PHILOSOPHY OF THE TECHNICAL PROCESS

A TRANSCENDENTAL EMPIRICAL STUDY

BY

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Declaration

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EKSERPT

In die studie is die grondvraag na die tegniese verwantskap ondersoek. Daar is gevind dat die term ‘tegnologie’ buite konteks misbruik word deur verskeie vakwetenskaplike outeurs. Sommige gebruik dit vir wat beter aangedui kan word met die term **artefakt**. Gevolglik is wat genoem was ‘tegnologie-oordrag’ eintlik beter beskryf met die terme artefakt oordrag. Ander het konsentreer op produksie en ontwerp wat eintlik beter beskryf kan word met die term **tegno-praktyk**. Sogenaamde ‘tegnologiese kennis’ is verder verwar met wat eintlik beter beskryf kan word as **tegniese kennis** en **tegniese geletterdheid**.

‘n Oorsig van terme en gebruike van outeurs in die veld van wetenskap en tegnologie studies (STS) veral diegene wat op ‘tegnologie’ gekonsentreer het, het die volgende elemente ge-identifiseer. **Tegno-praktyk** vir die praktyk van vervaardiging, ontwerp en instandhouding van artefakte. **Tegniese kennis** (tegno-kennis) vir die ondervinding van vorming en instandhouding van die artefakte. **Tegniese wetenskap** (tegno-wetenskap) vir die wetenskap wat kennis aangaande die tegniese proses byeenbring uit ander wetenskappe soos wiskunde, fisika en elektronika, byvoorbeeld om tegniese probleme op te los en moontlikhede te skep. Laastens was **tegniese geletterdheid** onderskei van **tegniese kennis** soos om ‘n motor te kan bestuur sonder om dit noodwendig te kan herstel.

Die gevolg van tegno-praktyk is gewoonlik ‘n artefakt. Wat interessant was is die feit dat verskeie die resultaat van ‘tegnologie’ as ‘tegnologie’ beskou het. Baie gevalle van

waar ‘n artefakt gelykgestel was aan die proses van tegno-praktyk was opgemerk natuurlik onder die term ‘tegnologie’. ‘n Verbasende paradigma versteendheid was gevind waar outeurs nie die onderskeid tussen die tegniese en tegnologiese kon onderskei nie. In ‘n sekere sin kan dit nie beter geïllustreer word as die volgende bevooroordeelde stelling dat dit tog ‘…duidelik is dat rekenaars tegnologie is…’ terwyl dit ewe-eens duidelik is dat rekenaars eintlik artefakte is, die resultaat van ‘n ontwerp en vervaardigingsproses.

Laastens is die transendentaal empiriese metode gebruik om die onties (transen-dentale) struktuurvoorwaardes vir die tegniese verwantskap in ag te neem en daarna is dit beskryf in ‘n ontologiese, (wysgerig) antropologiese en samelewingsraamwerk.

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ABSTRACT

In this study the fundamental question about the technical relationship is investigated. The term ‘technology’ was found to be misused out of contexts by various disciplinary authors. Some authors used it for the notion that could better be described as artefacts. Consequently what was called ‘technology transfer’ was little more than artefactual transfer. Others concentrated on production and design that could better be described by techno-practice. Still others confused so-called ‘technological knowledge’ with what could be described as techno-knowledge and techno-literacy.

A survey of notions of the authors in the field of Science and Technology Studies (STS), especially those that focussed on technology was done and it was found that the following elements were identifiable: **Techno-practice** for the ‘practice’ of the making, forming, designing and maintaining of artefacts. For this was required **Techno-knowledge**, for the know-how and experience in making, and maintaining these artefacts. Furthermore the element of **Techno-science** for the technical science that was recording knowledge from different sciences like mathematics, physics and electronics etc. to help in the solutions of techno-practice was identified. Lastly **techno-literacy** was distinguished from techno-knowledge, indicating the capability to use artefacts without necessarily having the knowledge to fix them. Driving a car but not being able to fix it sounds like a good example.

The result of techno-practice is normally an **artefact.** What was interesting, is that many saw the result of technology as technology. Many associate an artefact with the

process of techno-practice under the term ‘technology’. An amazing paradigm-paralysis was found that could not distinguish the technical from the technological and cannot be better illustrated than by the biased statement: “Clearly computers are technology…” where-as clearly computers are artefacts, the **result** of a technical design and production process.

Lastly the transcendental empirical method was used to consider the ontic (transcendental) conditions required for this technical relationship and it was described in an ontological, anthropological and societal framework.

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Preface

As with all postgraduate studies this project had its highs and lows. I learned a lot about the ‘politics’ of ‘things’ as Bijker indicated as his interest in the relationship between humans and artefacts. In my case it was just the ‘politics of studies’.
Postgraduate studies is not the ‘pure or disinterested’ search for the ‘truth’ as one might have thought to exist.

I think some thanking is in order.

To my study leader Prof DFM Strauss, a philosopher of some renown, that had the patience to guide me and the sympathy to spend a lot of his valuable time on this.

To my language editor Marietjie de Jongh who changed this project from a ‘foreign language’ to English with a lot of patience.

To my wife and children that never thought this will ever be completed.

To my colleagues that never understood what it was all about but still hoped that it will finish so that I will stop bugging them.

Thank you all

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1. Introduction

In this section the background of the research problem will be outlined, to be followed by a statement of the problem as well as an indication of the methodology employed in the investigation of the problem.

1.1. The problem

Initially, the problem was condensed into two short questions:

- What is technology[1]?
- How does it fit into reality and society?

The problem arises from the diverse and often contradictory descriptions of or notions about technology, which are found in literature and in everyday life. Assuming an intelligible *orderliness* within the world around us, it may be expected that a certain consistency and clarity would characterize references to phenomena associated with technology. Some blame the confusion in this regard on a lack of systematic reflection (Rapp, 1974: ix); or the lack of a

[1] At this early stage I would like to highlight a possible contextual fallacy. The question is what *is* (the characteristical nature of) the technical and NOT what is it *about* the technical? To talk *about* technology could include that it is good or bad, useful or treacherous, has a major impact or not etc. without worrying too much about what it really *is*. In principle we can all have an opinion *about* technology without knowing what it actually *is*. Here the 'unique' *identification* is of importance.

proper understanding of the subject field (Ströker, 1983: 325); or simply a lack of effort (Schuurman, 1980: 1).

We believe that the challenge is to develop a *systematic understanding* of technology that includes a model accounting for the structural features[2] of technology. The above-mentioned assumption regarding the *orderliness* discernible within reality presupposes an awareness of some or other *order for*. The notion of lawfulness or law-conformity suggests a difference between law or order and that, which behaves in an orderly way. An insight into the underlying *order for* technology may prove to be useful in demarcating the domain of technology – in deciding which phenomena ought to be included in the family of what is technologically distinctive.

The search for the *order for* or structural principle of technology is complicated by the term 'technology' itself. The suffix '-logy' normally indicates the presence of human thinking and theoretical reflection. *Bio-logy* is the scholarly study of 'bios' (i.e., of what is alive), and *socio-logy* is the theoretical study of social phenomena. Does it then follow that *techno-logy* ought to be seen as the scholarly study of *technical* phenomena? This

[2] At this point it might not be obvious that the persistent order for reality will also be relevant to 'technology' as part of this reality. The structural features assume that it is not an aspect but a structure in reality. Furthermore, any disciplinary (subject) science will not have the totality of this structure in its focus. This implies that only philosophy, as a 'totality' science will be able to supply a totality view.

consideration has prompted an investigation into the differences between the two terms *technology* and *technical*.[3]

Is it correct to suppose that what is called *technological* is the *scientific* study of the *technical*, where *technical* is viewed as the *applied construction and production* of things? Are the *technical sciences* or *engineering sciences* the same as or something different from *technology* or *technological science*? Another issue here is that if *technology* is in fact a science (as the term implies) it is tautological to speak of science and technology. Although it does seem to be intuitively clear that the *technical* and the *technological* are not the same, it is not so easy to distinguish between them effectively.

Latour (1999: 190) states that the word *technical* is a good adjective and that the term *technique* is an unsatisfactory noun. As far as he is concerned, technology is the upgraded version of technique. He proposes the use of the adjective only. It would be interesting to know whether or not modern literature has actually followed his proposal.

[3] Terms are lingual 'constructs' that can be coined without any relation to what is ontically given. For example, the terms 'triangular circle', which is grammatically correct, does not indicate a spatial figure that exists ontically; therefore terms do not guarantee an ontical logic. It is also clear that not all terms with a suffix 'logy' indicate "a study of''. It is accepted in this thesis that 'technology' is *not* the study of the technical. Another interesting 'mis'-construction is the term chronology. Although it is not the study of time as one would expect but the study of events in time as in history.

The more important point here is not the grammatical possibility because language does allow a wide possibility; but the nature or characteristics of the given. One can speak grammatically correctly of '*life*' without realising that life is not a thing but an aspect or function of a thing. Is the technical a thing or an aspect of a thing?

1.2. Background

The initial impression gained from an introduction to *Science and Technology Studies* (STS) is that in the available literature more attention is given to philosophy and to the sociology of science than to *technical practice*[4]. A second impression gained is that in the literature on *technical practice* the dominant approaches come from the disciplines of sociology and history and that very little has been done within the domain of the philosophy of *technical practice*. The preoccupation of the philosophical approaches encountered is with a kind of *social philosophy* where *the technical* is placed within society or in relation to society.

[4] Compare the volume allocated to science studies versus technology studies in a standard handbook of technology such as that of Jasanof for example. (HANDBOOK OF SCIENCE AND TECHNOLOGY STUDIES. 1995. Edited by Sheila Jasanoff [et.al.] Sage. London). It is also found in the works of the authors highlighted in this study.

In this respect the discipline of sociology provides valuable insights regarding the influence and interaction between *the technical* and society. We may take the view of Giddens (2001: 365, 376, 380) as an example. He relates technology to work, economic life, capitalist development, telecommunications or communication technology, and ecological disasters.

Tiles (1995: 12) explains that it often seems as if technology created more problems than it provided solutions in society. Both at the beginning and the possible end of life, physicians now have the power to keep alive, almost indefinitely, people who would have died had nature been allowed to take its course. Immunization against childhood diseases such as measles and chicken pox has contributed to overpopulation and hunger in developing nations and some attempts to increase crop yields to avoid starvation have required the introduction of costly fertilizers and pesticides, which, in turn, have caused chemical pollution and medical disorders. All these examples indicate that the technical solution to one problem often leads to the creation of many new, unanticipated problems.

Tiles argues that these ambivalent feelings towards ‘technology’ have developed into two conflicting visions – one optimistic, the other pessimistic: technical omnipotence versus technical impotence, or a vision of control of the environment and human destiny through technology versus the vision of technical systems running out of control (Tiles, 1995: 12).

Feenberg (1996: 1) describes another sentiment about the importance of technology for society. He argues that when technology was not praised for modernizing us, it was blamed for the crisis in our culture, and whether interpreted in optimistic or pessimistic terms, determinism appeared to offer a fundamental account of modernity as a unified phenomenon. This approach has now been largely abandoned for a view that admits of the possibility of significant 'difference,' i.e. cultural variety in the reception and appropriation of modernity. Yet the breakdown of simplistic determinism has not led to quite the upsurge of research in the philosophy of technology one might have hoped for.

Mitcham (1994: 9) points out that the first scholarly meeting to take philosophy of technology as a theme in its own right instead of approaching it by way of theories of culture or society was organized by Melvin Kranzberg of the *Society for the History of Technology* (SHOT). This was at a special symposium at the eighth annual SHOT meeting held in San Francisco in December 1965 in conjunction with a meeting of the American Association for the Advancement of Science, with the proceedings published in the SHOT journal, *Technology and Culture,* the next year.

Prior to this event, technology was *not* seen as a theme in its own right. Schuurman (1980: 1) explains that when systematic philosophical reflections on modern technical activity first appeared at the beginning of the twentieth century, its practitioners did not devote much effort to the structural analysis of contemporary technology. Their aim at that stage was primarily to defend technical activity as an independent segment of culture.

Van Riessen (1949: 1) also indicated that too little attention was given to the analysis of the technical as technical itself, initially at least. He argued that the problem of the interaction between (societal) culture and the technical had been addressed too soon. Although it is an important problem, he feels that it can only be properly addressed after an extensive philosophical analysis of the technical. This is what he has aimed to achieve.

Modern literature shows that a similar problem still appears to be haunting scholars in this field. It seems that less attention is given to technology as such than to its impact on society and on the economy. It simply seems to be sociologically more interesting that all major societal transitions have been linked to *technological change* where new materials, products, production processes and organizational processes have replaced the old, or that the *basket of technologies* that characterize a particular society always perform essentially the same function of providing transport, production, communication and living arrangements (Brotchie, 1985: 1,2).

Brotchie (1985: 2,3) further illustrates these changes by supplying many examples, of which the following can be highlighted: the partial displacement of public transport (that supported a paid labour force) by private transport; of telephone operators by direct dialling; of servants by kitchen appliances; of theatre by radio, TV and video; of formal working hours by flexi-time or part-time employment; of the coffee house by the home percolator; of large mainframe computers by personal computers. Even increasing personalized ('do-it- yourself') activity and greater informality are features of these newest shifts.

Many notions of technological change can be identified and these include notions of automation, telecommunication, the effects of energy prices and threats of shortages, unemployment patterns and their impact on lifestyle and urban activities. However, very little is said about technology as such.

A central problem in planning for technology is the issue of individual autonomy or freedom versus social (or societal) control (Harris, 1985: 297). This brings about the classic tension between individualism and universalism.

Feenberg (1996: 2) illustrates a variation of the problem clearly in his statement:

> 'There is something distinctive about modern societies captured in notions such as modernization, rationalization, and reification. Without such concepts, derived ultimately from Marx and Weber, we can make no sense of the historical process of the last few hundred years. Yet these are "totalizing" concepts that seem to

> lead back to a deterministic view we are supposed to have transcended from our new culturalist perspective. Is there no way out of this dilemma? Must we choose between universal rationality and cultural variety? Or more accurately, *can* we choose between these two dialectically correlated concepts that are each unthinkable without the other?'

Here the tension between 'totalising' and individualizing and deterministic versus indeterministic as opposing concepts in the study of the technical are illustrated. It is clear that opposing motives and contradictory views (also called 'ambiguity') about the technical and its role in society subsist. Although this could stimulate debate and research it could also be a symptom of a more fundamental tension originating from outside the focus of sociology.

1.3. Purpose of the Study

Because different disciplines develop their own nomenclature and because phenomena can be studied by different specialized sciences, some scientific concepts and ideas *typically* originate from outside the perspective or view of the specific discipline. It could therefore be possible that, whereas a study of the nature and structure of technology transcends the focus or scope of sociology, the impact of technology on society is within that scope. If the nature and structure of technology transcend the focus of sociology, it implies that sociology requires philosophical assumptions about technology in order to proceed with the analysis of the impact of such a phenomenon. (Strauss, 1988: 100).

Against this background, the aim of this study is to concentrate on a philosophical focus on the ‘technical activity’ as such[5] and the key questions that will be addressed in this study may be formulated as follows:

1.3.1. Are any of the different notions of technology in the current philosophical and sociological [6]discourses transcendentally acceptable?

The term ‘transcendental’ is used to designate those ontic[7] conditions making the existence and/or functioning of something possible. Synonymous phrases are therefore: *transcendental conditions* and *ontic conditions.* In order to

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[5] This seems to be misunderstood by disciplinary scientists. With *philosophical* is meant concentrating from an overall (ontical) view that transcends any specific disciplinary focus and secondly this study concentrates on the *technical activity* itself and its unique characteristics and NOT *about* the influence or any other statements *about* the technical that disciplinary scientists might have made. It would be a contextual fallacy to suggest that statements *about* technology are similar to statements *about the nature* of technology.

[6] It might be important to highlight that STS literature are in focus. Because of the ‘precisely’ focussed study of ‘ontical’ conditions of what is specific technical the relevant literature was limited but the study was still considered to be significant.

[7] The term ontic is used, as it is the most elementary conditions possible. The difference between ontical and ontological could possibly be illustrated as follows: a stone falling from my hand to the ground is the ontic given reality. A theoretical account of ‘the falling stone’ and why it does not fall upwards, for instance, is found in ontology. At this stage the explanation of why it happens is not important, the interest is in the conditions of what is happening.

assess whether or not the different notions of technology found in the current literature are transcendentally acceptable, a framework will be developed, yielding a set of conditions serving as criteria against which the various notions can be measured. The framework will take into account the question of the transcendental conditions that are required as 'elementary characteristics' or 'a priori' (Duintjer, 1966: 3) for our knowledge of reality and consequently of technology and will be used to examine the following problems:

1.3.2. How can a transcendental philosophical approach[8] focusing on ontology, epistemology, and anthropology be used to clarify our understanding of the *technical* or *technological*?

What is known as the transcendental-empirical method is oriented towards a structural cosmonomic order that reveals a totality in diversity, which does *not*

[8] It is important to realise that questions about technology and about its unique nature could be studied with different methodologies. One could study the issue by focussing on what Plato said, or what Socrates said, or Kant, or Habermas or compare what these and other philosophers stated. The transcendental-empirical method was preferred because it allowed an own study direction, focussing on the ontic characteristics, of the technical, in an ontical framework as orientation that will be described in the compact functional and structural theories of the Philosophy of the Cosmonomic Idea in the last chapter. The important issue here is that the ontic (factual) characteristics will be identified firstly, before a possible theoretical explanation will be given. Given the focus of this study it was clear that consulting also other representatives of the Philosophy of the Cosmonomic Idea (such as Van de Vlugt, Verkerk and Strijbos) would not add anything new to our argument.

inherently entail any antinomies or dialectical tensions[9]. This contradicts the widely accepted idea that everything is subject to historical change and that no constant fundamental structure prevails in reality that could act as a basis for all orderliness within reality (Strauss, 1988: 38).

Here the influence of an ontology, epistemology and anthropology (or the lack thereof) on our understanding of the technical will be highlighted in order to enhance our investigation of the following question:

1.3.3. What are the unique characteristics[10] of 'the technical' and/or 'technology' that will provide for an evaluation of the acceptability of diverging views?

Here the structural features of technology will be highlighted and used as a criterion for the evaluation of diverging views.

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[9] Without belabouring the point some implications are that reality is orderly, implying changes can only be noticed on the basis of what persists. Although things can obtain different meanings in different contexts, it does not follow that the contexts can override the persistent structure of entities. Strictly speaking an entity does not change its structure when it is used in a different context and the idea that things 'become' what they are 'through their use' is strictly speaking not supported.

[10] In line with the assumption in the previous footnote, a thing ought to have a persistent structure in (ontic) reality.

1.3.4. What relationships present themselves as important to ‘the technical’ and/or ‘technology’ in society?

This last question will focus on the relationship between technology and society and will *highlight the transcendental features* [11]of this relationship.

1.4. Plan of study

The study was undertaken in three phases.

In the first phase various notions and definitions found in the literature have been evaluated by means of a fundamental framework in order to assess their transcendental soundness. Concurrently the set of unique fundamental (transcendental) characteristics associated with technical practice have been refined.

In the second phase an analysis of [12]three leading authors in the field of Science and Technology Studies (STS) provided some theoretical

[11] These will obviously be within an ontological framework. The chosen ontology, which distinguishes well between structures and functions, will be on the basis of the philosophy of the Cosmonomic Idea.

[12] Early in the study these three authors were chosen. This choice did not proceed from assuming one or another specific connection between them. It is neither warranted nor

possibilities for an analysis of the meaning of technology. This analysis also accounted for three current approaches to technology in the field of STS. From these analyses a theoretical account of the place of 'technology' in some of its relations was highlighted.

Lastly, the place and relations of technology in society are considered from a *transcendental perspective*,[13] which might provide an insight into the interaction between the technical and society.

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desirable to superimpose a master narrative upon them. Ihde was chosen because of his influence on the American scene, Bijker, for his interesting view on the social construction of technology, especially bicycles, and Latour because of his known influence on science studies and his changing interest regarding technology.

[13] This transcendental perspective implies a totality view within the chosen ontology of the Philosophy of the Cosmonomic Idea that would be used to give a possible explanation of the structure and relationship of the technical in reality and society.

1.5. Theoretical framework

In this section various assumptions, the chosen methodology, terminology and the evaluative model are highlighted.

1.5.1. Assumptions

Duintjer (1966: 1) indicates that in the philosophical tradition the term ‘transcendental’ is used for ‘the most elementary characteristics’ of reality (in ontology) or for the ‘conditions for the possibility of all we know’. This implies that the term *transcendental* has both an epistemic and ontic scope.

‘Transcendental’ should be distinguished from ‘transcendent’ or ‘transcending’. ‘Transcendent’ is the opposite of ‘immanent’, indicating ‘outside’ and ‘inside’ respectively. When something is ‘outside’ the field of study of a specific subject discipline, it transcends the discipline, and when it is inside, it is immanent to it. The word ‘transcending’ also indicates the human capability to ‘break through’ certain barriers. We can transcend our actual surroundings and concern ourselves with recollections, future expectations, or theoretical images or we can start daydreaming. In all these examples we transcend demarcated barriers or frames of reference. People thus have the capability to move from one framework to another. Regarding the importance of a framework in general it can be argued that one does not register facts, events or things individually, but actually presupposes some kind of orientation framework that acts as a generalized view of reality providing for the interpretation of incidental impressions.

Although this fundamental or elementary realization of a totality accompanies our experiential cognition and aids us in our interpretation and placing of all our experience, it does not imply that we could *know* everything in advance. Duintjer (1966: 2) indicates that when one alludes to *the world* or *the whole,* it is not intended to be the sum of all objective existence but a mental space or position with which we are familiar, without specifically highlighting or recognizing it.

The term ‘ontic’ indicates all occurrences or phenomena with their discernable characteristics and relationships – for example, things, plants, animals, people, planets, etc. This is sometimes designated as the empirical or the factual or even (mistakenly) as *a posteriori*. Our fantasized creations, theoretical objects and representational contents are also included. Our intentional directedness can also occur within ontic reality. However, our intentional relation to ontic phenomena is guided by determined ontological notions. What is meant by *ontological notions* is a theoretical account of the *a priori* basic characteristics of reality. Such an account is worked out in theoretical frameworks and language structures while observing norms, schemes and symbols. Orientation frameworks such as these act as a field of presentation that determines the way in which phenomena reveal themselves to us.

This notion of individual facts or occurrences requiring some universality reveals itself in various forms. Duintjer (1966: 351, 2) explains that in physics the observation itself and the observation of facts are predetermined by specific ontological notions of the nature of physical concepts such as quantity, motion, force, position and time span. In conclusion one can say that ontological pre-suppositions open up the mental space or position or field from within which one can account for the experience of phenomena that are given in an ontic sense. In his explanation of the formation of theories Herman Weyl (1949: 151) argues that individual scientific statements cannot be ascribed an intuitively verifiable meaning, for truth forms a system that can be tested only in its entirety. In modern physics the building material is no longer the elements of consciousness abstracted from reality but purely arithmetical symbols. Dingler (1923: 305) in fact defines physics as that scientific domain in which the principle of symbolic construction is carried through completely. Weyl regards it as important that, coupled with this a priori construction, we also have experience and the support of experience by an experiment.

Max Planck (1970: 341) states a similar perspective concisely:

> 'To be precise there is generally no single question in physics which can be proven by measurement and unequivocally

answered, without the help of a theory.'[14]

Duintjer (1966: 351, 2) also identifies a pre-ontological dimension concerning the status and context of ontological notions. Ontic structures cannot be related to the creations or constructions of a human subject only, but must be experientially tested against the ontically given. Construction without experiential testing and confirmation might generate questions of adequacy.

Whenever a theoretical account is provided for what is ontically given, a specific theoretical framework is articulated that may make it difficult to appreciate insights derived from different or other frameworks. Consequently, a theoretical insight into given states of affairs ought to be distinguished from the ontic status of the latter.

To put it differently, 'out there' exists an orderly consistent reality, which we can experience and within which we live. Our insight into this reality is not equal to the reality itself although it is supported by the conditions of this reality – explaining why the expression transcendental-empirical is employed. Constructionists did realize that constructions are different from 'reality'. For that reason it is important to distinguish that one's understanding of reality can develop based on further experience and insights. Knowing reality is

[14] "Denn genau genommen gibt es überhaubt keine einzige physkalische Frage, welche direct, ohne Zuhilfenahme einer Theorie, durch Messungen geprüft und eindeutig beantwortet werden kann."

more than a mere copying of it (against realism) but it is also different from a purely subjective construction of it (against nominalism)[15].

1.5.2. Methodology

Whatever we can experience is made possible by given ontic conditions and since the latter idea is captured by the term *transcendental*, this approach could be designated as transcendental-empirical. The transcendental-empirical method will therefore be followed. It entails that the ontic (and epistemic) conditions of our experience of and reflection on reality ought to be articulated. The underlying assumption is that ontic[16] reality is experienced as a unity in its diversity. This diversity displays an inherent orderliness ultimately referring to an underlying and conditioning *order for*.

The preliminary research[17] of the field suggested that it might be wise to

[15] It is important to highlight that no argument is made for 'ontological' realism but for a transcendental-empirical approach that transcends – as just mentioned – the opposition between realism and nominalism.

[16] Although the expression *ontic reality* appears to be tautological it serves to avoid the constructionist fallacy according to which "reality" is nothing but a construction.

[17] Nothing of the preliminary research is reported here because it would lead to unnecessary duplication. Yet an indication is required concerning what has been done. All the authors studied were firstly interrogated on what they saw as the 'essential' elements of their notions. It was found that some authors see *artefacts* as the most important element of technology.

introduce new terms. This will entail the introduction of new ontic categories with the intention of creating some order in what appears to be conceptual chaos.

1.5.3. Ontical categories

The ambiguity of the term 'technology' indeed prompts the proposal of new terms. Not only the ambiguity of the term but also the fact that no clarity can be found about the ontic characteristics of the thing or function to which this term refer. Is it a thing or an aspect? The term itself cannot give any light on the problem and to ease the analysis one might as well go back to the ontically given.

As terms could have multiple meanings in different contexts, and might distract attention from the ontical context in which the study focuses, it was decided to analyze the ontical situation and to allocate terms for the ontical context[18].

Others saw *knowledge*, others saw *forming*, others *designing*, etc. All these elements were recorded and synthesized into ontic (factual) categories. In that sense they all contributed to this *evaluative model*. Unfortunately, they also all lacked the total picture as it in principle *transcends* their focus. All disciplines only use those conditions that seem relevant to their specialised interests.

[18] This seems to be misunderstood or overlooked by some critics. This implies also that the theorists discussed might have 'content' in their notions of the technical that might not

In order to find out whether or not the term 'technology' should be treated as merely a 'synonym' for 'technical' or for 'technique', this study proposes to develop a new classification scheme[19] and to apply it to descriptions, definitions, notions and statements involving technology found in the literature.

1.5.3.1. Techno-practice

Firstly, TECHNO-PRACTICE[20] will be used to indicate the *technical* activities involved in innovation, design, production, and maintenance in societies. The term includes the use of tools and technical artefacts. The result of techno-practice could be new artefacts but this does not imply that the artefact as

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correlate with the ontic elements, and therefore are slanted and irrelevant to the study of the ontic characteristics of the technical.

[19] This will thus be an ontical scheme initially and would be ontologically described in the last chapter.

[20] Just to clear up any confusion the term *practice* can be used in a multiple variety of activities for instance in the performance arts the musicians practice their vocation as artists, one can think of medical practice, legal practice, as well as communication practitioners. Although they all use techniques, it is artistic techniques, medical techniques and communication techniques. Techno-practice utilises techniques to form and produce artefacts for usage on preferable mass scale.

such is necessarily technical[21].

1.5.3.2. Techno-science

Secondly, TECHNO-SCIENCE will be used to indicate the reality of technical sciences (engineering) where knowledge of technical processes and of relevant scientific principles of mathematics, physics, electronics, and so on, are registered and conveyed.

It might be important to note that this differs from the meaning that Latour (1999: 203) attaches to the term. He uses it to denote the technical-science-industrial complex, which in this study is referred to as techno-practice[22]. More specifically modern techno-practice acquires its distinct place if we accept that it was 'influenced' by science and industry – as also argued by Van Riessen (1949: 499) and Schuurman (1980: 8). The interesting point here is that the relevance of historical development and of discerning periods might enable us to shed more light on the nature of modern techno-practice.

[21] Although this will be argued later an interesting implication must be highlighted. If all artefacts that are produced become technical it would imply that all of culture, all cultural artefacts that are produced through techniques, even society, would lose its individual nature or characteristics and would become technical. This is an unacceptable notion for an assumption that things have a persistent structure.

[22] Although the term might have obtained some support in sociology the usage in that context is still questionable and will be highlighted later.

1.5.3.3. Techno-knowledge

Thirdly, the term TECHNO-KNOWLEDGE will be used for technical know-how in techno-practice – for instance, maintaining, designing and producing the technical components of artefacts. This knowledge base could have been developed through intuitive experience, artisanship and/or systematic knowledge obtained through scientific activity. The important issue here is that techno-knowledge should not be confused with scientific knowledge.

1.5.3.4. Techno-literacy

The term TECHNO-LITERACY will be used to indicate the human competence needed to operate any artefact that requires some technical skill – like a cell phone, ATM, computer, VCR, motor car and so on. Techno-literacy as such would not require techno-knowledge – only the ability to use an artefact efficiently. It will be shown that the use of the term 'technology' sometimes results in techno-literacy being confused with techno-practice or techno-knowledge. This term would also allow of the notion of techno-illiteracy, which is akin to information illiteracy and would indicate incompetence in dealing with 'hi-tech' artefacts. This is obviously an important issue when it comes to more advanced versus less advanced techno-literate societies and the impact of techno-practice and associated artefacts on these societies.

1.5.3.5. Artefact[23]

The last term to be described is ARTEFACT. Negatively, this indicates an 'object' that is *not* produced by nature. Positively, it indicates all 'objects' formed (that is, created, designed and produced) through human ingenuity.

The types of artefacts are numerous and can be classified by their unique inherent structural principles, which should not be confused with the purpose of the artefact. Any purpose of an artefact presupposes an intrinsic structural nature and the latter can never be deduced from divergent *purposes.* An example to illustrate the point might be useful here. A book is made to be read. It can therefore be characterized as a *lingual object* and typified by an inner structural lingual typicality. It may also be used in various contexts for non-typical purposes without disclosing or realizing its typical *lingual* potential. When a bookshop buys and sells books they actualize their economic object function without reading all the books bought and sold. If it is concluded that a book is an economic object because it serves an economic purpose in a specific *economic* context (the bookshop), the typical *lingual* characteristic and potential of a book is ignored and its typical structural totality

[23] According to my language editor *artefact* is the British spelling and *artifact* the American. When I quoted American orientated authors I did not 'correct' their spelling.

misunderstood.

The key insight here is that the economic activity of buying and selling books do not actualize their internal lingual destination – namely that books are typically made to be read. Therefore contexts and purposes alone cannot replace the typical internal structural reality of artefacts. Further examples are art, furniture, buildings, bicycles, books, clothes and religious icons, to mention only a few.

Dooyeweerd (1984 Volume 3:146) mentions the difference between the *empirical reality* of things and their *actualisation*. Whether historical founded things of earlier times can still be used in accordance with their qualifying function depends on the historical milieu. Fashion can make things outdated on the one hand but on the other hand could make things sought after like antique furniture, glasses, ornaments, etc. Old Shawls, may be used as wall decoration, different from the first examples that still use those articles in their original qualifying function. The important point here is that the old shawl could still be recognised as an old shawl, although not used as a shawl anymore. Here the original qualifying function is NOT *replaced* by another a-typical aesthetic object function. The typical qualifying function is just not activated and another object function is actualised. Essentially, the qualifying function STILL exists, empirically, but is just not actualised. The *structure* did therefore not *change*.

It is important to realize that artefacts are not only ‘objects’ but could also be infrastructures that support ‘objects’. The electricity system or net consists of artefactual ‘objects’ like wires, substations, relays, generators, distribution boxes and insulation, for example. A system thus contains a combination of artefacts.

The term ‘object’ has been placed in inverted commas because the fact that material things display both ‘subject’ and ‘object’ relationships is not taken into account in positivist scientific circles. The practice of referring to ‘objects’ ought to be questioned in the light of the fact that material things are physical subjects – subjected to physical laws – and only ‘objects’ in non-physical contexts (such as objects of perception or of designation, i.e. sensitive and lingual objects). For example, a coin may be, as physical entity, ‘subject’ to physical laws and therefore be a physical subject, but it can also have an economic object function. This can be summarized by stating that insofar material things are physical, they are subjects and insofar they are non-physical (economic, lingual, etc.), they are objects.

Strictly speaking, one should not use the term object or subject unless the context is clear. Preferably the terms *entity*, *structure* or *thing* are used when contexts are not indicated and if something is referred to in general.

1.5.3.6. Other terminology[24]

In line with the previous notion of thing or structure the philosophy of the cosmonomic idea developed a notion of *enkapsis*. Enkapsis indicates the interlacement of distinct, differently structured or dissimilar structures into a totality where the intertwined structures retain their internal sphere of operation (sphere-sovereignty). An example here could be table salt indicated as sodium chlorine (NaCl). The important issue here is that neither Na nor Cl displays a salty (NaCl) characteristic on its own but neither of them loses its intrinsic structure in the totality either. This seems to be a highly complex notion for readers who straight-forwardly accept a part/whole relationship as an explanatory principle. However, from the NaCl example it is clear that the part/whole scheme has its limitations.

The term *technical* is used to indicate an aspect of reality. All concrete things, made by human forming power have therefore a technical aspect. This unfortunately does not mean that their totality is necessarily technical as each artefact has an own unique (typical) inner structure that qualifies or characterise it. It does allow for a technical substructure to be (enkaptically) interlaced into the totality.

[24] My thanks to Prof Mouton for his suggestion to clear up specific terminology early in the thesis to lessen the possibility of confusion later.

Lastly, the term technology is provisionally viewed as a ‘mis-construction’ of our rationalistic heritage that does not indicate any ontic (factual) unique or typical characteristics. The implication is that the usage of this term could indicate confusion, especially if no distinction is drawn between the technical and technological. All authors will be interrogated to confirm whether any ontical characteristic that is NOT indicated by techno-practice, techno-science, techno-knowledge or techno-literacy could possibly be allocated to the term.

1.5.4. Evaluative model

An overview of the literature[25] on the *technical* indicates that technical activity in society seems to consist of the interaction of human activities such as designing, producing and maintaining artefacts or systems of artefacts. An accompanying *know-how* seems to have developed through experience and

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[25] This was a preliminary study which was done and on which it was decided not to report in depth, as the insight of that study will be argued during this report. It might be important also to note that the study was NOT just a one-sided affair of a pre-theoretical bias that was forced onto authors. It was in the interrogation of these authors that the elements were identified. The fact that the order of the second chapter is according to the evaluative model highlights that the literature found confirmed the elements. The only weakness was of course that no single author used all the elements but that is understandable as the ontic (factual) elements and the factual totality would in principle transcend any particular (disciplinary specific) focus.

analysis. This will be indicated as techno-practice and techno-knowledge respectively. In the literature a clear distinction between older and modern technical activity is made and the difference is ascribed to 'the influence of science' on technology. This will be indicated as techno-science (engineering science) in the model. The relationships can be indicated as follows:

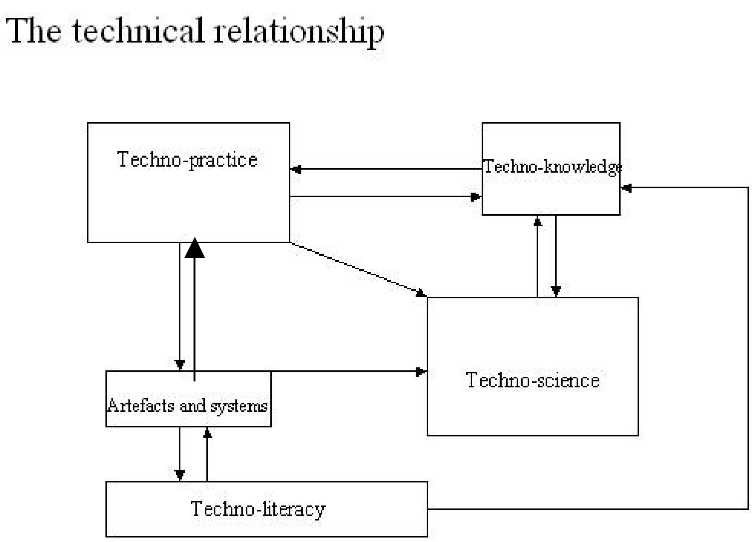

Fig.1. The technical relationship.

Techno-practice results in artefacts or artefactual systems. It has an interactive relationship with techno-knowledge: the knowledge is needed to design, produce, service or fix artefacts on the one hand, while, on the other hand, the experience gained through techno-practice improves our knowledge base. Artefacts furthermore interact with techno-practice as artefacts can serve as components of a system of artefacts and are thus recombined by techno-practice into other artefacts and systems.

Techno-science influences our knowledge base but it obtains feedback from current knowledge, current techno-practices and current artefacts.

Techno-literacy indicates the level of competence required for using an artefact and would obviously be influenced by artefacts and interaction with artefacts. Furthermore, how difficult it is to use an artefact also feeds back to techno-knowledge to improve and simplify designs and create newer artefacts. The impact of artefacts on humans and society in general is only hinted at in the notion of techno-literacy.

The term 'technology' is specifically excluded from the above model. Notions in literature will now be examined to determine whether the term 'technology' is used as a collective term for the above relationship or whether it is used for certain sections or combination of sections of the above model.

Please remember that the above model indicates the *transcendental* or *ontic conditions* for the technical activity. How this will be explained will be an ontological issue for later. Initially only the *ontical elements* will be used to try and get a notion of where authors place the focus in their usage of the term 'technology', in the technical activity, *within their own specific framework*.

It is almost to obvious to state but because this study specifically studies the ontic (factual) in an ontological perspective it will have the advantage of focussing on the issue in an ontological framework, which will allow a totality perspective or image, that any other more specific (disciplinary) perspective will not allow.

What is of importance is whether the more specialised (disciplinary) theoretical perspective on the one hand *confirms* the ontical conditions and on the other hand *possibly overlooks* other ontical elements, as can *in principle* be expected.

To put it differently, no (specialised) disciplinary perspective can hope to develop a totality view of ontic elements because it[26] transcends the disciplinary focus. To therefore engage in the disciplinary theory and evaluate the disciplinary theory, as a theory and not just its assumptions, as well as critical commentators to the theory, as if it could contribute to a totality view of

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[26]Scholars within particular disciplines (i.e. special scientists) are normally quite sensitive to the fact that special scientific work implicitly or explicitly depends upon a totality view of reality exceeding the point of view of any specific academic discipline. It seems as if they do not easily concede that even a discussion about a particular discipline necessarily transcends the universe of discourse of that discipline (saying what mathematics, biology or economics is) involves a talking *about* these disciplines and does not entail actively *doing* mathematics, biology or economics.

the ontic (factual) elements of the technical process viewed from a (ontic) totality perspective, is to misunderstand[27] the limitations of (specialised) disciplinary focuses.

Obviously the assumptions and the relevant parts of the theory of each author would be addressed and compared with the ontic conditions. What seems to create a misunderstanding though, is the confusion between addressing the theories in terms of the relevant ontical arguments and the evaluation of the theory in terms of its standing in the 'Realm of Knowledge'.

[27] To put it differently, this study wants to identify the basic (ontic) characteristics of the technical, which transcends any disciplinary focus. Attention is paid to different notions of 'technology' by different authors to establish the ontical logic of such terms. To expect this study to also evaluate the theories of the different authors that utilize the notion of technology and account for critique of their theories from other authors, is to misunderstand the purpose of this study. Although scholarship means to take note and learn from others it hopefully does NOT mean that a study must lose focus and bark up all possible trees.

2. Evaluation of notions of technology against the designed model

In this section a number of notions, descriptions and definitions of technology and related terms will be highlighted and compared with the proposed terms of the model. It is understood that many authors might not have the intention of describing technology within an ontical framework nor of concentrating on transcendental issues but the intention here is to explore whether any new perspectives could be added to the model. In the following sections some leading authors in STS will be analyzed with reference to the transcendental issues involved in determining the meaning of technology within an ontical framework.

The order of the following sections will be according to the elements of the ontical evaluative framework[28]. We will start with techno-practice.

[28] The order was chosen almost randomly but will follow all descriptions that try to describe the technical (technology) in terms of one of these ontical categories.

2.1. Variations on Techno-practice[29]

2.1.1. Modern Techno-practice

Schuurman (1990: 4) argues that in order to bring the distinguishing characteristics of modern techno-practice[30] into focus as clearly as possible, one must begin by comparing it with classical techno-practice. The differences can be accentuated by highlighting the extremes in the features of both. For this, Schuurman argues that one will momentarily have to ignore the *development* of classical techno-practice into modern techno-practice.

