Elements of an essay on human change
V12, 8 July 2011

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Part I

A preliminary remark

The following essay is an attempt to analyse the relationship between Marxism, Science and Technology.[1] This is an important and unfortunately often overlooked issue in many debates such as those on ecology. The problem can be understood as follows.
-All human activity is social, hence also the directions of academic research (in all fields), as well as the application of known technologies, are heavily determined by the socio-economical context. Some scientific activities and techniques fit a certain policy or ideology, and are therefore stimulated. An economy based on carbon fuel will put a lot of efforts in R&D to maximise the exploitation of such fuels. The invention and deployment of the atomic bomb by the American government changed the original aloofness in the Kremlin into an all out effort to meet the power challenge, and resulted in the dream of cheap energy for the millions. Though, originally, nuclear energy came (in west and east) as a by-product of the military nuclear efforts geared at methods that maximise the production of weapon grade fission materials.[2]

The notion of the socio-economical context is the field of sociology of science and technology studies. The key question here is: to what extent S&T can be seen as tools that can be applied at will in the hands of the societal powers? A club can be used to crack a coconut as well as the skull of a prisoner.[3]

- The idea that technology is a given, like a club, leads to over-optimistic ideas of the capability to apply a given application or approach in another environment. The best example is again the USSR where catching up with the capitalist West, based on the same underlying technical premises, became an obsession. In left circles it was not anathema to wonder if nuclear energy (the way we know it) would be safe under workers' control. Technological utopianism is part of all emancipatory movements. This is well described by Paul Josephson in his brilliant study on technological utopianism on the road to Stalinism and the policy of Stalinist states.[4]

- R&D developments have their own dynamics. Success creates success and if we have a breakthrough in a particular field, we see immediately a bandwagon effect. Hence, such a breakthrough will define a field for considerable time, until new obstacles or new concepts

[1] This essay is an extended version of a presentation given at the International Institute for Research and Education in Amsterdam. It goes without saying that this essay is an attempt to frame the issue and certainly not yet a worked out treatise.
[2] Holloway 1994.
[3] Stanley Kubrick's A Space Odyssey (1968), starts with the invention of the club.
[4] Josephson 2010.

emerge. This means that we face certain autonomy, in the development of successful R&D, which can result in a considerable internal inertia and blinds alternative avenues.

- Because S&T is a human endeavour, and because conscious human political action needs to be in concordance with the historical situation, political action is a craft in itself. The unique contribution of Marx and Engels to human emancipation is that they tried to break away from utopianism and conscientiously analysed the dynamics of their phase of capitalism in order to come to the fore with a theory that was able to understand their present day socio-economical situation in its historical context as well as advance a consequential theory of the means for emancipatory change, by defining classes as agents of change. It is no wonder that Marx and Engels were fascinated by the rapid and extremely productive development of nineteenth century R&D. They spend enormous efforts to try and master the latest developments: Not only in order to understand their phase of capitalism, but also to learn how to develop a rational theory about societal emancipation. In that sense they are children of their time and strong believers in enlightenment thinking; that knowing enables change and mastery of a situation.

- This attitude faded over the years. Over time most political thinkers became totally ignorant of the content and dynamics of S&T. This led to the already mentioned notion that technology is something that can be applied to the goals of whomever owns it. But ignorance can also lead to the idea of the supposedly intrinsic wickedness of a particular technology. This ignorance of what is actually at stake in new deployments give way to romantic hopes such as the global village as a result of Internet, or to using the fruits of novel science as proof for already existing ideas, or, the other way around, as an attack to rock solid beliefs. So it happens that quantum mechanics with its so-called indeterminacy principle was head-on attacked by Stalinist ideologues and is still embraced by all kinds of holistic philosophies.

- A related development is by taking the scientific approach in inventing novel theories that encompass all aspects of human life. A great example is Bolshevik of the first hour: Aleksander Aleksandrovich Malinovskii (1873-1928) aka, Bogdanov. Bogdanov became an important competitor of Lenin in the pre-revolutionary period. His most important argument was that in order to change society, delegitimation of the existing power structure, which was a key issue for Lenin, was not enough; a cultural proletarian “counter” culture has to be developed in order to make the change from revolution to a new society possible. To that order he designed an all compassing system named Tektology that tried to include all sciences. Tektology can be understood as a forerunner of a general system theory and a functionalist all compassing theory. In a certain sense it can also be seen as a precursor of twenty century structuralism. Here, we see an attempt to use the most modern scientific ideas as seeds for an all-embracing social theory for action. His sociology of knowledge is an important attempt to analyse the role of the social context in phrasing phenomena. Still important is his strong emphasise on labour as source of knowledge that has to be organised and his insistence that in the science of the future, that encompasses all parts of human knowledge, the opposition between intellectual and manual labour has been overcome.[5] Concluding, the problem at stake is to understand to what extent socialist theory and praxis can be treated as a “science”. That means that we firstly have to understand what a “science” is, as not all human intellectual endeavours mimic the paradigmatic model of the hypothetico-deductive model of natural science. The idea that socialism is a science and that the methods

[5] See Sochor 1988 for a balanced view, much better than Lacourt’s bizar suggestion that Bogdanovism acted as a precursor for Stalinist so-called proletarian science, in Lecourt 1977 , appendix. Bogdanov, Mirror of the Soviet Intelligentsia, pp. 137-62.
For a recent short overview of his more philosophical thinking, see: Gare 2000.

of socialism are scientific, introduces a false discourse as if we can prove the validity of socialist theory by a kind of fixed gold standard, as actually Karl Popper tried in his attack on Marxism. [6]
Not the name but the intrinsic dynamics of socialist theory must make it a rational emancipatory theory based on life and society as we know it.
Below I try to set out some notions needed for a more encompassing work.

