclear weapons exclusively serve as silent arguments in a political negociation on a great scale, then they are virtually superfluous and may be replaced with arguments of a different sort. One should look for these arquments in the logic of war, politics and commerce postulated by Clausewitz, but so far never made explicit. This 'if...then' proposition is obviously a short description of a counterfactual situation. The situation is so close to reality that it involves the instigation to apply the argument of transgression for the execution of a change of vital importance for the planning of our future in a global sense. Here it should be borne in mind, however, that the thinking in this field is encumbered with strong ontological and social ties.

These ties of rationality do not only serve the purpose of preserving stability in the sphere of scientific research. They also ensure political stability in certain countries with great political and military power. Since some of these rationality are connected with conceptions and view-points related to Marx, it may be proper to look at the connection between Clausewitz' and Marx' political views.

It should be noted that, in Marx, we discover an important variation of Clausewitz' ideas. Whereas war in Kant and Clausewitz is the continuation of the political strife between states with military means, in Marx war is the continuation of class politics and class-struggle by forces of arms. In so far as class politics and class-struggle is carried on with military means of a subjected or exploited class against a ruling or exploiting class, we are faced with an armed insurrection in the marxian sense. In the capitalist society described by Marx, the strife culminates in a proletarian revolution. It should be added that in Marx there is no proper theory of revolution. In as far as coherence and preciseness in concerned, his conception of revolution can hardly be compared to Clausewitz' minute analysis of war. It would seem, however, that in Marx' view a proletarian revolution on a global scale would involve that wars cease to be a means of settling a strife between national states.
This interpretation should be seen in the light of Marx' distinction between production and approprition of surplus-value on the one hand, and the distribution of surplus-value on the other. It is often overlooked that this distinction is at the foundation of Marx' analysis in Capital.
Since the worker without property is the producer of surplus-value, and the industrial capitalist as a representative of the capitalist class, as a whole, appropriates surplus-value, this relation of production and exchange involves struggles between two classes. (29)
These struggles may end up in a military confrontation in the form of a proletarian revolution and counter-revolution. As far as the distribution of surplus-value, in the form of industrial profit, commercial profit, interest and ground-rent is concerned, the situation is different. This strife may develop into war in the Clausewitzian sense, that is, war as a means of settling a strife between national states with military means. Marx' reasoning amounts to the assertion that appropriation and distribution of surplus-value as described in Capital

is suspended after the victory of the proletarian revolution on a global scale. Class-struggle has consequently come to an end, and the motivation for or the instigation to warfare in the Clausewitzian sense cease to exist. However, Marx' reasoning follows to some extent the same road as Clausewitz' thought. This road is classical in the sense in which Newton's thought is classical. Although Marx in his description of the transition from pre-capitalist commodity producing society to capitalist society furnishes a model-pattern of the application of the argument of transgression in social science - and so far it goes beyond the Newtonian ideal of science - he only hesitatingly opens the prospective view that a situation might come into being, where a revolution with military means does only not lead to the result wanted, but becomes virtually impossible. The global economical-political situation which has come into being since Marx in a letter to Weydemeyer of March 3rd, 1852,(30) gave an outline of his political views, requires a change in the theoretical and political outlook to the effect that the problems of war and revolution more and more take the form of logical problems or paradoxes, which demand a quick solution. Already Kant had a presentiment of such future situation.
Here it is important to realize that a widespread way of describing and debating Marx' work is misleading, and from the point of view of the theory of science non-acceptable. It is not pointless to call to mind expressions or slogans like 'the Marxist theory', 'the Marxist model' or merely 'Marxism'. Such expressions or slogans are systematically ambiguous and refer rather to the situation which pertinently has been called 'the Bable of Marxism'. In Marx we discover two forms of activity, which usually are mixed up. One is political. Another is scientific. As a politician Marx thinks like a politician and speaks the language of a politician. What he says about state, revolution, socialism belongs here and has not much to do with science.
We are here faced with interests, wishes, view-points, presumptions, guesses and hopes, which often take the form of vague predictions, and which may perhaps come true and perhaps not.