Schuurman defines techno-practice initially as:

> 'the activity by which people give form to nature for human ends, with the aid of tools' (Schuurman, 1980: 5).

It should be pointed out that this is not unique to techno-practice: art also

[29] The term techno-practice was selected after a preliminary investigation of various authors that described the need for 'application' or 'techniques' even 'applied science' where designing, forming, production (manufacturing) was indicated with the term 'technology'. As the term technology was found to also appeal to 'knowledge' or 'study' the term techno-practice was tentatively coined for the ontical situation of application or techniques of designing, forming and production.

[30] Schuurman uses the Dutch term 'techniek' which is translated as *technology* to indicate a practical activity, in contradistinction to *technological science*, which indicates a theoretical activity. In line with the evaluative model of this study the terms should rather be *techno-practice* and *techno-science* and are therefore corrected.

gives form to nature for human ends, with the aid of tools like brushes for painters or chisels for sculptors. The definition does indicate 'the technical aspect' of forming but is valid for all forming, not only 'technical' forming.

To him the differences between classical and modern techno-practice involve

> 'environment, materials, energy, skill, tools, the steps in technical execution, cooperation in technology, working procedures, the role of people in the formative process, and the nature of technology development'. (Schuurman, 1980: 5)

This could be summarized under the following headings.

2.1.1.1. The basic structure of modern techno-practice

Schuurman (1980: 11) argues that the grand quest in modern techno-practice has been to develop technical objects that can operate independently; this implies operators that can independently *form* something in nature.

> '...human proficiency *in forming* is projected into and transferred to the technical object. By means of automatic switches, people make provision for the technical forming process to undergo discontinuous changes with the passage of time.' (Schuurman, 1980: 11)

He argues that the projection of proficiency, the transfer of decisions, and the use of formed energy constitute the foundation of the independent operation of the modern panoply of tools and instruments. This panoply consists of what he called *technological* (to be translated as *technical*) operators. People need only to set these operators going.

He argues that the 'proficiency' of the *technical*[31] operator surpasses that of human beings in speed, reliability and accuracy. He indicates that mechanical 'decisions' are realized more quickly and faultlessly than decisions made and implemented by people. Furthermore, he stresses that the power of formed energy far exceeds human power. The implication is that people equipped with *technical* operators can accomplish a great deal more than people without them can. He also states that there are recently created technical operators that work in ways that bear little or no resemblance to human activity.

He names e*lectro-technology*, which might be better translated as electro-technics or electro-techno-practice and *chemical technology* (or chemical techno-practice) as examples of such operators.

He points out that through the *scientific* approach to modern techno-practice, a distinction has arisen between preparation (designing) and production (technical forming).

> 'Human responsibility and decision-making have been transferred to the phase of preparation, and the human activity of designing has thereby come to occupy a higher place. There has, in fact, been an intellectualization of technical labour. Preparation along the lines of the techno-scientific method leads to the accomplishment of a design for

[31] As indicated, Schuurman uses the term *technological;* this could be an imprecise translation.

> the execution; this design is complemented by the independent operation of the technological panoply of operators.' (Schuurman, 1980: 12)

He also points out that in some cases there is a possibility that technical operators can be controlled from a distance; this possibility is unrealised as yet (for economic reasons, for example), and in some cases will remain so – at least for the time being. In these cases *techno-practice* is restricted by certain particular circumstances. He believes that in the future, with the help of cybernetics, it will be possible to alter this situation because with the feedback principle, even the singular can be controlled.

To summarize, it seems that the most striking characteristics of modern techno-practice to Schuurman are the modern panoply of tools and instruments, technical forming, technical design, the independent technical operator, the scientific foundation and the techno-scientific method.

It is interesting that Schuurman distinguishes between *technology* and *technological sciences* as he specifically links them in his description, allowing for the *technological-scientific*[32] method as part of the *technological* process. Furthermore, he limits *technology* to 'forming' nature for human ends by means of tools and the *independent technological operator*. Crafts also form 'nature for human ends' although not by using independent operators,

[32] It is interesting that the method is indicated not only as 'technical' but as 'techno-scientific'.

the techno-scientific method or scientific-technical forming and design[33].

What is clear is that although Schuurman views matters from the perspective of engineering practice, he indicates a *totality* of various entities that would need to be placed in the correct relationship in the final design. In an engineering context, Schuurman focuses on the 'forming' function of the *technical operator,* which is maintained throughout the transformation process. He elaborates on this *technical forming* by distinguishing between designing and production in this forming process.

2.1.1.2. Division between design and production

In his comparative study of classical and modern techno-practice Schuurman (1980: 6) found marked differences in the area of technical forming. In earlier techno-practice, people performed and determined the sequence, using their own strength and skill. In modern techno-practice, human skill is projected into technical operators that have been actualized by means of formed, natural energy; the sequence in forming is delivered by automatic linkage and not human capabilities.

The most characteristic feature of modern techno-practice is the division existing between preparation and execution. The design process links these

[33] This hints to the fact that crafts could be a 'primitive' or 'less modern' techno-practice.

two stages. It is primarily in the preparation phase that people (engineers) are involved.

> 'Wherever possible, people are excluded nowadays from the post-preparatory, forming phase, and even where they are not excluded from the execution, the role of the worker in mass production has been analyzed in the preparation and immutably predetermined in the design.' (Schuurman, 1980: 24)

In designing, Schuurman argues, the engineer has in mind both the design of the product and a plan for its production. The production plan establishes as precisely as possible the order according which production should proceed and the design plan tries to establish the order for a thing, which implies the internal structure, and what he calls destinational function.

To summarize, the quest for production in which the product is fashioned in conformity with a theoretical design implies that the (free) labourer is as far as possible excluded from production in order to reduce the chances of deviation. The techno-scientific method accordingly requires production by technical operators. However, because of the limited forming possibilities afforded by their structural inflexibility, technical operators require a division of the production process. The production process therefore is a linkage of technical operators.

2.1.1.3. Steps in the designing process

Schuurman (1990: 38) outlines the following:

> '1. Initially the technical problem is described, analyzed, and scientifically processed and formulated.
> 2. Such established knowledge (of the laws) of things and facts as may be expected to contribute to a solution of the problem is gathered. When this has been done, the productive fantasy can begin to function.
> 3. The engineer imaginatively conceives technical solutions to details, or even to the problem as a whole, and then proceeds to formulate them scientifically.' (1980: 38)

In a certain sense, the engineer actualises the product of his/her fantasy in a design in terms of the laws appropriate for the technical object. Schuurman further points out that the demarcation of these phases is seldom clear in practice and that there is normally a constant interaction between phases.

> 'Theoretical and experimental operations are employed to ensure that the objectification in the design will provide a possibility for future realization in the execution.' (1980: 38)

This description highlights the role of people in the technical forming process. It seems as though the designing function is still a technical event, but the production or forming phase becomes an automatic technical fact or process. Schuurman explains the differences as follows.

2.1.1.4. Technical events, facts and things

According to Schuurman (1980: 12) technical events exist whenever people play the decisive role in the objectifying and actualizing relations. In this sense techno-practice is linked with a human capability. When human formative power forms technically it is identified as a technical event.

Whenever people cease to play a role it becomes a technical fact or an *automatic* forming process. Schuurman (1980: 12) believes that a technical fact is always introduced by a technical event. He stresses that if one disregards the event, one cannot understand the fact, for then the initiating role of people is ignored.

> 'The independently working technical operator is made possible by the introduction of the techno-scientific method in the preparation. Techno-science, mathematical physics and, frequently, chemistry together form the basis of the scientific approach of techno-practice, while the industrial enterprises provide the opportunities for realization. For this reason, modern techno-practice (especially the production or forming part) is characterized by the quest for automation, by worker redundancy, and by mass production.' (Schuurman, 1980: 24)

In the technical forming process, things and materials manifest themselves first according to their unique character. The function of the technical operator is *forming*; therefore it is active. In the forming process, the product undergoes a lasting alteration of form in the sense of technical individualization. The operator, which always brings about a process of energy transformation, maintains its forming function throughout this actualized forming.

2.1.1.5. Technical objects as specialized utilities in techno-practice

Schuurman (1980: 9) attempts to formulate the law for all technical objects. These are objects that are fashioned by people for the express purpose of being put to use in techno-practice. It is important to point out the feature that these objects have in common and at the same time show how their technical uses may differ.

> 'An important distinction is to be found in the fact that objects formed in technology are either technological objects or objects of another kind. The latter do not have a technological destination or purpose or end function; cars, houses, and washing machines, for example, do not. Technological objects are not just formed technologically; they also have a technological destination.' (Schuurman, 1980: 9)

This is a fundamental distinction that should be highlighted. It implies that a washing machine is not a technical object. It has a technical structure interlaced in its totality, could be said to be the result of a technical process and could have a significant influence on society; however, unlike a technical operator, it does not *form* any technical products.

On the other hand, the fact that a washing machine primarily exists to do washing and could be more technically advanced or more primitive than other models does not imply that it does not have an influence on society that could be linked with *technical forming*. It was formed by technical activity, even if Schuurman does not regard it as a technical object. These artefacts that are manufactured by modern techno-practice and which completely change our world are generally indicated with the term 'technology' whereas it should more precisely be indicated as artefacts and possibly 'artefactual' influences on our society.

Schuurman emphasizes that we should take note of a certain distinction between technical objects, since it will later on prove to be essential to an understanding of modern techno-practice. He states that technical objects may be *things* that may be more or less durable or they may be *facts* or *processes* subject to constant change.

Not every fact arising from actualization by a technical operator and directed to the realization of an energy transformation process has a technical destination or typical inner structure. A fact might find its destination in communication instead, as is the case with a tape recorder, or it might have a traffic destination, as is the case with traffic lights. These facts might well contain technical elements as parts. This concurs with the notion that a technical structure could be part of a totality, which is not necessarily destined as technical in the sense that it forms or transforms as a tool. Here again arts and crafts can be mentioned: they ‘utilize’ the formative power of techno-practice or have a technical substructure, but are not technical objects themselves.

2.1.2. The computer

Schuurman (1980: 19) considers the computer the pre-eminent *technical object* of the future. To him the computer is one of the most fundamental *technical* achievements of mankind. He indicates that a computer performs a range of functions. As a control mechanism it performs a *technical function* and is therefore a *technical object,* but as a 'thought' or 'communication apparatus' it performs an information function and then is *not* a technical object in the sense that it 'forms' something, but a communicative tool.

> 'What the computer produces is unforeseeable, and this distinguishes it from other technological operators. That the computer's results may contain surprises - within certain limits - does not mean that the computer, like the human being, is free. The computer works in a set way; its rapidity, precision, and accomplishments are so enormous that it is easy to forget that it is a tool or implement of human beings. The potentialities of the computer furnish fertile ground for all manner of optimistic or pessimistic speculation. On the one hand, the computer excites great expectations for the future. On the other hand, the surprising results arouse fear and anxiety.' (Schuurman, 1980: 19, 20)

2.1.2.1. Computers only work technically

Schuurman (1980: 20) stresses that in connection with computers, it is customary to refer to information-processing or data-processing.

> 'The danger in this is that one might be led to ignore the fact that information is fundamentally lingual. Language indicates and signifies something. And indicating and signifying are human activities, expressions of human freedom and creativity that cannot be tied up in set rules. The language, which results from human activity, can certainly be

> formalized, and formalized language can be objectified in the computer. Yet the significance of the objectified signs and symbols is human in origin; the computer's results receive their meaning through people.'(1980: 20)

He stresses that whenever these considerations are not respected, confusion may arise. In this regard he refers to the question concerning the machine's capacity to add new information – a notion that arises because it is forgotten that computers only work technically or electronically. He emphasises that the computer can only process data that has been analyzed and abstracted and then stored in an energy form – the signal.

> 'Although it would be much better, in the interests of avoiding confusion, to speak of signal-transmission and choice-transformation processes, the term data processing has already become well established. An improper use of such terminology can easily lead to misplaced notions and expectations concerning the computer' (Schuurman, 1980: 21).

Schuurman (1980: 21) explains that a signal in the computer can find its way along either of two alternative, mutually exclusive routes. One bit thus allows of two mutually exclusive possibilities - yes or no, open or closed.

> 'In a strict sense, what is processed is not information but the *analytical substratum* of information, and then by choosing. The number of possible choices in the computer depends on the number of independent switching elements with which the machine is furnished. Such mathematical processes as adding, subtracting, dividing, and multiplying can be reduced to a combination of these elementary choice possibilities. Through electronic switching, they can be processed one after the other at great speed. With the help of the controlled switching elements, millions of processings can be accomplished in one second. Where the fundamental processing consists of a choice of two possibilities, numbers must be transposed into the symbols of the binary system - 0 and 1. Analyzed and quantified information must also be translated

> into these symbols. When this has been done, processing on the basis of a great number of choices becomes possible.' (1980: 21)

A list of commands (also presented by the symbols 0 and 1) called a program guides the computer to process and store the results of the processing.

> 'Information theory and technical actualization are perfectly attuned to each other. The theoretical unit of information is *mirrored* in the switching elements, which are either 'open' or 'closed' and which can thus assume two theoretically equal positions independent of each other. The technical coherence and the mutual interaction of the switching elements, which together constitute the so-called logic system of the machine, can be constructed with the help of Boolean algebra. The "open" or "closed" positions of these switches function in this algebra as variables.' (1980: 22)

2.1.2.2. The application of computers

Schuurman (1980: 22) argues that the application of the computer is principally twofold: it can serve as a 'thought apparatus' which delivers information to people (in a certain sense it is then lingually destined) while it also serves as a control mechanism.

> '...in the latter it is interpolated between people and a fact or process, the destination of which need not be technological. In full automation, the computer is wholly integrated into the technological fact or process.' (1980: 22)

Schuurman indicates that the computer as a control mechanism has great significance; one can think here of automation and the programming of many machines in our daily lives. He argues that the structure of the computer is dependent on the destination of its application.

Schuurman stresses that although people may never be able to achieve these results by themselves, we are not to jump to the conclusion that the computer is independent of people. This refers to the idea that any technical fact or object requires a technical event.

In a certain sense this indicates that *techno-practice* and specifically the computer, as technical object, is not independent of humanity. Furthermore the computer also indicates a link between science and techno-practice that needs to be noted.

2.1.3. The Technical Versus Techno-practice

Firstly, we come across a position where the *technical* is confused with *techno-practice* as if techno-practice encompasses all technical activity.

Bunge (1999: 1, 2) argues that technology is the sector of human knowledge concerned with the design, repair, and maintenance of artificial systems and processes, with the aid of basic science and mathematics. The systems and processes in question may be physical, chemical, organic or social. To him even formal organizations qualify as artefacts, along with machines and high yield grain. Likewise, management, healing, and teaching qualify as artificial processes, along with steel lamination, construction and computation.

He argues that technology is about designing, planning, maintaining and repairing. So are moral philosophy and praxiology. In fact, facing a moral or praxiological problem, taking responsibility for it and reflecting on the means to solve it in the light of available knowledge and resources is regarded as a *technological* problem by Bunge. Conversely, exploring a technological problem in any depth necessitates invoking general praxiological concepts and principles, and dealing with a problem concerning social responsibility requires some ethical concepts and principles.

To Bunge the key to the classifying of technologies is that we should add philosophical technology to the extant branches.

His list looks like this:

- Physical technologies: e.g. mechanical, electrical, and mining engineering.
- Chemical technologies: industrial chemistry and chemical engineering.
- Biological technologies: e.g. agronomy and genetic engineering.
- Biosocial technologies: e.g. bio economics and normative epidemiology.
- Social technologies: e.g. management science and the law.
- Epistemic technologies: computer science and artificial intelligence (AI).
- Philosophical technologies: moral philosophy and praxiology.

From the above it is clear that technology is, in a certain sense, idolized[34]. Even a moral problem may be regarded as a technological problem. The transcendental issue here would be to indicate what is *not* a technological problem so that *non-technology* and *technology* can be distinguished from each other. Bunge sees all practical problems, solutions and artificial actions as *technological* problems and solutions. Secondly, the difference between the *technical* and *technology* is not clarified[35]; furthermore, management science, law and moral philosophy all become *technology* because technology has to do with the design, repair and maintenance of artificial systems in which all artefacts could be included. This also highlights the misconception that all artefacts are technological, which means that the inner structure of the artefact is ignored[36].

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[34] Idolization or absolutization implies that something is serving as the primary principle of explanation of everything else. This may lead to a one-sided over-emphasis. By viewing management and problem solving as technologies instead of techniques is a manifestation of such an over-emphasis.

[35] This could indicate a confusion.

[36] Just recall our remark concerning the realization of the internal structural destination of a book – meant to be read – and the multiple ways in which it can be used for other purposes not actualizing its typical qualifying function.

Bunge does not realize[37] that each artefact has its own structure that prevents it from being wrongly classified. For instance, he classifies organizations as artefacts whereas they could more correctly be indicated as social or societal subjects, instead of social objects, since they are active or subject in the social or societal sphere[38].

2.1.4. Praxiology

Quintanilla (1998: 2) explains that, within the framework of establishing the kernel of a standard theory of technological progress, philosophy offers three possible views of technology. He calls them cognitive, instrumental and

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[37] In other words, he does not distinguish between the *typical* and *a-typical* possibilities of objectifying (utilizing) an artefact.

[38] It is important to highlight that the theory of the author, in its wider context, is not under consideration. Only the usage of the description is evaluated against certain ontical conditions and distinctions (such as the difference between typical and a-typical usages of artefacts). The observation that the author did not consider these basic ontic distinctions is not meant to be an evaluation of his whole theory and its consistency against its own assumptions. Such an analysis exceeds the confines of this study. It is also important to notice that the issues discussed thus far do not merely concern alternative *definitions* set in opposition to each other, because the ultimate appeal is the *states of affairs*, to what is given in an *ontic sense* and in that givenness *make possible* every meaningful analysis and definition. The expression transcendental-empirical captures precisely this correlation between those conditions making something possible (such as technique and artefacts) and their variable manifestations within the limits of these constant (enabling) conditions.

praxiological views.

According to the cognitive view, technology is a form of science-based practical knowledge that allows us to design efficient artefacts to solve practical problems. Technological change is mainly effected through applied scientific research and the improvement of technological knowledge. Technical progress consists of the increase of technological knowledge and depends on scientific progress. In this case technology is linked to techno-knowledge, but more specifically that part of techno-knowledge that is linked with techno-science. Cases in which techno-knowledge is acquired through non-scientific methods are ignored.

According to the instrumentalist view, technology is a set of artefacts intentionally designed and produced to perform some definite functions and to satisfy some human needs. Technological change consists of the increase in the quantity and variety of artefacts, and technological progress is defined as a function of the range and importance of the human needs that can be met by the available technological equipment. In this specific case technology is equated with artefacts without taking into consideration that not all artefacts are *technological* or *technical* and that human formative power is not limited to techno-practice only.

According to the so-called praxiological approach, the basic technological entities are neither knowledge systems nor sets of artefacts, but complex systems formed by the artefacts plus their users or intentional operators. Quintanilla argues that we can characterize technological systems as action systems intentionally oriented toward transforming concrete objects in order to obtain, in an efficient way, a valuable or useful result. Technological change is effected by 'designing and producing new technical systems and improving their efficiency'. This is what is specifically meant by the term *techno-practice* in the guiding model.

Quintanilla (1998: 2) furthermore argues that technological progress may be interpreted as an increment of human power to control reality: new and more efficient technical systems applied to new and larger parts of reality mean a greater capacity to adapt reality to human desires. Here complex systems of artefacts and users hint at techno-literacy, especially when it is focused on the use of the system for better control.

The problem[39] with these approaches is that they do not take cognizance of the transcendental conditions of the technical and presuppose the technical or artefactual on the one side and human ability or knowledge on the other side as prerequisites in a relational perspective. These assumptions might not

[39] In this context the conditions for ontic (factual reality), as explained in the evaluative model, are not considered. The applicable critique about the focus of a relationship does not concentrate on any one specific element constitutive for the relationship.

be defensible because they exceed contexts and no distinction is made between the *technical* and *technological*. They also do not differentiate between techno-practice and techno-knowledge or between techno-literacy and techno-science[40].

2.1.5. Technology fulfils basic needs and is an inherent element of culture

Rapp (1999: 1) begins by asking some questions about the purpose of technology. Questions like: Why is it brought about? What is the reason for putting it to use? Which function does it perform? The answer usually given to these questions is that technology fulfils basic human needs.

He requests us to consider the famous saying that technology is the art of guiding the forces of nature according to human purposes. This implies that technology is meant to reshape the physical world in order to attain certain desired results or to perform specific functions. In this statement, the 'physical world' refers to the natural aspect and the 'functions to be performed' refer to the cultural aspect. It becomes evident that technology, by its very nature, involves material as well as cultural aspects, and that these are inseparably woven together

Rapp (1999: 2) argues further that the cultural aspect of technology is the

[40] All elements of factual (ontic) conditions required in the technical process.

most important one. Since modern technology has created a Second Nature, as it were, it is inevitably also shaping our view of the world and our way of life: in short, it is shaping our culture. According to him, it is impossible to speak in a reasonable way about technology without at least tacitly taking into account the natural as well as the cultural perspective.

He concludes that in this context one has to remember that technological artefacts are designed to extend, in one way or another, the natural capacities of humans: the car and the airplane multiply the efficiency and the range of locomotion; television extends the capacity of sight; and the telephone extends the reach of hearing. Taken in this sense he believes technology does indeed relate to basic needs, since a certain minimum of locomotion, sight, and hearing is indispensable for survival.

In the light of the proposed model Rapp misses some transcendental distinctions. He regards cars, airplanes, television and telephones all as *technological* artefacts. Do these artefacts indeed have an inner structure that will make them *technological*? It seems as if Rapp links technology with the production of artefacts in general and not just with techno-practice.

The art (or technique) of guiding the forces of nature could be indicated as human formative power. This formative power can be utilized in various contexts: forming words in language, forming art in aesthetics, forming laws in jurisprudence and forming artefacts through techno-practice. Equating technology with all formative activities and products implies that all forming is essentially linked with techno-practice, which does not take into account the contextual significance of the different types of human form giving[41].

People have a wide range of abilities that could be used in various contexts. This means that our abilities could be recontextualised. Human *analysis*, for example, could be channelled in scientific, technical, lingual, economic, legal or aesthetical ways, depending upon the context.

The fact that people have created an artificial (artefactual) world as second nature does not make that world *technological* but rather *artefactual*, implying that artefacts are not only technological but also scientific, historical, lingual, social, economic, artistic, religious and so forth. The term *artefactual* therefore embraces all normatively qualified cultural objects, including technical objects. In that sense an artefact not only fulfils a basic need but is inherently part of culture.

Lastly, to argue that technology fulfils a basic human need does not explain anything about the unique transcendental conditions of technology. What is interesting is the fact that Rapp inquires into the 'function' or 'purpose' of

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[41] As argued above human form giving could be historical, lingual, logical, economic, religious or artistic as well as technical. All types of form giving can therefore not be seen as technical.

technology (as fulfilling basic human needs) and places it in a social-human context[42] but does not inquire into the transcendental conditions or unique nature of technology.

2.1.6. Summary

Various frameworks have been noted in which *technology* is interpreted and categorized as variations of *techno-practice*.

The interest in technical sciences (engineering sciences) and the difference between *techno-practice* and *techno-science* require some insight into engineering practice and an engineering perspective on the philosophy of techno-practice; in these cases Schuurman has been consulted as philosopher and engineer.

This highlights the fact that techno-science or engineering science in the first place conserves knowledge recorded in theoretical formulations. Secondly, it clarifies the intuitively grasped insight of techno-practice as technical forming and its link with techno-science. Finally, it acts as the basis on which technical forming can be systematically (techno-scientifically) managed and controlled.

[42] This is what can be expected of a socially orientated scholar, as the worldview of sociologists is typically a physical-social reality. The ontical perspective transcends the focus of social scientists.

The engineer is therefore the builder and the elaborator of technical science. This also highlights the fact that, as far as modern techno-practice is concerned, ‘science’ or ‘scientific activity’ plays a crucial part that would have to be accounted for in a model of the technical activity. Technical science is a cultural activity because free human beings play a decisive role in its field of inquiry, namely the whole terrain of techno-practice.

To Schuurman, the most striking characteristics of modern techno-practice are the modern array of tools and instruments, technical forming, technical design, the independent technical operator, the scientific foundation and the techno-scientific method.

Next will be an account of variations of descriptions, definitions and notions of ‘technology’ of the next ontical, condition of the evaluative framework namely artefacts.

2.2. Variations on artefacts

Various authors have referred to artefacts as ‘technological’ or as ‘representative of technology’.

2.2.1. Technofacts

Ihde (1990a: 18) indicates *artefacts* and *technofacts* as technologies that interact with the human in various ways. He explains the ambiguity of objects through an example of the Acheulean hand axe - an oval-shaped stone that served as an axe but could also serve as paperweight or object of art. He stresses that an object finds meaning in the context in which it is used.

To Ihde the ambiguity of the Acheulean object is the ambiguity of technology in general. A technological object becomes what it ‘is’ through its uses. He stresses that this is not to say that the technical properties of objects are irrelevant, but rather that such properties in use become part of the human-technology relativity. Nor is it to deny that there is a specific type of history to the development of technical properties.

Ihde stresses that higher order or more complex transformations also occurred in the past but have been accelerated in today's high-technology contexts. He calls a technofact an object in which the very materials themselves have undergone levels of transformation. Plastics, now pervasive, simply do not occur in nature.

To summarize: stone, when formed or shaped, enters human praxis; on the one hand, all objects can be shaped into use-objects in various contexts, on the other hand, the contexts in which they are used can shape objects. This illustrates the interactivity of humans with artefacts in general.

Ihde also illustrates technology transfer with the example of the Spanish Conquistadors who took hawks' bells (small brass bells used in falconry) and mirrors, both designed for different purposes, as fascinating baubles to trade with the Arawaks and Caribs of Central America and the Caribbean. When the object is transferred, its use may be very different from what it has been in its previous cultural context.

The question arises whether it is valid to equate *technology* with *artefact*. Although it is possible to gauge the level of techno-practice from the artefacts produced by the activity (for example glasses and windowpanes relating to glassmaking as activity), it would be incorrect to assume that artefacts are equal to or represent such an activity. Thus, the artefact has an identity of its own, characterized by its own typical inner structure[43].

Another issue is the assumption that artefacts are *technological*. This assumption rests on the link between techno-practice and artefacts. If an artefact is *technological* because it is produced by technical activity, various problems arise:

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[43] Please refer to 1.5.3.5 where artefacts are described and where it is indicated that everything is characterized by a (multi-aspectual) typical structure.

Firstly, why is an artefact not *technical* in contradistinction to *technological* if it is produced by *technical* activity? What is the difference between *technical*[44] and *technological*?

Secondly, not all objects in ontic reality are indicated as *technical* or *technological* because one also finds economic objects, religious objects, social objects and art objects although they might have involved human technical activity. If all artefacts were **only** *technical* or *technological,* no other kind of objects could exist. This *construct* clashes with empirical experience[45]. The implication is that artefacts are not *technological* on the basis that they are artefacts; they can in fact only be regarded as technological if they are proved to be technological in contra-distinction to, for example, artistic or scientific artefacts[46].

The transcendental issue here is that no distinction is drawn either between *non-technological* and *technological* artefacts or between what is *technical*

[44] The lack of a distinction could indicate confusion.

[45] Please remember that the elements of the evaluative framework are ontical conditions. Any definition that does not account for all the conditions, lacks some conditions and can thus only be improved or discarded.

[46] Please refer to 1.5.3.5 where it is indicated that material things could be physical subjects but objects in all the non-material aspects. One can thus get different types of objects like logical objects, lingual objects, technical objects, economic objects, aesthetic objects, etc.

and *technological*[47]. It is simply axiomatically assumed that artefacts equal technology. Not even the term technofact saves the issue as refined material or alloys could be part of both non-technological (for instance economic objects like coins) and technical artefacts. What Ihde indicates as *technology transfer* could also be indicated as *artefactual transfer*. Furthermore his interest in human-technology relationships could be indicated more correctly as *human-artefactual* relationships. (Ihde 1990b: 126)

A relationship between humans and technology (or artefacts, for that matter) presupposes humans on the one hand and technology (or artefacts) on the other hand as two essential parts in this relationship. Any transcendental questions about either humans or technology (or even artefacts) transcend the focus or perspective of the relationship itself and cannot be answered from the relational perspective only[48].

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[47] At this stage the 'technical' can be described as an aspect or function of things in reality that aims to form or control the forming of things in reality. The 'technological' is viewed as a 'mis-construction' of the technical or of the 'study' of the technical or even equated to artefacts as illustrated in the text, found in the work of most authors of specialised sciences. *Please refer to p3*.

[48] If one *assumes* a 'relationship' between A and B, one 'has' to assume the existence of both A and B and can therefore NOT query the existence of either A or B without 'losing' the *assumed relationship*. Furthermore, by concentrating on either A or B separately the focus on the relationship is suspended for that moment.

2.2.2. Artefacts, activities and know-how

Bijker (1990: 3, 4) indicates that *technology* is a slippery term, and concepts such as *technological change* and *technological development* often carry a heavy interpretative load. To Bijker it seems unfruitful and indeed unnecessary to devote much effort to working out precise definitions, at least at this early stage of the research in progress.

He believes that the word *technology* has three layers of meaning. Firstly, there is the level of physical objects or artefacts; for example, bicycles, lamps, and Bakelite. Secondly, technology may refer to activities or processes, such as steel making or moulding. Thirdly, technology can refer to what people know and do; examples are the know-how that goes into designing a bicycle or operating an ultrasound device in the obstetrics clinic. He argues that because in practice the technologies cover all three aspects, it is not sensible to separate them further.

Again the transcendental issue is whether artefacts can be equated with technology. This could only be true if the artefacts were empirically proved to be technological. It is not clear why the above-mentioned artefacts are regarded as technological instead of technical[49], for instance.

Secondly, none of the specific examples display a specific technical or formative nature that would qualify them to be indicated as technological (or technical) instead of non-technological (non-technical) artefacts. None of these artefacts are specifically utilized in the technical design, production or maintenance functions of techno-practice, and so cannot even be regarded as technical tools in the technical process. To call them technical (or technological) is to ignore the transcendental conditions or the empirical experience relevant to the issue[50].

Bijker's notion of technology as processes or activities can be linked with techno-practice, and more specifically with the *formative function* of techno-practice. To equate technology with forming, however, is to equate *technology* with the *technical*, or more specifically, an aspect of the technical, namely only the forming or production, and not the designing, maintenance or servicing that could empirically be highlighted in modern techno-practice. In this specific case, *technology* is thus equated with the *technical*, but it is not explained why it is equated with only the formative process, instead of with all

[49] Here the issue arise again. Except for the explanation of the differences, as explained in previous notes, this inability to distinguish could also indicate the conceptual confusion that was found in the literature.

[50] It should be noted that an artefact is a result of techno-practice. Not all artefacts are technical, only those that will be used as tools.

the processes of the *technical*. The use of the term *technological* instead of *technical* or *techno-practice* is not explained either.

The third layer of meaning of technology – what people know as well as what they do – implies both techno-knowledge and techno-literacy. The examples of know-how given are actually of different natures. *Designing* is an aspect or function of techno-practice, whereas *operating* is a function of techno-literacy[51]. Ignoring the fundamental distinction between techno-literacy and techno-knowledge means that two entirely different sets of knowledge are equated. But empirical experience shows that someone who can drive a car may not be able to fix or service it – in other words, techno-literacy does not necessarily imply techno-knowledge[52].

2.2.3. Technology as system

Tiles (1995: 7-9) indicates that, from a historical perspective, techniques included the whole 'complex of ways' of 'doing and making' in which a technological device has a place. She uses a plough as example: different kinds of ploughs may be best suited to the demands of different kinds of soil conditions, terrain, and crops grown, or to the size of farms and fields. Grain

[51] Refer to 1.5.3.4

[52] It should be kept in mind that this is not just a terminological analysis but an ontical (factual) analysis. The evaluative model identified factual (ontical) categories.

farming on the scale practiced on the plains of the American mid-west requires large tractors pulling multi-furrow ploughs, but such machinery would be of no use to a hill farmer in North Wales.

The transcendental issue involved here is whether a plough as artefact can be equated with a technological device as is done above. The question could be rephrased as follows: Do ‘complex ways’ of ‘doing and making’ mean that it is techno-practice? Complex ways of doing have been identified before as techno-literacy. Driving cars, flying airplanes, working on computers or using complicated equipment does not mean one has the techno-knowledge to service, design or manufacture them as is required in techno-practice. Furthermore, ‘complex ways of making’ could be equated with techno-practice, but in that case a plough would be the result of this activity and be an artefact, which would not necessarily be technological. It would be possible to designate a plough as a ‘technical’ tool or instrument in the farming process. Although strictly speaking correct, the following misconception should be avoided. All artefacts could be indicated as ‘instruments’ or tools; for example, a chair is an ‘instrument’ (to sit on) or a knife and fork are instruments (to eat with). Furthermore one can argue that pots and pans are instruments (for cooking) and cars are instruments (for travelling). Such an ‘instrumentalist’ view that takes neither contexts nor inner structures into account would see all these artefacts as ‘technologies’ on the basis that they are ‘technical instruments’[53].

Empirically, a plough could be a ‘technical’ tool in farming, but farming is an activity that could be described as an economically guided *biotic-production* process where plants and animals are reared for food production. This should not be mistaken for techno-practice where design, manufacture and servicing of artefacts are done. If this difference were disregarded, it would be easy to mistakenly equate farming with techno-practice and even to speak of *farming technology* instead of farming techniques.[54] It is important to realize that all human activity has a technical aspect. In art the artist employs a specific technique, in cooking the cook employs specific techniques, and in sport the coach teaches the team specific techniques, but none of these cases transform the (specialized) ‘technical’ activity into techno-practice where we specifically design and produce artefacts for various uses.

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[53] If contexts and typical structures were taken into account, then one would realise that a pot is a cooking ‘artefact’ and a rifle a hunting ‘artefact’ and they are not ‘technologies’, whatever ‘technologies’ might mean. In 1.5.3.5 it was indicated that any cultural object has a typical qualifying function. When it is utilized in accordance with this function its internal destination is disclosed, but if it is employed or used in an a-typical way it is still objectified but not any longer according to its internal destination as a cultural object.

[54] With the advantage of a totality view of philosophy one would realise that each speciality has its own space, agricultural science and agricultural practice are different from technical science and technical practice or medical science and medical practice.

From a systems perspective Hughes (1990: 51) describes the development of (what he calls) large *technological* systems and the impact of these systems on society. He indicates that technological systems contain messy, complex, problem-solving components. He stresses that they are socially constructed as well as society shaping. Among the components in technological systems are physical artefacts, such as the turbo generators, transformers and transmission lines in electric light and power systems. Also included are organizations, such as manufacturing firms, utility companies and investment banks, and they incorporate components usually labelled scientific, such as books, articles, university teaching and research programmes.

Because they are *socially constructed* and adapted in order to function in systems, natural resources (such as coalmines) also qualify as system artefacts. An artefact - either physical or non-physical - functioning as a component in a system interacts with other artefacts, all of which contribute directly or through other components to the common system goal.

Hughes (1990: 54) also stresses that inventors, industrial scientists, engineers, managers, financiers and workers are components of, but not artefacts in, the system. Not created by the system builders, individuals and groups in systems have degrees of freedom not possessed by artefacts.

> 'Because they are invented and developed by system builders and their associates, the components of technological systems are socially constructed artifacts' (Hughes, 1990: 52).

Furthermore Hughes highlights that technological systems solve problems or achieve goals using whatever means are available and appropriate. He states that this partial definition of technology as problem-solving systems does not exclude problem solving in art, architecture, medicine, or even play, but the definition can be focused and clarified by further qualification: it is problem solving usually concerned with the reordering of the material world to make it more productive regarding goods and services.

Unfortunately, the above description of technological systems does not clearly identify the nature of the *technological* and even confuses it with *social* systems. The following transcendental issues arising from the assumptions made above should be considered. Where Ihde (1990a: 1) argued that artefacts are technological because they are technologically constructed, Hughes's view is that socially constructed artefactual components become social artefacts, while the system remains a technological system artefact.

To summarize, Hughes states that 'large technological systems' have three types of components: firstly, *physical artefacts* like turbo generators which might more correctly be indicated as technical components; secondly, organizations which incorporate books, articles and research programmes which could be indicated as societal artefacts, but which he indicates as *non-physical artefacts;* and thirdly, inventors, engineers and managers which could empirically be interlaced into the various totalities of societal organizations above, but which he indicates as *non-artefacts* because they have a 'degree of freedom not possessed by other artefacts' (Hughes, 1990: 54).

From these distinctive components – physical artefacts, non-physical artefacts and non-artefacts – he concludes that, because they are 'invented and developed by system builders', all these different natured components are 'socially constructed' artefacts (Hughes, 1990: 52).

The first question, in the light of the fact that artefacts can lose their 'identity'[55] and change from 'non-social' to 'social' artefacts, is why Hughes still refers to 'technological systems' and not simply to 'social' or societally constructed systems. The issue therefore is whether a 'technological' system becomes a 'social' system because system builders developed it. Can system builders create only 'social' systems or can they also create economic systems, technical systems, electrical systems and transport systems, and do all of these become social systems automatically?

Nowhere in his description of the components of these large *technological* systems does he refer to or identify any *technological* components. He

[55] Please remember that everything in reality has a persistent structure that cannot be overridden by contexts. Although a pen is a lingual object it can simultaneously have various other functions in different contexts without losing its nature as pen. This concerns opening up its typical, internal destinational function as opposed to deepening its other object-functions. Please refer to 1.5.3.5.

identifies physical, non-physical and non-artefacts only. Furthermore, technically speaking, these components will in any case *become* a *socially constructed artefact* if combined with other types of components by *system builders,* which implies that it should then be called a *social artefact*.

The second question concerns the nature of the *technological*. What exactly is meant by what is called the *technological*? How does it differ from the *technical*? Hughes argues that system builders invent and develop *social artefacts* or systems. Creating a social or even societal structure might be more accurately identified as a societal competency and not as a technical or technological competency. Hughes's bias towards the social or societal does not allow for the *technical* as *technical* but only for the *technical* as *social* or *societal*.

There are various societal structures[56] – for example economic, political, juridical, religious, and scientific or technical structures; but their unique *nature* transcends the focus of sociology. Sociology is only interested in the *societal perspective* on these structures. This explains Hughes's *social* perspective on *technical* systems. He does not contribute much to a

[56] It might be important to note that society is concerned with subject-subject relations where human subjects relate to each other in organizations that are subjectively (active) in their destinational function like (certitudinally qualified) churches, or (economically qualified) businesses where-as techno-practice concerns itself with subject-object relations where an active (technical qualified) process produces an artefact.

perspective on *technical* activity – only to our understanding of how the technical is interlaced with societal systems. The term socio-technical could serve to indicate this.

It is important to stress that the term *socio-technical* cannot be used to highlight anything of the *technical* as *technical,* because that transcends the focus of the social-technical relationship. In principle the *social-technical* relationship presupposes both the *social* and the *technical* as prerequisites and thus its focus is limited to the relationship itself[57]. However, the transcendental conditions regarding the nature of each of these components transcend the focus of any discipline that is merely directed towards this specific relationship[58].

The same holds true of a study focusing on socio-economic or socio-political relationships; it will not reveal anything of the nature of the economic or the political as such since both the economic or the political transcends the specific relevant relational perspective.

2.2.4. Dimensions of the technical world

57 This has been discussed extensively in previous sections.

58 Since the concrete entities and processes involved are multi-aspectual in nature they exceed the specific focus of any aspectually delimited scholarly discipline.

Tondl (1999: 1) argues that we live in a world of human beings (which he indicates as the social world and could arguably be indicated as the societal world), a natural world (i.e. the geosphere and biosphere), and a world of artificial human constructs (i.e. the world of artefacts). In this world, sometimes called 'our second nature', a key position is occupied by those artefacts that manifest our knowledge and, of course, our values, and that are sometimes collectively referred to as *technology* or the *technical world*.

He believes that stressing the knowledge- and value-related conditioning of technological constructs actually corresponds to the original meaning of the Greek word *techné*, i.e. abilities, skills, or knowledge for solving a certain problem by seeking, and especially creating, adequate means for such a solution.

He elaborates on the technical world, indicating that it contains objects, i.e. different human-made means, tools, machines, automation and artificial intelligence, and events and processes that transform the material, energy, and information aspects of our situation and that are disseminated and initiated by us, including processes of automatic regulation. We should realize that this technical world leads its own specific 'life', which continues to be enlivened by human knowledge and the development of that knowledge, by accepted value structures, and also by changes in those structures (Tondl, 1999: 1).

He argues furthermore that we should emphasize the usefulness of a global approach to individual segments of the technical world, and he stresses the need to adopt a systems approach – one which takes into account intellectual and value dimensions, as well as mutual interactions between intellectual, material, knowledge and humanitarian aspects of those components.