Stagnation and Development

The term "scientific socialism" has a negative connotation due to the usages of this term in the Stalinist tradition for a system of mental rules that claim to cover all human experiences, investigations and advancements.[7]
The Stalinist codification is called Dialectical Materialism, aka Diamat; an unclear term as it tries to weld two notions of a completely different kind. Dialectics is seen as the mutual determination of antagonisms while materialism is seen as a transcending of the nineteenth century notion of indestructible matter by a notion of absolute and fundamental laws of matter outside the human existence. Friedrich Engels used the term in his studies of natural and biological sciences and used it to indicate that also in nature all activities were coupled mutually interacting processes.[8]
Though, as from the sixties, the philosophers of the co-called socialist states became considerable less dogmatic and in many cases entered the problematic intricacies of the problems, it remains a believe system. The Marxists-Leninist theory of science of "the socialist states" is an all encompassing *Weltanschauung* that not only understands all knowledge in its historical context, but also a calibration system for new developments. The method became primary and all new developments were cast into this all embracing world view, therewith proving the superiority of the system; this way even the possibility of surprises in any field of knowledge was pre-empted.[9]

Already here we see a semantic problem as the notion of matter and materialism, as this notion changes over time and presently matter can be, scientifically, not better defined than stuff. This notion of real existing things (outside humankind) of which our sensations are the image, or copy is then mixed with a formalisation of the so-called three laws of dialectics (the unity of oppositions, transition of quantity into quality, and the negation of the negation), into a rigid so-called dialectical method, in contradiction to the: a) so-called "metaphysical" method in which objects are treated in isolation and not in their mutually interactions, b) Machism (named after the important late nineteenth century physicist and philosopher Ernst Mach) in which our sensory sensations are the sole basis of knowing, or c) mechanistic materialism in which material interactions are the source of everything. Historical materialism, as an approach to analyse the present as a result of historical processes, in opposition to Hegelian dialectics based on the "idea" and a teleological notion of the state, is, in Diamat, mechanically joined with the material substrate of human life and environment. The issue is NOT that human life is based in matter and that material interactions of all sorts define our existence. The issue at stake is if we are able to impose one method on all fields of knowledge? The whole idea of a superior overarching omnipotent view is already a

[6] Popper 1945.
[7] See e.g., Hörz 1976, Lenin 1908.
[8] Kircz 1998.
[9] Hörz et al. 1980.

dangerous idealistic or religious idea, a kind of God that exists outside of humankind itself. An important task, still to be done, is a worked out analysis of the mix-up of the term materialism and realism. Both philosophical currents take the existence of a real world outside human understanding, or better humankind as such, as starting point. In a simplified way we can state that diamat is realism endowed with the three dialectical "laws" for all aspects of reality, be it natural sciences, history or sociology and politics.

As a result of this dialectical materialism, the revolutionary left turned away from the issue of scientific socialism as a heuristic concept for a rational emancipatory theory. Sometimes a more, sometimes a less, adequate critique is published but did not counter it with a full answer to the essential underlying question of methodology. For decades the main thrust of serious socialists in the discussion was a forceful attack on the ossified and self-destructive Stalinist catechism.
This lack of a fundamental understanding of the vast problem area of how we actually have to define, analyse and henceforward develop a revolutionary praxis, remains a fundamental obstacle in the development of contemporary, revolutionary theory and its applicability in relation to natural sciences, biology and medicine and vice versa.

The notion that we cannot simply transplant methods from field A to field B, that is to say, we cannot transplant lock, stock and barrel the intellectual tradition form, say, geography to political science, is as obviously true as it is challenging: Obvious, because serious intellectual investigations in a particular field are always framed within the boundaries of its context and historical development; and challenging, because the human intellectual pursuit comprises a wholeness, though within a certain socio-historical context. Field A and field B are both expressions of human intellectual labour and hence must have some common ground, though we simply don't know yet what that is. The endless discussions on Snow's *Two Cultures*, for example, are no more than a confirmation that investigations in different realms of human understanding have different histories and different structures.[10] In a way, a competition exist between fields that allow well-defined or even axiomatic ways of system building, such as physics and mathematics, and fields, mainly in the humanities, that simply try to understand the dynamics, development and appreciation of human endeavour. It is remarkable that people like Karl Popper are still popular in the social sciences and hardly play a role in the hard sciences. This is not because all hard sciences adhere to the Popperian dogma but because currents in the social sciences believe that their methodologies are on par with, for example, those of physics. They claim to be a "science" and not just a field of study. As a result, the arrogance of the hard sciences is supported and even enhanced by the belief that they represent "true" knowledge because their results are reproducible and their theories explaining this reproducibility are so successful in their –limited- field.
On the other hand, we see the large field of social studies of science whose merit lies in proving that social context, discourse and rhetoric are part and parcel of the human pursuit of understanding the world. Interestingly, there is also in this field a great desire to prove that their methods adhere to the Popperian dogmas of applicability and failsifability.

Next to the serious sociological studies on the way research is conducted, we see, on one hand, the cottage industry of debunking the natural sciences, and on the other hand, the intellectually overlapping cottage industry of using the results of physics and mathematics – outside their context – in order to underwrite an immense panorama of religious, semi-religious or new age (though, often based on very old age ideas) *Weltanschauungen* [world views]. Most popular in this respect are fundamentally complicated notions such as relativity,

[10] Snow 1959.

quantum uncertainty, randomness versus deterministic chaos and the second law of thermodynamics.
The triviality is exemplified by the fact that in all serious investigations the boundary conditions are explicitly mentioned or, in any event, known and hence methods and technologies are always applied or valid within that limited context.
The dangerous part is illustrated by the deeply ingrained notion that we have a split, between nature and humankind. In this tradition everything in human development is purely a social construct based on a pre-given *tabula rasa,* called nature.

An early start of the notion of the intricate wholeness of nature and humankind was made by Vladimir Vernadsky in his book *Biosphere* of 1926 [11] and is independently reinventing by James Lovelock in his Gaia hypothesis of 1979.[12]
Humankind, and therefore human thinking, is part of nature. In physics terms, we can say humans are combined, non-linear, interacting complex systems; but such a definition is more semantically correct then practical operationally.

Part II

Human in nature

The goal of the whole enterprise is simple. We want to understand the world in order to change it to improve the well-being of humankind. It is a fully human centred endeavour.