It should be noted, however, that Marx' political view-points change to some extent in conformity with the development of his scientific analysis of capitalist society.
Of course it suggests itself to ask if there is anything at all in Marx' work that might be of value to the researcher of futures. The answer is in the affirmative! Here it should be borne in mind that Marx was the first social scientist who, in his investigations of capitalist society, applied classical methods of analysis and presentation. Still more important is his discovery and application of the argument of transgression in social science.
The methods of analysis in question are, in Marx, based upon the classical (Copernican) distinction between 'the forms of appearance' and 'the essence' of things. The most important methods of analysis are: conceptual analysis, for instance analysis of the concept of labour, the concept of value, and so forth; reductio ad absurdum arguments; analysis and classification of collected historical, empirical and statistical material; abstraction and idealization in connection with thought experiments or scenarios and establishment of counterfactual situations; application of the criterion of recurrence with a view to the discovery and formulation of social laws; application of symbols and mathematical formulation of social laws.
Here it is not the place for giving examples of Marx' application of these analytical procedures. We should rather concentrate on the argument of transgression, which is of uttermost importance in physics, biology, social science and futures research as well. It is noteworthy that Marx' discovery and application of the argument of transgression has not been registrated until recently. This peculiarity is connected with the fact that, in his variegated political herd of partisans or adherents, Marx' scientific achievements were for almost a hundred years, practically put aside or neglected in favour of his more or less obsolete political views. These achievements were so to speak wrapped up in the system of philosophical-ontological propositions, which under the marking of 'dialectical materialism' was wrongly imputed to Marx.
It is a strange political paradox that this discipline, which,

according to its proponents, is exempt from any form of dogmatism, imposes quite tenacious political, social and ontological ties of rationality on research, not only in the field of social science and of research of the future, but also in natural science. Where dialectical materialism has been dominating as state empowered philosophy, it has a strong inclination to put scientific life in irons. This is true in particular, where research approaches so delicate problems as war and revolution. That this is so, is connected with the fact that the ties of rationality in question concur in ensuring stability in the field of science and politics in societies where scientific and political crises are considered evils which rather are condemned or silenced by means of formulas contained in dialectical materialism than solved by the use of methods known from classical and modern science. Let us illustrate the situation through the presentation of Marx' use of the argument of transgression.

Marx' main problem in the analysis of capitalist society is: where does surplus-value or profit (industrial profit, commercial profit, interest, ground-rent) come from? In order to answer this question he postulates the existence of a pre-capitalist commodity producing society, whose actors are small peasants and artisans, who own their means of production and products. These products are alienated on the market as commodities. Since such society only is in existence here and there in a more or less pure form (for instance under ancient slavery and under feudalism), we are faced with a counterfactual situation. It is so close to reality, however, that a theory including some elementary laws concerning pre-capitalist production and exchange of commodities can be constructed. This theory, which includes a theory of money, is the theoretical point of departure for the description of the transformation of money into capital. According to this theory, the exchange of commodities is an exchange of equivalents, that is, an exchange of equal quantities of human labour in the abstract. This law is taken over from Smith and Ricardo, that is, the somewhat modified labour law of value, which is the theoretical starting point for all theoretical structures in Marx.

If it maintained that also commodities produced in capitalism are exchanged as equivalents, the creation of surplus-value or profit is apparently impossible. As acknowledged by Marx, 'the form which circulation takes when money becomes capital, is opposed to (widerspricht) all the laws we have hitherto investigated bearing on the nature of commodities, value and money, and even of circulation'. This paradox is formulated as follows: 'It is therefore impossible for capital to be produced by circulation, and it is equally impossible for it to originate apart from circulation'.