This means that individual components (of the technical world as well) mutually affect and condition one another. Furthermore, these components have their own life, development, birth and extinction. They occur within a certain temporal rhythm and develop in a certain direction. The different stages or phases of this life are described in biological metaphors drawn from ontogenesis and phylogenesis, with the emphasis on the dimensions of the intellectual and material, and of energy and information.

He lastly argues that we create a technical world in order to achieve our goals, creating a system of means to harness nature's resources and capacities and to put those resources to a better use, while remaining an integral part of nature and striving for a more perfect utilization of our resources and capacities.

From the above it seems that a very convincing case could be made for a technical world, technology and a systems approach that would enable one to deal with the situation. The argument is unfortunately based on assumptions with major transcendental flaws[59].

Firstly, equating the *world of artefacts* with *technology* implies that all artefacts are somehow *technological*. This position is confusing, as has been demonstrated above[60].

> If we realize that artifacts which can be described by the term technology include the modest tools of primitive humans—for instance, flint or simple hammers—as well as the instrumentation in today's chemical or biological laboratory or the control room of a large power-generating facility, we must come to the conclusion that any search for a single all-encompassing description offers no hope of success. (Tondl,1999:3)

Secondly, equating the *technical world* with *technology* and indirectly with artefacts, implies that all artefacts are *technical* instruments.

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[59] An assumption that has a transcendental flaw would be an assumption that does not take ontical (factual) conditions into account. To assume that water flows upwards or that a triangular circle can be drawn is contradictory to physical or spatial reality.

[60] It is of course not the same thing to state that all artefacts have a technical aspect or even a technical (sub)structure in contradistinction to stating that *all artefacts are technical in nature*. Whether there is or is not a 'technological' world is also another matter.

> Viewing the technical world as a system, then, this system is made up of interactions involving three basic subsystems, namely:
>
> —a subsystem of technological knowledge;
>
> —technical actions; and
>
> —technological artifacts. (Tondl, 1999: 2)

The contextual limitations involved in such an assumption are not taken into account, and the *technical* and the *technological* are treated as synonyms. Furthermore, artificial human constructs become *technological* constructs[61].

Neither of these assumptions is defendable[62].

Thirdly, stressing the knowledge and value conditions and defending them with the Greek word *techné* implies that all knowledge applications and problem solving are *technological*, which disregards the fact that techno-practice is specifically associated with the designing and forming of artefacts, and excludes other formative activities (art, science and societal) from

[61] If all human artefacts are the result of technical activity, it still does not mean they all become technical. This adds to the confusion surrounding technical artefacts and non-technical artefacts.

[62] Viewed from a transcendental point of view taking account of ontical conditions.

techno-practice[63].

Fourthly, although the systems perspective especially allows a focus on the interaction between individual components, it assumes these components as a prerequisite and therefore does not consider more transcendental questions about any part or component as such, because that transcends the perspective of the original specific focus of the interactive relationship. In other words, it would be a mistake to believe that more could be discovered about the unique nature of a specific component (like *technology* in the technology-human relationship, for example) in an interactive systems framework where the specific focus is the *interaction* of the components and not the *nature* of the specific components[64].

2.2.5. The dual nature of technological objects

Peter Kroes (1998: 1) argues that a *technological* object such as a television set or screwdriver has a dual nature. On the one hand, it is a physical object with a specific structure and physical properties, the behaviour of which is governed by the laws of nature. On the other hand, a physical object is also the carrier of a function and it is by virtue of this function that the object is a

[63] The evaluative model identified an activity as factual and labelled it as techno-practice. It was limited within a technical (manufacturing) context and might not be valid in other contexts. Thus conclusions are provisionally only drawn within the technical context.

[64] Extensively discussed in previous sections.

technological object. Function and physical carrier together constitute a *technological* object.

Usually a technological object is the embodiment of a human design and is specifically made to perform a certain function. This function means that, within the context of human action, it can be used as a means to an end. The function cannot be isolated from the context of use of a technological object: it is defined within that context. Since that context is a context of human action, Kroes calls the function a human (or social) construction. Therefore a *technological* object is a *physical* construction as well as a *human/social* construction.

This dual nature of technological objects is reflected in two different modes of description, namely a *structural* and a *functional* mode of description. In so far as it is a physical object, a technological object can be described in terms of its physical or structural properties and behaviour. This structural mode of description makes use of concepts from physical laws and theories and is free from any reference to the function of the object. The language of modern physics has no place for functions, goals or intentions. With regard to its function, a technological object is described in an intentional or teleological way: the function of a television set is to produce moving pictures, of a screwdriver to tighten or loosen screws.

Polanyi (1978: 330) confirms the above and states:

> 'The first thing to realize is that a knowledge of physics and chemistry would in itself not enable us to recognize a machine. Suppose you are faced with a problematic object and try to explore its nature by a meticulous physical or chemical analysis of all its parts. You may thus obtain a complete physico-chemical map of it. At what point would you discover that it is a machine (if it is one), and if so, how it operates? Never. For you cannot even put this question, let alone answer it, though you have all physics and chemistry at your finger-tips, unless you already know how machines work. Only if you know how clocks, typewriters, boats, telephones, cameras, etc. are constructed and operated, can you even enquire whether what you have in front of you *is* a clock, typewriter, boat, telephone, etc.'

Purely functional descriptions of an object have, from a structural point of view, a black box character in the sense that they do not specify any physical properties of the object: a television set is *something* (whatever it may be) to produce moving pictures, a screwdriver is *something* to tighten and loosen screws.

Some transcendental problems arise from the above description. Firstly, to state that a technological object has a function does not clarify whether this is a social, economic, scientific or even technical function. Saying that an artefact is 'usually the embodiment of a human design' indicates that it is the result of techno-practice – not that it is *technological*: there are many artefacts with different individual inner structures – not only artefacts with solely technical structures.

From this it follows that function and physical structure could constitute an artefact, but not necessarily *technology* or *technological objects*. Secondly, the idea that the *context* in which the artefact will be used is a social construct and that the object itself is therefore a social construct does not recognize that the artefact has an own identity and is not identical with the context of use. On the other hand, all artefacts are formed by human intervention and are therefore cultural objects in contradistinction to natural objects. But to equate that with social constructs and to view all artefacts as social constructs imply that the variety of types of artefacts that exist in reality is disregarded. It loses sight of the fact that the existence of economic artefacts, religious artefacts, artistic artefacts and scientific artefacts does not yield an 'artefactual' mode of distinguishing between them.

The division between functional and structural modes does explain that a physical structure could be studied by physics, that physics does not study the purpose of the object, and that the purpose implies a functional (cultural) approach that is more than just the physical structure. This holds true for all artefacts, technical and non-technical.

The transcendental criticism of the above description would be that no distinction is made between *technological* and *non-technological* artefacts; between the terms *technical* and *technological*, and between *social* and *non-*

social artefacts[65].

Kroes (2002: 1,2) indicates that on the one hand, the problem is how physical structure and function are related to each other in artefacts and what the precise role of intentions is in relating them. On the other hand, it is equally a matter for further inquiry how technical artefacts are related to social objects and what the role of physical realizations is in identifying them. There are numerous social entities created by man, e.g. codes of law or universities. Kroess argues that it seems that artefacts are always tangible, while such *social artefacts* are not, and asks whether this means that physical realization is irrelevant to *social artefacts*. Moreover, there is also a category of artefacts, such as computer programs, that seems to share some features with technical artefacts and others with social artefacts.

He proposes two 'triangles' of basic concepts: The first is structure - function - intention, and the second is technical artefact - physical object - social artefact. The relations between these triads and between the elements making up each triad are to be further analyzed and clarified. He explains that his interest mainly focuses on artefacts that are designed by engineers. His primary aim is to understand the type of artefacts that engineers design and

[65] If one cannot distinguish between technical and technological it could either mean that there is no distinction or that confusion reigns, the same applies to the distinction between social and non-social as well as technical and non-technical.

develop, as part of an effort to understand engineering practice better.

At this point it must be emphasised that artefacts are not necessarily either *technological* or *technical* simply because they were designed by engineers. The unique intended function and unique inner structure of the artefact distinguish social from economic or artistic artefacts. This was also noted by Mitcham (2002: 1) when he commented on the dual nature project. He argued that in this project the comparison may suggest the need to make some conceptual distinctions between different types of artefacts: tools, utilities, structures, machines, appliances, works of art, poems, concepts, and more. He queries whether the purported dual character of artefacts is the same in each case. It would perhaps still be useful to distinguish different types of material objects, and to consider how they may come to be engineered and/or utilized in quite different ways.

At this point it might be useful to recap the position taken that all entities are in fact 'totalities' allowing the interlacing of various structures into an enkaptical[66] unit. If we take a coin as an example, this in fact means that its physical structure, consisting of various metals and alloys, and its specific spatial form, lingual symbolism, economic value and juridical legitimacy (to

[66] Enkapsis is linked to 'capsule' indicating a unit that consists of an interlacement of distinct structures and or elements. In particular the interlacement of entities (or structures) is such that in spite of their shared domain of operation they also retain a distinct inner sphere of functioning – such as atoms and molecule within living entities.

mention just a few) are interwoven to form a specific, unique identity. That is why a coin can be studied in various contexts; for example, as physical subject, subject to physical laws, but also as economic, historical or even political object. It is, however, important to realize that in all these contexts, the fact that it was originally intended to serve as an economic object is still what qualifies or characterizes the coin as a coin. The other contexts are concerned with specific aspects of the coin, for example, the date or the political figure depicted on the coin, what it is called, its economic value, or its legitimacy.

Kroes' triangles of basic concepts do not serve to identify the transcendental conditions of artefacts because some of the underlying assumptions could be unfounded.[67]

2.2.6. Summary of conclusions

As illustrated above, labelling an artefact as *technological* or *technology* without taking cognisance of the inner structure of the artefact and

[67] It does not seem to be able to explain the ontical reality of a consistent structure as well as different meanings in different contexts that still recognise the structural integrity of artefacts. The triangles of structure – function – intention, and technical artefact – physical object – social artefact do not for instance regard the fact that an artefact is a physical subject with a qualifying inner structure that could be actualised in a different object function than its qualifying object function and therefore different than its original intention.

concentrating only on the context in which it is described, could lead to a 'contextual fallacy' as the context cannot override the inherent inner structure of the artefact. This does not mean that artefacts cannot be used in a-typical ways, but then their inner destination is not actualized – such as when a book is utilized as a doorstop. This use does not override its internal destination – a book is made to be read – it merely actualizes a non-typical object-function of the book.

The distinctive characteristic or the unique structure of artefacts has not been considered - neither in a technical nor a technological sense. This could also be indicated as a transcendental (ontic) flaw.

The next section will investigate variations of descriptions and definitions (notions) on what was identified as techno-science. After that the following distinctions of the evaluative framework will follow.

2.3. Variations on Techno-science

Poser (1998: 2) explains that it is common among scientists to distinguish sciences from each other by their topics, and, depending on these topics, by their methods. He states that the simplest kind of difference between science and engineering could be a distinction between a science of nature and a science of artefacts. According to him, enquiring into the ontic status of the entities of a discipline would be consistent with one of the classical methods of the philosophy of science, since ontological conventions constitute the categorical framework of a science.

He further argues that in traditional *technology* the *science of artefacts* seems to be true. He recalls the standard example – that there are no wheels and axes at all in nature. He argues that it might not be defensible to link technology with artefacts, especially with respect to the newest kinds of technology, which he calls the third technological revolution.

He argues that traditional engineering aimed at mechanical or chemical artefacts and at processes produced by these artefacts, but today we are confronted with technologies where it is not adequate to speak of artefacts in the traditional way. He inquires whether a cloned sheep could be classified as an artefact. He also asks whether a heart transplant or the implantation of a cardiac pacemaker turns a person into an artefact, and whether natural enzymes or resistant tomatoes produced by means of gene-mutated plants are artefacts.

He argues that the switch from physicalistic to biological technologies demands a meta-theoretical view, which differs from the traditional one in philosophy of science.

He further argues that experiments are the cornerstone of every empirical science. In all laboratories the objects of experience are manipulated, and all contain extended ‘technologies’ for experimentation and measurement. He argues that in many cases humans even produce the objects of the sciences, whether they are isotopes or macromolecules, polarized or monochromatic light. He concludes that all of this shows that we have to concentrate on methods, not on an ontology of artefacts, in order to mark the difference between science and engineering.

Of interest here, is that from a different angle, namely sociology of science, Pickering[68] (1995) links to the same issue of a ‘mangle’ in the practice of science. Here not from a ‘technical-to-science’ perspective (or techno-science as the original term in the orientating model) but from ‘science-to-the-technical’ perspective. Pickering is concerned with scientific practice, understood as the work of cultural extension (1995:3).

> My problematic thus includes the traditional one of understanding how new knowledge is produced in science, but goes beyond it in its interest in the transformation of the material and social dimensions of science, too. (Pickering, 1995:3)

Quite correctly, Poser indicates that both science and engineering have links with artefacts. To indicate *method* alone as distinctive could raise other issues, for example, if economics borrows a method from mathematics, does it then become mathematics or is it still economics?

[68] My thanks to Prof Mouton for highlighting this link.

To describe engineering as the *science of artefacts* raises the question whether other sciences could not also study artefacts. Engineering could be better described as the science of techno-practice where the design, maintenance and production *methods* of artefacts and systems are studied[69].

An interesting transcendental issue arises from the examples of sheep cloning and heart transplants. Is the cloning of sheep techno-practice? If not, how should it be categorized? Furthermore Poser axiomatically links technology with engineering; he argues that in engineering new technologies exist that do not result in artefacts.

Poser suggests that people produced *objects of science* that can be distinguished from objects produced by techno-practice. Isotopes, macromolecules, cellular cloning, polarized light and laser beams could be scientific objects at first. The transcendental[70] issue is whether a scientific technique in biology such as cross breeding or even cloning should be equated with techno-practice or even techno-science. Is this not a transgression of contexts? It seems as if the *scientific* technical is equated with the *engineering* technical or *techno-practice* under the umbrella term of

[69] This is based on the suggestion of Schuurman as described above.

[70] Our concern here regards a factual distinction: Is a technique in biology (cloning) to be seen as 'technology'? Why?

technology.

In the other examples of heart transplants or pacemaker implants the transcendental question is whether *medical* techniques can be equated with *engineering* techniques or techno-practice. Does the fact that there could be co-operation between medical practice and techno-practice negate the distinction between the two? Does the umbrella term *technology* in this case indicate a new totality that consists of an interlacement of techno-practice and medical practice to fulfil a basic human need?

Empirically, this new relationship is still guided by medical needs or requirements. Even if the initiative for a specific project originates from techno-knowledge, the results are still called medical equipment. All medical equipment, ranging from a stethoscope to obstetrics sonar and from X-rays to a heart-lung machine, are viewed as medical artefacts even though they are produced in co-operation with techno-practice. More advanced medical practice stays medical practice and does not become techno-practice. Heart transplants or pacemaker implants are indicators of advanced medical practice and not of techno-practice only. To confuse medical practice with techno-practice through the use of the umbrella term technology is to transgress contexts. This should be indicated as a contextual fallacy.

In his appeal for a new meta-theory because of a move from physicalistic to biological technologies, Poser assumes that technology is whatever it is without contexts.

The transcendental critique here would be that this view cannot distinguish between scientific practice (biological techniques) and techno-practice (engineering) and (mistakenly) assumes that biological techniques and artefacts become techno-practice or techno-science within techno-practice under the umbrella term technology. From the factual evaluative model's point of view this assumption is another example of a contextual fallacy.

2.3.1. The technology-science issue

Queralto (1998: 1) argues that the meaning of technology in scientific research has totally changed in recent decades. In the beginning, the classical relationship between science and technology established a subordination of technology to science. In a certain sense technology was regarded as applied science that helped the scientific process by manipulating the natural conditions of the scientific object. He argues that the influence of technology in the search for scientific objectivity did not bring about any significant changes regarding the epistemological framework of scientific knowledge.

Nevertheless, he argues that this conception is no longer applicable because the relevance of technology has become much greater than before, quantitatively and qualitatively considered. To him the role of technology is no longer subordinate to the instrumental requirements of science, but occupies a central position in the development of scientific knowledge and largely determines the progress of science. He states that in all scientific fields the use of sophisticated *technological* means is a *conditio sine qua non* for the development of the scientific enterprise. In this respect, he argues that it is possible to assert that technology is undoubtedly a *condition* of the possibility of scientific knowledge. Without technology it is impossible to develop science today. To him this new situation has relevant consequences that are to be taken into account in any attempt to understand the present epistemological status of technology.

He argues further that the influence of technology has become a determining feature of the epistemological constitution of scientific objects – as in nuclear physics, cosmology, biochemistry, etc. The point is not that science uses technology as an instrument: this is indeed true, but in his view a trivial remark. He stresses that the present use of technology modifies the traditional relationship between the theoretical and the pragmatic goals of scientific reason. To him technology is an 'epistemological mediation' of science and not only an instrument required by the present complexity of scientific research.

Pickering (1995: 22) argues for the practice of science where scientists constructs new machines to assist in the dialectic of resistance and accommodation, where resistance denotes the failure to achieve an intended capture of agency in practice and accommodation an active human response to resistance. Looking at his idea of reality or in his terms “the metaphysics that informs it” (1995: 5) he contrasts two paradigms or ‘idioms’ for thinking about science namely the representational and the performative.

> The representational idiom casts science as, above all, an activity that seeks to represent nature, to reproduce knowledge that maps, mirrors, or corresponds to how the world really is. (1995:5)

He argues that when one go beyond ‘science-as-knowledge’ to include the material, social and temporal dimensions, in an expanded conception of scientific culture, it becomes possible to imagine science not just as representative. He proposes the idea that the world is not filled with facts and observations but with agency. The world is continually (physically) doing things that bear upon us as forces upon material things.

He suggests is that we should view science as a continuation and extension of this ‘coping’ with material agency. He also believes we should see machines as central to how scientists cope.

> Scientists, as human agents, maneuver in a field of material agency, constructing machines that, as I shall say, variously capture, seduce, download, recruit, enrol, or materialize that agency, taming, and domesticating it, putting it at our service, often in the accomplishment of tasks that are simply beyond the capacities of naked human minds and bodies, individually or

collectively. (1995: 7)

He thus sees science in a performative idiom in which science is regarded as a field of powers, capacities and performances, situated in machine captures of material agency. (1995: 7)

The question can be raised, from a transcendental viewpoint, what is technology then if science is (technically) forming machines (as technical operators?) to accomplish tasks simply beyond human capacities? In a sense, he accommodates the technical into science.

The interesting transcendental issue is whether in the co-operation between a scientific technique and engineering technique (techno-practice) either one is subsumed under the other. Although it is true that scientific techniques are required to practice science, the question is whether it is correct to equate these techniques with *technology* or techno-practice. On the other hand, even if techno-practice is called upon to develop a scientific artefact or instrument, does that imply that science becomes techno-practice or is subordinate to techno-practice? The ontic uniqueness of techno-practice in contra-distinction from other techniques in various fields of human endeavour like art, science, economics and language should be recognized[71]. If understood correctly and

[71] Remember that things require a uniqueness to be identified and distinguished in the process of analysis. This implies that types of techniques differ in their types and not their

if the contexts involved are considered, the various scientific techniques would not mistakenly be seen as techno-practice under the umbrella term of *technology.*

It should also be noted that no distinction between *technical* and *technological* has been made above and furthermore, that the ontic nature of the technical would transcend the perspective of a theoretical view or paradigm that concentrates on the *interaction* between science, which has its own technical or scientific techniques, and techno-practice. This implies that science employs its own techniques instead of relying on technology or engineering (techno-practice). Scientific techniques within a discipline retain their identity and do not change into techno-practice under the umbrella term of technology[72]. [73]

'technique-ness'. Scientific techniques and technical techniques should therefore not be confused as all 'techniques' or (even worse) 'technologies'.

[72] This follows from the idea of the identity of a thing or entity to persist over time in spite of changes occurring on the basis of what is constant. Only the acknowledgement that change can only be established on the basis of constancy safeguard us against the impasse present in the thought of Heraclitus and the Sceptics. For that reason Einstein postulated the velocity of light (in a vacuum) to be constant – and whatever moves is moving *relative* to this constant. Einstein did not even claim that such a light signal actually exists, explaining why the physicist Stafleu can say the empirical confirmation of the fact that the velocity of light satisfies this assumption is comparatively irrelevant (Stafleu, M.D. 1980. *Time and Again. A Systematic Analysis of the Foundations of Physics*. Toronto: Wedge1980:89).

2.3.2. From technique to technology

Another variation of the issue regarding science and the technical is found in Aggazzi's argument (1998: 1) that two opposite positions characterize the present way science and technology are perceived. In his opinion the most widespread view renders them *identical*, as being practically one and the same thing (the so-called *technoscience*). According to one approach, the *intellectual* features of modern science dominate the traditional *manual* features of technology. Consequently technology itself has become *scientific* to such an extent that it is impossible to distinguish it from science. He argues that this view is tacitly presupposed in the way the progress of science is commonly understood. Examples of *technological* achievements are almost inevitably cited as instances of *scientific* progress.

According to another approach, modern science has in its turn been deeply affected by the spirit of technology, as constituting the proposal of dominating and utilizing nature. In consequence modern science has become indistinguishable from technology (Aggazzi, 1998: 1). This second view is common to several *instrumentalist* trends in contemporary philosophy of science that propagate an essentially negative judgment of science, because

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[73] Other philosophers of science – such as Popper, Kuhn and Stegmüller – wrestled with the problem of continuity and discontinuity, constancy and change.

modern science was allegedly born of the same pretension toward *manipulating being* that is at the core of technology, and this implies, as a consequence, that an attitude of *violence* underlies technology. (Aggazzi, 1998: 1)

As argued previously, the *scientification* of technology or the *technologization* of science does not change the identity or transcendental conditions of either of them. The creation of *techno-science* to subsume science and technology loses sight of relevant contexts. Even though techno-practice utilizes scientific knowledge it does not become a science. On the other hand, scientific techniques could be enhanced by techno-knowledge but still remain science.

Aggazzi argues that, contrary to the above two views, there is the position of those scholars who stress the different *aims* of science and technology: science aims at attaining objective knowledge and is therefore characterized by a strictly *cognitive* attitude; technology aims at producing concrete results (in the form of objects, commodities, tools, or procedures) and is therefore characterized by a *pragmatic* attitude.

According to Aggazzi (1998: 1), both positions contain some truth, but both are affected by certain misunderstandings. In order to evaluate them critically, he starts by proposing a distinction between *technique* and *technology,* although conventional, it is not arbitrary. It is not based upon a simple linguistic analysis but reflects certain conceptual differences that may suitably be appended to a double terminology that happens to exist in language.

He states that by *technique* we usually mean a display of practical abilities that allow one to perform easily and efficiently a given activity (be it purely material or bound to certain mental attitudes). But (perhaps less often) we also use *technique* as a collective noun, indicating the very wide spectrum of such simple techniques. In such contexts, these are sometimes indicated by the old-fashioned term *technics*. He feels that all the many effective concrete procedures - for example, producing certain objects, performing certain operations, and attaining certain goals - are summed up by the word *technique*.

Technique, in this sense, is the collective term for technics, and in this sense we usually speak, for example, of the 'technical skill' of a craftsman, lawyer or pianist. He argues that any such technique is essentially the skilful application of a certain *know-how,* which has been constituted through the accumulation and transmission of concrete *experiences* (that in particular also entails careful exercise), without being necessarily accompanied or supported by *knowing why* such concrete procedures are especially effective.

At this point it might be important to stress that although Aggazzi illustrates 'technics' in different contexts, like the technique of a pianist or craftsman, he does not stress the importance of contexts to techniques.[74]

Aggazzi (1998: 2) refers to the suffix, '-ology' found in the word *technology,* which he believes invites us to take advantage of the theoretical aspect of its use. He urges us to compare theology, sociology, philology and ethnology. These words suggest the presence of some kind of 'scientific', or at least theoretical, dimension. He argues that the Greek term *techné* includes this theoretical aspect, since it was used to indicate the capability of justifying, of 'knowing why', a certain procedure was efficient.

He proposes that the modern concept of technology can be interpreted as a new way of expressing the conceptual content of the Greek term *techné*. To him, perhaps the most decisive element distinguishing Western civilization from other great civilizations in history is its introduction of the theoretical into the domain of practice and doing. What he calls the 'invention of the why', arising from within Hellenic civilization in the sixth century B.C., led in that same context to the birth of both philosophy and science. He believes the very demand that moved philosophers to ask for the *reasons* for the existence and constitution of the cosmos (and to postulate principles and first causes to provide such an explanation) was also what moved the first mathematicians to provide the reasons (by means of *demonstration*) for the properties of numbers and figures. He argues that other peoples discovered them only

[74] That is to say, he does not account for ontical conditions as such.

empirically, translating them into *practical rules* of calculus. He believes that it was inevitable that a search for the 'why' should eventually take up the different kinds of efficient knowing that men had used in various fields; and that this gave birth to the notion of *techné:* efficient action where we know the *reasons* for its efficiency and what it is founded upon.

Aggazzi notes that the term *techné* is often translated as 'art', but today this is imprecise, since to us art essentially concerns aesthetic expression. The characteristics of *techné* are also parallel to those of *epistéme,* that is, *science,* since both are types of knowledge that demonstrate the reasons for what is observed empirically. *Epistéme* focuses attention on the *truth* of what is known; with *techné*, the focus is on efficiency. For him, the first concerns *pure knowledge;* the second, *knowledge of doing or making.*

He argues that if it is true that the domain of pure and simple knowledge of doing or making (that is, knowing *how* to do something but not necessarily knowing *why* the end is achieved) can be called the domain of *technique*, then we ought to find another term to designate that further dimension wherein efficient operation is conscious of the reasons for its efficacy and is founded upon them; that is, where operation is nourished by its grounding in theoretical knowledge. To him this new term is *technology*, which the guiding model would indicate as *techno-science.*

Aggazzi believes that a few useful points of reflection can be derived from these considerations. In the first place, he points out that a separation between science and technique is plausible (in the sense that we can characterize *science* as an eminently cognitive enterprise, and *technique* as an eminently pragmatic one). But technology can at most allow of a *conceptual* or an *analytic* distinction, without any real *separation* from science, since they are concretely intertwined and, so to speak, *consubstantial.* Here the maxim 'technology cannot exist without science, and science cannot exist without sophisticated technology' seems to apply. This, in his view, justifies the use of the term *techno-science* for designating this new reality. In the second place, he points out that an appeal to an *ethical dimension* strongly emerges *from within* techno-science itself; this is true because the particular form of creativity that characterizes this domain does not provide us with criteria for steering, directing, limiting, or orienting the growth of techno-science.

The development from technique to technology in the above explanation creates a few problems. If the '-ology' of technology indicates theory or science as in the examples given, it would mean that *technology* is equal to *technical science* or *techno-science*. Then it would be tautological to speak of science and technology, because technology in that case would be (the same as technical) science or techno-science.

But he also argues that technology is not a science: a science has a cognitive focus whereas technology has a pragmatic focus. They are inseparable, however – hence his notion of techno-science. Although he does distinguish between technique and science he confuses contexts when he states that *technology* (instead of techniques) cannot be separated from science because they are too strongly interconnected. He also overlooks[75] the possibility that asking transcendental questions can reveal some fundamental contexts. The first transcendental question is whether an engineering technique (in techno-practice) would lose its identity (as techno-practice) if it borrows some knowledge or insights from some scientific discipline like physics or mathematics. One can also ask whether 'physics' will become 'engineering' if it borrows some techno-knowledge from engineering to develop some kind of artefact or instrument for an experiment in physics.[76]

If their respective identities are not lost when sciences co-operate with other sciences – or with techno-practice, for that matter – or, on the other hand, when techno-practice co-operates with any of a number of sciences, then the

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[75] It is important to note that these do transcend his frame of reference and would thus in a certain sense not be expected.

[76] Scientific activities concern issues of theoretical knowledge – what we can *know*. The techniques involved in techno-practice, by contrast, concern what we can *do*. In both cases distinct and persistent realities are at stake. It also settles any attempt to 'confuse' scientific techniques with technical techniques in a new notion of techno-scientific techniques or any technologies.

particular creation of ‘techno-science’ to indicate a new totality within which science and techno-practice lose their identities is untenable.

Furthermore it must be pointed out that the question of ‘the invention of the why’ could be answered by philosophy and not by an examination of the suffix ‘-ology’. No clear argument has been presented to justify the use of the term *technology* instead of *technical* or *technics*. When the case is made for a development of the notion from a (contextual) technique to the umbrella term of *technology*, a transgression of context occurs[77].

2.4. Variations on Techno-knowledge

In this section attention will be given not only to the techno-knowledge of the engineer but also to the subject currently offered in schools.

2.4.1. Scientific versus engineering knowledge

Pitt (2001: 5) argues that engineering knowledge is a more secure form of knowledge than scientific knowledge. He argues that scientific knowledge is transitory – it changes as theories change. He further argues that scientific method too is not only transitory, but also unstable, depending on the area of science being discussed. According to him there is no single scientific method

[77] Also indicated as a contextual fallacy.

that can be used for all the sciences; he also believes that different methods might be appropriate for a science and the objects investigated by the science.

Finally, he argues that if scientific knowledge is to be appraised through a pragmatic theory of knowledge, and given that the objective is explanation, then as theories change, explanations fail. The history of science then becomes the history of failed theories and unsuccessful explanations.

In contrast, he argues that engineering knowledge is task oriented. If the application of engineering knowledge, consisting of information in books and task-specific methods and techniques, results in the production of objects and the solutions of problems which meet the criteria of those for whom the jobs are done, then it is successful. Furthermore he states that it is task oriented, and because real world tasks have a variety of contingencies to meet – e.g. materials, time frame, budget, etc. – one knows when an engineering project is successful or not. It is universal, certain and, if it works, must be true in some sense of the word 'true'. So, according to the criteria he advocates for science, engineering knowledge seems more secure and more permanent. What engineers know, therefore, is how to get the job done – primarily because they know what the job is.

If human knowledge is developed through experience and study, it always develops and one never stops learning. The implication is that our knowledge is in a state of flux and, as Pitt indicated, a history of failed theories and explanations. But this would also be true of technical solutions in the different scientific practices, because newer or more novel solutions appear every day. It therefore follows that our techno-knowledge is also in a state of flux and cannot be more secure than any other type of knowledge. The 'successful' engineering project mentioned earlier is only successful within a certain context and might cause other problems not apparent in the first solution, indicating that techno-knowledge, too, is impermanent. Lastly, on a lighter note, the engineer might have solved what has never been a problem – like extracting pure water from champagne.

2.4.2. Curricula in schools

Black (1998: 2) focuses on school curricula and specifically on the new subject of technology. He supplies an overview of the curricula in different countries, outlining a number of approaches.

He starts his argument by indicating that technology is a peculiar subject in that its status and its nature have been subject to radical changes in recent years. The subject is seen to serve several aims, which are assigned different relative priorities in different countries. There are many traditions associated with competing pressures in the re-definition of the subject. The different curriculum models within which the redefined subject is meant to fit and play a specific role, further complicate these changes and varieties.

Black listed the different approaches as follows:

- a technical skills approach, seeking emphasis on craft skills in treating resistant materials, food, and textiles, or in electronics and automatic control (e.g. Finland);
- a craft approach, in which the cultural and personal value of the combination of manual skill, aesthetic sensibility, and traditional design is to be preserved (e.g. the Swedish tradition);
- a technical production approach, seeking emphasis on skills appropriate to modern mass production and its control and organization (Eastern European - formerly socialist - traditions);
- an engineering apprentice approach, seeing the school subject as a preparation ground for specialist technicians and engineers in tertiary education;
- a ‘modern technology’ approach, which looks to the nature of ‘work’ in the next century and focuses strongly on information technology (some even interpreting the word *technology* to mean *computers* - a strong tendency in the French approach);
- a ‘science and technology’ approach in which it is assumed that these two subjects are, or ought to be, studied in close association with each other (as in Denmark);
- a concentration on design, seen by some as a central concept in the study and practice of technology (Northern Ireland);
- a problem-solving emphasis, focusing on an understanding of the nature of social needs in the definition of ‘problems’ and of the need for a cross-disciplinary approach to dealing with issues (Scotland, United States);
- a ‘practical capability’ approach, emphasizing personal and active involvement by pupils in dealing with realistic problems to offset the passive and receptive ethos of most of school education;
- an emphasis on the technology-society nexus, which calls for the study of technological or technical innovation as a driving force for social change and of its interaction with other forces that also drive change (the STS movement). (Black, 1998: 2)

He also points out that policy is mainly driven by one of these approaches in some countries, while in others there is an attempt to adopt several of them in concert. He states that some of them are closely linked with an emphasis on 'technology as a component of general education for all'. It is not quite clear what this means. In terms of the guiding framework it could mean:

- techno-practice as a component of general education for all;
- techno-knowledge as a component of general education for all;
- techno-literacy as a component of general education for all.

It seems that the latter option makes the most sense as the previous options are too specialized for *general* education.

He further states that in others, the emphasis is on vocational preparation, which is far removed from the 'technical'. He states that assuming that this emphasis is dominant, there can still be arguments about which of them provides the best preparation for employment.

Black indicates that this wide range of differences makes it difficult to communicate in discussions between countries. To complicate matters the school subject can have a variety of names; in the U.K. the terms *technology*, *design and technology*, *technology and design*, and *craft design and technology* have all been used, and each signifies a different rationale.

He argues that the differences are often associated with competing interests struggling to exert their influence on the school curriculum. He realizes that lack of consensus can inhibit policy development and he states that in the United States, groups have been in operation for several years, trying to draw up and achieve consensus on statements of national standards in most of the main school subjects. In technology the group assigned this task was one of the last to be set up and has yet to report.

It seems as if schools experience the same difficulty of arriving at a standardized notion of the *technical* and should possibly concentrate on aspects of techno-knowledge, techno-literacy and techno-practice.

2.4.3. Dual nature of techno-knowledge?

Kroes (2001: 1) argues that the dual ontological nature of artefacts has its counterpart at the level of technological (or technical) knowledge. According to him, technological knowledge therefore also has two faces. On the one hand, it concerns the physical (or structural) properties of technical objects. He uses a car to explain. It has all kinds of physical properties that are of crucial technical importance, such as its mass, the fuel consumption per kilometre, its shape, its air resistance, its breaking power, the shape of its combustion chambers, the temperature and pressure in the combustion chamber during a combustion cycle etc. Knowledge of these physical properties, of how they hang together and of the physical/chemical processes taking place in, for instance, the engine of the car during operation, is part and parcel of what he calls *standard technological knowledge* of cars. He further argues that, on the other hand, technological knowledge also concerns the functional properties of objects. Apart from knowing that a certain object has a round shape, is made of steel etc., we also know that it is a steering wheel – in other words, that it performs a certain function in a car. Car designers, mechanics and users express at least part of their knowledge of technical objects like cars by means of functional concepts. They say, for instance, that object X performs function Y, and assume that such a claim about object X may be true or false, just like any claim about a physical property. Technological knowledge, he concludes, consists of statements concerning not only the physical structure of technical artefacts, but also their functions.

He states that from the point of view of engineering design, the idea that technological knowledge involves knowledge of structures as well as of functions is rather obvious. The engineering design process may be interpreted as a problem-solving process in which a function is translated or transformed into a structure.

In Dutch, scientific thinking is distinguished from technical skills and know-how by two terms: 'kennen' and 'kunnen'. In a certain sense the engineering design process, as Kroess sees it, is therefore the movement from 'kennen' to ‘kunnen’.

Although what is indicated above as *technological* knowledge could be called *technical* knowledge, techno-practice is involved not only in designing, but also in forming and maintaining artefacts; in that sense it is a totality with interlaced structures, which could create the mistaken impression that it has a dual nature. An artefact could have a ‘technical’ substructure and yet be part of a totality with a different inherent qualifying structure, a cell phone, for instance, has a technical substructure, but serves as a lingual object or communication instrument. It should therefore not be seen as a technical artefact but rather as a communication artefact.[78]

2.5. Techno-literacy

Jenkins (1996: 2) explains a certain notion of techno-literacy that he calls ‘technological’ literacy. He explains that technological literacy is a term of more recent origin than scientific literacy. He explains that this is the case partly because the institutionalised study of technology as an activity is of more recent origin than the history and philosophy of science and partly because, in

[78] Of course it cannot be denied that artefacts may also be objectified in a-typical ways but that does not change the inherent typical nature (structural principle) of the artefact. It is therefore misleading to refer to it as if its internal structure changed. Alternatively this constant inner structure of entities that qualify their nature should be acknowledged when they are discussed in alternative (a-typical) contexts.

most advanced societies, the theoretical and scientific have come to be favoured at the expense of the practical and technological.

He believes that this preference may owe something to the fact that an essential element of technological capability is tacit rather than explicit. He argues that if tacit knowledge were indeed central to technological capability, it would not only be unlikely to yield readily to scholarly scrutiny but would also present problems concerning the accommodation of knowledge within educational systems. These systems are, for the most part, committed to imparting knowledge and understanding that is explicit, and of cognitive, rather than practical, significance. This seems to be an interesting attempt to explain why *technology* is so difficult to define.

He states that it should also be acknowledged that to those who regard technology as mere applied science, technology does not have its own knowledge base, and technological literacy reduces the ability to apply scientific knowledge. The important point, to him, is that some clarification of, and ideally consensus on, the nature of technological activity is fundamental to defining technological literacy and, consequently, to devising relevant educational programmes for technology.

Jenkins reminds us that, like scientific literacy, technological literacy is a slogan, not a demand for action. It serves as a rallying-cry to which individuals, governments, groups, organizations, and associations can positively respond since they perceive it as advancing their own interests.

He believes it is also useful to consider how individuals and societies understand technological change, to which technological literacy is, presumably, in some way related. It is now common to refer to the information revolution and to compare it with the industrial revolution in an attempt to signal the major social, economic, and other changes associated with it. Any revolution based on technological change makes some groups of workers redundant while simultaneously creating new forms of employment.

He believes that technological literacy offers the hope of disseminating to the wider public a better understanding of their day-to-day work and, thereby, of strengthening public, and in a broad sense, political support for technological activities. From this perspective, technological literacy is essentially concerned with an understanding of, and sympathy towards, technological capability.

Although techno-literacy could be made a slogan for a campaign and although it is linked with a clear understanding of the technical and techno-practice, it is actually more than just ‘propaganda’ for new artefacts or the importance of techno-practice. Techno-literacy also hints at the ability of individuals to use artefacts that have a technical substructure or that requires some skill to operate. This should not be confused with techno-knowledge or techno-practice.

Unfortunately, Jenkins does not succeed in clarifying the distinction between the terms *technical* and *technological* and what he indicates as *technological* could rather be designated as *technical*.

2.5.1. Thing knowledge?

Baird (2002: 1) makes a case for a materialist epistemology that he calls 'thing knowledge'. This is an epistemology in which the things we make bear our knowledge of the world, on a par with the words we speak. It is an epistemology opposed to the notion that the things we make are only instrumental to the articulation and justification of knowledge expressed in words or equations. He believes our things do more than this. He argues that they bear knowledge themselves and, frequently enough, the words we speak serve instrumentally in the articulation and justification of knowledge borne by things.

It might be true that things reveal their meaning in different contexts and relationships. Identifying this meaning or 'knowledge from artefacts' requires as presuppositions a 'literacy' to 'read' this meaning or 'knowledge from the artefact' and its contexts of use, as well as the capability to know and interpret this meaning. The knowledge is therefore not in the artefact but in the 'eye of the beholder'. To know presupposes as a transcendent precondition an 'I' who must have a capacity for knowledge. Passive objects, like books for example, cannot 'know'; only the active 'I' can know or not know what is written in the book.

2.6. Summary and some preliminary conclusions

Firstly a short summary of distinctions so far and then some preliminary conclusions.

2.6.1. Summary

If one views the technical process from a transcendental point of view, it was found that thus far five elements were identified. These were indicated as techno-practice, techno-knowledge, techno-science, techno-literacy and artefacts. In a preliminary study it was found that different authors identified some of these above elements, in different combinations, in their notions, definitions or examples in their arguments. These authors were categorized under each of these elements as headings.

Obviously, these categorizations are not cast in stone and some authors were much more complex to be boxed-in under just one heading. It is important to note that the theory of the author itself, and its conclusions in terms of his/her own assumptions were never evaluated as that was never the intension. Only the author's assumptions and 'theoretical constructs'[79] in terms of the technical were tested against a (factual) ontic given. The fact that a specific element was indicated was automatically credited as confirmation of the factually given and thus was not even highlighted. The content and the assumptions were further compared to try to refine and improve our own understanding.

It was also accepted that an analysis of the technical in an ontic context transcends the perspective or focus of any disciplinary context. This implies that none of the authors would be expected to supply a totality view of the technical and only partial descriptions of significance to the disciplinary perspective could be expected.

2.6.1.1. Variations of techno-practice

Under this heading various authors were interrogated to illustrate some variations and interesting highlights. Schuurman described from an engineering point of view the difference between modern and classical practice and that the ideal is to control the production process from a distance. Where the classical practice were dependant on material, skill, and

[79] Here definitions, notions, suggestions and conclusions about the technical or one of its elements are implied.

experiential knowledge the modern were freed from these limitations and also divided the design from the production.