Having said that, my argument follows from the following fundamental observations: 1) that the world is a whole, 2) that humankind is part and parcel of nature; and that, 3) on one hand, nature creates humankind; while on the other hand, humankind is a driving force in shaping nature. But we are not driving a company lease car, which can be traded in, or can use the fruits and animals around us as we wish, such as Genesis (1:28-29) states. [13]
Our goal as Marxists, and here we come immediately to one of the main tenets of Marxism, is that we say that we want to start with an understanding of the situation and dynamics of the world and thence want to apply this understanding in such a way that, from a humanistic standpoint (and this is the second prime feature of Marxism) we improve the living conditions of humankind (and ipso facto for all living creatures) in concordance with the natural constraints, so that in the long run the changes we consciously make do not backfire on us. So, the hope expressed by Bukharin and Preobrazhensky that" Concurrently with the disappearance of man's tyranny over man, the tyranny of nature over man will likewise vanish" doesn't mean paradise but means an social structure that understands nature's and a fortiori human's constraints. [14] That is something completely different from a consciousness of so-called natural necessity, the basis of the economic deterministic current in Marxism.
A third feature of Marxism is that, contrary to modest thinkers who understand that the challenge is of an exceptional scale and hence revert cowardly to a higher being for understanding totality, our founders, as good labourious children of the Nineteenth century, state that the only conscious agent for change is humankind itself; hence, stop interpreting and start moving.
So, this last Marxist mission statement in which Marx parts from Feuerbach, leaves us with

[11] Vernadsky 1926. On Vernadsky, see: Bailes 1990.
[12] Lovelock 1979.
[13] Kircz 1994 and Kircz 1998.
[14] Bukharin and Preobrazhensky 1919, p. 77.

quite a bit of homework.

Sensing and interpreting

The first issue is to understand the relationship between phenomena and their interpretation within a consistent theory. The second issue is that, as we develop theories, in as many fields as we can discern, the notion of a unifying theory is always looming around the corner, though we have no idea on what level of abstraction we reach it. The programme of the introduction of an almighty (human made?) god, solves everything beyond comprehension. The big bang theory suggests a primordial unity that is broken into opposing parts. On the other end of the scale the Vienna School's logical positivist programme aimed at unification by a human-made well-formed linguistic approach of naming objects, though based on human observation statements. The differences are enormous.
On the more practical level, in most disciplines we hardly have even a *temporal* set of basic notions and rules. Definitions of objects of investigation change constantly with the progress of knowledge. We stand in the middle of a turbulent stream of observations, interpretations, theory-making, applications and expert guesses and wade towards a goal which is not even well understood: *A better world*.

Marxism, as understood by its founders and some of their heirs, is a conscious enterprise in which we try to understand the mutual metabolism of humankind and nature, void of ungrounded hopes for a better humanity based on abstract notions of perceived intrinsic goodness of humankind. Here we see immediately the difference with utopian currents. The Marxist goal of a better world is grounded in knowledge of the understanding of Nature's behaviour and in particular the conscious human aspect therein; that is to say, human society. I say "Nature's behaviour", because that phenomenological experience is what we try to cast into a theory which helps us to extrapolate from the present to the future. In the dialectic between induction and deduction we start with concrete observations and through hypothetico-deductive reasoning attempt to reach explanatory and forecasting theories, which remain popular as long as they can be applied, even if we understand their limited applicability.

Human-centric

The human observes objects and experiences phenomena, names them and tries to systematise the behaviour of these objects. The mind then suggests notions and from patterns rules and tries to reformulate this in a *symbolic* language. In that process we transcend the physical reality and create a mental model. In the case that this model is fit for calculations we talk of a form of computer program or mathematics; a well-defined, strictly rule-based, system of thinking.
The whole reason for doing this is because we experience regularities and irregularities and have the firm impression that nature is a complex, intertwined system of rules and objects, which we try to approximate with formal mental models.
At this place it might be useful to note that the type of formalities is not yet defined. Nothing demands that we have to adhere to forms of simple, first-order logic and Aristotelian syllogisms and not, e.g. forms of modal logic, which are still rarely applied. It is the other way around. We attack the unknown by prompting it by models – as simple as possible - in order to test to what extent these models are sufficient for certain goals.

This whole enterprise is purely human-centric, including the suggestion (or intuition?) that nature is based on an aesthetically-pleasant framework – from Kepler's Harmony of Spheres for the planetary system via Dirac's aesthetics of well-formed formulae to Weinberg's dream of a theory of everything.[15]
Nature gave rise to humankind, but by conscious human suicide, by a meteoric impact, volcanic explosions or by disturbing the huge solid methane slabs on the bottom of the oceans, nature will change her course and will carry on undisturbed, as you cannot speak of a disturbance without defining a "natural" state or trajectory. [16]
One thing is clear, humankind is not the "natural" state of nature, in the sense of the biosphere, and certainly not a stage or the end of a teleological route to eternity (whatever that means) but just a phase in a particular setting. [17]
If we talk about the destruction of nature, we only talk about the demolition of the present-day human habitat, including all that comprises it, like the flowers in the fields, the singing birds in the sky and the herring in the North Sea.

On language

In our understanding, what distinguishes humankind from animals, the complex language faculty, can be set aside as a prime feature. Not because non-linguistic communication is impossible, not because we do hardly know to what extent animals have consciousness or communicate to each other, which they do, but because our language faculty, together with our memory, is a tool that enables us to name objects which do not exist as such in pure, phenomenological low-level sensory experiences. Human communicative thinking is able to develop theory; that is to say, transmittable understanding and fantasies that can last forever.

It is tempting to spend the next several pages on a discussion of semantics and semiology, because it is by naming an object or a thought that we tear it apart from its environment, let it be born like a child that leaves the mother's womb, and give it the freedom to develop. The essential issue in naming something is the negation of the totality of what we experience. In experiments and experiences we are able to name tangible objects, such as a table, or abstract notions, such as infinity or labour power, and set them apart as elements in a dynamic theory of how parts of our world develop. As Roy Harris clearly states, there is a wide gap between the interplay of symbols which we can define and fix forever, such as those in mathematics, and those in language which represent a much richer and complex resource. In building a theory we transcend the actual.
Harris's integrationist alternative to fixed codes construes communication as a continuum of creative activities in which participants strive to integrate particular circumstances.
The fixed code at which science aims must somehow be able to override all linguistic diversity because its definitions are based on universal truths that brook no denial.
His conclusion is: *at long last, [that] the limits of science are the limits of language. And that is toto caelo different from believing that the limits of language are the limits of science.*[18]
This is an important statement which clearly stresses the tension between the understanding of our world in linguistic terms and the ordering of these terms in linguistic theory and the

[15] McAllister 1996. Weinberg 1992.
[16] See also Grundmann 1991.
[17] See, e.g., the works of Stephen Gould.

[18] For Roy Harris see: http://www.royharrisonline.com/index.html

multitude of possible scientific models or theories that demand new ways of linguistic expression.
We now arrive at the vexing issue of models, metaphors and analogies.