However, Marx does not stop at this precise formulation of the paradox. He suggests a method for its solution, insisting that 'the conversion of money into capital has to be explained on the basis of the laws that regulate the exchange of commodities, in such a way that the starting-point is the exchange of equivalents'. And he continues:'Our friend, Moneybags, who as yet is only an embryo capitalist, must buy his commodities at their value, must sell them at their value, and yet at the end of the process must withdraw more value from circulation than he threw into it'. (31) Here the argument of transgression is at work. It happens in the following way: A historical phenomenon which did not come into existence under the condition of pre-capitalist commodity producing society, and which so far is 'new', must be taken into account. The producers of goods in this society are gradually separated from their means of production to the effect that they offer 'a something' for sale on the market, which is not produced <u>for</u> the market, but which, none the less, is taken <u>to</u> the market for sale. Marx calls this 'something', which is sold and bought on the market, <u>labour-power.</u> The core of this transgression is: labour-power is conceived as a commodity, its value is defined, and it is subordinated the law of value to the effect that it, like other commodities, is exchanged as an equivalent. It should be noted, however, that this particular commodity is not bought by the common consumer, but only by 'the elected', that is, the industrial capitalists, who do not use this commodity in a usual act of consumption. The point is that it is used in an act of productive consumption. As it turns out, in capitalist circulation of commodities a productive act is inserted, an act that does not exist in pre-capitalist commodity producing societies. Here production and circulation are rigorously separated. Now, the commodity labour-power has properties which are unique in the world of commodities. In the first place, it differs from the commodity called 'means of production' in having the property that it reproduces its own value when it is used in the process of labour. Secondly, it produces a surplus-product whose value precisely is the surplus-value. The industrial capitalist buys raw material, means of production and labour-power on the market at their value - that is presupposed in the argument. Therefore he can satisfy the condition that the commodities produced in capitalism are sold at their value, but with profit. The allegation that the distinction between 'necessary labour', that is, labour necessary for the reproduction of the value of labour power, and 'surplus labour' should be arbitrary, is repudiated through a reductio ad absurdum argument, which may have the form: suppose that profit is created by selling the capitalistically produced commodity above its value, and so forth. As shown by Marx in chapter V of Capital I, this assumption leads to absurdities. This example shows that the argument of transgression not only plays an important role as a guide-line by the construction of new theories in mathematical and physical sciences, but has made its way to Marxian social science as well. Until recently it has been overlooked that Marx' analysis of capitalist society has been directed by the argument of transgression. (32) Therefore it has hardly been understood that the method which he applied by the solution of paradoxes in social science not only were applicable to the analysis of social-economical

processes beloging to the past. It was hardly imagined either that this method might be useful by the study of fictive future situations, that is, in futures research.
Here it should be borne in mind that scientific discoveries and technological inventions in principle are unpredictable, and that this fact is a sufficient reason for taking the standpoint or position that it cannot be the main task of futures research to make forecasts or predictions. Rather should the construction of new social theories have a first priority in futures research. With the argument of transgression as a guide-line, and envisaging the break-down of old ties of rationality, the constructors of such theories should be guided by the analysis of the fictive or counterfactual situations called scenarios, whose close-to-reality character should be ensured by taking into account newly discovered facts so far overlooked. This is quite in accord with the point of view that it is not the task of futures research to ask answer questions like 'when this?' and 'when that?', but rather to raise the problem: 'How can this or that goal be achieved or realized?' Such a point of view ceases to be a triviality, if we take into consideration that the problem concerning the future - and above all the global problem concerning international or interstate conflicts and class conflicts - demand a change in the structure of thought which may be likened to the revolutions in our ways or habits of thinking to which the history of science bears witness. I order to point out the importance of and the difficulties in going 'beyond' such classics of social science as are Clausewitz and Marx, and in order to emphasize the role which the argument of transgression may have in futures research, it may be useful to quote some remarks which Werner Heisenberg made in a lecture delivered in Vereiniging Deutscher Wissenschaftler in München 1969. The title of the lecture is: 'Change in the structure of thought in the development of science'.
'Finally some words concerning the strong opposition offered to any change in the structure of thought. A person who is a science worker during his life time is familiar with situations

where he is faced with new phenomena or new interpretations of phenomena. He is ready to give his thought new contents. He cannot be conservative in the sense that he adheres to what is old and customary. In the development of science this process goes on without too great resistance or too great conflicts. The situation is different, however, when new phenomena enforce a change in the structure of thought. Here even the most outstanding physicists are in a very difficult situation. The demand for changing the structure of thought may here arouse the impression that the whole foundation for his way of thinking is removed. A researcher who for years has fought for great achievements in his science with a structure of thought to which he has got accustomed since his youth, cannot be ready to change his structure of thought because some new experiments have been performed. In the most favourable case it may happen - after discussions of the new situation, lasting for years - that a change of mind takes place which opens the road to a new way of thinking. I am convinced that the difficulties in this respect cannot be overestimated. When you have had the experience to be a witness to the despair with which clever and conciliant scientists react on the demand of a change in the structure if thought, you can, conversely, wonder how such revolutions in science have been possible at all.'(33)

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