Bunge, also an engineer, agreed with Schuurman that technology is the sector of human knowledge concerned with the design, repair, and maintenance of artificial systems and processes, with the aid of basic science and mathematics. Unfortunately he did not take into consideration that each entity has a typicality and transgressed, so to speak, contexts in such a way that he wanted to classify non-technical processes under technical processes.

Quintanilla argued that technological change is effected by 'designing and producing new technical systems and improving their efficiency'. This is what is specifically meant by the term *techno-practice* in the guiding model, therefore confirming such an activity. Unfortunately he also did not reveal a totality view of the technical relationship.

Rapp links technology with the production of artefacts in general and not just with techno-practice, confusing the general human technical capability with techno-practice. This confirmed that human form-giving is multi-aspectual, and consequently could also be focussed on techno-practice as such, although Rapp did not realise that.

2.6.1.2. Variations on artefacts

Ihde indicated *artefacts* and *technofacts* as technologies that interact with the human in various ways. Furthermore he believed a technological object becomes what it 'is' through its uses not realising that the inner typical structure actually persists and that artefacts themselves cannot be 'technologies'. This will be explained further in the next chapter.

Bijker believes that the word *technology* has three layers of meaning. Firstly, there is the level of physical objects or artefacts; for example, bicycles, lamps, and Bakelite. Secondly, technology may refer to activities or processes, such as steel making or moulding. Thirdly, technology can refer to what people know and do; examples are the know-how that goes into designing a bicycle or operating an ultrasound device in the obstetrics clinic. He argues that because in practice the technologies cover all three aspects, it is not sensible to separate them further. On the one hand this confirms artefacts, techno-practice and techno-knowledge in the orientation model but on the other hand it confuses techno-literacy and techno-knowledge as well as the nature of artefacts produced by techno-practice. This will be discussed further in the following chapters.

Tiles and Hughes stressed technological systems, as also to be seen as artefacts. Tondl on the other hand argues that we create a technical world in order to achieve our goals, creating a system of means to harness nature's resources and capacities and to put those resources to a better use, while remaining an integral part of nature and striving for a more perfect utilization of our resources and capacities. In a certain sense this confirms our technical formative power to form culture in general. We form cultural things like art, tables and chairs, language, laws, values and even theories. This unfortunately does not indicate the typical uniqueness of the technical forming process in techno-practice.

Peter Kroes argued that a *technological* object such as a television set or screwdriver has a dual nature. On the one hand, it is a physical object with a specific structure and physical properties, the behaviour of which is governed by the laws of nature and on the other hand it performs a function. This in a sense confirmed the existence of artefacts as result of techno-practice. Why he called it an technological object instead of technical could indicate confusion, especially if he does not indicate that each artefact has a typical inner structure which implies that not all artefacts is necessarily technical.

2.6.1.3. Variations on Techno-science

Poser indicates that both science and engineering have links with artefacts and therefore he argued that the difference is in method. To indicate *method* alone as distinctive could raise other issues, for example, if economics borrows a method from mathematics, does it then become mathematics or is it still economics? Only if one accepts that each entity has a typical uniqueness can one agree that mathematics and economics are distinct although they may both use mathematical formulas. Techno-science will thus also have an own uniqueness as a technical science different from other sciences and also different from techno-practice.

Pickering sees the 'science' part of techno-science and argues that science developed into a 'techno-science'. He thus sees science in a performative idiom in which science is regarded as a field of powers, capacities and performances, situated in machine inter-actions with material agency. The technical is thus incorporated into science.

Aggazzi summarised that two opposite positions characterize the present way science and technology are perceived. In his opinion the most widespread view renders them *identical*, as being practically one and the same thing (the so-called *techno-science*). In the other approach, modern science has in its turn been deeply affected by the spirit of technology, as constituting the proposal of dominating and utilizing nature. In consequence modern science has become indistinguishable from technology. From an ontic viewpoint the *scientification* of technology or the *technologization* of science does not change the identity or transcendental conditions of either of them.

Aggazzi also tried to argue for the term 'technology' instead of 'technique', where he argued for another term to designate that *further* dimension wherein efficient operation is conscious of the *reasons for its efficacy* and is founded upon them; that is, where operation is nourished by its grounding in theoretical knowledge. To him this new term is *technology*, which the guiding model would indicate as *techno-science.*

2.6.1.4. Variations on Techno-knowledge

As illustrated Pitt held the view hat engineering knowledge is a superior type of knowledge in comparison with scientific knowledge. He followed that route in an effort to give engineering a more dominant position or importance in society over science for example. From a transcendental point of view the argument was not supported.

Black started his argument by indicating that technology was a peculiar subject in that its status and its nature have been subject to radical changes in recent years. The subject is seen to serve several aims, which are assigned different relative priorities in different countries. This confirmed that techno-knowledge might be required but it also indicated major confusion between techno-knowledge, techno-literacy and techno-science. He states that some of the approaches are closely linked with an emphasis on 'technology as a component of general education for all'. It is not quite clear what this means. In terms of the guiding framework it could mean:

- techno-practice as a component of general education for all;
- techno-knowledge as a component of general education for all;
- techno-literacy as a component of general education for all.

It seems that the latter option makes the most sense as the previous options are too specialized for *general* education.

Kroess argues that the dual ontological nature of artefacts has its counterpart at the level of technological (or technical) knowledge. According to him, technological knowledge therefore also has two faces. On the one hand, it concerns the physical (or structural) properties of technical objects, on the other hand, technological knowledge also concerns the functional properties of objects. This unfortunately still could not distinguish between techno-knowledge and techno-science.

2.6.1.5. Variations on Techno-literacy

Jenkins argued that some clarification of, and ideally consensus on, the nature of technological activity is fundamental to defining technological literacy and, consequently, to devising relevant educational programmes for technology. He believes that technological literacy offers the hope of disseminating to the wider public a better understanding of their day-to-day work and, thereby, of strengthening public, and in a broad sense political, support for technological activities. From this perspective, technological literacy is essentially concerned with an understanding of, and sympathy towards, technological capability. This in a sense confirmed the existence of such an element as techno-literacy although it was confused with techno-knowledge by various other authors.

Baird lastly, makes a case for a materialist epistemology that he calls ‘thing knowledge’. This is an epistemology in which the things we make bear our knowledge of the world, on a par with the words we speak. Identifying this meaning or ‘knowledge from artefacts’ requires as presuppositions a ‘literacy’ to ‘read’ this meaning or ‘knowledge from the artefact’ and its contexts of use, as well as the capability to know and interpret this meaning. Also this insight contributed to the realisation that a separate techno-literacy element should be identified.

2.6.1.6. Preliminary conclusions

Before proceeding with an analysis of specific interpretations of the technical as presented by various authors, the following preliminary conclusions can be drawn:

The term *technology* cannot be equated with *artefacts*. Not all artefacts are technical; they could have a technical structure encapsulated in its totality, but that would not automatically make them technical.

No clarity has been reached regarding the distinction between the *technical* and the *technological*. It turns out that *technological* has been employed as an umbrella term to categorize all technical activity like techno-practice, techno-science, techno-knowledge and techno-literacy under one heading without recognising the contextual limitations of each activity.

It has been also argued that the so-called human-technology relationship can more precisely be indicated by the term human-artefactual relationship.

Furthermore transcendental questions about the technical transcend the view or perspective of an approach that concentrates or focuses on a relationship (society and technology, for example) in order to study the interactions in the relationship[80].

Although the technical could be described as formative power controlled by

[80] Previously argued extensively.

humans, this does not imply that all formative actions occur only in techno-practice. The umbrella term *technology* suggests that all technical forming is technology, but forming or designing and creating also occur in other spheres of life. Artists can form, design and create, as can scientists. This does not make them technologists or subject to techno-practice, techno-science or techno-knowledge.

This explains how scientists can clone sheep as a scientific experiment without changing science into 'techno-practice'. To equate scientific techniques with techno-practice under the umbrella term of *technology* is to discount the identity of scientific techniques as different from techno-practice. This negation of identity also contributes to the negation of contexts, leading to a contextual fallacy.

In the next three chapters three leaders in the field of Science and Technology Studies will be investigated. The purpose is to explore whether any further elements for the technical relationship might have been overlooked on the one hand and whether these notions already identified could explain their notions. If the elements are ontically based, and these leaders are scientifically busy with reality, at least some elements must be confirmed by both parties. As special scientists do not focus on an ontical totality view, they might not be familiar with all the elements, only those they found useful in their own theory.

3. Analysis of the position of Don Ihde

In this section an analysis of the theoretical models and notions of Don Ihde[81] will be attempted. The purpose of the whole thesis is to arrive at a heuristic model of ontical elements of modern technology. Although a specialised (disciplinary) focus is not equipped to supply a totality view of ontical features that transcends its focus, it might still identify certain elements that might have been overlooked or might confirm certain elements that are proposed. It is self-evident that leaders in the field could contribute significantly in this regard[82].

Ihde is identified by Mitcham (1994: 97) as one of the proponents of the Pragmatic Phenomenology of Technology, a school of thought that adopted the point of view of the humanities, in contradistinction to that of engineering.

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[81] My thanks to Prof Walther Ch. Zimmerli who suggested Ihde as a worthy candidate to be studied.

[82] It should be stressed that an analysis of notions and models relevant to the *technical* only will be attempted. It will serve no purpose to even attempt to evaluate his sociological-philosophical theory as such and neither to try and evaluate its impact on the current theory or his standing or critique of others or by others on his theory. This study stands and falls by the assumption that he has 'standing' and his notions are worthwhile to analyse. This study is only interested in the *ontical logic* behind his notions. None of his critics attempted a transcendental empirical analysis of his work, meaning no contribution towards an ontical logic can be expected. It also transcends their theoretical framework.

In the preface to his *Technology and Lifeworld: from garden to earth*, Ihde indicates that his contribution is one of a trio that concentrates on the philosophy of technology. Here the focus is on a systematic reformulation of a framework and a set of questions regarding technology within culture[83] (Ihde, 1990a: ix).

Don Ihde begins by distinguishing between what he calls 'idealist' and 'materialist' attitudes towards technology. The first sees technology as applied science; the second sees science as theoretical technology. Siding with the latter approach, he sketches a phenomenology of human-technology-world relations. He argues for a historic-ontological primacy of technology over science and further uncovers a basic amplification-reduction structure to all technology-mediated relations[84].

He aims at avoiding the extremes of both utopian and dystopian interpretations of technology, which have intermittently dominated the field of technology. He focuses on two issues, namely human–technology relations and the cultural embeddedness of technologies.

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[83] It is important to highlight that he wants to look at 'technology in culture', this implies a relationship of technology with something else, implying the existence of both are pre-supposed.

[84] Examples of his ideas will follow.

Ihde (1990a: 117) argues that humans are social beings. He believes we thrive only if we participate in a wide range of social and cultural activities. Life in a community, according to him, is our natural milieu. He states that those who see community life as a burden that limits freedom misunderstand our relation to our community and the culture it embodies. We cannot live well without culture - any more than an otter can thrive without swimming. He regards culture as essential - not mere decoration; he believes our nature as human beings demands that we create a culture if we do not have one and that we sustain it if we do.

He elaborates on this view by stating that 'culture' can also be defined as a historically transmitted pattern of shared meanings embodied in symbols, beliefs, language, societal and ethical relations, tools and praxis – a system of inherited conceptions and praxis expressed in symbolic forms by means of which people communicate, perpetuate and develop their knowledge of and attitudes towards life. According to him, focusing on concepts only stresses the mentalistic while underplaying the materiality of culture and the extent to which culture is embedded in and sustained by everyday practice. To him, culture refers to ways in which we express ourselves in religion, narrative myths, language, sports and even body language, but it also includes characteristic ways in which people dress, farm, organize their society, make and use tools. Within this broader characterization he distinguishes various cultural forms, e.g. religious, political and aesthetic. 'Culture', however primitive, would therefore include all those societal and symbolic practices – artistic, religious, sporting, linguistic, political, labouring and child-rearing – in which people participate and which they recognize.

The above description of Ihde places 'the technical' squarely in the cultural domain. He believes that we do not live in a 'culture' per se: we live in communities of various sizes and degrees of complexity, from small, nomadic villages to enormous mega-states. These communities embody, structure and reflect culture, which consists primarily of a set of practices, power relations, institutions, habits, traditions, values and attitudes.

At this stage, a comment needs to be made on the distinction between the factual (what is) and normative values (what ought to be) in the description of communities (society) and culture. One is tempted to link it with the Kantian dualism of nature (what is) and freedom (what ought to be). The question can be raised whether sociologists see society as factual, and culture as representing value, and whether this perception explains why they distinguish between society and culture. This can lead to a distortion of these notions in the sense that culture might be more than only the abstract norms and beliefs of society and might therefore include factual structural relations and sets of practices and traditions.

Ihde continues by pointing out that living practices change. He states that change is not only brought about by external pressures, but is also generated internally as standards, approaches, ways of thinking and feeling are found wanting. According to him, technology plays no small part in both external and internal changes. He argues that the move from realism to abstraction in art was hastened by the invention of the camera (which should be noted as an artefact) and the invention of tubes of paint (also artefacts), which allowed of greater spontaneity and demanded less in terms of training. He believes technologies (as artefacts) can also transform a practice from within. He cites the example of instruments that, becoming more finely calibrated, enables engineers to raise standards of tolerance, which, in turn, enables them to design and build increasingly fine and economical devices. In terms of the model this can be explained as artefacts that aid techno-practice and possibly techno-knowledge.

He further argues that although the human-through-technology impact on today's world is clearly greater than at any time in history, it is not necessarily a change for the better. He states that, regardless of cultural differences, all ancient civilizations surrounding the Mediterranean effected (a) deforestation, (b) over-grazing by sheep and goats, and (c) irreversible erosion, resulting in the present aridity of the Mediterranean basin (Ihde, 1990a: 119).

3.1. Technology

Ihde begins with a broad notion of technology as

> '… those artifacts of material culture that we use in various ways within our environment …' (Ihde, 1990a: 1)

Credit could be given to Ihde for the indication that the technical process brings forth artefacts like cameras and tubes of paint that changed art techniques, and that it is part of culture. Unfortunately, artefacts do not become technical, technological or technology because it is the result of a technical production process. To indicate artefacts as technology some ontic (factual) conditions are ignored.

The issue can be summarized as follows[85]:

Artefacts might be the result of a technical process but their inner structure, goal or use might not be technical. If all artefacts were technical because 'technological' or 'technical' processes produced them, then all artefacts would **have** to be technical and **no** non-technical possibility would exist. This would raise questions about artistic, social, lingual, economic and even religious artefacts.[86]

The phrase '*artifacts of material culture that we use in various ways'* does not account for non-technical artefacts. Furthermore, it implies that the usage of

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[85] This was already widely discussed in the previous chapter and is just summarised here.

[86] Remember that although an artefact can have different uses in different contexts it still does not lose its persistent unique structure.

an artefact is also only *technological* or *technical*.[87] The use of a car or cell phone is not *technological* but artefactual[88]. A contextual fallacy arises if all artefacts are equated with technology. Artefacts have their own identity or structures that can be distinguished from the manufacturing process or the knowledge needed to design and produce them.[89]

To designate all artefacts as *technological* is to absolutize or give undue preference to the technical aspect of reality. It amounts to an argument that does not adequately account for the ontically founded distinction between the technical and the non-technical, not to mention *technological* and *non-technological*. In order to arrive at the transcendental conditions of cultural objects, the relation between what is technical and non-technical or the technological and non-technological should also be considered.

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[87] In other words, if all artefacts of a material nature are technology, then it means all artefacts have the same unique structure namely 'technological'. But if all artefacts have the same uniqueness, namely technological, then no other types of artefacts (non-technological) can exist. However, we do experience different types of artefacts, such as economic artefacts, religious artefacts, societal artefacts, historical artefacts, etc. The (onto-)logical conclusion therefore is that *not all* (material) artefacts are technological in nature.

[88] With artefactual is meant according to the typical structure of the artefact. Cell phones are communication artefacts, etc.

[89] This fairly extensive critical reaction to the view of Ihde finds its background in the discussion of previous chapters. Its focus is on different types of things and the argument is that Ihde's distinctions do not account for these states of affairs in a satisfactory way. In other words, the analysis is transcendental-empirical and not "transcendent-uncritical".

If the transcendental perspective is neglected, difficulties may arise in the attempt to understand different societal contexts in which *technical* objects are embedded, and in distinguishing *technical* from *non-technical* artefacts[90].

Ihde holds that animal technics involves the temporary use of found objects (thorns, sticks, etc.), and this was no doubt the case with early man as well. But to man, sticks do not remain sticks; they become spears or arrows. Found objects are shaped and thus become *technological* artefacts.

The comment needs to be made that spears and arrows could be *technically* manufactured and shaped, but they are not necessarily *technological* artefacts. Their inner structure or destination would be *societal*, since hunting was important in the socio-cultural context. It might also be borne in mind that the structure of the artefact should be empirically identified and should not be confused with purpose or intention of usage. That arrows and spears are societal in destination rather than *technological* does not imply that they were not technically formed – they are still the result of a technical forming process.

[90] This is of course the case because Ihde did not (never had the intention to) consider the ontical characteristics of the technical. That this is typical of all specialised (disciplinary) theory is obvious and does not make his contributions to the theory invalid. In his own words he is interested in the interaction of technology with society and made valuable contributions there.

Ihde's notion of these weapons as *technological* artefacts is therefore misleading.

Lastly, the anthropologist, Karl J. Narr (1974: 99), distinguishes between animal technics and human creativity. He stresses that in the case of human artefacts (artificially produced implements), the shape is not predetermined. Unlike a stick that can be turned into an implement by the removal of superfluous branches and leaves, the shape of flake tools, for example is not pre-established by the natural shape of the stone. Furthermore, the functions are not predetermined either as they are not extensions or enhancements of the human body; implements are used, for example, for cutting - an important *new* function that does not pre-exist in the human body.

> 'Evidently they are products of real invention in the sense of establishing a new principle of technique and manipulation based on true insight into conditions and relations'. (Narr, 1974: 99-100)

The method of manufacturing is not predetermined either since the implements are not simply made by means of hands or teeth, but by using other implements like hammer stones.

It seems that human technics (to use Ihde's term) and animal technics are clearly distinguishable on the basis of insights and creativity and even new principles.

3.2. Assumptions of experience and the life-world

Ihde explains that phenomenology takes the structure of experience itself as one of its primary phenomena. He further links this with a relativistic ontology of human existence but he stresses that it is not relativism, but rather an account of relations, for example an account of human–world relations, which determines and outlines the dimensions of human existence. He suggests that a metaphorical model for understanding phenomenology is precisely that of a 'relativistic' science.

> 'A simple way of stating this model is to indicate that the '*primitive*' of the system (the smallest or simplest unit) is itself a set of relations' (Ihde, 1990a: 23).

One example is the relation between an observer and the world around him. In a modified illustration of Einstein's relativity theory, he describes two trains, A and B, with an observer positioned in train B. If train A moves backwards, then from the observer's point of view three possibilities exist:

- B is stationary and A moves backward;
- A is stationary and B moves forward;
- Both trains move in opposite directions.

Ihde sees in each case 'stability' within the observer–observed relationship.

> 'The relationality of human–world relationships is claimed by phenomenologists to be an ontological feature of all knowledge, all experience. Negatively, it would be claimed that there is no way to "get out of" this relativistic situation…' (Ihde,1990a: 25).

Ihde (1990a: 27) stresses that this process is structural in the sense that it undertakes to understand the structure of the relationship as it exists in the life-world. He believes the function of the notion of life-world is to combine the elements in a unified system. His life-world is perceived through his senses and he experiences concrete 'bodily' entities around him. He calls this micro perception. Abstraction, notions or ideas arise from this practical (pre-scientific) perception. To him it is a cultural acquisition that can be repeated and, once sedimented in cultural experience, becomes taken for granted. This cultural or hermeneutic perception is referred to as macro perception. He believes both belong equally to the life–world, and both dimensions of perception are closely linked and intertwined.

> 'There is no micro perception (sensory–bodily) without its location within a field of macro perceptions and no macro perception without its micro perceptual foci'. (Ihde, 1990a: 29)

He sees the relation between these perceptions not as derivative but as figure-to-ground. Micro perception occurs within its hermeneutic–cultural context and all such contexts are actualised within the range of micro perceptual possibility.

> 'The histories of perception teach us that every version of micro-perception is already situated within and never separated from the human and already cultural macro perception which contains it'. (Ihde, 1990a: 42)

He illustrates this by showing how different cultures group the stars in recognizable patterns (macro perception), in their limited experience (micro perception) of 'their part' of the sky.

Ihde assumes:

> ‘a double-sided analysis of the range of human–technology relations’. (Ihde, 1990a: 30)

The implication for Ihde (1990a: 30) is that one of the sides of the perception remains within the limits of micro perceptual and bodily experience whereas the other side must remain that of a cultural hermeneutics that orientates our existential life.

He (Ihde, 1990a: 23) explains that the structure of experience is subjective, but that it has a context of constancy or ‘objectivity’ such as peer review (inter-subjectivity), experimental design (context constraints), and so forth. The same structure of experience belongs to all of the sciences. He illustrates this with an example from physics where the ‘behaviour’ of atoms and their constituents is not directly observable, but must be made available through a technologically mediated (instrumental) observation situation.

> ‘The bubble chamber, accelerators, electron– and computer-enhanced microscopes, all bring into mediated or indirect presence the micro-phenomena which are of interest to the physicist’. (Ihde, 1990a: 23)

As indicated above, Ihde assumes a ‘relativistic’ ontology where the ‘smallest’ unit itself is a relationship. Its ontological nature could probably be better expressed by the term ‘relational’. An interesting point arises: if the ‘smallest’ unit itself is a relationship, it presupposes at least two ‘elements’ ‘related to’ each other which could themselves not be in a relationship if they are already part of the 'smallest' unit-as-relationship. This implies that the smallest 'unit' cannot be a relationship.

He does not elaborate on this ontology[91] and does not realise that another principle involved is the principle of *orderedness,* implying *order for* and *orderliness of*, which is required by ontology to make experience and knowledge possible.[92]

Ihde (1990a: 31) then proceeds to the anthropological framework where he concentrates on human experience. He states that experience is relational. He actually expands the basic principle of meaning in context by indicating a micro perception situated in a cultural macro perception, and applies it to human experience of technology. Ihde highlights a double-sided analysis of the range of human–technology relations where one side is within the limits of

[91] I think this is significant. For a disciplinary focus, a lot of ontology is assumed or borrowed and it is not the task of such a focus to go and 're-invent the wheel'. It would be a pity if the idea were created that because this project is only interested in ontical (factual) elements in a totality, it therefore does not bother to engage with disciplinary theorists. The engagement will obviously be limited to identifying and distinguishing ontical elements. The elements were either observed and incorporated or missed and left out. No evaluation of the disciplinary theory as such (meaning not only the assumptions but as disciplinary theory within the discipline itself, as opposed to other theories in the discipline) could possibly be attempted. It is outside the focus of this thesis.

[92] This was discussed in chapter one where the orderliness of reality was indicated as a transcendental condition.

micro perceptual and bodily experience, while the other side must remain that of a cultural hermeneutics that situates our existential life.

From this framework he indicates the possibilities of *technologically mediated* observation of human experience. Because he reduces technology to artefacts[93], one could refer to *artefactually mediated experience*.

What is of interest in the above is Ihde's interpretation of 'meaning in context' where he realises that perception (micro perception, that is,) is always situated within a bigger framework (macro perception) or paradigm. He then uses this framework to indicate how artefacts interact and change paradigms. Although he realises that there are transcendental conditions for perception, he does not indicate that there might also be transcendental conditions for technology[94].

Ihde elaborates on technology's role in artificial perception:

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[93] Remember his own definition was technology is all artefacts of material culture.

[94] As stated before, this technically transcends the disciplinary focus of the interaction between technology and society.

3.2.1. Artificial perception through technology

He (Ihde, 1990a: 42) argues that if there is no simple seeing, but only situated seeing – that is, both *seeing as* (macro perception, relating to a framework) and a *seeing from* (micro perception, relating to the body) – then a structure of perception is implied.

Ihde (1990a: 43) argues further that although we perceive the sky from a distance, we can also take a closer look by using a telescope or other instruments. This technologically embodied perception distinguishes the modern person from the ancients who did not have these instruments.

> 'Not only have our perceptions changed – those embodied through instrumentation are incommensurate with naked observation in however small degrees – but so also have our praxes'. (Ihde, 1990a: 44)

To him this implies that when Galileo looked through his telescope, a paradigm shift was possible. Micro perception and macro perception shifted through the involvement of technology (or more correctly an artefact). Artificial revelation enabled a newly technologically (or artefactually) embodied science that stood in contrast to and far beyond the reaches of ancient Greek science. As far as he is concerned, perceptual instrumentation places the observer in ever new relations to the universe at micro and macro levels: first though the use of the telescope, then through the use of the radio telescope.

> 'To cement the point inversely, take all instrumentation away from the scientific community and then ask what it would and

> could do. Its limits would very quickly reduce to precisely those admirable, but at best speculative notions of our Greek forefathers'. (Ihde, 1990a: 57)

It must be pointed out that scientific techniques and techno-practice are not the same and to equate 'scientific instrumentation' with 'technology' is a contextual fallacy[95] as argued in the previous chapter.

Ihde (1990a: 59) also mentions the example of a clock. Once developed, it transformed the perception of time because time measurement became possible. To him the clock was the 'key-machine' of the modern industrial age. He reminds us that it was an automatic machine, measuring the motion of heavenly bodies; even nature was read as though it were a clock.

Spatial perception is also technologically (or rather, artefactually) mediated. Hermeneutic maps and instruments are used to mediate perceptions. The magnetic north pole and the compass replaced the North Star, and today the modern satellite-based GPS systems replace the older systems.

From the above it is clear that Ihde views 'technology' as the instrument that makes paradigm shifts possible: it shifts micro and macro perceptions, it supports or even enables science and scientific discoveries, and it changes

[95] Again here it might seem an insensitive or unfair conclusion but unfortunately cannot be ignored BUT it should be remembered that this technically falls outside the focus of a disciplinary perspective.

the perceptions of time and space of our life-world. Without it we would not be able to experience and know and develop more than the ancients. In that sense it is a tool for development and perception. The technical, however, might be ‘more’ than the mere ‘artefacts’ that Ihde highlights.

3.2.2. Contextual Complexity

Ihde (1990a: 68) also points out that not only do we perceive with *technological* objects, we also perceive different uses for objects. He illustrates this statement with an example of a symmetrically shaped, oval stone, which can be viewed as an object of art, a paperweight or an Archeulean hand axe from a Stone Age toolkit. Because, phenomenologically speaking, there is no ‘thing-in-itself’, only things in context, it must be borne in mind that contexts are multiple. Ihde concludes that the object is or could be any of the things named, or its identity could be determined by how it is used. He regards this as an ambiguity that is part of technologies. The ambiguity of the Acheulean object is the ambiguity of technology in general.

Don Ihde states that our actions are embedded in the multiple ways we interact with and presuppose our technologies, yet the human–technology juncture displays a puzzling ambiguity:

> ‘A technological object, whatever else it is, becomes what it ‘is’ through its uses. This is not to say that the technical properties of objects are irrelevant, but it is to say that such properties in use become part of the human–technology relativity’

(Ihde,1990a: 70).

Even technical properties are significant in the context of use. Stone, once shaped, enters praxis. Thus what is 'natural' in the stone becomes artefactual within the relation.

With this statement Ihde reveals the origin of a possible contextual fallacy[96]. On the one hand he acknowledges the *technical* properties of objects, which are obviously consistent within a structure (from a transcendental point of view) and which he indicates as relevant; but then he moves to the anthropological framework and makes this *subject to* the *relativity of* that framework, which he calls the human-technology relativity.

To make it practical: while the structure of reality is consistent, our insight into reality is obviously subject to various conditions like our intelligence, experience, paradigms and various other factors. Fortunately, our variable insight into reality still does not make the consistent structure of reality inconsistent and cannot negate this consistent structure. When one places an artefact within a framework and attaches some meaning to it, it still implies

[96] As explained that no specialised (disciplinary) context can obtain a totality (overview) view of the ontical characteristics of the technical unless it departs from the disciplinary perspective and moves towards an ontical totality perspective. True to a limited disciplinary perspective he tries to solve the problem within his disciplinary context, namely the human-technology framework.

that one attached only a *limited* view of the object within a *limited* context; the nature of the artefact in its totality might transcend the focus of the framework of this context.[97]

Furthermore, the structure of the artefact itself also *limits* usage, which makes the statement that it 'becomes what it is through its usage' valid in only a very limited context[98], with the result that contextual transgressions could easily arise. The following example may serve to illustrate this statement: a pen is primarily used as a lingual object or writing instrument. If one person uses a pen as a weapon to defend herself against a pickpocket in one specific instance, it does not follow that soldiers should be issued with pens instead of rifles. The structure of the pen severely limits its use as a weapon. This implies that the (typical) structure of an artefact determines its use - its use does not determine its structure or identity. Overlooking this implication will result in contextual fallacies[99].

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[97] This point seems difficult to swallow for all disciplinary orientated readers. They somehow believe that they do possess a totality view; they confuse it with the idea that their view is *theoretical* and therefore *just as legitimate* as any other theoretical view. Although a totality view is theoretical, not all theoretical views are totality views.

[98] This must be stressed. It is valid up to a point. Granted for the purposes of a disciplinary approach possibly close enough. The purpose of this thesis is to go beyond a disciplinary view to a totality view.

[99] Although Ihde does not go as far as the example given the position had to be stated. A way of interpreting his view is that he is saying that objects (such as pens) have no meaning or

The problem could be clarified by referring to the consistent structure of reality where every entity has a typical structure. It is important to realize that although such entities have a consistent structure, they could be used for different purposes without the purpose influencing the structure. A book is meant to be read. Its structure is that of a lingual object. However, books can be sold, which implies that not their qualifying lingual function but their economic object function is actualised. In a sense this is not a typical function of books. Other examples of a-typical functions would be the use of books as doorstops or paperweights. The point is that in all these cases the structure does not change: it is still a book that is sold, a book that is used as a doorstop and a book that is used as a paperweight.

Ihde overlooks the various relationships in which an artefact could reveal meaning[100], just as he misses the different subject-object relations that are

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function (and even identity) unless we use them. Strictly speaking that is not true either, even if I do not use a pen, it stays a pen. Even if I use it as a weapon it stays a pen. The structure of the pen determines that. All the other meanings in all the different contexts still do not change its pen-structure.

[100] Remember that Ihde never used the terms ‘meaning in contexts’; it is an insight of the philosophy of the cosmonomic idea, a constant structure and different meanings in different contexts. Ihde used the terms ‘becoming what it *is* by its uses’ not indicating a constant structure but indicating a ‘changeability’. Granted for his disciplinary approach it was sufficient to indicate that artefacts ‘changes’ (identity?) in different contexts.

possible. He does identify some relationships of artefacts, but only in terms of cultural contexts. Although the structure of an artefact limits its usage, there are still relational contexts for usage. Ihde identifies these as different cultural contexts.

3.2.3. Cultural context of artefacts

Ihde (1990a: 138,140,141) states that there are no universal technologies. Instead, he argues that technologies bear the scars of conflicts, compromises and social solutions reached by the particular society in which they have been developed.

He explains that latecomers to the development process have perceived the particular technology that originated in Europe as universal and a-historical. He stresses that this is not the case, and that one consequence of the absorption of technologies by a developing country will be cultural dependence and a form of cultural colonialism. He concludes that, by indiscriminately absorbing a technology from another culture, a developing nation is often burdened with the social and power relations that are inextricably bound up with it.

He states that one might as well speak of social transplants, for transferring a technology from one society to another resembles organ transplantation.

There is the immediate ‘post-transfer' phase when attention is lavished on it in an attempt to make sure that it ‘takes'. Results vary from the beneficial to the comic and catastrophic (Ihde, 1990a: 140, 141).

The problem is that artefacts could be transplanted but not necessarily the *technical infrastructure* to produce these artefacts. Is it then technology transfer or just *artefactual* transfer? Here one sees the cultural/societal change brought about by *artefacts* and not *technology* per se. The essential ambiguity of human-artefactual relations has been revealed, and along with it, the phenomenon of variant cultural embeddings.

At the complex level of a cultural hermeneutics, Ihde believes that technologies may be embedded in various ways, since the same technology in another cultural context becomes a quite different technology. Ihde (1990a: 144) refers to the nature of this technology-cultural structure with the term *multi-stability*.

In the relationship with humans and humans-in-culture, artefacts transform experience and its variations. Indicating that an artefact could have different uses in different cultural milieus concurs with the epistemological principle of ‘meaning in context’ or, according to Ihde, micro and macro perception or experience. This holds true for all artefacts, not only so-called technological artefacts (or technology).

Secondly, no unique description of what technology or technological artefacts are in distinction to non-technological artefacts has been given yet[101]. As a result, it is proposed that this explains why Ihde confuses *technologies* with *artefacts*.

3.3. Transfer or transplant

Ihde (1990a: 126) states that, just as there is no such thing as *an* equipment, there is no equipment separate from the culturally constituted values and processes of a specific society. He stresses that in addition to an object tying in with a new set of cross-cultural exchanges, the context of the previously familiar object changes value and position.

Ihde (1990a: 127) finds that the adaptation of a transferred technology – initially, at least – depends upon its being able to fit into an existent praxis. Realizing that this 'fit' also depends on the structural limitations of the artefact could refine this statement. Nevertheless, Ihde states that, even when it is

[101] The difference ought to be indicated in some kind of ontology. If no distinction is indicated, it indicates that the problem of the difference or similarity between the two is not solved. Again this falls outside the focus of any particular (special science) discipline, and should be solved by ontology. As this thesis is at this stage focussing on ontic characteristics, a possible solution will be given in the last chapter where a possible ontological explanation will be proposed.

adapted, the context of meanings may differ radically relative to the sedimented type of praxis in the recipient culture. One need not go into the more exotic cultural examples to take note of this phenomenon.

His (1990a: 127) example of the Indian prayer wheels used as windmills in the West is also an example of two different cultural embeddings. He reminds us that in the West, where nature was already regarded as a resource, wind power was adapted for a variety of power uses such as pumping water, grinding grain and sawing lumber. Interestingly enough the windmill was also invented in the Islamic countries Iran and Afghanistan but in spite of the obvious need of power for irrigation, these windmills were never used in other Islamic countries and so did not become what they were in Europe.

Ihde (1990a: 128) explains that a double context exists. First, he argues, there is the involvement of the artefact in its immediate use-context. It 'is' what it 'is' in relation to that context. In so far as such contexts, particularly at the simplest levels, may be widespread in cultures, a transfer is a relatively simple matter (hawks' bells used as baubles). In each case two things determine the identity of the transferred artefact:

- the kind of transfer
- the overlap of cultures.

The overlap may be minimal. But, he continues, there is also the juxtaposition of larger cultural contexts, which may not overlap at all. In this case the artefact is what it is in relation to this cultural field. He concludes that there is therefore a sense in which the windmill as windmill was not transferred. He argues that the mere technical aspects of the prayer wheel do not constitute a windmill until reconstituted within the new cultural context. The following contrasts have been noted in studies of artefacts developed in China but not in Europe: using gunpowder and fireworks in celebrations is very different from using the same materials in siege and warfare.

Ihde (1990a: 128) indicates that the temptation may be strong here to jump to a 'context less' conclusion that the technology as such is *neutral* but takes on its significance dependent upon different 'uses.' But he regards such a conclusion as a kind of disembodied abstraction.

Ihde (1990a: 129) argues that in historical explorations the objects that could easily be transferred could be steel knives and axes, together with hawks' bells, beads, mirrors and the like, but in today's neo-colonialism these are more likely to be wristwatches, radios, televisions, calculators and computers. The characteristics of transfers from both eras are similar. Radios and watches have particularly fascinating features. The watch, even in a community that does not practice strict timekeeping, becomes a coveted fashion accessory. The fashion praxis into which a watch fits is virtually universal; the radio even more so. It can transmit sounds already familiar to the recipient.

The new artefacts, though complex infrastructures of high-technology culture are involved in their production, do not at this level transcend the simple use-object transfer of praxis. There can therefore be a flow of artefacts and techno-facts that do not massively transform the cultures. Could this be indicated as *artefactual transfer* in distinction to *technology transfer* that transfers the technical production and maintenance processes as well? Ihde does not distinguish between 'artefactual' and 'technological' transfer; his examples all indicate *artefactual* transfer.

3.3.1. Cultural Resistance

Ihde points out that the present march of high-technology culture across the globe is a fact about which both proponents and critics would agree. One result of this march is the decreasing ability of traditional (primitive or *relatively undifferentiated*) cultures to withstand radical change or possible cultural extinction. These cultures are the most vulnerable to the impact of technologization.

What Ihde (1990a: 151) is suggesting is a crude categorization of cultural response to technologies carried by foreign sources to indigenous groups:

- There are what he calls 'monocultures' of a more primitive or traditional type which are normally dominated by the culture of the incoming group;

- Secondly, he identifies so-called middle or compromised adaptations in which selected technofacts are accepted into the indigenous culture or either adapted into a new cultural context
- Thirdly he mentions cultures that can successfully resist most of the elements of the incoming culture
- Finally there are cultures that adopt and modify themselves, from the incoming group.

Ihde (1990a: 153) supplies examples of monocultures, which include the inland Aborigines of Australia, the Inuit and the Tasaday, to which could be added any number of the disappearing groups of South American tribes of Brazil or Peru. He states that monocultures are marked by a relatively high degree of cultural isolation that protects their cultural integrity.

Ihde believes (1990a: 155) that *technology* has allowed contemporary man to 'inherit' the entire earth. To him the 'ontic' conditions (that makes it possible) for monocultural existence have been breached. These conditions of a monoculture are like that of the habitat of a specialized species. If the habitat is destroyed, the condition making it possible is removed and it either dies or adapts.

In the current context, Ihde (1990a: 151) is suggesting that only equal cultures with the sense of self-confidence are likely to be able either to reject or to adopt what is met within a cross-cultural exchange of the sort that occurred during the historical voyages of discovery.

Ihde (1990a: 154) reasons that contemporary communications technologies (artefacts) are as powerful as they are because of the multiple sets of dimensions they embody. He cites the example of mini-cassettes used during the Iranian Revolution. Although the Shah's government was relatively successful in controlling the media, propaganda was communicated through the distribution of the small, easily concealed tapes for cassette players.

This, according to Ihde, is an example of the essential pluricultural pattern made possible by that contemporary technology. He argues, however, that it is an inclination, not a determination of technology, as the degrees of resistance against a pluricultural result continue to illustrate. He realizes that a pluricultural pattern is not neutral either.

He stresses that today's array of desktop publishing technologies, cassette recorders and the video camera provides an opportunity for decentralized minority expression. A claim of police brutality - almost always difficult to prove and usually dismissed by review boards - was given a new angle by using a video camera during a dispute in New York City.

> The results were so dramatic that the police commissioner acted promptly to dismiss and rearrange high-ranking persons in the chain of command. (Ihde,1990a: 156,7)

Similarly, he points out that television is changing the role and position of referees in sport for example, because decisions can be reversed or confirmed.

Here again Ihde does not distinguish between artefacts and 'technology'. What he claims is in fact true for artefactual transfer, which does not necessarily imply technological transfer per se. Even in the clock as an example of selective adaption he does not realize that what he indicates as technological adaptation is essentially artefactual adaptation. He refers to the clock as an artefact that is differently used or adopted by various societies.

Ihde (1990a: 129) argues that ancient Chinese civilization was amazingly sophisticated and, like most ancient civilizations, had a highly developed knowledge of astronomy or *heavenly* phenomena. As in many other ancient civilizations, an observation of the heavens revealed much more than mechanical 'movements' of stars and planets. A near universal for ancient astronomy is some version of astrology in which the positions of stars and planets is (hermeneutically) thought of as related to existential processes. Chinese astronomy was accurate enough to make the oldest-known prediction of an eclipse, recorded in 1361 B.C. The hermeneutic instrument that records and reflects these movements is the calendar; and, as we shall see, it is an accurate calendar, which in turn relates to the first Chinese clock.

That clock, invented by the Imperial Astrologer Su Sung some time shortly after 1077 was not for telling hours but for creating an astrological calendar: the Emperor had to know the movements and positions of the constellations - in precisely the way Su Sung's Heavenly Clockwork made possible. In China the ages of individuals and their astrological destinies were calculated not from the hour of birth but from the hour of conception.

To Ihde (1990a: 130) the clock 'is' what it is in relation to its embedded cultural matrix, which, in China, until modern times, remained very different from that of the West. A brief glimpse at some of those contrasting values may be instructive:

- Official centralization in the office of the Emperor kept all calendars the property of the imperial house.
- Emperors were kept hidden from the public and, while powerful as decree givers, isolated from public life.
- Calendar-keeping was related to the astrological features important to social predictions. So long as the clock was kept particularly focused within the imperial confines, it too was isolated.