On metaphors

The crucial issue in education and conveying knowledge is in establishing a link between the level of understanding, within the social context of the student, and the material to be conveyed. In Vygotskyian terms the zone of proximal development or in Leninist-Trotskyist terms a *Transitional Programme* approach.[19] Explaining a new idea or a new notion demands the use of a known idea or known understanding as a conveyor belt to the new concept. It is beyond the scope of this essay to dwell on the vast literature on metaphors and metonyms, but in relation to our subject, we have to realise that naming and explaining depend heavily on taking examples or metaphors at face value or as vehicles for understanding a transcended meaning or new concept. In science we regularly see the use of metaphors to explain a new idea.
A beautiful example is the breakthrough in understanding the atom, when in the early Twentieth century; Niels Bohr came up with the metaphor of the atom as kind of planetary system with a positive nucleus at its centre and negative electrons circling around it. This mental model, though scientifically completely obsolete, still serves in endless popular science narratives. The interesting fact is that people must understand and accept the planetary system before they can be exposed to and understand Bohr's model of the atom.

Political rhetoric is littered with sloppy analogies, metaphors and examples, such as the use of the words war, attack, best, etc. This style is disastrous, in particular if works of our founding fathers are promoted lock, stock and barrel to catechisms, as is the case with Lenin's polemic against Bogdanov and empirio-criticism and Engels' *Anti-During* or his *Dialectics of Nature* notebooks. [20] Interestingly Bogdanov put a great emphasis on what he calls substitution in the process of phrasing knowledge in the language of the social hegemonic superstructure.

The Dialectical Materialist ideology of Stalinism is a prime example of taking creative reasoning out of its socio-historical context and recasting it in eternal truisms. Words, definitions, examples and metaphors out of context lose their teeth and are reduced to formalisms, that is to say, estranged, alienated and sterile mantras. [21]

What is a science?

Science is a term that came into fashion around mid- Nineteenth century, before that time it was called philosophy or natural philosophy. It became, due to the success of the natural sciences and in particular the applied part of those, the Holy Grail for all studies in human understanding. A science is understood as a set of notions and rules that model phenomena.

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[19] Vygotsky 1978, p. 84.
[20] Lenin 1908, Engels 1882.
[21] For surveys on the discussions on modern science in the (early) SU see in particular Joravky 1991 and Graham 1987. Certainly in the early days after the revolution the epistemological issues were taken seriously before the bizarre ossified DiaMat became a state religion. An old anti-communist, but interesting, reference is the overview work of the Soviet Dialectical Materialist doctrine by the Vatican Jesuit scholar Gustav Wetter 1964.

Phenomena, for a long time, could be equated with observables, which is a technical term in physics for those objects that can be directly or indirectly observed. The important issue here is that observation in most of the cases is indirect. Many features we do not see or experience at all, but express them in phenomena that we encounter, indirect, with our senses. The notion that sun burns, vision, astronomical so-called gamma ray burst as well as UMTS wave bands for the next generation mobile telephones are all expressions of the same notion of light particles or waves - named photons – is a good example. Many phenomena are packed into one essence, the photon, which in itself is ontologically a fundamental notion and is a measure of energy, where energy is ontologically something which expresses itself in photons but not in photons alone.
A scientific theory is a consistent model with a very important single feature, namely that it allows us to expand its reach from known phenomena to not yet known. In other words, it allows for verifiable predictions.
I like to follow Russo and take one of his important examples to highlight the issue. [22]

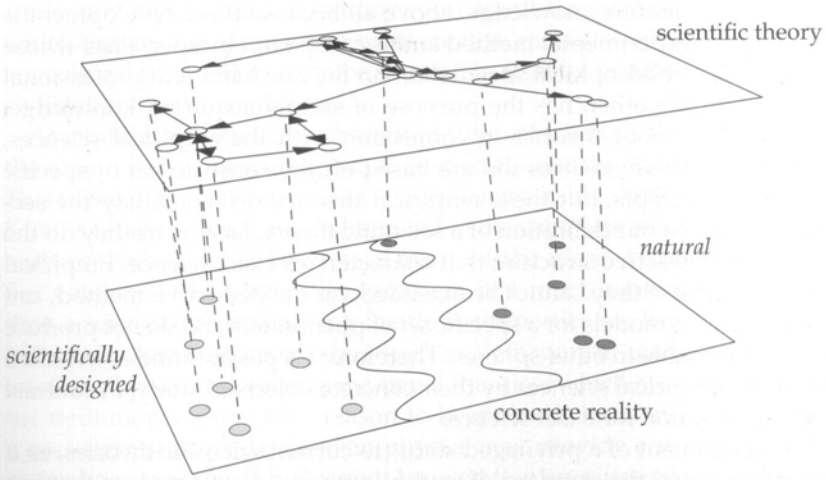


FIGURE 1.1. The role of scientific technology. Dark-shaded circles on the concrete (lower) plane represent objects from nature or prescientific technology. Their counterparts on the theoretical (upper) plane are linked via logical deductions (arrows) to many other constructs, which may or may not have a concrete counterpart. Some of these theoretical constructs give rise, via correspondence rules (dashed lines), to new concrete objects (lightly shaded circles on the lower plane).
Lucio Russo: The forgotten revolution, p.19.

It is clear that we can have series of scientific theories that all serve their goal within a limited social and historical context. As long as the predictions made by the theory fulfil the needs of its practitioners we see no problem. But new phenomena and new outlooks continually emerge and therewith the desire to reach a consistent patchwork of interlinked theories or preferably a theory that encompasses as much of the phenomena and predictions as possible.

From a pragmatic point of view, the need for an all-encompassing theory is not really needed. As long as a patchwork of theories suffices for all practical purposes, many people can live with that. But the essence of science, as an art of understanding, is that our ontological framework demands the integration of all those various parts because we take the world as a

[22] Russo 2004.

whole and hence all practical "local" theories ultimately have to fit into a comprehensive understanding. By local, I mean theories that fulfil all practical purposes within a certain realm at a certain historical time in a certain social setting. At present we read a lot about so-called string theory as one of the attempts to overcome the essential ontological differences between two, as far as we know, "true" theories, General Relativity Theory and Quantum Mechanics. But be aware of the fact that ontological they are at odds to each other. In GRT space, time and energy are coupled notions, in QM we have a clear so-called "canvas" of independent time and space coordinates on which the physics theatre is playing. The mathematical trick to add more and more so-called dimensions reach a level in which everything is diluted into a creamy hot soup that curdles into different realms by cooling (so-called symmetry breaking). A beautiful mathematical construct that avoids the age old quest of what the notion time and space actually is, by stipulating that these notions only come to the fore, later in the development of nature. [23]