Ihde (1990a: 131) stresses that each of these factors stands in direct contrast to the Latin Western introduction of a clock that was public, kept time, and was socially adapted. He stressed that it should be noted that as a hermeneutic device, a clock clearly has a multidimensional set of possibilities, which, in turn, may fit easily into a number of cultural, multi-stable structures. In that respect, Ihde believes, the clock is an example of the essential, although non-neutral, ambiguity of technology.

To correct the contextual limits one should rather postulate that the clock is an artefact (the result of techno-practice but itself not *technological*) that has a multidimensional set of possibilities in the human-artefact relativity. The human-artefact relationship is but one dimension of artefacts and the totality of artefacts as artefacts cannot be limited to this one dimension, nor can it be uniquely defined by this one-dimensional representation of 'technology'.

A transcendental description of the structure of artefacts can only be made in a wider ontic context and not in the limited *anthropological-interaction-with-artefacts framework* that Ihde uses. The various possibilities of *clockness* or, as Ihde's puts it, *is what it is* in various cultures is also limited by its structural restrictions, which implies that it cannot become anything other than *some sort of clock*, although it might have different impacts on different cultures.

Without the benefit of the wider ontic framework, Ihde attempts to structure technology only within the human-artefact relativity. The result can only be a limited description that does not indicate any uniqueness and does not take the consistent structural characteristics into account. This is the result of the limitations of the framework because any transcendental issues would transcend the focus of the human-artefact relational framework that assumes both humans and artefacts as essential presuppositions of the interactive framework.

3.4. Ihde's attempt to structure technology

In opposition to what he calls *an objectivist account* that would attempt to describe or define technologies by the characteristics of objects that involve some combination of physical and material properties, he wants to discover the various structural features of the ambiguous *human– technology relations*. His purpose is to reduce the open ambiguity to a structural analysis that acts across and accounts for the range of possibilities that occur within the *essential ambiguity* of technology.[102]

It needs to be noted that an ambiguity does indeed exist in human-artefacts relations. However, it does not follow that it is valid for technology only because not all artefacts are *technological*. Furthermore, the analysis of the ambiguous human-technology relations will only supply one dimension of

[102] What is remarkable is that he realises that artefacts have more than just *physical and material* properties, and then searches for an answer in a relationship between humans and artefacts, instead of analysing the structure of artefacts as enkaptical totalities and latent normative object functions.

technology (or rather artefacts) and will neither give an overall view of technology in all its consistent structural dimensions nor reveal its unique characteristics.

From this follows that within his own chosen framework Ihde would not be able to pose truly transcendental questions regarding technology, since within his framework notions of technology and humans are already presupposed. It seems to be difficult to answer questions like *what technology or its intrinsic meaning is* within this framework.[103] That is also the reason why he cannot differentiate between artefacts and technology. In every instance where he is quoted, the term 'technology' could be replaced by the term 'artefact'.

Within this limited framework of human interaction with artefacts he discusses three programmes of analysis. The first programme is called Phenomenology of Technics, in which he concentrates on the micro perception of humans with technology. In his second programme, called Cultural Hermeneutics, he concentrates on the macro perception or cultural context of technology, and in the third programme, called Life-World Shapes, he tries to describe the wide overall life-world influence of technology.

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[103] Note that the phrase "intrinsic meaning" does not refer to the 'meaning' of a word, but to *ontic states of affairs*, to their *intrinsic structural traits*. Disciplines with a limited scope (the special sciences) do not always explicitly put forward an articulated total view of reality. For that reason the 'meta-theoretical' level of our analysis restricted itself to a "pre-disciplinary" underlying perspective.

3.4.1. A phenomenology of technics

In this programme Ihde concentrates on micro perception, where I-as-body interacts with the environment by means of technologies.

> 'To embody one's praxis *through* technologies is ultimately an *existential* relation with the world' (Ihde, 1990a: 72).

He identifies and argues for various sets of existential relations. The first is called *embodiment relations* between the 'I' and the 'world'; examples are seeing by means of spectacles or hearing by means of a hearing aid. As with Galileo, observing the moon through his telescope, the 'technology' is in a mediating position. This pre-supposes a relative transparency, a technical fit and it's being appropriate for the proposed use:

> 'Embodiment relations display an essential magnification / reduction structure which has been suggested in the instrumentation examples. Embodiment relations simultaneously magnify or amplify and reduce or place aside what is experienced through them' (Ihde, 1990a: 76).

A second existential human–technology relation is called *hermeneutic*. In a sense it is associated with the macro perspective of cultural interpretation or enframement. He relates it to interpretation or reading. Writing transformed the perception and understanding we have of language. To him, writing is a technologically embedded form of language, instead of a technically formed (objectified) lingual object.

> 'In the case of the printed text, however, the referential transparency is distinctively different from technologically embodied perceptions. *Textual transparency* is hermeneutic transparency, not perceptual *transparency*' (Ihde, 1990a: 82).

Another example is the 'interpretation' or 'reading' of the dial of an instrument in a nuclear power station where the heat cannot be personally checked. The dial reading must then be 'interpreted'.

Alterity relations are relations to a technology where technological 'otherness' is a 'quasi-otherness', stronger than mere 'object' but weaker than the 'otherness' found within the animal kingdom or in other humans. As an example Ihde uses a spinning top. Once the top has been set to spin, it imparts of the embodiment relation between human and artefact. What makes it fascinating is this property of quasi-animation, a life of its own. More modern examples are video games and computer games where one 'competes' against an interactive machine as 'quasi-other'.

Another relationship identified is called background relations. Here attention shifts from 'technologies' in the foreground to 'technologies' in the background. Technologies designed to be in the background are automatic and semi-automatic machines; for example, a heating/cooling system that is automatically controlled with a thermostat, or a semi-automatic toaster that remains in the background while functioning.

> 'Background technologies, no less than focal ones, transform the gestalts of human experience and, precisely because they are absent presences, may exert more subtle indirect effects upon the way a world is experienced' (Ihde, 1990a: 112).

Horizon or boundary issues are highlighted as borderline examples. When a tooth is crowned, one may initially experience the strangeness of something added, but after a time the tooth becomes almost totally embodied. Other examples are implants like hip joints of stainless steel and Teflon which elicit only a fringe awareness. Even more extreme examples, like the birth-control pill, arise from chemical transformations. Ihde calls them edible technologies.

> 'The pill, once taken, functioned as a kind of internal background relation of the most extreme fringe type' (Ihde, 1990a: 113).

Although Ihde systematically identifies various relationships a human has on the micro-perceptual level, namely embodiments, hermeneutic, alterity, background relations and boundary relations, this only highlights the various interactions between humans and artefacts and obviously[104] does not help to answer the transcendental question of technology as such. He has, however, made a contribution to an understanding of how humans experience artefacts on the micro-perceptual level. The indeterminate nature of human experience and freedom of choice is well accounted for and will contribute to this specific aspect of the final model. From an ontical perspective, which transcends the specific disciplinary perspective that he uses, Ihde unfortunately still (mis)uses the term 'technological' instead of referring to what is 'artefactual'.

[104] This is because it transcends his specific focus as argued before.

In his next programme he more clearly transgresses contexts[105] by anticipating transcendental issues regarding ontic conditions within an anthropological context.

3.4.2. Cultural Hermeneutics

This is Ihde's second programme in his attempt to 'structure' technology. Again his approach is not transcendentally orientated or geared to ontic conditions; he still operates within an anthropological perspective and is, more specifically, concerned with humanity's interaction with technology. This has a bearing on the ways in which cultures embed technologies. Ihde's aim is to suggest a framework of interpretation that can provide a perspective on some contemporary questions concerning 'technological' culture.

Technologies as instruments of culture in *technology transfer* are investigated first. Ihde found that the acceptance of a transferred *technology* depends on its ability to fit into a praxis. When the technology is adopted, its context may change radically in the new culture. A double set of contextual involvements is at stake.

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[105] Obviously from an ontical perspective.

Firstly, he identifies the involvement of the artefact in its use-context. It is what it is in that specific context[106]. If these contexts overlap with those of other cultures, a transfer is a simple matter – for example, a steel axe or knife easily replaces a stone axe or knife.

Secondly, when the larger cultural contexts do not overlap but remain in juxtaposition, the adopted technology is recontextualized,

Ihde warns:

> 'The temptation may be strong here to leap to a context less conclusion that the "technology" as such is "neutral" but takes on its significance dependent upon different 'uses'. But such a conclusion remains at most a kind of disembodied abstraction. The technology is only what it is in some use-context' (Ihde, 1990a: 128).

It is therefore possible that easily transferable objects, like watches and radios, while implying complex infrastructure, do not massively transform cultures. Cultural interface occurs between instrument involvement and cultural values and their related complexes.

> 'It may make little immediate difference if a wrist watch is worn as a fashion object, but if it successfully carries in its wake the transformation of a whole society into a clock-watching society with its attendant social time, then a large issue is involved' (Ihde, 1990a: 129).

[106] As already indicated many times, it was argued that the structure determines that something 'is what it is' and the context just reveals certain additional meaning possibilities.

Ihde identified varieties of technological experiences. He categorizes cultural responses to technologies carried to indigenous groups as follows:

- Monocultures are overwhelmed by new technologies;
- compromise adoption with the technologies used in new cultural contexts;
- rare instances of successful resistance;
- adoption through approximation of the new cultural shape.

It is clear that at the complex level of cultural hermeneutics, technologies may be differently embedded; the ‘same’ technology in another cultural context becomes a ‘different’ technology. In opposition to a bi-stability of paradigm or gestalt switch, Ihde prefers the term *multi-stability*, indicating an essential pluricultural pattern made possible by that contemporary technology. Ihde stresses that it is an inclination and not a determination of technology.

Here again the fact that ‘artefacts’ play different ‘cultural’ roles in different cultures has been exposed and placed in a system or structure. Whether the transfer of an artefact like a steel axe to replace stone axes can be viewed as *technology transfer* is questionable. Only the artefact is transferred, *not* the techno-practice to make or produce these axes. As it has also already been argued that artefacts are not the same as technologies, the whole idea of technology transfer must be questioned.

Furthermore, the argument that technology 'only becomes what it is through use' loses sight of what is ontically given[107]. A transcendental method is required to account for the ontic conditions and the ontic principles (therefore it is once again a contextual fallacy). The fact that an artefact could be used in a typical or an a-typical way does *not* invalidate any ontic conditions. An analysis of the ontic character of technology is required. To put it differently, even if technology as such (and not only artefacts) were utilised in different ways by different cultures, it would still not imply that it is not technology or that technology is only one-dimensional. All it implies is that humanity with its freedom of choice put a positive construction on the fact that technology can vary in different contexts, which are determined[108] by ontic conditions.

Ihde's non-transcendental approach and non-ontological framework obviously do not allow him to obtain a clear transcendental and ontological totality view on the technical as demonstrated in his understanding of 'technology' as having no constant structure, that indicates an ontical persistency[109].

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[107] This is of course because it transcends his frame of focus, but also allows for improvement.

[108] This thesis argues that the ontic conditions identified in the evaluative framework from theory and by factual observation obviously determines our understanding or insight into these conditions. One of these insights is that artefacts have a constant structure that determines their ontic character, although additional meanings (object functions) in different contexts are possible.

[109] This was extensively argued before.

In terms of transcendental considerations[110], meaning can only be ascribed to reality. This implies that if something is real, it has to have meaning – or essence, which is not to be confused with substance. If it does not have meaning (or essence, in a certain sense), it is not real. If Ihde concludes that technology does not have essence or meaning, it therefore implies, from a transcendental perspective, that technology does not 'exist' (or is not real), which implies that his whole explanation of the relationship between humanity and artefacts (or technology, as he uses the term) refers to a relationship between humans and something that does not exist[111].

3.4.3. Life world shapes

Here Ihde tries to analyse 'life world' technologies or, more correctly, artefacts, that shape or influence our life world. The task Ihde sets himself is distinctly contemporary. He intends to read the life world primarily in terms of important and new 'image-technologies' or image-artefacts. This includes television, cameras, photography and computers. He again tries to avoid both utopian and dystopian interpretations of technology.

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[110] In line with the assumptions indicated in the beginning of an orderly reality that reveals meaning through relationships, or structure or aspects.

[111] This is in a sense transcendent critique and only valid from outside Ihde's point of view. It is of course a result of transcendental considerations as well.

He refers to the first curvature of the contemporary life world as pluriculturality.

> 'It is a life form arising out of the use of image-technologies catching up to cultures' (Ihde, 1990a: 164).

He states that it is a distinctly post-modern form of multiculturality. He argues that contemporary television is not neutral. It creates something of an own subculture. Engaging with another culture is not a one-way relation, but an interrelation. Image-technologies are communicative and communications are always implicitly bi-directional. It is part of their essential ambiguity, their unique form of non-neutrality. The array of image-technologies that have transformed cultural perception are producing the same effects as those technologies that earlier expanded the cosmos and the micro world.

> 'Pluriculturality is in fact a proliferation of ways of seeing' (Ihde, 1990a: 174).

The second and related curvature of the 'high-technology' life world is the increasing importance of decisions. Digits leave out the durational flow of motion and replace it with digital 'jumps' in a digital watch, implying inferences or mini-decisions.

> 'Part of the institutionalisation of calculative reasoning comes in the elevation of the varieties of utilitarianism employed in most forms of risk or evaluative assessment practices' (Ihde, 1990a: 178).

He feels that technology assessment is dominated by such versions of (quantitatively oriented) utilitarian ethical methods. Technology also 'allows' decisions to be made concerning life and death - a decision can be made not to use birth control technology, and not to accept life-sustaining technology, especially in terminal cases.

Oscillatory phenomena are another curvature of the contemporary life world. These are related to the omnipresence of image-technologies and are the mass responses that exaggerate reactions and aggrandize actors in society. Some examples are:

- the student uprising in 1968;
- higher education inundated with students striving to be investigative reporters after Watergate, and
- the recent flood of MBAs.

Ihde also points out that technological catastrophe also carries with it an oscillatory response. Chernobyl, Three Mile Island and Challenger led to immediate and strong public response that had political implications for the technologies involved.

> 'They are illustrations of the greater powers of contemporary (as compared to any pre-modern) technologies' (Ihde, 1990a: 189).

To conclude, Ihde highlights the fact that contemporary 'technology' or artefacts have greater powers than older artefacts. Especially newer image artefacts have been able to provoke stronger reaction from societies than ever before. He places artefacts and the possibilities that these artefacts create squarely within post-modern pluriculturality. He also highlights the fact that artefacts are non-neutral.

This fits in with the sociological theory of a 'knowledge society' in which 'science and technology' as knowledge producing activities have significantly increased the capacity of society to act (Stehr, 1994: 105) and react, increasing the indeterminacy, fragility, malleability and volatility of society in the future (Stehr, 1994: 158, 9).

This analysis of human artefactual relations highlights the new possibilities of artefacts and the impact of artefacts in modern society but unfortunately still does not highlight the ontic conditions[112] of technology.

3.5. Conclusions

Although Ihde has concentrated on human-artefactual relations, described the different structures of these relations, and revealed valuable insights in this relationship, the transcendental questions of 'the technical' transcend this framework. His framework presupposes a notion of the technical and of humanity as prerequisites to the framework and is therefore unsuitable for studying the transcendental questions of technology as technology. As clearly

[112] Granted that it hints to certain ontic conditions as a contribution to the ontic characteristics of the technical.

indicated various times, Ihde did not intend to get to grips with the technical from an ontical point of view as it transcended his specific framework. Getting to grips with the *nature* of technology implies asking about its ontic character.

The conclusions Ihde arrives at are from an anthropological framework and contains various contextual fallacies[113], as has been pointed out above. Given the limitations of the framework, various problems arise. The most prominent problem is found in his confusing of artefacts with 'technology'.

3.5.1. No unique description of technological artefacts

The notion of technology as 'those artefacts of material culture that we use in various ways in our environment' (referred to in 3.1) should be reconsidered. This definition does not distinguish between other 'non-technological' cultural artefacts such as artistic, lingual or religious artefacts, and technical or 'technological' artefacts. Although it is accepted that 'technological' artefacts are cultural, they surely differ from other 'non-technological' cultural artefacts. Conversely, if technological cultural artefacts could not be distinguished from non-technological cultural artefacts, it would either mean no distinction were possible or that what is truly distinctive had not been identified.

If no distinction were possible, so-called 'technological' and 'non-technological' artefacts would be essentially similar and the difference would

[113] As argued from an ontic perspective. Explained in previous chapters.

only be a matter of semantics. In that case all artefacts would be 'technological'. They would all be a product of a 'formative technological process'. It unfortunately has a further implication. All culture would then be 'technology'. This would be so because everything 'made' by humans would then form part of technology. A work of art – a painting or statuette, for instance – would be 'technological' in nature because its creation required techniques (the techniques of art) embodied in a 'technical' process.

But if 'making' (or forming) and the resultant artefact were technology, it would imply that the 'making' (or constructing) of a theory in scientific activity would also be technology. According to this argument, a theory would be a 'type' of artefact[114]. By implication the 'making' of a scientific theory would then also be technology, implying that science would be a special kind of technology[115]. If everything that is 'made' were technology, all of culture (in contradistinction to nature) would be technology. This line of argument will fall into an antinomy as it negates all contexts in which 'forming' has different meanings, as well as the different modes of 'forming'. The alternative, transcendental-empirical argument is that the technical does have an ontic uniqueness that must be highlighted in a unique definition or description.

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[114] Normally artefacts are *objects* and insofar as theories are objectified in written articles and books they may also, metaphorically, be designated as "artefacts".

[115] The fact that science has specific scientific techniques is of course true, but the misinterpreting of that as technology indicates that the problem originates from outside the disciplinary framework of sociology.

Although Ihde opposes any objectivist attempt to describe or define technology by referring to the characteristics of objects, which involve a combination of their physical or material properties, he implicitly accepts technology as artefacts of 'material culture'. He attempts to structure technology by a 'structural' analysis of what he regards as an 'ambiguous human-technology relationship'. His purpose is to reduce the ambiguity to a 'structural' analysis. This assumes either a *structure* for technology or for the interaction of humans with technology.

In this attempt he does not concentrate on what is distinctive about technology but merely makes assumptions about technology[116]. By not distinguishing technology from non-technology he cannot distinguish technological artefacts from non-technological artefacts. The result is that whatever relationship he identifies also holds for non-technological artefacts.

An interesting issue here is that it might not be *technology* that influences our perceptions but our *artefacts*. What he attributed to technology should be attributed to artefacts or culture. It is not human-technology relations but human-artefact relations or general artefactual relations that are involved.

[116] As can be expected from any disciplinary approach.

The term *artefactual transfer* could be used for what Ihde indicates as *technology transfer*. An artefact becomes 'what it is' (within its structural limitations) in the context of its use and could therefore become something different in a new context in another culture. In that case the issue here is to distinguish between non-technological and technological artefacts. To Ihde all material artefacts are technological: the wristwatch and the compass and the axe. They all are created through technological activity[117].

Another problem identified here is that the term 'technics' seems to be used for all 'technical artefacts'. This seems to indicate all artefacts that have a 'highly' technical structure. This still disregards the context of the artefact. This seems to indicate the combination of physical or technical qualities that Ihde specifically tried to resist. A redefinition of terminology might be called for.

Lastly, if technology does not have a typical structural meaning, the implication is that it would be difficult to relate it to ontic conditions.

[117] As argued, this may lead to what was indicated as a 'contextual fallacy'.

3.5.2. An effort to find a unique definition

As no unique ontic characteristic of technology has been identified[118]. This problem might be solved by analyzing the structural relationship of technology with what is distinct from technology in an ontological perspective, which would in principle be a different framework.

All artefacts have various aspects, and all have a technical side or aspect. They are all the result of a technical formative process. Different artefacts can be identified by their different qualifying or characteristic or destinational functions or their typical structure. This does not mean we 'limit' an artefact to a single application. It only means that in line with a transcendental approach each entity displays an identifiable uniqueness.

The term 'destinational' does not imply any sinister determinism referring to a 'bigger scheme of things' but only designates an identifiable distinctiveness and consistent structure. If an artefact were to be scrapped, it would obviously lose its identifiable structure and could be 'harvested' for other later artefacts: a broken wine glass could be melted down and become part of a beer bottle. The social or cultural usage of the glass and the diversity of its uses in different cultures are not disputed. In that sense the entities are identified or

[118] It was obviously also not in Ihde's project, as he expressedly indicated his interest in the human-technology relationship.

classified into relatively broad categories. The categories in which artefacts are classified give meaning to the artefacts and this allows of different uses in different contexts.

The destinational function or typical structure is actually indicated by the names given to the different artefacts. A musical instrument like a piano is primarily created to 'produce' music. Although it has a highly technical structure, it is designed to be not a technological operator but rather a musical instrument. A pen is primarily a lingual object (artefact) used as a tool in the lingual communicative process, even though it is the result of a technical forming or production process and more technically advanced than some pencils. Likewise my computer (as word processor) is a lingual artefact used as a writing tool to complete this thesis. It is, technically speaking, more complex than a pen, but remains primarily a lingual artefact and does not become a technological artefact – not, of course, if *technological* means, as in techno-practice, the process of making artefacts, as performed by a technical operator or machine.

Claims that computers are tools of communication, expression, artistic creation and entertainment are all provided for by this interpretation. If the term 'lingual' is interpreted in terms of 'signification', communication could be seen as socially deepened signification. The computer could also have additional uses as controller of a technical process, but then one would have to agree that in that specific case, it is not a PC used in an office but a specialised product like the computer that monitors processes on board a car.

It seems that only artefacts that are placed in a technical context can become technical artefacts. Artefacts placed in a social context become social artefacts and artefacts placed in an artistic context become art. It is therefore wrong to designate all artefacts as technological on the basis that they are the product of a technological process – this overlooks the context and the structure of the artefact.

The relationship of an artefact to its destinational function, in a certain sense, identifies its ontic meaning. The result is that only technical artefacts are technical; not all artefacts.

Technical operators seem to have technical forming as their destinational function. All artefacts that act as technical operators, like machines and computers that control a forming process, seem to be technical artefacts.

4. Analysis of the position[119] of Bruno Latour[120]

Bruno Latour is professor at the Centre for the Study of Innovation at the School of Mines, Paris. Accessing his website revealed the following (Latour, 2003):

He was born in 1947 in Beaune, Burgundy, to a wine grower family. He was trained first as a philosopher and then as an anthropologist. After field studies in Africa and California, he specialized in the analysis of scientists and engineers at work. In addition to work in the philosophy, history, sociology and anthropology of science, he has collaborated in many studies in science policy and research management.

There is always some uncertainty about presenting Latour's disciplinary

[119] As indicated with the title an analysis of his position, that is assumptions and notions on the *technical* only will be attempted. Similar to the case with Ihde no attempt to evaluate his total social theory or the critique on his theory as such will be attempted. As explained before, to evaluate the rest of his theory as well as his critiques falls outside the frame of this study. The study is interested in the *ontical logic* of the assumptions and notions of the technical and not in an evaluation of his theory. None of his critics involved the ontical logic of the transcendental empirical method and furthermore it transcends the focus of their interests. To expect such an engagement misunderstands the scope and purpose of this study. This study thus holds the assumption that he is 'worth while' to take note of.

[120] My thanks to Prof Mouton who identified Bruno Latour as an author of standing worthwhile to be studied.

affiliation. He was trained as a philosopher and could be presented as such — in the continental, not the Anglo-American, sense of the word. However, he was afterwards trained as an anthropologist and, finally, he is professor of sociology at the Ecole des Mines and has taught that discipline for twenty years — a special sociology to be sure since his students are engineers. The PhD programme he is directing is called 'socio-economics of innovation'. So one can present him as a philosopher, an anthropologist or a sociologist, knowing full well that none of these would like to have him join their club (Latour, 2003).

4.1. Introduction to Ontology

In his series of essays on the reality of science studies called *Pandora's Hope* (1999), Latour gives an overview of his thinking on various topics, including science and technology. He indicates that what he would call *adding realism to science* is actually seen by fellow scientists as a threat to science, a way of diminishing the truths it represents and its claims to certainty. According to them he is undermining science and the power it has. Latour tries to rectify this misunderstanding and highlights the new or 'different' form of radical realism that science studies have uncovered.

In his effort to rectify this, he has to start with, the classic philosophical question about the nature of reality. He points out that in this ontology the first problem to consider is the strange invention of an *outside* world. To ask a question like, 'Do you believe in reality?' assumes a 'distance' from reality and the possibility of losing contact with reality. Latour points out that Descartes raised a similar issue when he asked how an isolated mind could be absolutely, as opposed to relatively, sure of anything about the outside world:

> 'Descartes was asking for absolute certainty from a brain-in-a-vat, a certainty that was not needed when the brain (or the mind) was firmly attached to its body and the body thoroughly involved (i)n its normal ecology'. (Latour, 1999: 4)

Latour argues that this division was never resolved. Descartes tried by detouring through God, Hume tried a shortcut to associated stimuli of reality, excluding God. Kant's 'a priori' started a form of constructivism where the outside world now had the mind-in-the-vat as its centre.

> 'Instead of retracing their steps and taking the other path at the forgotten fork in the road, philosophers abandoned even the claim to absolute certainty, and settled on a makeshift solution that preserved at least some access to an outside reality'. (Latour, 1999: 5)

He argues that the universal 'a priori' of Kant was the link with reality. Later a more reasonable candidate, namely 'society', replaced the 'transcendental Ego' or mythical mind put forward by Kant. Now the prejudices and paradigms of a group determined the representations of every one of its members.

Latour points out that this view does not represent a 'retracing' of 'steps', but goes even further in distancing the individual's vision, which becomes a 'view of the world' for the group. Latour argues that this 'society' was itself just a series of ‘minds-in-a-vat’ – ‘many minds in many vats’, as he puts it (Latour, 1999: 7).

Latour also hints at another solution that consists of taking only part of the mind out of the vat, offering it a body again and putting the assembled aggregate back in relation with a world that is a self-evident and unreflexive extension of ourselves.

> ‘The real world, the one known by science, is left entirely to itself. Phenomenology deals only with the world-for-a-human-consciousness’. (Latour, 1999: 9)

This he also finds unsatisfying for solving the dilemma. He states that this teaches us a great deal about how we are always immersed in the world’s rich and lived texture; we will never be able to escape from the narrow focus of human intentionality – we will always be restricted to the human point of view. He indicates that for all its claims of overcoming the distance between subject and object, phenomenology leaves us with the most dramatic split between a world of science, left entirely to itself, absolutely inhuman, and a world of intentional stances entirely limited to humans.

Latour proceeds by asking why we do not choose the opposite solution and forget the ‘mind-in-a-vat’ altogether. (Latour, 1999: 9). If science can invade everything, it can surely put an end to Descartes’ long-lasting fallacy and make the mind a wriggling and squiggling part of nature again.

The answer, according to Latour, is the fear of mob rule: an age-old fear, prevalent since the time of ancient Greece, that generated the fallacy of absolute truth and of a brain-in-a-vat not dominated by unreasonable brute force, but ruled by the power of reason.

> 'It is because we want to fend off the irascible mob that we need a world that is totally outside – while remaining accessible! – and it is in order to reach this impossible goal that we came up with the extraordinary invention of a mind-in-a-vat disconnected from everything else, striving for the absolute truth, and, alas, failing to get it'. (Latour, 1999: 13)

Latour argues from within a combined anthropological and epistemological framework. He highlights the relativity of the knowledge process, indicating that the 'absolute' mind-in-a-vat cannot eliminate the problem of absolute truth without 'subjective contact' with reality. Although the interaction between humans and reality is relative or relational, a constant or orderly structure of reality, which also applies to humans, is still a pre-requisite in the relationship[121]. The transcendental issue of the nature of this *orderliness* and *order for* reality transcends the focus of his specific framework. The relationality of this relationship between reality and humankind, and humankind and knowledge (or experience) does not imply that reality itself is not constant or consistent or orderly (indicating *orderliness*) or that no *order for* reality exists.

[121] This is a consequence of the idea that an orderly reality exists.

This requires a specific transcendental focus on the nature of reality. Latour tries to give an account as summarised in the next section.

4.2. Latour's Ontology

To Latour the modernist settlement, illustrated below, is the division or distinction of nature 'out there', mind 'in there', God 'up there' and society 'down there'. Latour sees it as a settlement that can be replaced by several alternative ones (Refer to Fig. 2):

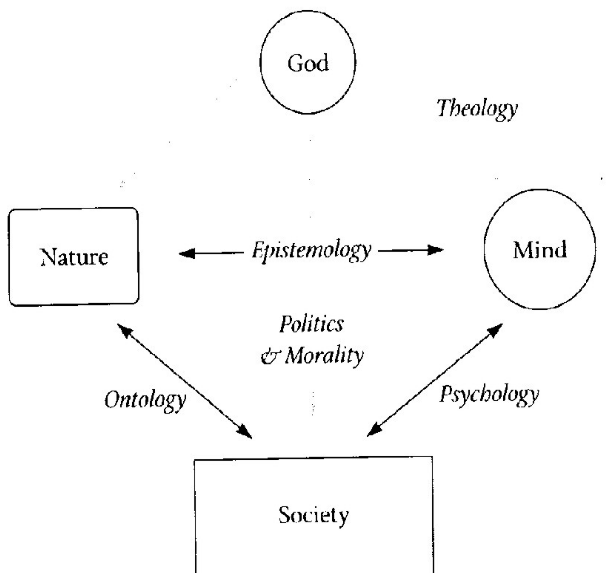

Fig.2. Illustration of the Modernist settlement by Latour. (1999: 14).

Latour argues that science studies made some discoveries in this connection: firstly, that the objective existence is not inhuman, cold, isolated or a-historical because it has been labelled that way in order to combat the mob with a so-called indisputable objectivity. Secondly, that when he says science is social, he does not mean that certainty is compromised and that the existence of reality is denied.

> 'We do not need a social world to break the back of objective reality, nor an objective reality to silence the mob' (Latour, 1999: 15).

Latour believes that we live in a hybrid world made up at once of peoples, stars, electrons, nuclear plants, markets etc., and that humanity is responsible for turning it into either an unruly shambles or a cosmos. (Latour, 1999: 16)

He believes that he is caught between two 'cultural' battle lines as drawn by a division of labour between the two sides of the campus, namely natural science and the humanities. He indicates that natural scientists deem the sciences accurate only when they have been purged of any taint of subjectivity, politics or passion. On the other hand he argues that the humanities deem humanity, morality, subjectivity and reality worthwhile only when these have been protected from any contact with science, technology and objectivity. Latour believes that he fights against both camps and is therefore seen as a traitor by both.

> 'To put it even more bluntly, science studies has become a hostage in a huge shift from Science to what we could call Research. While Science had certainty, coldness, aloofness, objectivity, distance and necessity, Research appears to have all the opposite characteristics: it is uncertain, open-ended; immersed in many lowly problems of money, instruments, and know-how; unable to differentiate as yet

> between hot and cold, subjective and objective, human and nonhuman' (Latour, 1999: 20).

He also refers to another dispute. Just as there is a dispute in the scientific disciplines between the model of Science and the model of Research, so there is also a fight in the social sciences and humanities between two opposing models, namely what he loosely calls post modernism and what he calls 'non-modern'.

> 'Everything the first takes to be a justification for more absence, more de-bunking, more negation, more decon-struction, the second takes as a proof of presence, deployment, affirmation and construction'. (Latour, 1999: 21)

Latour argues that Post Modernism is descended from the series of settlements that have defined modernity.

> It has inherited from these the disconnected mind-in-the-vat's quest for absolute truth, the debate between Might and Right, the radical distinction between science and politics, Kant's constructivism and the critical urge that goes with it. (Latour, 1999: 21)

He states that it feels the same nostalgia as modernism, but tries to take on the failures of the rationalist project and therefore its rejoicing in virtual reality and its debunking of 'master narratives', its over-emphasis on reflexivity, and its claim that it is good to be stuck inside one's own point of view, but it has not retraced the path all the way to the point that started this impossible project in the first place.

Latour argues that science studies are engaged in non-modern tasks. To him, modernity has never been the order of the day. Reality and morality have never been lacking.

> 'The fight for or against absolute truth, for or against multiple standpoints, for or against social construction, for or against presence, has never been the important one. The program of debunking, exposing, avoiding being taken in, steals energy from the task that has always seemed much more important to the collective of people, things, and gods, namely the task of sorting out the 'cosmos' from an 'unruly shambles'. We are aiming at a politics of things, not at the bygone dispute about whether or not words refer to the world' (Latour, 1999: 22).

From the above we can conclude that Latour assumes an 'objective' reality consisting of a hybrid of things. He points out that this reality is not 'cold', as science would like to believe. Furthermore, to strive for absolute certainty does not seem feasible; to realise that 'the mind in the vat' is actually part of a body and of reality, and to sort out 'cosmos' from this reality is the task of science studies. He wants to be involved in the politics of things and not in arguments over words and their meanings like the linguistic philosophers.

What Latour indicates as 'sorting out' the *cosmos* from an *unruly shambles* has two phases. The first phase concerns the transcendental issue of the orderliness of reality that answers to an *order for* reality as part of the structure of the ontical and is accounted for by an ontological theory. This phase of the 'identifying of order in reality' should rather be assigned to ontology as part of philosophy and not to science studies, as Latour indicates.

The second phase would *assume* the order of reality and work towards the greater detail of specific sciences and their relationships in reality. The framework and focus of science studies is not the order of reality or the nature of science but the relationships of science in society. Science studies would *assume* an ontology but might not focus on it. The transcendental issue of the 'order of the ontical' as expressed in ontology transcends the framework of science studies.

The fact that he wants to be involved in the 'politics of things' indicates his specialised focus that assumes 'things' and their (political) interaction as prerequisite presuppositions and which therefore does not really consider ontic issues in terms of a truly transcendental perspective. This could lead to contextual fallacies where a conclusion reached within a certain context is invalidly applied in other contexts without taking the contextual limitation of the conclusion into consideration.

He specifically indicates his opposition to 'arguments over words' and he tries to explain his epistemology, which differs from that of the linguists. (Latour, 1999: 69)

4.3. Latour's Epistemology

Latour developed his argument when he first began to study scientific practice, which enabled him to offer a more realistic account of 'science-in-the-making', grounded firmly in laboratory sites, experiments and paradigmatic preferences of groups of colleagues. In this study of the research process, he counters the model offered by the philosophy of language: two disjointed spheres – words and world – separated by a vague and radical gap that must be reduced through the search for correspondence or reference. (Latour, 1999: 69)

Latour argues that

> '... knowledge, it seems, does not reside in the face-to-face confrontation of a mind with an object, any more than reference designates a thing by means of a sentence verified by that thing. On the contrary, at every stage we have recognized a common operator, which belongs to matter at one end, to form at the other, and which is separated from the stage that follows it by a gap that no resemblance could fill'. (Latour, 1999: 69)

Latour thus rejects the 'Gegenstand-relation' of a knowing subject versus a knowable object and the linguistic reference or denotation of an entity by a term for that entity. He recognises an operator that is linked with form and matter, the two contrasting notions of Greek dualistic thought.

The question is whether this reference process does not still occur in the relation between the knowing subject and an external subject/object[122].

[122] This could be indicated as a subject/subject and/or subject/object relationship and not necessarily the Gegenstand-relationship.

Latour (1999: 70) developed a model of transformation for the reference process which may be pictured as a trade-off between what is gained (amplification) and what is lost (reduction) at each information producing step. In analysing the expedition to BOA Vista (the purpose of which was to explain a forest-savannah transition), he found that something was lost and something gained at each stage of the process of moving from compiling individualized sample data to drawing generalized universal conclusions. He shows how stage by stage they lost locality, particularity, materiality, multiplicity and continuity, which he indicates as reduction. On the other hand, they gained standardization, compatibility, text, calculation, circulation and relative universality. The report contains not only information about the whole of the forest and savannah to which they can return, but also an explanation of its dynamics. He calls this amplification.

> 'An essential property of this chain is that it must remain reversible. The succession of stages must be traceable, allowing for travel in both directions. If the chain is interrupted at any point, it ceases to transport truth – ceases, that is, to produce, to construct, to trace and to conduct it' (Latour, 1999: 69).

Latour argues that truth-value circulates like electricity passing through a wire, as long as this current is not interrupted. We can elongate the chain indefinitely by extending it at both ends, adding other stages, but we can neither cut the line nor skip a sequence, despite our capacity to 'combine' them all in a single 'black box':

> 'I can never verify the resemblance between my mind and the world, but I can, if I pay the price, extend the chain of trans-

> formations wherever verified reference circulates through constant substitutions' (Latour, 1999: 79).

Latour therefore realises that no 'objective' (absolute) knowledge is possible, but he indicates how a chain of transformations could be developed to 'transport' the 'truth'. He therefore gives guidelines for validity and reliability or, in other words, normativity. If you break these norms, you break the chain of truth. On this basis he explains how science could use this system.

4.3.1. The circulatory system of science and scientific facts

Latour tries to counter the prejudiced view that science studies aims to provide a *social* explanation of science.

> 'Science studies, to be sure, rejects the idea of a science disconnected from the rest of society, but this rejection does not mean that it embraces the opposite position, that of a 'social construction' of reality, or that it ends up in some intermediary position, trying to sort out "purely" scientific factors from "merely" social ones' (Latour, 1999: 84).

According to Latour (1999: 97) there are no true statements that correspond to a state of affairs and false statements that do not, but only continuous or interrupted references. Truthful scientists did not break away from society to a cold, objective world of science, nor were liars influenced by the vagaries of passion and politics in society. To him the quality of reference of a science depends on its capacity to interest and convince others and its routine institutionalization of these flows.

On the one hand the problem is that judging the validity of a statement by how interesting and convincing it is to others (groups or society in general) implies that false statements could be accepted as true if they were simply well propagated. This implies that truth is related to what the group finds convincing[123].

On the other hand he is at pains to point out the value of the verification chain, which in itself supplies evidence that allows the scientist to make claims. This would hopefully automatically convince a consensus view of the truth.

Unfortunately, groups could be so biased that they might never find the truth. Furthermore, groups are 'just many-minds-in-many-vats' in Latour's own words, yet he wants to use groups to vouch for truth.

From an ontic position, truth should at least be related to ontic principles and confirmation (or falsification) through empirical experience. Truth could be used or abused (by half-truths in propaganda, for instance) because of the relation of humanity with reality. People have the freedom to act and can do so in conformity or nonconformity with the norm. It is this same freedom of choice that allows of the translation operations that Latour speaks of:

[123] On the one hand it could also explain the problem of Aristargus who propagated a helio-centric universe and was ignored for 18 centuries.

> ‘Translation operations transform political questions into questions of technique, and vice versa; during a controversy, operations of conviction mobilize a mixture of human and non-human agents’ (Latour, 1999: 98).

Latour mapped the five different loops that science studies need to consider in order to reconstruct the circulation of scientific facts (see Fig. 3 below).

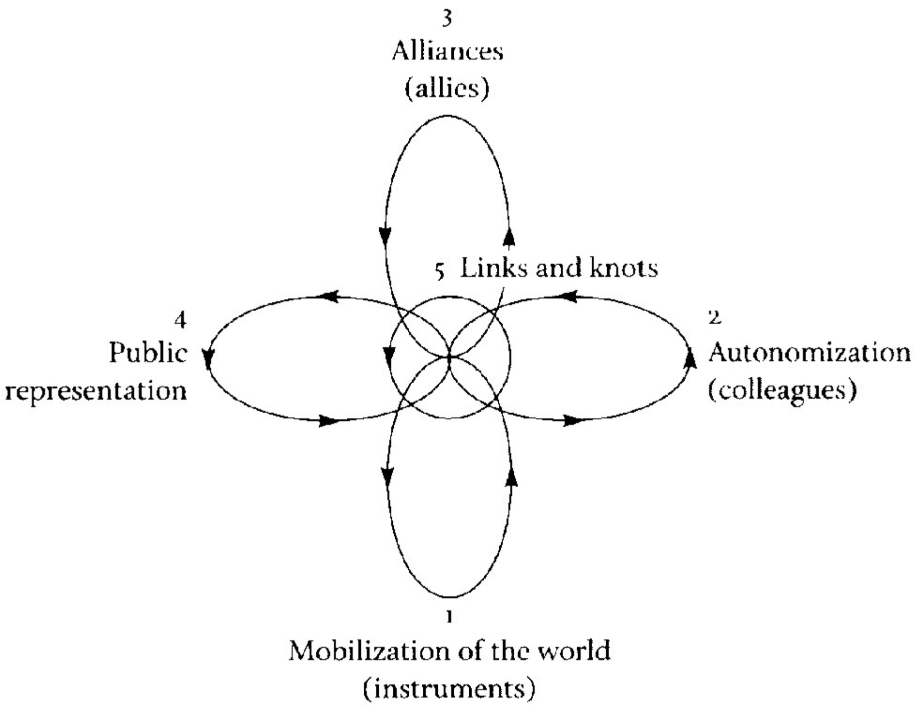

Fig 3. Illustration of Latour’s model of the scientific process. (Latour, 1999: 100).

The conceptual element (links and knots) is in the middle, like a central knot tying the four other loops.