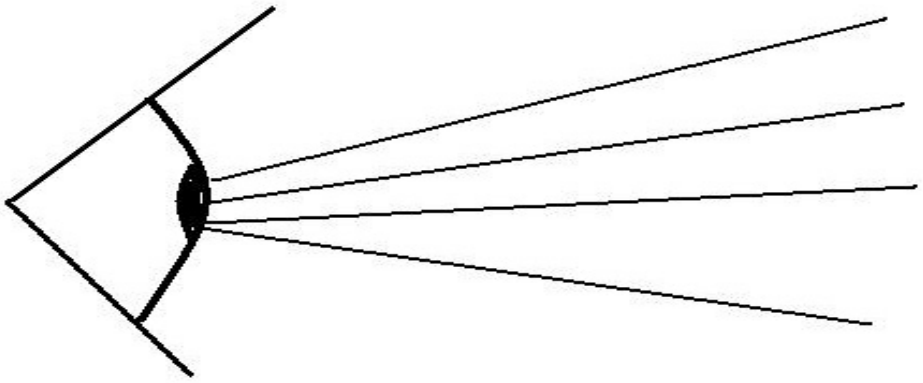
Historicity of ideas

Marxism is a current of thought that tries to understand the actual as a consequential result of social forces of the past in such a way that continuing developments as well as ruptures are understood and their internal tensions are seen as driving forces for change. This means that Marxism develops her own vocabulary just as any other "science" and that this vocabulary uses words and build on existing notions, though often by changing the content of the terms. This is a completely normal procedure in every science, where words receive a new connotation every time we make a further step in understanding. Every socio-historical context has its own frame of reference and hence ideas and words are coined within that context. It is precisely for that reason that Marx and Engels used a lot of words in defining their fundamental notions in clear terms as notions that pertain to a particular historical context: modern capitalism.

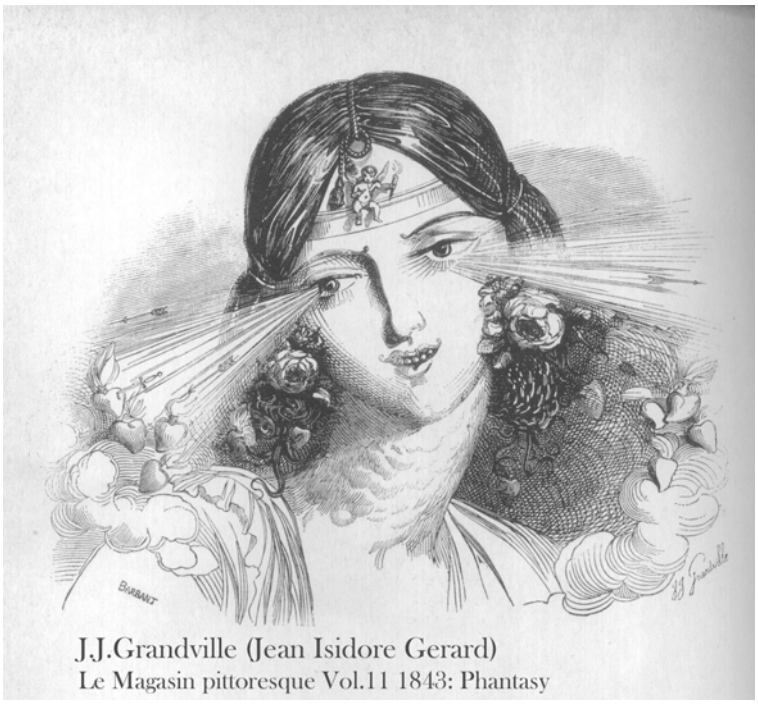
As an example it is interesting to take the theory of vision, as given by Russo's study on Hellenistic science. In Hellenistic natural philosophy there were various doctrines of sight based on the idea that an *opis* (visual ray) was something actually emitted from the eye. Herophilus of Chalcedon, a contemporary of Euclid (300 years before our dating system) paid particular attention to the eye... His was the first description of the retina, which he named *arachnoides* ("like a spider web"), and of three other membranes...[24]

This knowledge, and the knowledge of the function of sensory nerves, could have suggested the existence of a discrete set of photoreceptors. To construct a mathematical model of vision, then, it is natural to consider a discrete set of "visual rays", one for each sensory element of the retina, and that is exactly what Euclid does. The resulting theory can explain quantitatively the resolving power of the human eye.
For Euclid the sharpness with which an object is perceived depends on the number of visual rays. [25]

[23] For a good readable critique on String theory, see: Smolin 2007.
[24] Russo 2004, p. 144.
[25] Russo 2004, p. 149.



This theory of vision is a good example of the transformation of experimental knowledge into a consistent theory. In the course of time we changed our mind and now have a theory of light which is of a complete different nature and which struggles with the antagonistic interpretation of the well-known enigma of particle-wave duality.
However, in many day-to-day experiences the idea that light is emanating from the eye is still an accepted way of saying. You still steal a glance or cast covetous eyes upon another person.



J.J.Grandville (Jean Isidore Gerard)
Le Magasin pittoresque Vol.11 1843: Phantasy

In the same way Marxism develops ontological categories which are unique for its way of analysing the dynamics of world history. The principle, and in my opinion most important, notion is that of Labour Power. [26]

Human labour is that force that enables us to create ideas consciously and subsequently tools and social structures, this according to the famous bees metaphor in Capital volume 1. This human mental and physical ability to creating new objects, shapes the own social structure

[26] By the way, also in Lukacs' thinking, though he needs a few thousand pages in his *Zur Ontologie des gesellschaftlichen Seins* to say so. Lukacs 1984.

and therewith also the nonhuman environment, the eco-structure of the planet. In other words, as soon as humankind invented the steam engine and developed the basic notions of energy, free energy and entropy, thermodynamics as a theory started to fill our mind. At the same time, the steam engine became the forerunner of the combustion engine and an economy based on fossil fuels. The ecological effects of that are nowadays again cast in terms of thermodynamics models. Our understanding of the ecological effects of global warming by human labour are grounded in human made mental-labour concepts based on the steam engine.