The first loop is concerned with expeditions and surveys, instruments and equipment and also with sites in which all the objects of the world, relevantly mobilized, are assembled and contained.

> Through this mobilization the world is converted into arguments. (Latour, 1999: 102)

These logistics are indispensable to the practice of science.

The second loop is labelled autonomization,

> … because it concerns the way in which a discipline, a profession, a clique, or an 'invisible college' becomes independent and forms its own criteria of evaluation and relevance. (Latour, 1999: 102)

No one can (independently) specialize without the concurrent recognition of a small group of autonomous peers. In addition it includes the history of scientific institutions and the history of professions and disciplines.

The alliance loop indicates that nothing can be developed, for example, no discipline can become autonomous, and no new institution can be founded without alliances. Groups that would previously not have had anything to do with each other may be enrolled:

> 'The military must be made interested in physics, industrialists in chemistry, kings in cartography, teachers in educational theory, congressmen in political science' (Latour, 1999: 103).

These alliances do not prevent the pure flow of scientific information but are the lifeblood of scientific activity.

The fourth loop of public representation indicates the massive socialization of novel objects like atoms, fossils, bombs, radar, statistics and theories into the collective that could overturn the normal system of beliefs and opinions. This link is not more remote than the previous loops. How have societies formed representation of science, nuclear energy, nuclear disasters, etc?

> Like all the other loops, this loop requires from scientists a completely different set of skills, unrelated to those of the other loops, and yet determinant for them all. (Latour, 1999: 105)

Latour confronts this by highlighting the anomaly that one could not expect to produce a discipline that would modify everyone's opinion, without expecting at least a passive acceptance of the discipline.

> 'Our sensitivity to the public representation of science must be all the greater because information does not simply flow from the three other loops to the fourth, it also makes up a lot of the pre-suppositions of scientists themselves about their objects of study' (Latour, 1999: 106).

The fifth loop has to hold many heterogeneous resources together. Latour explains what would happen if there was no fifth loop.

> 'The world would stop being mobilizable; disgruntled colleagues would flee in all directions; allies would lose interest; and so would the general public, after expressing either its shock or its indifference. But this death would ensue just as quickly if any of the other four loops were cut off' (Latour, 1999: 107).

This model does not allow of a separation of a scientific content from an extra-scientific content like social fictions or social dimensions. The 'content' of science is not something contained; it is itself a container: concepts hold the collective tightly together. A concept does not become more scientific because it is further removed from what it holds, but because it is more intensely connected and promotes closer circulating reference.

Latour developed a sociologically oriented model of science as a ‘collective’ of relations represented in five loops. No other collective is exactly the same; it is unique and therefore different (distinguishable) from any non-scientific ‘collective’. He does not indicate its uniqueness but simply assumes it. Latour further resists specifically the philosophy of language that sees reality as two disjointed spheres separated by a gap. He wants to bridge the gap with an operator between the changing matter and constant form and transforms from the one to the other in a circulatory reference process. He believes the *circulatory process* guarantees truth. Truthful statements do not break the chain of reference and are accepted in routine institutionalisation of ideas as well as by groups.

4.3.2. From fabrication to reality

In his effort to break the division of world versus mind (or word), Latour investigated the terminology of the old paradigm. He found that ‘fabrication’ carries the implication that something is false and that ‘constructed’ implies that it must be deconstructable. He indicates that they were *technical* metaphors used in early science studies as in ‘construction of fact’ or ‘fabrication of neurons’. (Latour, 1999: 114)

In studying various other metaphors he discards the correspondence theory that postulates a correspondence between world and words, so that the word ‘cat’, for instance, is represented in the world by a small ‘meowing’ animal. He developed new terms, namely *articulation* and *proposition*.

A ‘pro-position’ suggests not a position, thing, substance or essence pertaining to nature that is made up of mute objects facing a talkative human mind, but an *occasion* for different entities to interact.

In a sense Latour uses the term *articulate* to overcome the limitation of ‘correspondence’ between words and world. Essentially it implies that the word ‘dog’ does not bark like the animal and therefore ‘lacks’ correspondence, but, on the other hand, it articulates the proposition. To articulate is to signify or give symbolic meaning:

> ‘Instead of being the privilege of a human mind surrounded by mute things, articulation becomes a very common property of propositions, in which many kinds of entities can participate’ (Latour, 1999: 142).

Furthermore, while statements are aimed at correspondence, which they can in principle never achieve, propositions rely on the articulation of differences that make new phenomena visible. Latour regards articulation as part of reality:

> 'Articulation between propositions goes much deeper than speech. We speak because the propositions of the world are themselves articulated, not the other way around. More exactly we are allowed to speak interestingly by what we allow to speak interestingly' (Latour, 1999: 144).

According to Latour these articulated propositions established between knower and known are relations that are entirely different from those established traditionally. As far as he is concerned, it captures much more precisely the rich repertoire of scientific practice. It is interesting that Latour places meaning in reality itself.

Latour furthermore uses the term *event* to highlight the possibility of adding new elements to an experiment or discovery, for instance:

> 'No event can be accounted for by a list of the elements that entered the situation before its conclusion' (Latour, 1999: 126).

Latour accepts events as part of hybrid reality, which explains that new elements could be added to experiments as well as to the process of discovery. One can thus always discover another item of a collective, relationship or artefact. The important issue here is that another element of an artefact does not change it to something other than an artefact. If the technical structure of an artefact is discovered, it remains artefact and does not become technology as Ihde would have it.

4.4. Technology

Because he opposes the traditional subject-object relationship as a means to obtain knowledge and has developed his own circulatory system, Latour believes that the less familiar the terms describing human and non-human association are as regards the subject–object dichotomy, the better; he believes each element is to be defined by its associations and is an event created at the occasion for each of those associations.

This chosen stance unfortunately forces Latour to lose some of the advantages of the subject-object relationship, as will be shown later.

Latour (1999: 193) argues that in the modernist settlement, objects were housed within nature and subjects within society. Latour replaces subjects and objects with different terms in a new paradigm.

He replaces 'society', which is turned into a fairy tale of social relations from which all non-humans have been carefully enucleated by the social scientists, with the notion of the 'collective'. We live in collectives and not in societies. Collective is defined as an exchange of human and non-human properties in a corporate body:

> 'Whereas objects could only face out at the subjects – and vice versa – non-humans may be folded into humans through

> the key processes of translation, articulation, delegation, shifting out and down'. (Latour, 1999: 193)

Latour offers four meanings of technical mediation where human and non-human actants could interact or mediate. (Latour, 1999: 178)

The first he calls goal translation, where he uses translation to mean displacement, drift, invention, mediation or the creation of a link that did not exist before and that to some degree modifies the original goal. He cites the example of a citizen with a gun and shows how this combination (gun – citizen or citizen – gun) displaces each individual actant's goal and generates new possibilities through composition, which is also the second meaning of technical mediation. Here the example is that B-52s do not fly – the US Air Force flies.

The figure below provides a summary of what Latour indicates as the various steps of interaction between actants, human and non-human. (Fig. 4)

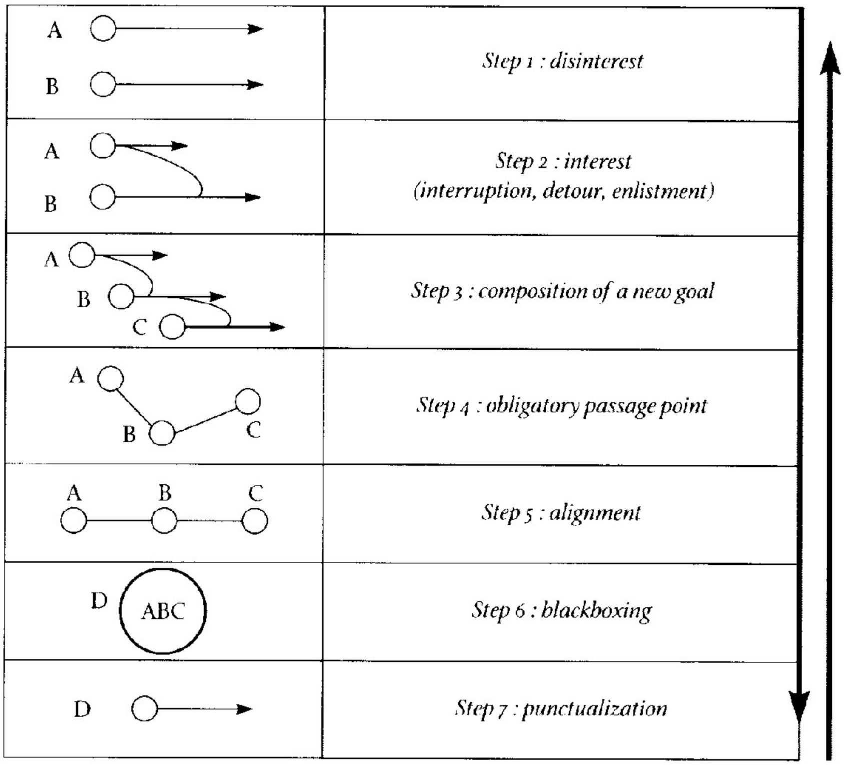

Fig.4 Illustration of technical mediations in different steps. (Latour, 1999: 184)

Because Latour attempts to develop a new paradigm in opposition to both the modernist settlement and the 'object-subject' dichotomy, he does not define any object or subject as 'technological':

> 'We now understand that techniques do not exist as such, that there is nothing that we can define philosophically or sociologically as an object, as an artefact or a piece of technology. There does not exist, any more in technology than in science, anything to play the role of the foil for the human soul in the modernist scenography' (Latour, 1999: 190,1).

He actually provides a solution to the problem regarding technical artefacts or 'objects':

> 'Technical artefacts are as far from the status of efficiency as scientific facts are from the noble pedestal of objectivity. Real

> artefacts are always parts of institutions, trembling in their mixed status as mediators, mobilizing faraway lands and people, ready to become people or things, not knowing if they are, composed of one or of many, of a black box counting for one or of a labyrinth concealing multitudes' (Latour, 1999:193).

Quite correctly Latour clearly recognises the fact that entities (or artefacts) can acquire different meanings in different contexts. This is because meaning is revealed in relationships within related contexts.

Artefacts reveal meaning not only in contexts but also through their structural uniqueness[124]. These 'so-called real' artefacts that Latour mentions still need to be identified as types of artefacts in the last instance. When he does identify them he limits them to a certain functional-structural type of combination. It is also here that the use of subjects and objects – terms which Latour rejects – could fruitfully be used.

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[124] From an ontic position, within an ontology, an issue that Latour does not consider is the fact that entities have constant structures. What this implies, is that all artefacts, on the other hand, also have an ontic orderliness and constancy of structure and that this structure could be identified only on the basis of this constancy. Furthermore, all entities ontically have some unique characteristic that distinguishes them from other kinds of entities and which in a sense qualifies and in certain cases limits their applications, otherwise we would not be able to identify or classify them.

Latour accepts meaning as part of reality. Furthermore, artefacts can have different meanings in different contexts. Why can an artefact not have an existential (ontic) meaning in an ontic (transcendental) context?

Latour only sees the societal context of artefacts in which artefacts seem to have unlimited, multiple applications depending on the (unlimited) contexts. On further consideration, in an ontic framework, it could be argued that all artefacts have limited *typical* applications.

The ontic being governed by *orderliness* and an *order for* every entity in reality implies that every structure has an inner *typicality* that qualifies or distinguishes it from all other structures in reality. This typicality is characteristic and reveals unique meanings in different contexts. It would therefore be possible to identify the typical structure with its typical characteristics in typical use contexts. It is also possible that this structure could be used in a-typical contexts and in a-typical ways. A book is *typically* meant to be read although it can a-typically be used as a paperweight or doorstop.

4.5. Human and non-human

Latour concentrates on the problem of the relationship between humans and non-humans, which to him represents the divide between nature and society.[125]

He argues that one does not need the noun *technique* or its upgraded version, *technology*,[126] when separating humans from the multifarious assemblies with which they combine. He prefers the adjective *technical,* which can be used in many different situations. (Latour, 1999: 191)

Firstly, the term applies to a series of subprograms. When one says that something is a technical point, it implies that one deviates (for a moment) from the main task and will eventually resume the original or main task.

Secondly, the term 'technical' indicates the subordinate role of people, skills and objects that perform this secondary function; they are indispensable but invisible in a black box, if functioning normally.

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[125] As argued before, concentrating on this relationship would not allow a totality view on the technical as it in principle transcends this relationship.

[126] Unfortunately he does not explain the *nature* of this upgrade.

Thirdly, it could indicate a hitch or catch in the smooth functioning of the sub programme as indicated by the phrase ‘there is a technical problem to solve first’. In this sense it could be an obstacle, a detour, or the beginning of a new translation of goals.

The fourth meaning Latour indicates is the unique ability to make oneself indispensable. This occupation of privileged though inferior positions indicates obligatory passage points.

Lastly, the term could indicate a modus operandi, a chain of know-how or gestures bringing about some anticipated result as in a *technique of communication*. (Latour, 1999: 192)

Latour disagrees with the traditional notion that a richer mixture of the social and technical characterizes primitive collectives, whereas modern, more advanced collectives are more objective and therefore devoid of ties with the social order. This implies that modern technology and humanity are seen as objective and efficient, whereas primitive technology is seen as ‘low-tech’. He argues that one finds more extended chains of action between machines, automatons and devices as well as more people and more transactions in modern collectives. (Latour, 1999: 196)

According to Latour, critical theory states that techniques are social because they are *socially constructed*.

> 'To say that social relations are "reified" in technology, such that when we are confronted with an artefact we are confronted, in effect, with social relations, is to assert a tautology, and a very implausible one at that: If artefacts are nothing but social relations, then why must society work through them to inscribe itself in something else?' (Latour, 1999: 197).

Latour maintains that society is *constructed* but not *socially constructed.* (Latour, 1999: 198) Social order is impossible without socialized non-humans.

He devised a model (Pragmatogony) with the intention of fighting modernism by finding the hideout in which science has been held since being kidnapped for political purposes. In this pragmatogony he fights the myth of progress. He points out the relationship between humans and non-humans and the pattern that emerges where relationships are constituted from previous relationships, as illustrated in the following model.

The odd numbers in this model deal with humans and the even numbers with non-humans. Whenever we learn something about the management of humans, we shift that knowledge to non-humans and endow them with more and more organizational properties. In the odd-numbered levels the opposite process is at work. What has been learned from non-humans is re-imported so as to reconfigure people (see Fig. 5 below).

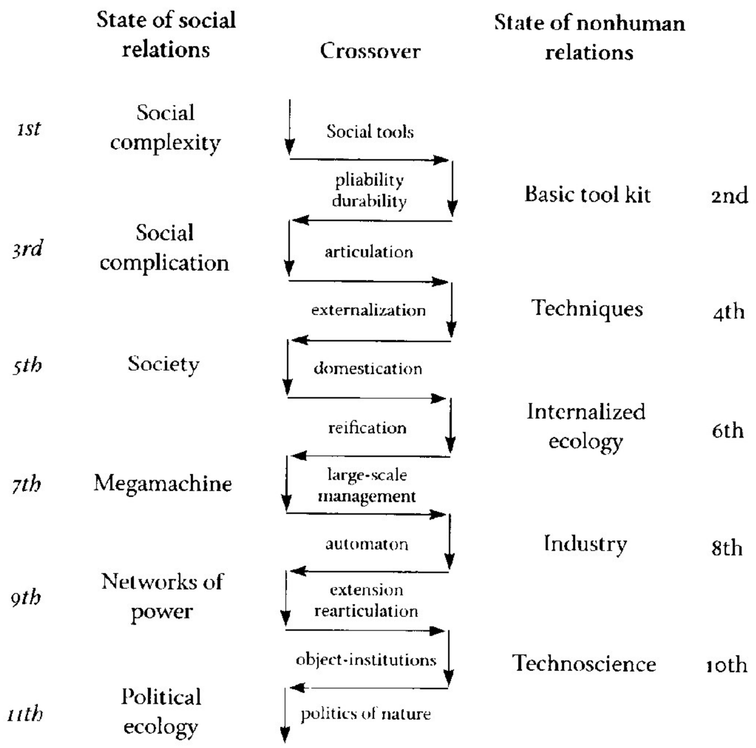

Fig.5. Illustration of Latour's pragmatogony. (Latour, 1999: 213)

At Level 1, humans engage in societal interactions to repair a constantly decaying social order. They manipulate and interfere and survive in groups. Latour calls this *social* complexity, but it could possibly be better expressed as *societal* complexity, since 'societal', (not 'social', as social scientists would have it) indicates a structural collective of humans.

What Latour calls the basic tool kit is found at Level 2. What is a tool? It is the extension of social (or societal) skills to non-humans. We generate tools by shifting societal or human competencies to non-humans – by treating a stone as a partner, modifying it and using it to act on another stone:

> 'Pre-human tools, in contrast to the ad hoc implements of other primates, also represent the extension of a skill rehearsed in the realm of social interactions' (Latour, 1999: 211).

At Level 3, Latour speaks of 'social complication'. The social, or rather societal, realm becomes visible and attains through the enlistment of the non-human (or tools) some measure of durability as in cultural traditions and habits. The involvement of non-humans resolves the contradiction between durability and negotiability because non-humans stabilize social negotiations, are at once pliable and durable, and can be shaped quickly. Once shaped they can last longer than the interactions that fabricated them.

Techniques are placed at Level 4. He defines technique as a 'modus operandi'. Techniques are articulated subprograms for actions that subsist (in time) and extend (in space). They suggest a semi-social organization that assembles non-humans from very different materials, seasons and places:

> 'A bow and arrow, a javelin, a hammer, a net, an article of clothing are composed of parts and pieces that require recombination in sequences of time and space that bear no relation to their original settings' (Latour, 1999: 209).

In a sense the 'social' or human interaction of the previous level is utilized in a non-human sphere. Techniques are the processing of tools and non-human actants by organizations that extract, recombine and socialize them.

At Level 5, we come across society. It is from techniques, the ability to nest several subprograms, that we learn what it means to subsist and expand, to accept a role and perform a function. By re-importing this competence into the definition of society we taught ourselves to reify it, to make society stand independent of fast-moving interactions. Society exists, it precedes individual action, lasts longer than any interaction and dominates our lives. To Latour, society is not socially constructed. Non-humans proliferate below the bottom line of social theory as far as he is concerned. It is a collective that is more than merely social.

At Level 6, we find internalised ecology:

> ‘The intense socialization, re-education, and reconfiguration of plants and animals – so intense that they change shape, function, and often genetic makeup – is what I mean by the term ‘internalised ecology’ (Latour, 1999: 208).

Latour argues that in order to admit animals, plants and proteins to the emerging collective, one must endow them with the social characteristics necessary for their integration. This results in a man-made landscape for society, like cities and towns.

> ‘In describing the sixth level we may speak of urban life, empires, and organizations, but not of society and techniques – or symbolic representation and infrastructure’ (Latour, 1999: 208).

The megamachine is found at level 7. If one considers where industry comes from, one realizes that it is neither a given nor a sudden capitalist discovery of the objective laws of matter. The megamachine is seen as the organization of large numbers of humans and non-humans by means of chains of command, deliberate planning and accounting procedures with specific functions or goals:

> 'At some point in history human interactions come to be mediated through a large stratified, external body politic that keeps track, through a range of 'intellectual techniques' (writing and counting, basically), of the many nested subprograms for action. When some, though not all, of these subprograms are replaced by non-humans, machinery and factories are born. The non-humans, in this view, enter an organization that is already in place and take on a role rehearsed for centuries by obedient human servants enrolled in the imperial mega machine' (Latour, 1999: 207).

The hypothesis can be summarized as follows: before it is possible to delegate action to non-humans and to relate non-humans to one another in automation, it must first be possible to nest a range of subprograms for action into one another without losing track of them.

At Level 8 one finds industry that developed by allowing non-humans to replace humans in the mega-machine. Latour extends to matter a further property that can be thought of as exclusively social in his notion of industry. Non-humans have the capacity to relate to one another when they are made part of the assembly of actants that everyone calls a machine. This automation is given autonomy of some sort and submitted to regulating conditions or laws that can be measured with instruments and accounting procedures:

> 'From tools held in the hands of human workers, the shift historically was to assemblers of machines, where tools related to one another, creating a massive array of labor and material relations in factories that Marx described as so many circles of hell' (Latour, 1999: 206).

To relate non-humans to one another in an assembly of machines, ruled by laws, is to grant them a sort of social life.

At Level 9 Latour places networks of power. The phrase *socio-technical imbroglio* is preferred because it replaces the dualistic paradigm of social and technical with a *seamless web* of technical and social factors. The extension of networks of power in telecommunications, transportation and the electrical industry is impossible to imagine without a massive mobilization of material entities. The technical invention of electric light led to the establishment of a corporation of unprecedented scale, its scope directly related to the physical properties of electrical networks. In this regard various global corporations in motorcar manufacturing and petroleum products also come to mind.

Techno-science is placed at Level 10.

> 'Through technoscience – defined, for my purposes here, as a fusion of science, organization, and industry – the forms of co-ordination learned through "networks of power" (see Level 9) are extended to inarticulate entities' (Latour, 1999:203).

Non-humans are endowed with speech, although primitive; with intelligence, foresight, self-control and discipline, both on a large scale and on a micro-scale. Although automata have no rights, they are more than material entities: they are complex organizations.

The eleventh layer is political ecology. The last interpretation of the crossover – the swapping of properties between humans and non-humans – is the simplest to define, because it is the most literal, according to Latour:

> 'Lawyers, activists, ecologists, businessmen, political philosophers, are now seriously talking, in the context of our ecological crisis, of granting to non-humans some sort of rights and even legal standing' (Latour, 1999: 202).

He argues that previously, contemplating the sky or space above earth meant thinking of matter or nature; it has now become a socio-political imbroglio, since the depletion of the ozone layer has caused a scientific controversy, a political dispute between North and South, and immense strategic changes in industry. Literally, not symbolically as before, we have to manage the planet we inhabit and must now define a *politics of things*.

As with all previous crossovers, the last one mixes elements from both sides: the political with the scientific and technical. Technologies have taught us how to manage vast assemblies of non-humans: our newest socio-technical hybrid brings what we have learned to bear upon the political system.

To Latour the illusion of modernity has been to believe that the more we grew, the more separate objectivity and subjectivity would become, creating a radically different future. The mistake of the dualistic paradigm was its definition of humanity. To conceive of humanity and technology as polar opposites is to overlook the sociotechnical nature of human interaction. We are never limited to social ties and never face only objects.

His diagram relocates humanity right into the crossover, the central column, the articulator and mediator between mediators. This seems almost ironic. Latour designed this scheme to deal with the subject-object dichotomy as well as the human non-human issue. Here he places *humans* (subjects) as the *active mediator* between passive objects and other cultural subjects or societal relationships. Ironically he also distinguishes between social relationships (involving human cultural subjects) and tools and machines (involving non-human natural and cultural objects) and places the human between them.

The term 'totality' can be used for Latour's hybrid collectives.

4.6. Epistemological implications

According to Latour, subjectivity and objectivity are not opposed: they grow together, irreversibly. This implies that there is more than one way of knowing. He traces the dispute between Socrates and Callicles and highlights the fact that reason (science) was utilized to obtain political power against the people (demos). Indicating that unlimited power could be dangerous and should be limited to what is 'right' is only one step closer to truth via reason. In this context of aristocracy, the hordes are defeated by a force superior to the reputation and physical force of the people (demos) and their endless and useless practical knowledge:

> 'When Truth enters the scene, it is not as one man against everyone else, it is as an impersonal, transcendental natural law, a Might mightier than Might' (Latour, 1999: 225).

Socrates identified two kinds of persuasion: conviction (without understanding) and knowledge (epistéme). Furthermore, he makes a distinction between real knowledge and practical know-how:

> 'The distinction between knowledge and practical know-how is both what allows him to appeal to a mouth-shutting superior natural law and also what is enforced by the very action of shutting the mouths of the ten thousand people who go about their business every day "without knowing what they do". If they knew what they were doing, the distinction would be lost' (Latour, 1999: 231).

One can recognize how a certain form of reasoning (epistéme) was kidnapped for a political purpose it could not possible serve. Against this background Latour indicates the difference between what he calls Science no. 1 and Science no. 2.

Science no. 1 is not a description of what scientists do. It is an ideology that has never had any other use apart from offering a substitute for public discussion. It has always been a political weapon for doing away with the constraints of politics.

> ‘Science no. 2 deals with non-humans, which in the beginning are foreign to social life, and which are slowly socialized in our midst through the channels of laboratories, expeditions, institutions, and so on, as recent historians of science have so often described’ (Latour, 1999: 259).

This hints at different points of view and their integration into as many lives as possible. Science no. 2, unlike Science no 1, needs lots of controversies, puzzles, risk-taking and imagination; scientists and the public involved in controversies should *not* keep their mouths shut.

Latour reminds us that the division between theory and practice, between content and context and even nature and society, is not a given; the divide is made by Reason. Similarly, the division between knowledge and belief was created, which in its turn divided reality into facts and fetishes. The irony is that in the classical division, fabricated facts become illusory; if not fabricated, they become real (see Fig. 6. below).

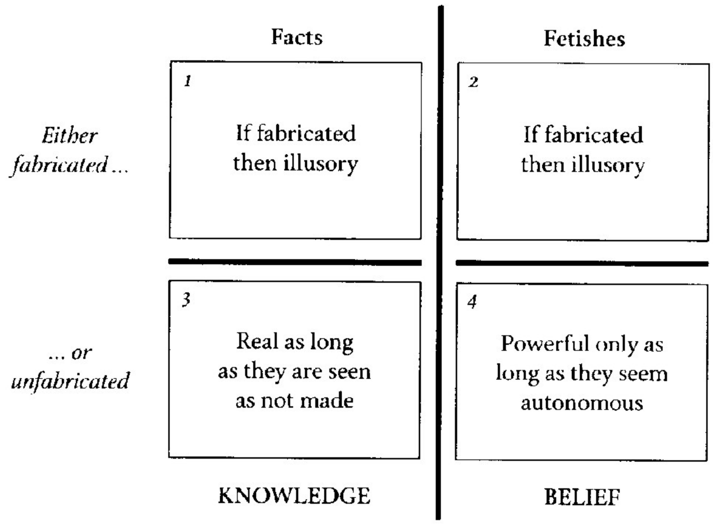

Fig. 6. Latour's illustration of facts and fetishes correlated to knowledge and belief. (Latour, 1999: 273)

The same is true of fetishes. When facts were allowed into our collective existence, great clouds of fetish delusions, oppressions, manipulations and prejudices were dissipated. But facts have been taken too far in an attempt to transform everything else into beliefs or something believable. The burden of supporting all these beliefs becomes unbearable when science itself is submitted to the same doubt. It is one thing to attack beliefs when we are supported by the certainties of science, but what happens when science itself is transformed into a belief? The only solution is post-modern virtuality. Virtuality is what everything turns into when belief in belief runs amok.

Latour proposes a reunited situation because he has proved that facts are in fact 'fabricated' through human action in a 'fabricative' experiment. He names this new collective factishes (see Fig. 7 below).

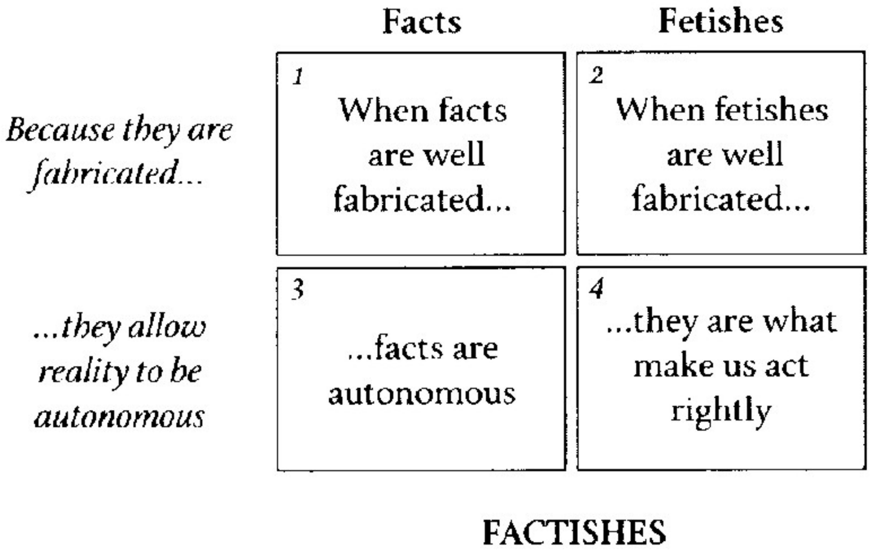

Fig. 7. Latour's construction of factishes. (Latour, 1999: 274)

> 'The factish suggests an entirely different move: it is because it is constructed that it is so very real, so autonomous, so independent of our hands' (Latour, 1999: 275).

Attachments do not reduce autonomy, but foster it. Latour regards the terms 'construction' and 'autonomous' as synonyms. He attacks the modernists and postmodernists, indicating that in all their efforts at critique, they have left belief untouched. They believe in belief. He argues that it is a belief in belief that allows of the distinction between a world 'out there' and a palace of ideas, imaginations, fancies and distortions 'in here'. For the postmodernists there is one physical world 'out there' and many mental worlds 'in here'.

> 'The role of the intellectual is not, then, to grab a hammer and break beliefs with facts, or to grab a sickle and undercut facts with beliefs (as in the cartoonish attempts of social constructivists), but to be factishes – and maybe also a bit facetious – themselves, that is, to protect the diversity of

> ontological status against the threat of its transformation into facts and fetishes, beliefs and things' (Latour, 1999: 290,1).

According to Latour, the subject–object dichotomy has lost its ability to define our humanity because it no longer allows us to make any sense of 'inhumanity'! He attempts to substitute the notion of humans and non-humans for the subject-object dichotomy. He claims not to try and overcome the divide but to go in another direction. The term 'collective' that combines humans and non-humans is Latour's answer to the subject-object dichotomy.

4.7. Conclusion

If it were true that idea-frameworks regulate concepts like a paradigmatic regulator, it would imply that a new paradigm allows new possibilities. Latour's new ontology as regulative framework also allows of new possibilities and opportunities for notions and concepts. He literally starts with an ontology where he chooses, in opposition to Descartes, a relative certainty rather than absolute certainty.

Latour also opposes the classical position of a 'mind-in-a-vat', which implies that the brain (or reason) is superior to all other faculties. Don Ihde also mentions that Galileo preferred his observations through the telescope to the speculative world-view that the earth was the centre of the universe. Galileo was a Copernican who believed that the sun was the centre of the galaxy.

This choice of Galileo also rejects the absolute dominance of reason (Ihde, 1990a: 44, 57).

Latour effectively unmasked phenomenology and illustrated that it deals with only a ‘world-for-a-human-consciousness’, limited to human intentionality. He actually accuses it of being the cause of the most dramatic split between subject and object, leaving us with a ‘world of science’ left entirely to itself and a world of intentional stances left entirely to humans.

Latour explicates the division of mind and the superiority of the mind by means of an interesting interpretation of the historic argument between Socrates and Callicles; he argues that these ideas have their origin in the fear of mob rule. This fear led to the fallacy of ‘absolute’ truth that cannot be overrun by a ‘mindless mob’, and, associated with it, the ‘competent’ mind that possesses the knowledge of absolute truth and that can therefore not be dominated by ‘unreasonable’ brute force, but by the power of reason only.

4.7.1. Latour’s realism

Latour believes in a hybrid world made up of people, things and societal life forms. He rejects the natural scientist’s position that facts are accurate only when purged from all subjectivity, politics and passion, as the original Greek philosophers indicated. He also rejects the view of the humanities that humanity, morality and subjectivity are only real if protected from contamination by science, technology and heartless objectivity that limit human freedom.

Essentially Latour discards the ‘historical’ dispute relating to modernity and postmodernity; he is aiming at a *politics of things*, the task of sorting out the ‘cosmos’ from an ‘unruly shambles’. This he believes to be more important than arguments about whether or not words refer to the world.

Latour develops a different ‘epistemology’. He argues that knowledge does not reside in the face-to-face confrontation of a mind with an object any more than words can designate things. The word ‘dog’ does not bark like a real ‘dog’.

Latour developed a model of transformation in a circulatory reference process in which the mind ‘contacts’ reality. He pictures it as a trade-off between what is gained (amplified) and lost (reduction) at each information-producing step. Traceability and reversibility guarantee truth. In his view, true statements that correspond with a state of affairs and false statements that do not, do not exist – only continuous or interrupted references that circulate.

He proposes a model of science as a collective with five loops to explain the circulation of scientific facts. Some of the interesting implications are that the model does not allow of a separation of a scientific content from a meta-scientific content like social fictions or social dimensions.

In the light of the notion of the *seamless web* that must bridge the (to Latour unacceptable) dualistic socio-technical divide, aspects of this 'totality' are not recognised. Society is a seamless web and nothing else. A collective like the scientific process exists only as a total collective. The question could be posed whether someone could limit his/her interest or study to a certain dimension like the social dimension. Could one be interested in the social aspect instead of the political aspect of a new scientific discovery? If 'yes', then the 'scientific' content of Latour's model should allow for a 'meta-scientific' possibility like social dimensions. If science is a collective, one can focus on some of its aspects, which will allow of social, economical, technical and other functional views of an object or field of study. In this way the socio-technical as a possibility will not be discarded.

Discarding the theory of correspondence, he creates new expressions, namely 'articulation', 'event' and 'proposition'. The term 'event' highlights the possibility of adding new elements to an experiment or discovery. The term 'proposition' is an opportunity (event) for different entities to interact and the term 'articulation' goes much deeper than speech and is placed as part of reality.

4.7.2. Latour's views on Technology

Latour argues against the modernist view of objects in nature and subjects in society.

The term *totality* includes the possibility of interlaced human and non-human parts. Latour's notion of a gun–citizen is such a totality that could be structurally analysed. Latour indicates various ways of technical mediation like goals, translation, composition, black boxing, etc. which are excellent examples of the interaction or interlacement of parts in a totality or an event.

Because he opposes the 'object-subject' dichotomy, he does not define any object or subject as 'technological'. The question is why he does not identify a totality or collective as 'technological'. He did identify a scientific 'totality' or collective; then why not a technical or technological collective? Could 'technology' not also have such a structure? He furthermore identified techno-science as a fusion of science, organization, and industry, which could be seen as a 'collective'.

To him technology does not exist; there is nothing that can philosophically or sociologically be defined as an object or an artefact or a piece of technology. He argues that the adjective 'technical' is more appropriate than the nouns 'technique' and 'technology' to distinguish humans from the multifarious assemblies with which they combine. Although there is something to be said for Latour's claim, the totality (collective) itself should be distinguishable from other collective events and collectives. This is a transcendental necessity. The ontic uniqueness of entities implies that an entity should be distinguishable from all others to qualify as an entity. To identify an entity therefore distinguishes it from all other entities. To identify A simultaneously distinguishes it from everything that is not A.

To put it more formally and positively, each collective (totality) or event must be distinguishable from all other (dissimilar) events or collectives. The fact that Latour could create a model of the scientific collective implies that it is different from a technical or artistic collective, from a galaxy of stars or other hybrids in his world. A citizen–gun totality is certainly not the same as a citizen–motorcar totality. If this is true, a technical (or rather, technological) totality, which is the interlacement of unequal objects and subjects, should reveal a unique set of characteristics different from a scientific or artistic totality. Latour missed this point completely.

He further indicates that '*real* artefacts are always part of institutions', 'not knowing if they are composed of one or of many, of a black-box counting for one or of a labyrinth concealing multitudes'. This again raises the question whether artefacts are technical by necessity or on some other basis. Could one have an artistic artefact, economic artefact or even religious artefact that is therefore not technical? This implies that not all artefacts are technical. Furthermore, some indication of the nature or characteristics of such artefacts will be required to distinguish between technical and non-technical artefacts. Like Ihde, Latour does not make such a distinction. Where Ihde simply assumed that all artefacts are technical, Latour simply assumes that they are not identifiable as they are interlaced with some bigger totality. If all entities have meaning in contexts, it implies that all artefacts will also have meaning in a fundamental ontic context. On the basis of its typical context a-typical contexts could be highlighted[127]. Latour missed this as well[128].

The fact that Latour suggests that artefacts are part of a totality or collective indicates that totalities could have a technical sub-structure. He indicates five meanings of the word 'technical':

- a series of sub-programmes;
- the subordinate role of people, skills or objects, indispensable but invisible in a black box;
- a hitch or snag in the sense of an obstacle, like a 'technical problem';

[127] This was extensively argued previously, but can be summarised as follows: if all structures have a typical inner structure, then this will be highlighted in a typical context. All other non-typical usages will not change the typical structure. Technical artefacts, like tools, could thus be identified in a typical context.

[128] As explained before because he did not consider the ontic characteristics of the technical. He was interested in the 'politics of things' which do not cater for transcendental investigations.

- a unique ability or knack or gift;
- a modus operandi or chain of know-how.

Although not his intention with this typology, and because the ontical transcends his specific focus these designations do not reveal the unique nature or characteristic of the technical that would distinguish it from other non-technical activities.

In his pragmatogony Latour refers to essential prerequisites in the societal knowledge, experience or know-how required before a society can ‘develop’ or progress to the next level. Although this is not a historical progression, it is a progression of complexity. In this model he expresses some notions of science and technology that should be highlighted.

At level 2 Latour speaks of a basic tool kit. A tool is the extension of the societal skills of humans to non-humans. We generate tools by shifting competencies to non-humans, treating a stone as a partner to act on another stone. This indicates a process of formation: forming things of stone by using another stone.

At level 4 Latour refers to *technique* as a *modus operandi*. A technique is an articulated sub-programme for actors that subsist in time and extend in space. According to Latour, ‘a bow and arrow, javelin, hammer, clothing or a net are composed of parts and pieces that required recombination'. In this sense all these artefacts are the result of a *technical* recombination or forming process, but are not necessarily *technical* in themselves or *technical operators* or tools to act on other objects.

At level 8 we find industry that developed by allowing non-humans to replace humans in the mega machine of organizational structure and relations for the purpose of producing or assembling products.

At level 10 we come across the term 'techno-science', which is a fusion of science, organization and industry. The question arises: why not technology and science? The reason is that to Latour technology 'does not exist', but science as collective does. What distinguishes science from, for instance, industry and art? They are all collectives (totalities), but Latour has no way of distinguishing between them in his pragmatogony. This is a notable weakness in Latour's argument.

Latour's efforts to divert the subject-object dichotomy and the division between knowledge and belief brought about the creation of the term 'factish' indicating a combination of facts and fetish.

He believes that the dichotomy cannot be overcome, but he indicates that the intellectual is not supposed to break beliefs with facts or undermine facts with beliefs, but rather to protect the diversity of their ontological status.

The implication is that this protection is extended to all the entities involved, including subjects and objects, humans and non-humans, facts and fetishes, as well as the beliefs which Latour tries to ignore. Reason and belief can enrich each other instead of undermining each other.

5. An Analysis of the Notions[129] of Wiebe E Bijker[130]

Bijker explains that his book, *Of Bicycles, Bakelites, and Bulbs. Towards a Theory of Sociotechnical Change*, is the result of a personal detour that turned into a main route. He started with socio-political concerns about the role of technology in society and this became an academic thesis.

Like many Dutch engineering students in the 1970s, he was drawn to the STS movement whose goal was to enrich curricula of both schools and universities by offering new ways to explore issues such as the risk of nuclear energy and environmental degradation.

This analysis is based on this book. It is important to realize that Bijker's approach is sociological[131] rather than philosophical, in contrast to the predominantly social-philosophical approaches of the previous authors.

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[129] Although argued previously, it is again a reminder that only the notions of the author toward the *technical* will be investigated. It is assumed that the author is significant and worthwhile and no attempt to evaluate his theory and its respective critical reactions are contemplated as this transcends the focus and purpose of this study which only concentrate on the *ontical logic* behind the assumptions and notions. None of his critics attempted to concentrate on the transcendental conditions as it transcended their foci as well.

[130] My thanks to Prof Mouton for highlighting Wiebe Bijker as a worthwhile author to study.

[131] This implies that he will not be able to distinguish the meaning-nucleus of the technical, as he does not proceed from an ontological viewpoint.

5.1. Introduction

Bijker (1995: 4-5) says that the stories we tell about technology reflect and can also affect our understanding of the place of technology in our lives and our society. He believes that such stories harbour theories. In his studies he found three models:

> 'First, there were those who looked down their noses at mere story-tellers. These were the scholars, often with backgrounds in the social sciences, who advocated general typologies, precise conceptual definitions, and macro-theoretical schemes that could produce "real" insights and explanations.
> Second, there were those who poked fun at any theoretical generalization beyond the uniquely detailed story. These students, often of the historians "tribe", scanned the empty theoretical boxes and abstract schemata that did not display any familiarity with what "really" went on.
> Third, there were the political activists, who considered any detour into academia a betrayal of the immediate societal tasks that should be the constant overriding concern of critical intellectuals' (Bijker, 1995: 5).

He found that all three approaches are equally necessary. He believes that effective societal action concerning issues of technology and science cannot do without scholarly support, while academic technology studies have much to gain from engagement with politically relevant issues. Furthermore, to his mind, only an integration of detailed empirical case studies with general conceptual frameworks can form this link between academia and politics.

Lastly he believes that an integration of case studies, theoretical generalizations and political analysis is called for to understand the relations between technology and society and resolve issues of socio-technical change.

Bijker uses as a guide a new research programme of a constructivist study of technology, which is mainly based on a combination of historical and sociological perspectives. This is the so-called SCOT (social construction of technology) paradigm. Efforts to include economics and philosophy are also made, as will be illustrated later.

> ‘A central adage for this research is that one should never take the meaning of a technical artifact or technological system as residing in the technology itself. Instead, one must study how the technologies are shaped and acquire their meanings in the heterogeneity of social interactions’ (Bijker, 1995: 6).

In light of the fact that any disciplinary approach cannot cater for an ontic totality view, any statement about the meaning of a technical artefact that indicates some meaning other than in the ontic needs to be investigated in this thesis, as this thesis simultaneously tries to identify other possible frames which could enlighten the ontic framework.

It is accepted that the meaning of something should not reside in itself. This pre-supposes that no ‘thing-in-itself’ exists. One can now search for a framework within which to interpret this meaning in line with the principle of meaning in context. Bijker searches for this context in social interaction. This is obviously *not* the only framework that can be used. Although the framework of social interaction would highlight various issues, it must also be borne in mind that any transcendental issue would *transcend* this specific framework.

If meaning were ultimately associated with reality, then the widest possible context, which will encompass all other contexts, or is fundamental to all other orientations, would be the context of ontic conditions. This framework would focus on the ontic meaning of technology in all its potential and possible relationships and within all possible frameworks.

The chosen societal or social relations framework would make assumptions about ontic reality[132] and could generate contextual fallacies, if not closely monitored.

5.1.1. Socio-technical change framework

Bijker highlights the fact that within the constructivist's approach three lines of work can be distinguished, namely the systems approach, the actor-network approach and the social construction of technology (SCOT) approach. From the SCOT approach he has developed arguments that he believes are of general relevance for the whole spectrum of modern constructivist studies.

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[132] This is in line with all special or disciplinary scientific activity.

He points out that the newer research programmes are designed to avoid the pitfall of linear development or even implicit assumptions of linear development. Such assumptions were often found in earlier technology studies (see Fig. 8. below):

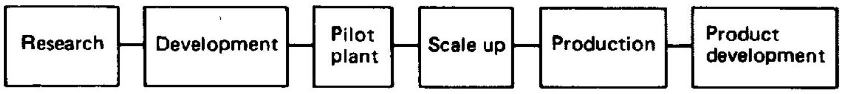

Fig. 8. Bijker's illustration of a six-stage model of the innovation process. (Bijker, 1995: 7)

The problem is that an expected linearity blinds us to retrospective distortions, because it results in an implicit teleology or determinism, suggesting that the whole history of technological development followed an orderly rational path, as if today's world was the precise goal towards which all decisions in history were directed.

Another pitfall that he highlights is the asymmetrical analysis of technology. This indicates a focus on successful innovations, which suggests an underlying assumption that it is the success of an artefact that offers some explanatory ground for the dynamics of its development. A historical account concentrating on the retrospective success of an artefact leaves much untold. A 'failed' artefact could also have contributed to the stabilization or closure of a design. It could, if nothing else, indicate how something should not be done.

This is an important contribution to our insight into the development of 'artefacts'.

Bijker also refers to the key debate in the history of technology on the primacy of internalist versus contextualist (or externalist) studies. Internalists believe that one can understand the development of a technology only if one starts with an understanding of the minute technical design details of technology. Contextualists, by contrast, believe that the economic, social, political and scientific contexts of a technology are as important to its development as the technical design characteristics.

The irony here is that in certain circumstances both are right and wrong. If one is interested in studying the historical development of a technical design like the computer chip, one requires an 'understanding of the technical design in its minute details' and the appropriate framework. On the other hand, if one is interested in studying an artefact in society, one requires the broader context. The focus of the problem will determine the appropriate framework. This is an application of the epistemological principle of meaning in context[133].

[133] In the epistemology of the philosophy of the cosmonomic idea it is argued, as mentioned in chapter one, that facts are placed within the framework of a law order, reflected within a correlating theoretical framework. The latter determines the meaning of all concepts. This is indicated by the idea of *meaning in context*.

What does seem to be lacking is the insight that the transcendental questions of technology transcend even these frameworks and that the place of the technical in reality might contribute to a better understanding of its structure and its interaction with humanity and society[134]. This was precisely the critique of Van Riesen (1949: 1): that from the beginning too much attention was given to the influence of technique on society, with the result that the place and characteristics of the technical as entity were neglected.

Although Bijker regards context as important he is not a pure contextualist. He believes that

> '… rather than being satisfied with the distinction between technology and its context as the basic dimension for analysis, we must figure out a way to take the common evolution of technology and society as our unit of analysis' (Bijker, 1995: 10).

At this point some issues should be highlighted.

Firstly, to find the true *meaning* of technology, a transcendental account of ontic conditions should be used, but this does not mean that the ontic is the only possible perspective to use when studying technology.

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[134] Keep in mind that the SCOT movement does not advocate a transcendental approach and that it transcends their focus. This unfortunately still does not mean that it is not relevant or cannot contribute to our understanding of the ontic conditions of the technical.

Secondly, Bijker has already stated that he is interested in the context of social interactions, which focuses on how technology and society interact. Transcendental questions will transcend this specific framework since the framework pre-supposes a notion of technology and of society as necessary pre-requisites in the framework, and the focus of his framework would be on the *interaction* of the two elements and not the transcendental conditions or the structure of either of these entities.

Thirdly, Bijker indicates that he wants to specialize even further. He is interested in the evolution or development of technology, in the development of society, and especially in the commonalities of these developments or evolution.

This is a legitimate framework or context within which to study the 'developmental interaction' of technology and society. He will, however, require some orientation and notions that are 'outside' this framework and for that he would need to use a philosophical or orientating framework to guide certain assumptions.

To put it differently; the framework above presupposes three notions, namely *society*, *technology* and *evolution*. It does not allow of the notion of a *totality* and cannot provide a *comprehensive definition* of society, technology or development, because all are presupposed in the framework. Furthermore, something cannot be fully explained by its relationships only[135].

Bijker also highlights the issue of technological creativity. The long-standing question is whether it is a 'necessity', which implies that an invention will sooner or later emerge out of felt needs, independent of individual creativity, or whether the act of ingenuity without which needs might never be fulfilled is primary, with individual 'genius' being the impetus behind creative technology.

Bijker tends to regard the development of technology and its inventions as a social process. He introduces a conceptual framework that links the stories of individual inventors to a sociological analysis of their positions in a specific technological culture. This is in line with his chosen sociological 'developmental interaction' framework and is quite legitimate, provided it is realized that it is but one framework for or approach to the study of the development of technology.

[135] Although it might seem that the position of Bijker is criticized too quickly, it by now should be clear that our analysis is involved in developing a 'meta-theory' or 'pre-disciplinary theoretical' approach where almost none of the theory of Bijker will be discussed for the sake of its theory, but for the sake of assessing the relevant ontological assumptions. Bijker states his framework and assumptions in his own words and it is obvious that any ontical totality view of technology will transcend his theoretical framework.

A last guideline comes from political science. The notion of power, according to him, was not addressed by earlier sociologies of technology. Power as a central category has been avoided because explanations in terms of power so easily result in important factors being overlooked. Bijker refines the notion of power to illustrate that strategies are employed to create a certain outcome. In his analysis of power strategies, he especially focuses on the role of artefacts. He further focuses on the actual design process of an artefact.

In his selection of artefacts he picked cases that would allow of a focus on the 'hard' contents rather than their systematic aspects. He therefore concentrates on 'elementary innovations', rather than technological systems; for example, the bicycle rather than the motorcar, Bakelite rather than synthetic material in general and the fluorescent lamp rather than electric lighting in general:

> 'The cases are also varied in terms of their underlying engineering background: mechanical engineering (the bicycle), chemical engineering (Bakelite), and electrical engineering (the fluorescent lamp). With respect to industrial context, the cases move from a blacksmith's workshop (bicycle) to an early scientific laboratory (Bakelite) to a large industrial laboratory (fluorescent lamp)' (Bijker, 1995: 12).

Further differences are that the bicycle is aimed exclusively at the consumer market, Bakelite as a moulding material is aimed at the industrial market, and the fluorescent lamp has a hybrid character. In patent literature a distinction is made between a product and a process patent. The bicycle and fluorescent lamp are products, whereas Bakelite is a process patent.

It is important to note that the selection of these cases was guided by 'an intuitive and common sense idea' about 'technology' and 'society' and their 'developmental process', and that a clear definition or description of society and technology has not been provided. It is taken as a given. Again this is in line with the fact that a 'specialized' framework or context would borrow notions and approaches via assumptions from other general frameworks or philosophical frameworks.

No new transcendental or ontological description or definition of technology or its ontic nature could therefore be expected[136], but rather a contribution to our understanding of the developmental interaction between society and technology. Concentrating on artefacts and the design of artefacts in his case studies should enable Bijker to make a clear distinction between artefacts and technology, thereby avoiding the contextual fallacy that occurred when Ihde equated artefacts with technology.

5.1.2. Requirements for a theory of Socio-technical Change

Bijker highlights four requirements for a theory of technological development as is shown in the table below.

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[136] Although this is clearly stated a lot of critique was received on the fact that Bijker did not give a totality view of the technical when it was correctly concluded. Refer to 5.6

Requirements for a theory of technological development	
1. Change/continuity	The conceptual framework should allow for an analysis of technical change as well as of technical continuity and stability.
2. Symmetry	The conceptual framework should take the "working" of an artifact as *explanandum*, rather than as *explanans*; the useful fuctioning of a machine is the result of socio-technical development, not its cause.
3. Actor/structure	The conceptual framework should allow for an analysis of the actor-oriented and contingent aspects of technical change as well as of the structurally constrained aspects.
4. Seamless web	The conceptual framework should not make a priori distinctions among, for example, the social, the technical, the scientific, and the political.

Table 1. Bijker's requirements for a theory of technological development. (Bijker, 1995: 13)

Firstly, he acknowledges that two approaches to technical change exist: a rational, goal directed activity and a process of trial and error with an accumulative result of small and mostly random modifications. The most recent studies of the sociology of scientific knowledge stress the contingent character of scientific development; it is assumed that this contingency would also be fruitful for studies in technical development. This borrowing assumes that all technical development cannot be logically or pre-determinately or even easily explained.

On the other hand, he noticed that too much contingency would result in actors who have no meaningful history of their own. Evidently, an explanation of orderly constancy and continuity in history and the conditions under which they exist is required. According to the first requirement listed in Table 1, namely ‘change/continuity’, technical change and stabilization or the stability of artefacts must be explained.

The second requirement that is highlighted is the principle of symmetry. This concerns the issue that the success or failure of an artefact is to be explained symmetrically by the conceptual framework. The principle of symmetry has its origins in the strong programme in the sociology of knowledge (Edinburgh School) of the early seventies and has had a major influence on all subsequent sociology of science studies:

> ‘Understanding the construction of “working” and “nonworking” as nonintrinsic but contingent properties is the second requirement for the theory of technical change …’ (Bijker, 1995: 15)

It is important to stress that the notions of ‘working’ and ‘non-working’ are limited to the ‘social developmental’ framework. It would not be valid for a transcendental approach to ontic conditions. In an ontological framework the ‘meaning’ of something is related to its ‘ontic’ identity (structure) and meaning or ‘working’, so to speak. If something loses its ‘identity’ or ‘purpose’ or ‘working’ it will cease to have the same meaning. A wineglass that broke into splinters is not a wineglass any more but glass splinters, but it does not change into ‘nothing’.

On the other hand, a sword may lose its 'societal function as weapon' in the modern age and become only a historical or artistic artefact, but it still remains a sword. The implication is that even though an artefact can become 'non-working' in a societal context, it still is an entity or (changed) 'artefact' in an ontic context and could therefore still be identified as 'something'. If this were not the case, it would be impossible to identify an artefact as artefact. It is only because one can still (ontically) identify an artefact as artefact that Bijker can determine whether it is 'working' or 'non-working' in a societal context.[137]

It would in light of the above argument be a *contextual fallacy* to conclude that the 'societal' working or non-working of artefacts is equal to the identity and 'working or non-working' of artefacts in an ontic sense.

The third requirement is closely related to the *orderliness of* and *order for* reality expressed in the constancy and change of reality. Bijker indicates that the emphasis on the contingent character of technical change may seem to imply that anything is possible and that each configuration of artefacts and social groups can be built up or broken down at will. He stresses that it clearly underestimates the solidity of society and the stability of technical artefacts. This also loses sight of structural constraints. The third requirement stresses that the actor and structure of the artefact should be made visible.

[137] Please refer to 1.5.3.5.

The final assumption is that society must be analyzed as a seamless web:

> 'The analyst should not assume a priori different scientific, technical, social, cultural and economic factors' (Bijker, 1995: 15).

From a transcendental philosophical view this requirement seems very limiting. All assumptions have an a priori character at first. The notion of the 'seamless web' itself is therefore assumed a priori.

The question arises why one may a priori assume the notion of a 'seamless web' but not 'scientific, technical, social, cultural and economic factors'. What about a case where a framework is constructed (as Bijker does when he assumes a priori 'society', 'technology' and 'interactive development') in which a specific focus on the economic or political influences of artefacts are of interest? Can one then assume a priori an economic or political factor?

Furthermore, there is the question of lingual, political, aesthetical, ethical or certitudinal factors. They were not mentioned above; can it therefore be a priori assumed that they may be a priori assumed?

5.2. The Social Construction of the Safety Bicycle

In chapter two, Bijker systematically analyses the historical technical conditions and societal attitudes towards bicycles.

He identifies or ‘defines’ the notion of ‘relevant social groups’. ‘Relevant’ in this sense implies groups related to an artefact and which had an impact on such an artefact. With this notion Bijker therefore correlates a social group with a specific artefact.

Another notion is ‘interpretative flexibility’. The Penny Farthing could be regarded as an ‘unsafe bicycle’: it is difficult to steer and propel and, because of its high front wheel construction, it topples over easily, resulting in a hard fall for its rider. This, however, was one of its attractive features to young men with daring and athletic skills who wanted to show off and impress girls, making it a ‘macho bicycle’. Interpretative flexibility therefore articulates the more fundamental concept of ‘meaning in context’, suggesting that artefacts could have different meanings for different groups in different contexts.

He stresses that the macho bicycle is radically different from the unsafe bicycle – it is designed to meet different criteria, it is sold, bought, and used for different purposes and it is evaluated according to different standards. In his classification it is considered a machine that ‘works’, while the unsafe bicycle is a ‘non-working’ machine.

In terms of Bijker’s descriptive model, it is implied that the Penny Farthing was deconstructed into two different artefacts:

> 'Each of these artifacts, the "Unsafe" and the "Macho" are described as constructed by a relevant social group, and this description also includes a specification of what counts as "working" for that machine, for that group' (Bijker, 1995: 75).

It is important that 'working' and 'non-working' are socially constructed assessments, rather than intrinsic properties of the artefact and are only valid in social interaction between artefacts and social groups. This limitation will also limit the conclusions that one arrives at about artefacts.

Bijker thus argues that the account of bicycle development can be adequately summed up by distinguishing two separate artefacts, the 'unsafe' and the 'macho', hidden within one contraption of metal and rubber, etc. This demonstrates the notion of interpretative flexibility, if one considers the different design trends.

He points out that designers who regarded the bicycle as unsafe sought to solve the safety problem by moving the saddle backward, adding auxiliaries, reversing the position of the small and large wheels and making changes to the basic scheme. The 'macho' developed in the opposite direction: the front wheel was made as large as possible, stiffer spokes were developed for the large wheel, etc.

> 'To distinguish two different artifacts in this way is more straightforward than trying to cope with the wide spectrum of different designs, even though one needs some imagination to see them within that one Ordinary' (Bijker, 1995: 76).

Bijker calls this sociological deconstruction. The possibility of demonstrating the interpretative flexibility of artefacts by sociological deconstructions implies a sociological explanation of the development of artefacts:

> 'If no interpretative flexibility could be demonstrated, all properties of an artifact could be argued to be immanent after all. Thus there would be no social dimension to *design*: only application and diffusion – or *context*, for short – would form the social dimensions of technical development' (Bijker, 1995: 76).

A point that Bijker seems to miss is that meaning can also be attached to relationships. Not only the artefact has properties; the relationship between the social group and the artefact has meaning too. Interpretative flexibility should therefore also refer to the relationship itself; therefore, to allocate all meaning as immanent to the artefact, as he indicates, is not the only possible alternative.

To Bijker it is important to realize that relevant social groups do not simply see different aspects of one artefact. The meanings given by a relevant social group actually 'constitute' the artefact. There are as many artefacts as there are relevant groups and there is no artefact not constituted by a relevant social group.

The fact that different groups give different meanings to an artefact and in essence create a 'societally' useful artefact seems acceptable. From an ontic point of view the structure of the artefact, which is stable or persistent, with an identifiable uniqueness or qualification, will determine its meaning. The meanings of other groups in other contexts cannot change the ontic nature or reality of the artefact. In an ontic context the meanings attributed by groups cannot constitute the reality of the artefact.

To Bijker, meaning-giving serves as a substitute for the idea of objectification. In a certain sense *meaning* turns into a feature of the *meaning-giving subject,* whether this is an individual or group, but this perspective leaves out of consideration the ontic conditions (or modal aspects) that make every conceivable act of *meaning-giving* possible.

From his chosen sociological framework Bijker indicates that once an artefact has been deconstructed into different 'societal' artefacts, what then has to be explained is how these different artefacts develop, which dominate and which fade. In the case of the bicycle the macho dominated in the beginning, but was superseded by the 'safety' bicycle. The notions of 'stabilization' and 'closure' can explain this.

Closure means that the 'interpretative flexibility' of an artefact (in a societal context) diminishes. Consensus among the different relevant social groups on the dominant meaning of an artefact emerges and the dominant artefact will stabilize within the relevant social groups. It is important to realize that the invention of the bicycle was not an isolated event, but an eighteen-year process before final closure and stabilization occurred.

In this case study Bijker argues for and succeeds in meeting two of the four requirements for a theory of socio-technical change. The focus on relevant social groups and interpretative flexibility ensures that the model meets the requirements of symmetry while the concept of closure and stabilization explains constancy amidst what is contingent.

No specific link between artefact and technology has been identified yet, other than the a priori assumption that there is a link. In addition, no distinction between the *technical* and *technological* was highlighted, nor between the *societal* and *technical*. The implication is that the societal construction of a 'safety' or 'macho' machine does not indicate whether it is a *technical* or *technological* artefact in addition to it being a *societal* (group) artefact.

5.3. The Social Construction of Bakelite

In this section Bijker uses an empirical case study to illustrate that, even in the instance of an individual inventor, a social constructivist analysis is possible and yields fruitful results. The second aim is to explain the concepts of ‘technological frame’ and ‘inclusion’, which relate the interactions of individual actors to the social process that forms relevant social groups.

In his case study Bijker describes the cultural, scientific and industrial background of the case. The earliest moulding material, which was of natural or semi-natural origin, determined the cultural context of chemical work in this field.

In summary, he explains that natural rubber (or ‘India’ rubber) cannot withstand temperatures above 80 °C or less than 10 °C. In a vulcanization process, rubber is heated with sulphur, which renders it more flexible and durable. Varying the amount of sulphur could control this; more sulphur makes it harder and less flexible, suitable for many new applications.

He points out that the range of applications brought new relevant social groups into the picture. Applications ranged from electrical insulation to ‘hard’ rubber (vulcanite) and ebonite, from car battery storage compartments to the manufacture of surgical instruments, artificial teeth and ebonite furniture.

He continues by explaining that the depletion of natural supplies necessitated the creation of new plastic materials like Parkesine from nitro-cellulose, which could be produced from paper and ivoride.

5.3.1. Technological Frame

Bijker introduces the notion of ‘technological frame’, referring to the relevant social group of celluloid chemists. They were strongly motivated to produce a plastic material, initially aimed at the consumer market, but eventually also the industrial market.

They tried to modify the production process to remedy the flammability of the product and to develop new applications. They searched for cheaper raw materials, working towards a fully synthetic plastic. It is this diversity but also coherence that the concept of technological frame is meant to capture. Being located among actors, it structures the interactions between the actors of a relevant social group, and it develops when interaction with an artefact begins. Existing practice guides future practice but without logical determination. If existing interactions move members of an emerging relevant social group in the same direction, a technological frame will develop, otherwise there is no frame, no group and no further interaction.

Bijker gives an example of this in his case study. He compares Parkesine and celluloid. Parkesine, the first celluloid substitute, did not give rise to a specific technological frame because the interactions around it came to an end before a relevant social group and further interaction could develop. The opposite happened to celluloid: its stabilization was accompanied by the establishment of a relevant social group of celluloid chemists and their continuing interactions gave rise to a new technological frame (see Table. 2).

Elements of the technological frame of Celluloid chemists

Elements of the technological frame	Technological frame of Celluloid engineers
Goals	Production of fancy articles
Key problems	Price of the solvent camphor, the flammability and molding characteristics of Celluloid
Problem-solving strategies	Modification of the solvent in the reaction
Requirements to be met by problem solutions	Set by the standards of the natural plastics: color, lack of shrinkage and distortion, price, aptness for being molded
Current theories	No chemical theory
Tacit knowledge	Application of heat and pressure without specific maxima
Perceived substitution function	Natural plastics
Exemplary artifacts	Celluloid; production machinery such as presses, preheaters

Table 2. Summary of elements of the technological frame of celluloid chemists. (Bijker, 1995: 126)

5.3.2. Degrees of inclusion in a technological frame

The degree of inclusion of an actor in a technological frame shows to what extent that particular frame structures the actions.

Bijker explains how Baekeland, the inventor of Bakelite, was involved in different relevant social groups. As amateur photographer and later the inventor of Velox photographic paper that was sold to Kodak Eastman, he was part of the technological frame of photo chemists. After the deal with

Kodak Eastman, he could not become involved in photography and he moved to an electro-chemist frame.

Baekeland became interested in the reaction between phenol and formaldehyde in about 1902. At that stage the chemistry of phenol-formaldehydes was in disarray:

> ‘Chemists in Europe were mixing various formaldehydes, phenol, solvents, acids, and alkalies, under different pressures and with or without applying extra heat to dry the product. The results ranged from sticky syrups to unmanageable solids that defied chemical analysis’ (Bijker, 1995: 144).

Baekeland tried to find patterns in this chaos. He set out to map the role of all possible variables in the reaction, typical of someone with a high degree of inclusion in the technological frame of photo chemists, unlike the celluloid chemists that simply substituted one solvent for another or the dye chemists aiming at chemical analysis. From this it is clear that one can be included in different technological frames and in different relevant groups. Bijker shows that Baekeland had a high degree of inclusion in the technological frame of the photo-chemists.

5.3.3. The Stabilization of Bakelite

It was several years before a form of Bakelite stabilized for a longer period; this is different from the development of the bicycle. Bijker points out that in the case of the bicycle it was the interpretative flexibility of the various relevant social groups that constituted different artefacts resulting in closure. Here we also see a series of quite different bakelites, the first four of which did not stabilize for longer than a few weeks or months:

> ‘Only the fifth, by that time called Bakelite, did stabilize for a long period of time, although of course further modified as more relevant social groups got involved. It seems more appropriate to view this as a stabilization process, because it did involve the gradual “condensation” of one specific meaning of the artifact Bakelite ...’ (Bijker, 1995: 151).

Baekeland could not devote all his time to Bakelite research. After various trips he continued his research and filed his first patents. These ‘heat-and-pressures patents’ did not describe the process in any precise sense. This process was still to be refined in the following years after he filed the original patent on 13 July 1907:

> ‘It is fascinating to see in Baekeland’s laboratory notebooks how great the interpretative flexibility of the various ‘facts’ still was, long after the ‘moment of invention’ as symbolized by the filing of the patents. Baekeland continued to be unsure and he studied virtually all parameters’ (Bijker, 1995: 152).

Between 1911 and 1917 several developments contributed to the stabilization of Bakelite. Firstly, a number of patent litigations, which formed the newly emerging relevant social group of Bakelite engineers, occurred. This was partly because more chemists from the celluloid chemists’ group were enrolled and partly because the trials helped to explicate the Bakelite technological frame. Although Baekeland won all his legal battles, he also engaged his opponents afterwards and found new forms or license agreements to develop Bakelite even further:

> 'These patent struggles and commercial rearrangements did contribute to the stabilization of Bakelite, as can be seen in Baekeland's description of Bakelite after the closure of the controversy with Leback and his review of Phenol-formaldehyde resins after the resolution of the conflict with Aylsworth and Redman' (Bijker, 1995: 172).

The second way in which Bakelite was further stabilized was collaboration with other industries. Bijker (1995: 174) explains that the automotive ignition people took to Bakelite. Its insulation properties, chemical resistance and quality as moulding material soon won over most producers. Automotive engineers soon found other applications, like steering wheels, door handles, instrument panels, gearshifts, knobs etc. The electricity industry made switches, insulators, moulded meter covers, circuit breakers, parts for home appliances such as toasters, washing machines, electric irons, vacuum sweepers, etc. The booming telephone and radio industries, which needed small, precision-moulded components, gave further stimulus to the application of Bakelite.

The third important factor in the stabilization of Bakelite was World War I. Bijker (1995: 176) explains that firstly, the companies of German origin had to split. Secondly, the plastics market was affected. There was a greater demand for ignition systems for military trucks and aeroplanes, but raw materials were scarcer. In Europe it caused a wild search for substitutes, resulting in mostly inferior quality with changing compositions and properties. At the end of the war the market was flooded with these wartime substitute plastics that damaged the regulatory function and public image of synthetic plastics. In the United States the public image of plastics did not suffer such damage. Here

> chemistry came out of the classroom and enjoyed the positive connotations of the ‘machine age’. (Bijker, 1995: 178).

After the war an over-supply of phenol resulted in low prices that were advantageous for marketing Bakelite products.

The relevant social group of industrial designers was the fourth factor in the stabilization of Bakelite.

> In the 1930s, industrial design emerged as a profession. (Bijker, 1995: 179).

It was then typically restricted to luxury items produced in small quantities. The new streamlined machine style, recognized as modern, worked against the poor image of the substitute plastics of the First World War.

> During the Great Depression manufacturers had another goal: to produce better products for less money. Industrial design thus had to contribute to the reduction of the manufacturing costs and mass production while maintaining products’ exclusive and luxurious appearance. (Bijker, 1995: 182).

Lastly, Bijker (1995: 188) explained, the stabilization of Bakelite was influenced by the relevant social group of customers. Based on two surveys conducted in Germany and Holland, the construction of a consumer group was attempted. Bakelite had a relatively positive connotation and was more familiar in industrial regions than in rural areas and better known for its elegant designs than for its non-flammability or chemical resistance. It was known as an object of use but was not associated with elegance or luxury – as a gift, crystal or delftware would have been preferred.

From the above it is clear that stabilization was not a quick, straightforward process. It involved various 'relevant' groups, from engineers to users, and various political and economic factors over a length of time. The process of production also underwent change, which brought about variations of Bakelite.

5.4. Technological Frame as a Theoretical Concept

In the case study of bicycles, Bijker concentrates on the succession of different 'social' artefacts. With Bakelite it seems one should focus on the process of technical change. Bijker points out that additional concepts are required for doing this.

He proposes the notion of a technological frame. According to him, technological frames outline both the central problems and the related strategies for solving them. He explains the dynamics of technological frames, highlighting that they do not reside in individuals but are located in relevant social groups. It therefore needs to be continuously sustained by actions and interaction. They are not fixed entities but are built up as part of the stabilization process of an artefact:

> 'The social construction of an artifact (e.g., Celluloid), the forming of a relevant social group (e.g., Celluloid engineers), and the emergence of a technological frame (e.g., the Celluloid frame) are linked processes' (Bijker, 1995: 193).

To simplify matters Bijker implicitly indicates a one-to-one relationship between a relevant social group, its technological frame and an artefact.

Two important issues must be highlighted. Firstly, a group of actors consisting of different relevant social groups (engineers, consumers, industrialists, etc.) is of course working with a variety of artefacts and, secondly, different relevant social groups could use one artefact. Bijker illustrates it as follows (see Fig. 9).

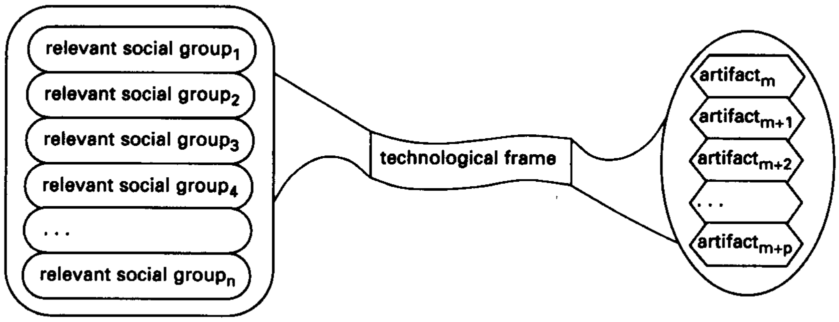

Fig. 9. Bijker's illustration of technological frames. (Bijker, 1995: 196).

Where relevant social groups differed in their attribution of meaning, interpretative flexibility was observed and different artefacts were socially constituted (unsafe or macho machine). When consensus emerged among the social groups, the process of 'closure' was noted.

This differs from 'stabilization' in which the artefact acquires an increasing degree of stability. Stabilization occurs not because, in the conflict of relevant social groups, one eventually dominates, but because the artefact does not change significantly:

> 'By rendering the two sides of the analysis – social groups and technical artifacts – into aspects of one world, "technological frame" will be helpful in transcending the distinction between hitherto irreconcilable opposites: the social shaping of technology and the technological impact on society, social determinism and technical determinism, society and technology' (Bijker, 1995: 195,196).

The 'technological frame' serves as the connecter in Bijker's theoretical framework of the 'common evolution of technology and society' – he believes that he connects 'irreconcilable opposites' within his framework, which is, in short, society and technology, as indicated in the quotation above. In effect he only 'connects' a relevant 'group', which is a component of society, and artefacts, which are not necessarily technological, within this 'structure'.
The assumption that artefacts are technological in nature is questionable, as has previously been indicated. Therefore it is not socio-technical but group-artefactual relationships that are identified.

Lastly, a more appropriate way to explain the notion of 'technological frame' is to describe it as a group-artefactual frame. Yet no explanation of why it should be ‘technological’ instead of ‘technical’ is given. It is actually the acceptance of artefacts by society – in other words, techno-literacy – that is studied, as well as the feedback of these artefacts on the techno-knowledge and techno-practice used to stabilize designs.

5.5. The Social Construction of Fluorescent Lighting

Bijker demonstrates further how his framework can be put to work to link the development of artefacts and the development of society and social power. In the previous chapters he reviewed cases of mechanical and chemical engineering with a consumer and industrial focus; these cases involved a process and a product.

Here he chose an electrical engineering case with the intention of addressing the economic and power dimensions of *technological development*. The technical design had been completed months before the ‘final’ social construction was carried out by managers at a conference table. In this case it was proved that economic and political power play a role in technical development.

5.5.1. The history of the Electric Lamp Industry

Bijker (1995: 201,2,3) summarised the history of the electric lamp industry. In the 1880s Thomas Edison began the electric lighting industry in the US. Three large companies dominated the market. They were the Edison General Electric Company, the Thomson-Houston Electric Company and Westinghouse.

The Edison and Thomson-Houston companies merged in 1892 to form General Electric. The proliferation of patents for all sorts of technical electrical artefacts was a problem; it became difficult to set up any electrical system without infringing upon some or other patent.

By 1896, General Electric and Westinghouse established a cross-licensing agreement allowing access to each other's patents. General Electric commanded 50% and Westinghouse 10% of the market, and smaller firms shared the rest.

Because these small lamp manufacturers found it difficult to compete with General Electric, they established the National Electric Lamp Company in 1901. It was set up as a holding company, leaving the individual firms relatively independent. Interestingly, General Electric purchased almost 75% of the stock but kept out of the day-to-day management.

> 'Publicly, the National Electric Lamp Company and General Electric presented themselves as competing, but they signed various patent licensing agreements, and most of the firms in the electric lamp business (including Westinghouse) partici-

> pated in price and market-sharing agreements' (Bijker, 1995: 203).

The development of the tungsten filament lamp also dealt the final blow to gas and arc lighting. By 1912 General Electric held an 80% market share and licensed most of the remainder under its patents. General Electric held all the crucial patents and between 1913 and 1945, lighting in the USA was incandescent lighting as manufactured by General Electric. (Bijker, 1995: 203).

> On the supply side, the market was thus relatively cohesive. General Electric and Westinghouse manufactured all types of lamps, while smaller companies had to limit themselves to a few types. (Bijker, 1995: 204)

On the demand side the market was segmented. Firstly, outdoor lighting, including street lighting, used incandescent lamps and neon-sodium discharge lamps. Secondly, coloured outdoor advertising lamps formed a different segment of the market and high-voltage discharge lamps were used in this segment. (Bijker, 1995: 204)

Bijker indicates (1995: 204) that the market for indoor lighting was divided between household and large commercial buyers. Lastly, there were so-called miniature lamps for automotive and photographic uses. A last group called specialized lamps was used for different specialized purposes. (Bijker, 1995: 204)

Bijker (1995: 204,5) points out that a new relationship developed called the Mazda group. The Mazda companies consisted of General Electric and Westinghouse with a special agreement while all the other smaller firms were licensed according to a more limited or restricted agreement. The Mazda companies had links with sales agents, central electric utilities and fixture manufacturers. All dealers had to sell Mazda lamps at consumer prices ultimately set by the Mazda companies. Grocery, drug and electrical stores acted as retailers, more strictly controlled than would have been the case under normal market conditions.

Bijker (1995: 206) indicates that the central electricity-producing utilities had originally been organized as licensees of the Edison, Thomson-Houston or Westinghouse companies and with the continued increase in the use of electrical appliances both groups stayed dependent on one another. The basis of this relationship was an understanding that each side would promote the interests of the other two.

> 'The utilities undertook to sell and promote Mazda lamps – and the appliances and other electrical apparatus of the Mazda manufacturers as well – and for their part, the Mazda manufacturers undertook to promote their products in such a way as to add to the amount of electricity consumed' (Bijker, 1995: 206).

Lastly, Bijker (1995: 207) points out that a similar close relation existed between the Mazda companies and the fixture manufacturers. The Mazda companies produced mainly lamps. Smaller companies produced sockets, reflectors and other auxiliaries.

A system of specifications for incandescent lighting was introduced. This system was maintained by the RLM Standards Institute, an association of the largest fixture manufacturers. It established standards that the products of its members had to meet, which also favoured Mazda lamps.

The Mazda companies therefore occupied a privileged position and dominated the market and were bound to an agreement with the electricity suppliers to add to the electricity that would be consumed.

5.5.2. Fluorescence and the social construction of fluorescent lighting

> 'The phenomenon of fluorescence had already been known for a long time, when the physicist George Stokes studied fluorite, a mineral that displays the effect strongly, and coined the term "fluorescence"' (Bijker, 1995: 217).

Bijker (1995: 217) mentions that the term 'fluorescence' was used for illumination phenomena caused by some form of external radiation like X-rays or ultraviolet as opposed to illumination caused by heating (incandescence). Phosphorescence is fluorescence that persists for a while after the existing radiation has ceased. Bijker mentions that phosphors were sometimes used for all fluorescent materials, which is confusing.

> The successful application of neon lamps in advertising led to the use of fluorescence to create a wider spectrum of more distinctive colours. The tubes were internally coated with fluorescent powder. (Bijker, 1995: 217)

The colour of the light, the high voltage and high installation costs initially did not seem to make it suitable for general indoor lighting.

In France, Andre Claude experimented with high voltage daylight lamps and by 1936 it had been possible to obtain white light from a single tube. It was used on a limited scale indoors. Claude's company started conducting business in the United States but General Electric had managed to confine them to the field of outdoor lighting through an agreement not to intrude on each other's markets. General Electric had meanwhile given little attention to fluorescent lamps since before World War I and only made a serious effort in the late thirties. In July 1935 a high-efficiency lamp was demonstrated at a closed meeting of naval officers and General Electric officials. It was tested aboard a ship and some months later a practical, low-voltage fluorescent lamp was introduced to the public at the national convention of the Illuminating Engineering Society.

> On 21 April 1938 General Electric announced the commercial availability of the low-voltage fluorescent lamp. (Bijker, 1995: 220)

When the fluorescent lamp was officially launched it was specifically meant to provide 'tint-lighting'. It could provide a wider variety of brighter and deeper colours than incandescent lamps. It was expected to find application in specialized lighting, ranging from theatre interiors to ballrooms, art galleries and showcases.

> 'But within half a year of the introduction of the fluorescent tint-lighting lamp, another artifact emerged: the high-efficiency daylight fluorescent lamp' (Bijker, 1995: 227).

The utilities feared that the efficiency of the fluorescent lamp might lead to decreased electricity sales. An internal memorandum of Westinghouse lends support to these fears. (Refer to Table 3)

Comparison of profits to be gained by different relevant social groups in the cases of the fluorescent lamp and the incandescent lamp

For every dollar the user spends annually with	incandescence	fluorescence
The utility gets	80%	44%
The contractor gets	10%	12%
The equipment suppliers gets	6%	20%
The lamp suppliers gets	4%	24%

Source: R. G. Slauer (Westinghouse Lamp Division, Commercial Engineering Department to Westinghouse Lamp Division) to A. E. Snyder (Westinghouse Lamp Division, Executive Sales Manager), letter dated 12 July 1939 (Committee on Patents, 1942: 4818–4819; 4818).

Table 3. Comparison of profits to be gained by different relevant social groups in the cases of the fluorescent lamp and the incandescent lamp. (Bijker, 1995: 228)

The comparison of profits in the above table shows that utilities got half as much for fluorescence as for incandescence. Lamp suppliers got six times more and the equipment manufacturers got three times more. Even the contractor got more.

The utilities tried to keep the fluorescent tint-lighting lamp in the forefront in opposition to the high-efficiency daylight fluorescent lamp. They argued that claims about high-efficiency might be true, but only when fully verified, which had not been done as far as they were concerned. A controversy arose. Although the utilities and the Mazda companies both felt threatened, a third relevant social group appeared on the scene: the smaller independents. In 1938 the Hygrade Sylvania Corporation introduced its own line of low-voltage fluorescent lamps. This was followed by the Consolidated Electric Lamp Company in 1939 and later also by the Duro Test Corporation. For the latter two it was just an addition to their established line of incandescent lamps.

Under its B-class license restrictions, Hygrade Sylvania cashed in since it had long been attempting to grow, but was never able to command more than five percent of the total market. Its engineers worked on fluorescent lamps as early as 1934 but it did not seem commercially attractive. When the Mazda Companies introduced their lamps in 1938, Hygrade increased its research activities, gained control of some patents and started its own low-voltage fluorescent lamp production. It resulted in a patent infringement suit, which was only settled after World War 2.

Hygrade's fluorescent lamps challenged General Electric's control of the market. The utilities sensed a realignment of forces taking place among lamp manufacturers. The Mazda companies admitted that Hygrade was capturing a sizeable portion of the market; in this way the general public became a relevant social group and Hygrade made this relevant social group its ally. Bijker (1995: 234) points out that within the relevant social group of the general public, women were singled out as a group because a widespread acceptance of fluorescent lighting in the home would directly depend on the housewife.

The last relevant social group according to Bijker (1995: 234) was the fixture manufacturers. General Electric and Westinghouse only produced lamps; the other companies produced the fixtures. Yet Hygrade produced its own fluorescent lamp fixtures and thus marketed complete lamps, putting pressure on the fixture manufacturers.

To resolve this conflict a conference between the Mazda companies and the utilities was held on 24 and 25 April 1939:

> 'At this conference the idea emerged that fluorescent lighting might be reserved for high-level lighting only. At the meeting a third fluorescent lamp was designed – not on the drawing board or the laboratory bench, but at the conference table' (Bijker, 1995: 238).

The light this lamp was supposed to provide was the colour of daylight and could be indicated as the high-intensity daylight fluorescent lamp. Bijker stresses that the lamp did not even physically exist, but there was closure, albeit rhetorical closure. The stabilization of the lamp would still take another year and the introduction of the fluorescent lamp was so rushed that the Mazda companies had not been able to prepare the fixture manufacturers for their task of designing the auxiliaries. The result was an inadequate supply of fixtures. Many small firms took advantage of the situation and started fluorescent lamp fixture businesses:

> ‘These ‘tin-knockers’ often produced quite objectionable installations, which were nevertheless so satisfactory to their customers that the demand for fluorescent lamps quickly increased further. On the other hand, this also boosted the power factor problem’ (Bijker, 1995: 247).