Two remarks can be made here: Firstly, this ontological notion of labour power is fundamental because it is the creative driving force across human history as a result of our biological propensities, such as the need for procreation and food. [27]
Secondly, it is important to realise that inventions (looking glass, steam engine, space craft, iPod) must not to be mistaken for discoveries (steam and ice are both water, sperm is necessary for a pregnancy). Discoveries are made within a certain socio-historical context that enables it, remain part of our world independent of the changes of the societal context. This means that mental constructions such as an analytical theory are certainly socio-historical determined; but discoveries are socio-historical determined in another way. Theories come and go, but inventions become part of material life that drives human ingenuity.
This is already exemplified above with Euclid's idea of visual rays. The looking glass, once invented becomes transhistorical. It simply is here and remains. It is a human invention void of any natural evolutionary development. Contrary to Therapsids, who died out in the Triassic-Jurassic extinction event. If these creatures were able to invent the looking glass, it would be still available. It goes without saying that the actual invention or finds and its successes strongly depend on the social-historical context, as history of science and technology studies prove. However, the theory describing its working is changing. That means that products of creative labour, though differently described and rated in different periods are gifts for ever. We cannot get rid of the wheel, nor of the nuclear reactor, we can only decide not to use them in well-defined circumstances. However, we can loose the knowledge how to make or how to use inventions as is frequently proven in cases of extreme neglect (the Greek knowledge of building aqueducts during the breakdown of the Roman empire) or destruction (the knowledge of conquered civilisations).

The next level of ontological categories in Marxism beyond labour power, includes socio-historical notions such as capitalist labour, class, profit and the like. These are analytical notions, products of human mental labour power necessary to name and understand modern capitalism, its dynamics and its overthrow.[28]
And as the founding fathers clearly state, these notions cease to have the same content, are transcended, after the abolition of capitalism and the withering away of the capitalist state. This important aspect is the basis of all discussions about cultural revolutions, previous to, during, and after revolutions. Since the already mentioned Lenin-Bogdanov controversy it

[27] See for a forceful attack on genetic predestination and an analysis of the relationships between sex, reproduction and economics: Eldrege 2004.

[28] This means that the form labour power takes in the productive process will change. Under hegemonic capitalist production it gives rise to the two entangled classes of the proletariat and the capitalist (a 'unity of opposites' in Leninist terns): those who can only sell their labour power on the market; and those who own the means of production. Different forms of exploitation occur under different production relations.

became an essential element in the discussion about transitional societies and the policy to advance emancipation by changing morals and culture.

Marxism as a science

Rivers of ink have been spilled in discussing a proper definition and methods to compare investigative crafts (sciences) and theories.

Within the zoo of sciences and theories, we can simply state that Marxism is a human endeavour aimed at understanding social phenomena in order to consciously change them. This is not very different from, say, chemistry where the aim is to understand chemical substances and reactions in order to apply them for the well being of the owner of this knowledge. In Marxism, the owner of its knowledge is the world proletariat and its allies. The underlying fundamental difference between chemistry and Marxism is that humans cannot change the laws of biology and chemistry but only make use of them, as far as they understand them. Whilst in the case of social relationships and societal formations, we are dealing with human-made structures and, hence, we can change these laws.
For that reason, all attempts to cast human relations in metaphors of human-made structures is void, though they can play a role as heuristic vehicles. In eighteenth century we have seen La Mettrie with his *L'Home Machine*, in the late 1980's we saw enthusiastic currents defending the supposed modularity of the mind, based on the modularity of computer, input, processor, memory, and output devices. This hype was followed suit with making the (selfish?) genes the cornerstone of all human activities. Presently, this is overtaken by the notion of the neurological plasticity of the human brain. What's next?
In all these cases as well as the cases that Marx, and in particular Engels, investigated, we can learn a lot from it and can try and apply it to a certain extent as metaphors and models for understanding social behaviour. But again, they remain heuristic models. So, we also have to address Marxist heuristics and analyse the key notions in Marxist theory.

We can change social relations if we have a sufficient knowledge of human nature, that is to say that what makes humans as a result of both our biological substrate and our social being. The biological limits of humankind have to be taken into account. We are accursed: we cannot fly, and we also age, feel pain and can suffer illness and brain damage. [29]
In order to act politically we need knowledge on various levels. The surface level of interhuman societal interactions is the playing field of sociology and deals with human behaviour and power plays. However, this level is based on material humans and a material environment. This bedrock provides limits to the capabilities of changing society. Humans will never become angels, saints or animals. After all only the human species is capable of large scale murdering and torturing its fellow humans in a preset, conscious, and deliberate way. Humans are a special brand in the animal kingdom.

This notion brings us to the pressing issue: to what extent do the lower levels of life, namely the physico-chemical substrates we are made of, determine the higher surface level of social interactions? And in the reverse direction, how does the social environment alter our body,

[29] See, e.g. Sebastian Timpanaro, On Materialism 1975, but also the important discussion on the role of the media as extension of human activity started by McLuhan in 1964 and recently eloquently updated by Lanier 2010 and Carr 2010, in their concerns of the usage of Internet.

e.g. by millennia of using tools?[30]
With the emergence of modern science this tension is heatedly debated. Are humans machines with a free soul, or are we dealing with a complicated structure where bodily feelings like pain, anger, happiness or well-being is the expression of the tensions between living mater and thinking (grey) matter, whatever that might be? In a traditional Marxist sense the thinking matter transcends the non-thinking living matter by becoming an antagonist entity as it not only negates mechanical, non-thinking matter, but is also able to exploit it and use it for self-invented, thoughtful, goals. This transcending into living from nonliving matter is still an object of investigations. For millennia we have seen people who tried to overcome their biological substrate by denying their body, as we see with fakirs, Catholic monks, and many others obsessed people.
On the other end of the scale we see a growing tendency to reduce the human as a direct mono-linear extension of its genetic or neurological scaffolding. Interestingly, in both these tendencies we see on the one hand the old, idealistic tradition of denial of the biological substrate of thinking matter and on the other hand the primitive materialist reflex of grounding everything in a linear development from so-called primitive structures to complicated structures. In both extremes, the actual social human body is denied.
We safely can forget these currents as they don't solve the problem of the difference between non-living matter and dead matter. As the first is the fertile precondition to life, whereas the latter is the end of the story of life and a return to non-living matter. The religious proposition that in this cyclical development, in the construction of life, a soul is created that escapes again to other worlds in the agony of dead is not part of the discussions in this essay. [31]
It goes without saying that life is more complicated. The primitive contradiction between life and death cannot be sustained in view of modern biology in which the whole notion of life (in the sense of non-thinking life) is under review. Even if we take DNA molecules as the ultimate building blocks of life, then still the creation of those very DNA molecules and the enormous variety of creative power from DNA chips, like viruses, to mammals are still open for research. The hegemonic idea that complicated life is a hierarchical crowning of an evolution from lesser structures does not exclude that new forms of life can result from brake away parts of complicated DNA, as some researchers consider viruses to be.

Dialectics and non-linearity

Many of our mental models or pictures, be they scientific or otherwise, are based on modelling. But modelling is based on well-defined notions and is, like all knowledge, historically contingent. In particular in more technical fields, models serve a most important aid to understanding.
It took quite a while before the heliocentric model of our planetary system became a societal accepted truism. However, if we confront regular people with all the arguments against this picture, most of them will drop the idea immediately.[32]

As said above, the planetary atomic model is now common sense and still in use in fields like chemistry and pharmaceutics where atoms and molecules are pictured as differently sized balls and chemical binding is represented by sticks. The ball and stick model allows for the most beautiful simulations of chemical reactions and modelling. However, the physicists

[30] See, e.g. the interesting study of Wilson 1998 on the co-evolution of Hand and Brain.
[31] Near-death or out-of-body experiences can be measured as neurological brain activity, even after cardiac arrest.
[32] Why is it not storming if the globe races with 30 km/second around the sun? See: Easlea 1980 p. 33.

know that particles are just one kind of representation of matter and in essence we deal with fields, that is to say waves and not balls.[33]
Interestingly, as already said, many a social scientist tries to mimic natural sciences in declaring the same type of modelling and methodologies. The hypothetic-deductive method, which is our current view of performing decent investigations, in no way demands mimicking natural science methods but allows for using them as examples or metaphors. This can be very successful, but does not relieve us from the task of understanding the ontological difference of the input of those "methods on loan". The most bizarre examples of this practise are found in self-declared "sciences", such as marketing science, communication science, religious science, and management science. Here, the almost allegoric use of well-defined notions from the natural sciences are used as rhetorical devises for sloppy reasoning and false metaphors.[34]

The main problem and the main mistake made by believers of an ideology, such as Diamat, is that in the right social setting, the ultimate true will be revealed. All human knowledge is socio-historically contingent. It is clear that historically our knowledge is exploding, and it is hopeful, even beautiful, that many chapters in this knowledge get increasingly integrated in a comprehensive book of knowledge. But contrary to this advance of knowledge, the human story cannot be equated with the book of nature. In that book we play our role as agent, not as scribe.
Also the idea that we eventually will reach an all-encompassing theory needs further exploration. It is telling that in modern physics and not in sociology the idea that laws are contingent comes to the fore. It now becomes clear that physical laws, which are human-made constructions based on named observations and relationships between them, hold within well-defined pockets of our knowledge. They are good For All Practical Purposes (FAPP), to use a term of the famous John Bell, after whom the Bell Inequalities in quantum mechanics are named. Self-assembly as one of the features of life can have many forms and rules.[35]

The tantalising feature of natural science is that based on well-defined and well-formed notions of non-living matter we turn out to be able to understand natural activities as well as create totally new contraptions which never will arise from any evolutionary path. The fact that the watch is a unique human-made object which has a manufacturer does not mean that the unique feature of an independent thinking bag of proteins, bones and water (the human body) needs a creator. In a sense the human is more mundane, evolutionary speaking, than a watch is or an iPod.

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[33] In many important discussions among socialist physicists (and certainly not only in the USSR) the mutually excluding pictures of elementary entities as waves or particles have been equated with a "dialectical" opposition. To what extend is a wave antagonistic to a particle, I don't know? It depends on your definitions of antagonism. Whilst in quantum field theory both these notions are sublimated, though leaving out the issue of what exactly local and spread out phenomena are. Also here we struggle in understanding the incompatibility of otherwise excellent notions such as place and time. It goes without saying that elevating this nagging issue to a post-structuralist language game obscures matters only more.
[34] Terms such as: a quantum jump/leap for a big step forward or change. Whilst a quantum jump is the measure of the tiniest amount of energy. Or chaotic behaviour and bifurcations as examples for unknown behaviour. Whilst chaos theory is stickily deterministic. The real issue here is not randomness but the level of calculatability and predictability.
[35] For a good introduction on so-called emerging properties, see: Laughlin 2005.

The successful application of natural science methods to medicine and other human-related crafts force us to think deeper on the vexing issue of the differences between neurological knowledge, psycho-pharmaceuticals and the understanding of human thinking and mental functioning. In this discussion more then in all other fields we face the problem of determinism. The scientific tradition of humankind is one of analysis, of tearing apart wholeness in those parts which we can, with our knowledge, understands as more or less independent parts. That way we reach the idea of fundamental building blocks that on the way back reconstruct the original whole. The successfulness of these methods is daily proven, this in contrast to more "eastern" ideas of wholeness that certainly serve comprehension but not operational understanding. Zen and religion certainly play a role in fostering human modesty, but not in solving the material contradictions created by modern S&T in capitalist society.

Marxism as guidance for R&D?

All theory is a social construction. The question is to what extent does a particular socially constructed theory becomes a practically useful tool in developing and emancipating humankind. In the philosophy of science much time is spent on the issue of comparing theories. In general the consensus is that a theory that is able to incorporate another one, which means saves all phenomena, and even is able to explain all features of an older theory, as well as explaining new phenomena, is a superior theory and more "true".
Two remarks have to be made. Firstly theories that describe certain fields in greatest detail can still be at odds with theories that do the same in an adjacent or even the same field. The prime example is the dichotomy between General Relativity Theory and Quantum Mechanics, as mentioned above. Both theories are true as hell that is to say as far as we understand, based in this terrestrial world. However, both theories are ontologically completely at odds with each other. The present-day discussions on unification of both in a so-called quantum gravity theory is basically close to the discussions between Newton and Leibnitz about the absoluteness of space.

It is certainly a matter of a philosophical taste, or even political outlook, what line of reasoning is preferred. The old communist David Bohm, who became in his old days befriended with Krishnamurthy and hence is now an icon of new age philosophies, had his alternative approach of quantum mechanics firmly rooted in a materialist world view that did not accepted chance as a primitive notion. Interestingly, it is now well accepted that the fact that his ideas were almost universally denied were more of a social-political nature than of a scientific one. Today both ways, traditional QM and the Bohm's causal interpretation (now also named Bohmian Mechanics) can reach the same result. In other words they are more or less on par in describing the phenomena.[36]

Standard philosophy of science requests a test in forecasting a measurable effect that one theory can predict and explain whilst the other cannot. The question is if such an experiment *cruxis* really solves this problem. Such a call for an experiment *cruxis* is a primitive hope for a final answer and a uni-linear development of knowledge. In reality, every theory is, can, and will be falsified. Newtonian mechanics is wrong but we all use it everywhere, QM, which is proved correct in modern electronics, is wrong because it cannot deal with gravity and GRT, which is proved correct in every car using a GPS, is wrong because it cannot deal with quantum behaviour. All three are human made social constructs using a particular semantics

[36] See, Cushing 1994. On the fascinating life of David Bohm, see: Peat 1997.

as well as syntax, and all three serve us well. The interesting point is what standpoint makes one theory fashionable. A strong driving force is applicability, which results in new products on a market (in the world of scientific research funding this is called Valorisation of Knowledge). But, for instance, in the field of astrophysics it is much more the ontological questions of the beginning of life and the universe that drives the interest, rather than any practical usage. Funny enough this research endeavour is called fundamental, which is a clear linguistic allusion towards a religious notion of prime movers from which all the rest emerges.

Advanced capitalism demands advanced answers based on contemporary knowledge

One of the most astonishing features of modern Marxism is its complete reduction to social theory as if the notion that everything is a social construction relieves us from an understanding of on what ideas and theories present day society has been built. Just open any book on management, economics, psychology or any other social science, and you see that it is fully exploiting, metaphorically or directly, methods and theories that sprout from natural science. Statistics, chaos theory, catastrophe theory, thermodynamics, classical mechanics, frivolous incursions in quantum mechanics or even relativity theory.
Something very strange is going on here. On the one hand it is, correctly, said that the social circumstances enable the developments of certain theories and product lines. Society, or better the market, is ready for it and R&D programmes are tuned towards perceived success. On the other hand the intrinsic dynamics of the underlying theories are just taken for granted. Again, the difference between the historicity of theory and the trans-historicity of products must be sharply distinguished.
Another aspect is of course the post-modern claims that deny the fact that all these transient theories do indeed describe part of reality correctly within the limits of their reach. The material rooting of language, and language games, in reality is simply denied.
A good example is the outcry for sustainable energy, a notion the large capitalist industrialists certainly accept as a profitable challenge. Everybody is aware of the energy crisis and the consequences of the human pollution of the environment. However, without a deep knowledge of the intricacies of the various energy forms and production, sustainability is a hollow phrase. Solar energy captured by solar cells is only a solution if, and only if, the intrinsic pollution of the manufacturing of solar cells is understood, otherwise we will see a repetition of the down fall of the Atoms for Peace programme of the 1950's, or the present crisis in hydro-power stations in natural rivers, to name two examples. The answer is not only a reduction of energy consumption (go and tell that to the Chinese and Indian workers), but a massive R&D effort into energy research. A project, which will take many decennia and will have a long time to market. In no way such a research endeavour will see a “knowledge validation” that gives a ready return on investment. Such an understanding demands the call for a long term, non-capitalist, planning, which is at odds with the present hit-and-run economic models.[37]
Countering modern capitalist methods from crowd control to chaos theoretical calculations at the stock market demand an immanent critique, just as capitalist production as such, because it became part and parcel of it.

[37] An immediate, quick, answer is a political answer: the only societal source of excess money is presently the direct (Afghanistan, Libya, keeping up the own military forces at home) and indirect (aid, training of troops, etc. for friendly countries) military expenditures, because this subsidized sector of capital destruction is the pure antagonist of a sustainable energy industry.

The same way capitalism is harvesting and pruning all new ideas, methods and techniques modern science and mathematics produce, socialists have to master them and assess their usability for whom and for what. Again this brings us back to the Lenin-Bogdanov controversy about the capability of the proletariat to transcend capitalism, whilst contrary to the bourgeois revolution, the proletariat is not able to build already its own structures within the dying old culture. Following Lenin amassing all knowledge is needed to shape a new proletarian culture, and this cannot come to fruition by starting a new culture now.
Marx and Engels spent enormous time in enthusiastically reading about the latest developments in biology, geology, chemistry, etc., etc. Their notes are now coming into print in the new MEGA2 publications. It is not only of historical reasons, but much more for methodological reasons to appreciate this, though, the books they read and the conclusions or hopes they obtained from their content are now out dated.
The evergreen of criticising Engels for his notebooks on Dialectics of Nature, is as unproductive as arguing against any other example that fuelled theoretical thinking, because now partly outdated science was the metaphor and stimulant for Marx and Engels to shape their theory of mutually interacting and excluding agents. The essence of the issue is that Engels toyed with the rapid and fascinating developments in, e.g., chemistry to get a better understanding of interacting and mutually determining systems. In other words abstract dialectics could be seen in the metaphorical mirror of chemistry.

The issue is not interesting to prove if nature is yes or no dialectical, according to human-made models (Hegelian or not), but to develop creative thinking in which the concepts or mutually interrelated and mutually determining dynamical systems can be worked out further, among other sources by looking at successful theories in the natural sciences, biology (once evolution theory, now also neurology), etc. That does not mean that these, often incompatible, theories are to be taken for granted, but by learning and exploiting their methodological powers we can make progress. The same is true for mathematics. A critique of first order logical reasoning, though still the hegemonic primitive way of thinking for most people, is politically useful. But advanced model logic theories, now already make deep inroads in modern ethics of all sorts. [38]
The relatively new mathematics of non-linear mechanics (that is the field of mutually determining systems such as gravity theory and weather forecasting) can fuel the discussion on notions such as the difference between anti-poles, antagonisms, contradictions, negations and other forms of closely related consequences of naming in context and dynamical developments in practise.

In other words in understanding the world in order to change it, we need a full fledged programme of how modern bourgeois thinking understands that same world and to what extent the most advanced thinking in that camp is developing and using modern science and biology as metaphors and mental scaffolding.
It is outside the scope of this essay to dwell further about such attempts in the early Soviet Union, before all odds were put on centralised developments of heavy industry. Or, to take a more contemporarily hot potato that the disastrous intrinsic dangerous design of nuclear reactors is equated with the idea that - in principle - the burning of nuclear fuel will always be more dirty and dangerous then other energy sources.

[38] Modal logics are those logics, presently part of bachelor programmes, that deal with ‘it ought to be that’ (deontic), ‘it is know that’ (epistemic), ‘it is believed that’ (doxastic) or ‘ it will be case that’ (temporal).

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