The Mazda companies, utilities and fixture manufacturers held a number of meetings and the result was an agreement that some kind of certification system had to be developed. It would specify the technical requirements that all auxiliary parts had to meet.

The Fleur-O-Lier Association was established, sponsored by the Mazda companies; the specifications were to be developed by the lamp manufacturers. Bijker (1995: 248) points out that progress was slow because the initial specifications were not acceptable to the utilities. He highlights that the negotiations about the certification scheme show unambiguously that the artefact that was stabilizing was the high-intensity daylight fluorescent lamp.

Bijker (1995: 249) indicates that one of the reasons why the Mazda companies and utilities wanted to control the fixture manufacturers was to be able to compel them to produce fixtures equipped with glass shielding so that lamps would not be too bright, which could damage the eyes. Ironically, such glass shielding was less necessary than in the case of incandescent lamps but one did have to use more electricity to get the amount of light that one would have had if the glass shielding were not there. According to Bijker this possibility of controlling the light output finally got the relevant social group of utilities to co-operate fully with the certification scheme.

In conclusion, Bijker (1995: 248) believes that it was Hygrade Sylvania that got the process going. In 1939 they started producing fixtures for their incandescent lamps themselves. Bijker points out that these were well designed and enabled Hygrade to offer a complete lighting unit of the highest standards. Its line of fluorescent fixtures, furthermore, included a wide variety of styles.

5.5.3. Power and the Development of Artefacts

> 'One point will be evident by now: the fluorescent lamp was developed in the midst of power games. Various exertions of power figured prominently, though not always identified as such: patent licensing, cartel forming, price setting, political pressure' (Bijker, 1995: 260).

Bijker regards power as a relational concept. It is exercised rather than possessed. Just as an artefact is constituted in interaction rather than having an intrinsic meaning independent of context, power is an instance of interaction.

Bijker (1995: 263) employs the terms 'semiotic power' and the 'micro-politics' of power. The case studies indicate that meanings become fixed or reified in certain forms, which then articulate particular facts, artefacts, agents, practices and relations. This fixity is semiotic power, the taken-for-granted categories of existence as they are represented in technological frames.

The micro-politics of power describes how various practices transform and structure the action constituting a particular form of power – that of producing technological frames.

> 'It will be clear that semiotic power and micropolitical power are inextricably linked: micro-politics results in a specific semiotic structure, while the semiotic power in turn influences the micropolitics structures'(Bijker, 1995: 263).

According to Bijker (1995: 263) the semiotic and micropolitical aspects of power can be directly linked to the processes of closure and stabilization. He argues that the reaching of closure, where the interpretative flexibility of an artefact is diminished and its meaning fixed, can be seen as semiotic power resulting from a multitude of micropolitical structures in relevant social groups.

He elaborates that in the stabilization process the micropolitical interactions also result in fixing more elements in the semiotic structure. The result is that more people in the relevant social group are enlisted, new relevant social groups can be formed and the meanings of the artefact can be elaborated upon.

The conclusion is that a technological frame linking these processes constrains the actions of its members and exerts power through the fixity of meanings of artefacts (semiotics). It also empowers its members by providing problem-solving strategies, theories and practices that represent the micro-political aspects of its power.

The following example can serve as illustration: to have a patent does not in itself makes one powerful. The crucial question is how the micropolitics of power will result in that patent being instrumental in transforming the actions of others.

5.5.4. The Politics of Socio-technical Change

Bijker (1995: 269) develops his arguments in three steps. Firstly, in the bicycle case study, he indicates that it is necessary to regard 'technical' development not as a straightforward process, but as a social process involving relevant social groups and the interpretative flexibility of artefacts. This illustrates the fact that development cannot be explained solely by referring to the intrinsic properties of artefacts. To him, artefacts 'work' because they have been accepted by a relevant social group.

Secondly, he introduces the notion of technological frame. In this model he demonstrates how the interpretative flexibility can be mapped and how an artefact can either fail or attain a stable interpretation, which he indicates as closure. The artefact, on the other hand, can also stabilize to a certain degree. Technological frames link these two processes interactively.

In the last case study Bijker proposes a twofold notion of power. His conception of power has two aspects: a semiotic aspect that emphasizes the importance of the fixation of an artefact's meanings and a micropolitical aspect that focuses on the continuous interaction of relevant social groups in the technological frame. This case introduces the idea that the distribution of power is a factor in the shaping of technology and society.

With these insights Bijker (1995: 173) explains that the notion of a 'seamless web' serves as a reminder that non-technical factors are important for understanding the development of technology. It inclines to contextual approaches as opposed to internalist analyses. To him it is never clear, neither a priori nor independent of context, whether a problem should be treated as technical or as social and whether solutions should be sought in science, economics, or some other domain. He reminds us that it was not engineers but managers at a business meeting that designed the high-intensity fluorescent lamp.

At this point it must be stressed that Bijker's chosen framework does not allow him to solve the problem of whether something is 'social' or 'technical'[138]. It should be borne in mind that his framework is only concerned with social and technical interaction. He has to assume a priori notions of society and technology and assume that there is interaction. This includes the possibilities of societal development of technology and technical development of society. The true nature of the problem can of course be outside, or transcends, this chosen framework; if that is the case, he will have to borrow from a wider context.

He stresses that the relations analyzed were simultaneously social and technical and should be called socio-technical ensembles. He states that the

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[138] Argued in previous footnotes.

technical is socially constructed and the social is technically constructed. To him, all stable ensembles are bound together as much by the technical as by the social. (Bijker, 1995: 273)

From an ontical point of view this is possibly another example of a 'contextual' transgression. He actually analyzes social groups (as components of society) and their interaction with artefacts, of which some were definitely not *technological*, especially bicycles and lights. Bakelite could be moulded and used as a technical component in a technical forming process. *Socio-technical* is almost too presumptuous. *Socio-artefactual* or *group-artefactual* is possibly more precise.

But he wants to do more. He aims at a relation or heterogeneity that is more than just social and technical, which in principle lies 'outside' his chosen framework.

> 'The theory of socio-technical change that I am developing, for example, must mirror the heterogeneity of this socio-technical "stuff" without resorting to just "adding up" the social and the technical' (Bijker, 1995: 274).

Bijker uses the notions of 'technological frame' and 'inclusion' to distinguish between different configurations of the power or political relationship between society and technology

In his first configuration no clearly dominant technological frame guides the interactions. To Bijker (1995: 276) this means that no single dominant group and no effective set of vested interests exist in that interaction. Under such circumstances, there will be many different innovations which could be completely unconventional, implying that these socio-technical ensembles are subject to variation in all respects.

In his second configuration Bijker explains that one dominant group is able to insist upon its definition of both problems and appropriate solutions, which implies one dominant technological frame. Under such monopolistic circumstances, Bijker believes that innovations tend to be conventional.

In his third configuration, in which there are two or more entrenched groups with divergent technological frames, arguments that carry weight in one of the frames will carry little weight in the other. Under such circumstances Bijker believes that criteria external to the frames in dispute may become important when appeals are made to enlist third parties. Amalgamation of vested interests is the process of closure that often occurs.

Bijker (1995: 279,280) also argues that there are three routes for the politics of socio-technical relations:

The first is to forget that the initial interest in STS was politically motivated and simply regard STS as an academic field.

A second route turns to political concerns like science and technology policy studies where the insights gained are used to develop concrete policy instruments.

He prefers a third route leading to a politics of technology. This politics will deal with questions of value-ladenness, of potentials (emancipatory and oppressive), of democratization and of the embeddedness of technology in modern culture. The semiotics and micropolitics of power in socio-technical ensembles are what interest him.

5.6. Conclusion

Bijker highlights the fact that technical development is not a straightforward process but an undetermined (indeed, indeterminable) societally influenced process where relevant societal groups interact in the process of development. No groups have a privileged position and all groups cannot be controlled.

He also highlights the power play involved on both sides of the technological frame, namely closure by different groups and the stabilization of different artefacts. He also emphasizes the relational character of power play.

To him the constructivist perspective provides a rationale for a politics of technology. Interpretative flexibility indicates that the stabilization of artefacts is a social process and hence subject to choices, interests and value judgments or, in short, politics:

> 'Without an understanding of the interpretative flexibility of socio-technical ensembles, the analysis of technology and society is bound to reproduce only the stabilized meanings of technical artifacts and will miss many opportunities of intervention' (Bijker, 1995: 281).

It is true that the societal stabilization of artefacts and the interaction between groups are societal processes and hence subject to various choices, which he defines as politics. Whether interpretative flexibility indicates that stabilization is a societal process is questionable. It is only a function of his chosen framework. As argued, interpretative flexibility indicates that within various frameworks different meanings could be given to different artefacts. In an ontological framework an artefact will be interpreted in its ontic or real character, whereas in Bijker's chosen framework it can only be interpreted within the developmental interaction between groups and artefacts. Within his framework interpretative flexibility is a societal process. But it is important to realize that it is but one framework.

The constructivist argument that the core of technology – that which constitutes its 'working' – is socially constructed is likewise limited to a narrow framework as seen within the relationship between society and technology.

Obviously, the core of technology can also be analyzed in terms of a transcendental account of ontic conditions, of which the societal is one dimension.

Within Bijker's chosen framework a politics and theory of socio-technology have to account for a balance between malleability and obduracy and a balance between actor and structure. He (Bijker, 1995: 282) tries to explain that an artefact in the role of exemplar (that is after closure, when it is part of a technological frame) becomes obdurate. The relevant social group has invested so much in the artefact that its meaning has become quite fixed and forms part of a network of practices, theories and institutions, so that it cannot easily be changed.

Bijker (1995: 283) highlights that the obduracy of technology can take on at least two different forms, one associated with the artefact as exemplar and the other with the artefact as boundary object. For him, part of the process of closure and stabilization is the creation of inside/outside boundaries. Actors with a high degree of inclusion are further inside the boundary than actors with a lower degree of inclusion. The obduracy of artefacts as boundary objects for actors with low inclusion presents an 'all or nothing' choice.

He (Bijker, 1995: 284) describes the choices indicating that for actors with a low degree of inclusion, an artefact presents a 'take it or leave it' decision. He argues that they cannot modify the artefact when they take it, but life can go on if they leave it. For highly included actors, on the other hand, there is no life without the exemplary artefact, but a lot of life in it.

Although the combination of technological frames of actors and artefacts and the semiotics and micropolitics of power are meant to describe this process of developing socio-technical ensembles, it was shown that Bijker did not consider all the indicators of an ontic framework as could be expected from a disciplinary approach. Some important distinctions are the following:

He equates groups to society and artefacts to technology. He furthermore cannot distinguish different types of artefacts and sees artefacts as ‘all products of technology’, denoting ‘machines as well as technical processes, hardware as well as software’ (Bijker, 1995: 291). As argued before, artefacts cannot be equal to technology[139].

Lastly, Bijker (1995: 13) specified the requirement of society as a seamless web. A conceptual framework should not make a priori distinctions between, for example, the social, the technical, the scientific and the political. This can be disputed from a transcendental epistemological point of view. It is accepted that the term ‘a priori’ has different meanings in different contexts. It

[139] We leave aside other aspects of Bijker’s sociology because we restrict our analysis to those elements that may contribute to an ontological totality view on the technical.

is not clear in what context Bijker uses the term, but as he chose an interactive social-technology framework, it is assumed that he uses it in this framework.

If this is the case, his framework pre-supposes or assumes the notions of society and technology, as has already been indicated. He requires *both* as a priori before he can even start analyzing the interaction. From an epistemological point of view all assumptions are initially a priori until a posteriori proved or disproved. It is therefore an epistemological 'pre-condition' to start with an assumed paradigmatic context and concepts. Unfortunately the requirement that no a priori distinctions should be made can in this context also mean that no such distinctions validly exist, because they are not to be used.

This brings about the question: why this requirement? Is it not possible that two artefacts can exist and could be distinguished on the *basis* of different aspects? The implication from an epistemological point of view is that Bijker cannot use different aspects to distinguish between, for example, economic artefacts, artistic artefacts, technical artefacts and say, religious artefacts.

One can sympathize with this requirement if he has in mind that in society there are structures (like artefacts, 'totalities' or Latour's 'collectives') that function as concrete entities, involving all possible aspects simultaneously, which should not in a biased fashion be reduced to one of their aspects. A requirement of fairness or validity or an appeal for the analysis of the totality should suffice, or even an appeal that society should be viewed as a web. Even this appeal is a priori and he should not get involved in a priori exclusions.

Although Bijker has contributed to our understanding of the development of artefacts and the relationship between the social and technical, he does not offer a unique description or model of ‘technology’. It has, of course, never been his intention. Before he starts his analysis he actually proceeds from an a priori understanding of technology and society.

His study of the history of artefacts and their interaction with groups sheds a different light on *artefactual development* and the undetermined character of such development that is influenced by various social actors in various social contexts. Ironically, he studies artefacts (and their relations to groups) and calls it technology. None of the artefacts he mentions are either technical operators or involved in techno-practice and should not be linked to the technical or techno-practice at all. Unfortunately his study of the politics of things does not bring us any closer to the technical or to techno-practice.

From an ontological perspective it would also be clear that he also tries to achieve goals that transcend the limits of his chosen framework.

6. Conclusions and proposals

The study started off with the questions of what 'technology' is and where it fits into reality and society.

Linguistically the term 'technology' indicates the study or science of the technical ('techno' and 'logy') – in other words technical science or techno-science. This is especially evident in the German tradition. In the English tradition many problems arise. One of these problems is that the term indicates a *science*, which makes the phrase 'science and technology' tautological. Furthermore, many authors imply something 'more' than 'just' science when they refer to technology – for instance, some material 'objects', artefacts, tools, instruments or even processes.

On the other hand some authors use the term 'technology' *not* in the sense of a scientific study but in order to designate an artefact or even the *process* of producing *artefacts.* Sociologists view technology as some *knowledge producing* activity involving tacit practical know-how that can change society. Its power to change society is of particular interest to some sociologists.

As could be expected[140], no clear ontical definition of technology as

[140] As was argued before, an ontical totality view of the technical transcends the focus of sociology as discipline.

technology has been found in the studied literature. Many definitions of technology as a set of artefacts or as a set of systems or set of techniques are found but it seems that the authors are reluctant to go beyond the idea of *technology as an important agent of change* in society. It is therefore clear that *technology* is important and should be studied. It has furthermore simply been assumed that technology exists and is not just a figment of the imagination. On the basis of this assumption further transcendental consideration is not required. The issue, therefore, is to develop a theory that would recognize the importance of technology and to give some flesh to the ideas.

The result is that *technology* has been studied from various angles – for example, its interaction with society in a framework that *assumed* society, technology and an interaction. The typical *nature* of technology as ontical entity cannot be studied in such a framework because before one can work in that chosen framework one has to assume some kind of ‘idea’ of ‘technology’ and ‘society’ and of the ‘interaction’ between them. One cannot reappraise one’s own *conception* of technology in that specific framework.[141]

As a result of these assumptions about technology in the various frameworks various difficulties have arisen. For example, artefacts that are definitely *not technical* are indicated as *technological*. Furthermore, no difference between

[141] Extensively argued in previous sections.

technological and *technical*[142] artefacts is indicated and some authors do not distinguish between *technological* and *non-technological* artefacts.

In order to go beyond the idea of technology as an agent of change it has been decided to move away from the term *technology* on the assumption that it is an (ontically) *inadequate lingual construction*[143] from a transcendental-empirical point of view and to develop a model of *technical activity* against which certain notions of *technology* can be measured. In principle it is possible to create 'lingual constructions' or terms for things that do not exist in an ontic sense. An example would be 'time-machine', meaning a machine that 'creates time' or which allows 'time travel' which exists only in science fiction and in our imagination. Another type is a combination of contradictory terms that does not indicate things that can possibly exist in reality (ontically) – like 'a square circle' or 'round triangle'. The issue here is whether the lingual construction 'technology' denotes any empirically tested (ontic) phenomenon.

6.1. Historical influences on techno-practice.

In the literature it is clear that historical development has made a fundamental contribution to our understanding of techno-practice. Techno-practice has

[142] This could indicate confusion.

[143] That would be a lingual construction that does not account for ontic conditions like for instance a 'square circle'.

been indicated as related to the historical development and formative power of humanity. More diversified, advanced societies have more advanced techno-practice.

History has also shown that advanced societies were sometimes outmanoeuvred by less developed societies, as was the case when more advanced European nations lost wars against Mongols on horseback. This indicates that historical development is indeterminate. It is still not clear why certain societies developed and others collapsed.

In the literature three phases of techno-practical development are utilized, namely the ancient or distant past, current history and the future.

6.1.1. Historical developments or revolutions?

Jonas (1990: 41, 42) states that if we are concerned with characteristics of modern techno-practice (he uses the term technology), we should ask what distinguishes it formally from all previous instances of techno-practice. One major distinction in his opinion is that modern techno-practice is an enterprise and process, whereas earlier techno-practice was a possession or artefact. He describes techno-practice as comprising the use of artificial implements (artefacts) for the business of life, together with their original invention, improvement and occasional additions. He believes such a tranquil description will do for the greater part of the history of techno-practice but not for modern techno-practice. In the past, generally speaking, a given inventory of tools and procedures used to be fairly constant, tending toward a mutually adjusting, stable equilibrium of ends and means, which – once established – represented an unchallenged optimum of technical competence for lengthy periods.

Jonas (1990: 42) accepts that revolutions occurred, but more by accident than by design. The agricultural revolution, the metallurgical revolution that led to the Iron Age, the rise of cities, and so forth, *just happened* rather than having consciously been created. Their pace was so slow that only in the time contraction of historical retrospect do they appear to be 'revolutions', creating the misleading impression that their contemporaries experienced them as such.

Innovation does not always originate in so-called advanced societies. With the introduction first of the chariot, then of armed horsemen into warfare, the innovation did not originate in the military art of the advanced societies that it affected, but was thrust on it from outside by the (much less civilized) peoples of Central Asia.

> Instead of spreading through the technical universe of their time, other technical breakthroughs like Phoenician purple-dying, Byzantine 'Greek fire', Chinese porcelain and silk, and Damascene steel-tempering, remained the

jealously guarded monopolies of the inventor communities. Still others, like the hydraulic and steam playthings of Alexandrian mechanics, or the compass and gunpowder of the Chinese, passed unnoticed in spite of their serious technical potentials (Jonas, 1990:42).

This interesting situation can now easily be explained if one considers the distinction given in the technical model of ontical categories. The closely guarded secrets of the inventor communities were obviously the techno-practice of the invention. At that stage no patent protection existed, therefore one had to keep the process a secret. The artefacts (called technology) and its usage potential (techno-literacy) were obviously widely recognised.

To Jonas, the great classical civilizations had reached a point of what he calls 'technical saturation' – a balance between means and needs and had little cause later to go beyond it. He believes that from there on,

…convention reigned supreme.(Jonas, 1990:42)

He believes tools, techniques, and objectives remained essentially the same for long times – from pottery to monumental architecture, from food growing to shipbuilding, from textiles to engines of war, from time measuring to stargazing. To him improvements were sporadic and unplanned. Progress therefore – if it occurred at all – was by inconspicuous increments to a universally high level that still excites our admiration and, in historical fact, was more liable to regression than to progression. The former at least was the more noted phenomenon, deplored by the epigones with a nostalgic remembrance of a better past (as in the declining Roman world).

More importantly, to Jonas, there was, even in the best and most vigorous times, no proclaimed idea of a future of constant progress. He argues that there was never a deliberate method of going about it, like ‘research,’ exchanging information widely about the experience, and so on. Additionally no ’natural science’ as a growing body of theory existed to guide such semi-theoretical, pre-practical activities (Jonas, 1990: 41, 42).

At this stage it is important to realize that a historical view could also shed light on our understanding of techno-practice. The fact has to be noted that there is an idea of a future of constant progress in modern techno-practice, as well as a deliberate method, such as research, of going about it. This also brings about a need to investigate the 'research' method of techno-practice at a later stage.

6.1.2. Historical Frameworks

Hickman (1990a: 245) enquires about the relation between contemporary *technology* and the *technologies* of the past. Do changes in technological paradigms, including our attitudes toward technology and the metaphors and myths we use to characterize them, emerge from hardware innovations, or do such innovations arise from our changing metaphors, myths, and paradigms? At this point it must be highlighted that the guiding model allows for interaction between two independent issues – the hardware and the paradigms – in techno-practice and artefacts, techno-knowledge and techno-science.

Hickman states that, despite different perspectives, there is a startling consistency in accounts of the history of technology. Various authors articulate three stages: a remote past, an immediate past and an immediate future.

He highlights various authors to illustrate his argument. What was found interesting was the fact that although variances between his examples of different authors exist the interesting consistency indicates an interesting historical context in which techno-practice could be interpreted.

If one consider the interesting fact that in the development of a society from agriculture to industrial, the agricultural activity was not replaced but just augmented by the industrial, meaning that although more of the community were involved in the industrial than in the agricultural, the agricultural still existed side by side with the industrial, still supplying in the minimum needs of society.

In a sense a similar tendency was found in thee interpretation of the different historical frameworks of the authors he compiled. This could possibly be useful in interpreting the different types of techno-practice found in modern society.

A summary of some of the authors that Hickman covered could be highlighted to indicate some interesting correlations.

The position of the late Spanish philosopher José Ortega y Gasset (1990: 254-263), can be summarised by highlighting that an understanding of the patterns of technological history is based on an examination of humanity's changing consciousness of its own making and doing and not on a chronicle of technological inventions. He argues that there have been three such stages, which he calls the technology of chance, the technology of the craftsman, and the technology of the technician. What was found interesting was the idea that during early human history, technological innovation was largely perceived either as chance occurrence or as a gift of the gods.

Later, when a sufficient store of technical skills had been accumulated, technology (techno-practice?) came to be thought of as a body of knowledge, or know-how, to be identified with the work of an artisan. This could possibly be better described by the term ‘techno-knowledge’

In its current phase, the technology of the technician, methodology and execution have become the proper tasks of the engineer and the worker, respectively. A distinct awareness is highlighted of the human’s own inventive power within an abstract system of invention called ‘technology.’ In this case it seems better to indicate it as techno-practice.

Another example noted by Hickman (1990b: 82) is that of Marx. What was interesting to note was that Marx regards the first stage of technology simply as ‘pre-capitalism,’ which he divided into three sub stages:

The first was the family and tribe going about their hunting and gathering, and engaging in primitive agricultural practices. Secondly, slaves were required for the smooth operation of the technological system as agricultural production became more advanced and the crafts and trades were more developed. Thirdly, medieval Europe replaced slavery with the feudal system. The rise of the bourgeoisie, who accumulated capital and exploited the worker, prepared Marx's second major period of technology.

Marx’s second stage of technology is known as ‘capitalism’ and, the third stage and the immediate future is Socialism.

Hickman (1990b: 82, 83) also highlighted Dewey’s view of technical development and indicates that Dewey's first stage is that of the hunter. His view is that tools are almost nonexistent for the hunter. What was found interesting is the suggestion that the aesthetic and the instrumental were not readily distinguished or easily distinguishable and there is little awareness of objects as such because they are thoroughly functionalized. His second stage highlights the Greeks. The third stage highlights the scientific revolution of the sixteenth and seventeenth centuries.

Hickman (1990b: 82, 83) suggests that another way of reading Dewey's history of the philosophy of technology is to treat his remarks on hunting cultures as preliminary. This would make his first stage the one dominated by the Greeks. Dewey's second stage would then be the scientific revolution of the age of Galileo, and his third stage would be the immediate future that offers the possibility of applying the methods of scientific technology to every area of human valuation. This alternative description would have the consequence of bringing Dewey's schema into line with those of the other historians of technology (Hickman, 1990b: 82, 83).

Hickman (1990: 247) indicates that another influential voice among historians of technology has been that of Lewis Mumford. Mumford warns us that the notion that a handful of inventors suddenly made the wheels hum in the eighteenth century is too crude to be precise.

Mumford (1990: 283,4) divides the history of technology into three overlapping and interpenetrating stages: the eotechnic, the paleotechnic, and the neotechnic.

Mumford places the eotechnic, or ‘dawn’ of modern technology, between the years 1000 and 1750. Its material resources were primarily wood and stone;

its sources of energy were wind, water, and animals; and its dominant attitude toward production was that of the craftsman.

He indicates that the division between stages are not clear and stresses that most of the major inventions of the paleotechnic, germinated during the eotechnic. These inventions include the iron horseshoe the modern form of the harness, glass, mechanical clocks, the telescope, cheap paper, the printing press, the magnetic compass, and (to him) perhaps most important of all, the scientific method. The developments were gauged by speculation that with the new machinery of the paleotechnic, a worker could perform nearly 1,000 times as much work as his or her eotechnic predecessor.

Seen in retrospect, however, their culture seems more crippled than developed.

> Here was something almost without parallel in the history of civilization: not a lapse into barbarism through the enfeeblement of a higher civilization, but an up-thrust into barbarism, aided by the very forces and interests which originally had been directed toward the conquest of the environment and the perfection of human culture (Mumford, 1990: 283).

No single date can be given for the end of his paleotechnic period. It did not, in his opinion, even get under way in the United States before the 1850s or in the Soviet Union before the 1920s. For most of Western Europe its end was probably marked by the close of the First World War in 1918, but there are some third world countries that have never experienced it to any significant extent and whose technology is still best described as eotechnic.

In time, however, the paleotechnic materials, coal and iron, were replaced with synthetics of all sorts. Steam power was replaced with electricity. Automation began to effect a shift from factory economies to service economies. But in 1934 Mumford warned that the neotechnic period was just beginning and that the ideals of the paleotechnic still dominated the industry and politics of the western industrial democracies.

Since Mumford wrote, great technological inventions such as the gasoline engine, the phonograph, the motion picture, and the airplane have altered the cultural landscape. Since that time, the neotechnic period has seen the invention and development of television, computers, space-age alloys, and rockets to the moon (Hickman, 1990: 245-252).

An important implication to be noted is that the techno-practice of the different eras could in principle be mixed in the current society and a historical framework must be accounted for in the model of techno-practice.

6.1.3. Proposed model

The preferred framework is a combination of Mumford (1990: 283) and José Ortega y Gasset's (1990: 254). Mumford spoke of eotechnics, paleotechnics and neotechnics and Ortega spoke of the *technology of chance*, the *technology of the craftsman* and the t*echnology of the technician*.

The following historical model is proposed:

Historically one can distinguish between (1) Basic Techno-practice, (2) Craft Techno-practice and (3) Automated Techno-practice.

The term Basic Techno-practice is preferred because it is relevant to 'primitive' techno-practice as well as an uncomplicated process still surviving today. This primitive (or in more recent times *basic) techno-practice* originally used to be *individualized non-standard efforts* by individuals that were conceived and successful only by chance and/or experience. There was no thought of developing or improving artefacts and, possibly, society. There were no standard procedures or systematic analysis and design to speak of and all artefacts were home-made for a specific purpose. Even today we find *basic techno-practice* in ingenious home-made solutions to small problems on farms and at home, and, of course, in some less developed societies.

With the term *Craft Techno-practice* we would like to indicate the process that utilized tools and know-how in terms of standard procedures to create artefacts that could be sold, like shoes, clothes and furniture. Craft Techno-practice has also provided the basis for the manufacture of machines and other driving engines like windmills, sailing ships and steam ships, and is used in the building industry as well. This type of techno-practice still exists although it is sometimes modernized through machinery and used in specialized applications.

The term *Automated Techno-practice* indicates the process that specifically utilize a systematic-technical method to describe the problem and provide its solution through designing artefacts and their production processes. This type of techno-practice is much more machine dependant and strives for total automation and standardized procedures. Because this is not always feasible, human artisans will still be required for certain jobs. It is closely linked to the industrial complex in society. A panoply of tools and machines are utilized.

This historical characterization shows although techné existed prior to the techno-scientifically based modern automated techno-practice, it was not left uninfluenced by it.

6.1.4. A revolution

The development from craft techno-practice to modern automated techno-practice has been called a revolution. The development from primitive (basic) to craft techno-practice was described as normal development, because the old and the new existed side by side for several centuries.

The beginning of modern automated techno-practice changed society and the whole approach to techno-practice. A developmental approach on the basis of scientific knowledge, the re-contextualisation of scientific knowledge as techno-knowledge, and its influence on techno-practice created the industrial revolution and revolutionized techno-practice itself.

Modern automated techno-practice changed existing craft techno-practice into machine craft techno-practice. Modern technical tools like welders, pop-riveters, grinders, electrical drills and machine equipment became available to the homeowner. In this way the basic (primitive) homemade techno-practice has been changed into simple singular solutions at home. Only in primitive cultures (mono-cultures) will some primitive techno-practical activity still be found.

In essence techno-practice today is dominated by the modern techno-scientific approach. It changed the craft and basic (primitive) approaches into machine craft and into simple singular solutions that one still finds at home. It is important to realize that techno-practice is not one-dimensional; it is multi-dimensional totality ranging from automated and specialized processes to less specialized machine crafts and simple homemade solutions. They all contribute to artefacts that can be utilized in society.

6.2. A Transcendental Empirical Model

A transcendental empirical model assumes an orderly ontic reality in which society and technical activity are to be found.

An overview of a tentative model of the technical relationship as an evaluative model is provided in 1.5.4. Various notions and ideas are identified and classified according to the different parts of this tentative model. This model presupposes a certain ontology and epistemology that needs to be explained. On this basis a model of the technical process and its relation to society will be formulated. To recap, a summary of the technical activity will be supplied. The presupposed ontology and epistemology will be highlighted before insights and problems previously identified are integrated into models to indicate the interaction of the technical and society within reality.

6.2.1. Model of the technical relationship

This model was identified from various ontical elements that were identified from the various authors investigated. All the authors identified at least one of these elements in their assumptions or explanations. As explained it would rather be surprising if any disciplinary author would have highlighted all or most of these elements as it in principle transcends the focus of any specific discipline.

It indicates some relationship between ontic (factual) elements that was found to exist in the process of technical design, development and manufacturing on the one hand (Techno-practice) and the result of this activity (artefacts) and its usage of these artefacts (techno-literacy). On the other hand the requirements needed for techno-practice in terms of techno-knowledge and even techno-science was also observed and plotted on this model.

The lines between the elements indicate the links and direction of the interaction between these elements. This is a tentative result of a synthesis from the current literature. It does give an overall view of the elements involved in the technical process of manufacturing and usage, which was indicated by the term ‘technology’ in various sources. This is obviously not final but can be a start to further developments.

The technical relationship

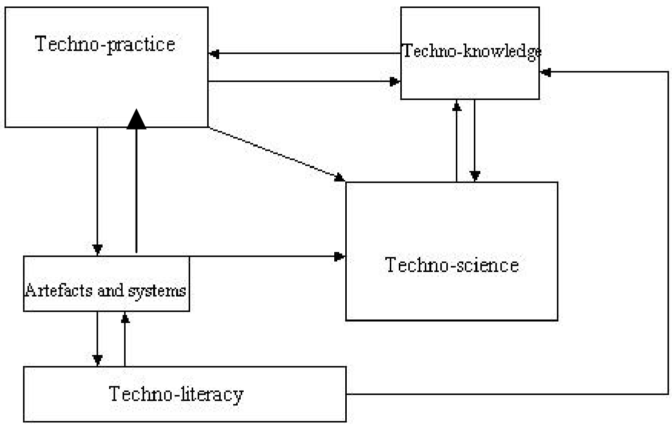

Fig.1 The technical relationship (revisited)

Firstly, TECHNO-PRACTICE was used to indicate the technical activities involved in innovation, design, production and maintenance in societies. The term included the use of tools and technical artefacts. The product of techno-practice could be a new artefact but this does not imply that the artefact as such is necessarily technical[144].

The important issue here according to Schuurman (1980:12) is the fact that a techno-practical event always involves a human and a techno-practical fact is

[144] This was discussed extensively in the previous chapters.

always started by this event but then operates independently, through the control of machines. The ideal is mass production through individual control of each product through cybernetic feedback that makes individualised control possible.

Sometimes, in phrases like *science and technology*, the term *technology* is used when *techno-practice* would have been more appropriate; for the sake of clarity, the phrase should probably be *science and techno-practice*.

TECHNO-SCIENCE was used to indicate the reality of technical sciences (engineering) where knowledge of technical processes and of relevant scientific principles of, for instance, mathematics, physics and electronics, were registered and conveyed. It was linked to our techno-knowledge and received feedback from techno-knowledge and techno-practice, as well as from the artefacts themselves. In engineering engineers therefore study older artefacts to identify possible improvements to be developed as well as take note of better production and automation possibilities. The ideal of production and control from a distance, without human intervention, is still the end goal.

TECHNO-KNOWLEDGE was used for the technical know-how in techno-practice – for instance the maintenance or servicing or fixing of a technical component in an artefact or the design or production of a technical component in artefacts. This knowledge base could have been developed through intuitive experience, artisanship and/or systematic knowledge obtained through scientific activity. The important issue here is that it should not be confused with scientific knowledge.

TECHNO-LITERACY was used to indicate the human competence required for operating any artefact that needs some technical skill, like a cell phone, ATM, computer, VCR, motor car and so on[145]. There is no indication that techno-literacy requires techno-knowledge – only the ability to use an artefact efficiently. It has been illustrated that this notion is sometimes confused with techno-practice or techno-knowledge through the use of the term 'technology'. This term would also allow of a notion of techno-illiteracy akin to information illiteracy that would indicate incompetence in dealing with 'hi-tech' artefacts. This is obviously an important issue in relation to more advanced versus less advanced techno-literate societies and the impact of techno-practice and associated artefacts on these societies.

ARTEFACT indicates all structures formed (created, designed, produced) through human ingenuity. The types of artefacts are numerous and can be classified by (inner) structural principles inherent to the unique structure of each artefact, which should not be confused with the purpose of the artefact.

This model is obviously related to society and reality, which implies that an

[145] ATM is an automatic teller machine and VCR is a videocassette recorder.

ontological framework that would illustrate this model's place in reality and society is required.

6.3. Proposed Ontology

Where Latour believes we live in a hybrid world made up of peoples, stars, electrons, nuclear plants and markets etc. and further believes that humanity has the task to turn it into either an unruly shambles or a cosmos, it is proposed that this world is a cosmos *already*; it is not humanity's task to *create* or *construct* a cosmos, but just to try and *understand* and *live in* it. In giving shape to human society, underlying principles are positivised – but these principles themselves are not the creation of human beings. If it were not for the *order for* and the *orderliness in* the cosmos that responds to this *order for* the cosmos, nothing would have been possible.

Consider for a moment Latour's hybrid reality of stars, electrons and nuclear plants. If no *orderliness* existed it would have been impossible to identify stars. Without an existing *order for* stars, they cannot be recognized as stars. His belief in a hybrid world presupposes some kind of *order for* his reality. The stars reveal an *orderliness* different from that revealed by electrons, but in line with the *order for* stars in reality.

Every analytical act of identifying and distinguishing therefore presupposes an *order for* as well as *orderliness in* the cosmos. Furthermore, this presupposes an element of constancy on the basis of which change could be distinguished, as well as characteristics that could be identified on the basis of similarities and distinguished on the basis of differences.

In a certain sense everything is therefore *subject to* an *order for,* and reveals *orderliness* in the cosmos. This allows for a different notion of reality. Latour indicates a division in reality by phenomenology (1999: 9). The division between an objective reality (out there) and subjective reality (in here) can be replaced by the proposition that both these realities are in fact subject to conditions (in the sense of an *order for*). In a certain sense then no 'objective' reality (that is, a reality that is not subject to anything) exists. Everything is conditional or subject to conditions. All things are at least subject to the *order for* reality.

Within this orderly reality one can distinguish an order for universal aspects as well as an order for concrete structures in reality. The Philosophy of the Cosmonomic Idea developed a well thought-out analysis of these two dimensions of reality that is extremely fruitful for the theoretical task of the various disciplines. In the course of this analysis the relevant distinctions will be explained. An orientational summary will be highlighted in the following sections as required.

6.3.1. The functional cosmonomic order[146]

We experience reality in its rich variety of aspects and entities. In everyday life concrete entities are experienced in their multi-aspectual nature. For example, something like a motorcar has an aesthetic aspect (its beauty), an economic aspect (its price), and so on. Dooyeweerd (1953-1958) developed a systematic theory in which a detailed account of the different aspects in reality is given.

Every aspect of reality is characterized by a unique core meaning, designated as its meaning-nucleus. In addition, every aspect is linked to all other aspects because the meaning of each aspect finds expression only in its coherence with those aspects that are different from it. Since the aspects are arranged in an ontic order, some connecting links refer back and others forward to those aspects that are placed earlier or later, as the specific case may be, within their temporal cosmic order. The nature of this temporal cosmic order is revealed as an order of complexity.

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[146] Please realise that up to now we were analysing ontic conditions. Only at this point can we try to explain these ontic conditions in an ontology. One could study 'technology' by studying different ontologies of different philosophers. The method chosen, the transcendental empirical method, allowed a study of ontical (factual) categories and not just the study of different ontologies. To study ontologies could direct the study towards investigating different ontologies instead of ontic (factual) elements. The study of different ontologies was therefore specifically excluded as it was felt that it could be an independent project on its own.

The following aspects can be identified:

ASPECT OF REALITY	MEANING-NUCLEUS
15) certitudinal aspect	faith and certainty
14) ethical aspect	moral love
13) juridical aspect	adjudication
12) aesthetic aspect	harmony
11) economic aspect	avoiding excess (balance)
10) social aspect	social intercourse
9) lingual aspect	symbolic meaning (signify)
8) historical aspect	controlled formative power (cultural development)
7) Logical aspect	analytical thought
--	--
6) psychical aspect	sensory feeling
5) biotic aspect	life
4) physical aspect	energy
3) kinematic aspect	motion
2) spatial aspect	continuous extension
1) numerical aspect	discrete quantity

The first six aspects are *natural* aspects and the next nine are *cultural* aspects, the reasoning being that natural laws prevail in the first six aspects and cultural norms prevail in the following nine aspects.

6.3.1.1. Order of the aspects

According to a cosmic principle of serial order the aspects are arranged in an order of increasing complexity.

The meaning of the numerical aspect does not presuppose that of space, but the reverse does not hold, since the very distinction of one, two or more dimensions reflects the meaning of number. Similarly, *magnitude* reminds one of the quantitative foundations of space because it is possible to distinguish between one-dimensional magnitude (length), two-dimensional magnitude (surface), three-dimensional magnitude (volume), and so on. The difference between the (ontic) meaning of number and space and a theoretical analysis of the meaning of these aspects should be considered, because the latter cannot make headway without making use of terms relating to other aspects. When mathematicians speak of the *domain* of number they might not realize that the term ‘domain’ is derived from the core meaning of the spatial aspect, just as they might not realize that their employment of terms like *constants* and *variable* relate to the core meaning of the kinematical and physical aspects respectively.

Likewise the meaning of *motion* presupposes that of number and space because the *path* of a moving body will be non-existent without the (foundational) coherence with the meaning of spatial extension and because specifying the *speed* of a moving body requires an appropriate *number* – such as when the speed of a car is specified as 60 kilometres per hour: '60' is a *number* while 'kilometres' represent a *distance in space*.

The physical force needed to accelerate a car presupposes all three aspects mentioned. It differs from the mere *continuation* of a movement that reflects the core meaning of the kinematical as it is captured by the law of inertia, in terms of which it is meaningless to inquire into the *cause* of movement since one can only meaningfully refer to the cause of a *change* in motion. Motion is something given, something primitive; only a change of motion – acceleration or deceleration – requires a physical force.

The biotic function of a living entity presupposes the physical aspect of reality but at the same time transcends the meaning of the latter because the opposition between 'life' and 'death' is not found within the physical realm. It is therefore meaningless to speak of 'dead matter' because it implies that matter must have been 'alive' before it *died.*

Sensitivity, which relates to the meaning-nucleus of the psychical aspect, pre-supposes life, which relates to the biotic aspect – just consider the phrase 'sense organs' – whereas logical thought, characteristic of the logical-analytical aspect, is related to sensitivity. One must be aware of A and non-A before one can logically distinguish between them.

Historical development, with formative control or power as its core meaning, is not possible without the ability to identify and distinguish (logically) and sensing (psychically). Language and symbols with meaning (from the lingual aspect) are formed, indicating the foundational link to the historical. Social interaction, one of the features of or actions in the social aspect, in turn pre-supposes shared meanings in language.

Appreciating the economic value of a commodity requires mutual (social) understanding on the basis of shared (linguistic) meanings (communication) and manifests an awareness of what is enough – the avoidance of what is excessive. Furthermore, aesthetic beauty or harmony pre-supposes the avoidance of excesses, which is the meaning-nucleus of the economic aspect of reality.

The meaning of the juridical is based on the harmonization (aesthetic) and balancing (economic) of a multiplicity (numerical) of legal interests. Moral (and immoral) actions presuppose the meaning of the juridical aspect because an immoral action such as stealing entails the foundational juridical meaning of unlawfulness. Finally the meaning of the fiduciary (faith) aspect, with its core meaning of *certainty*, is founded in ethical integrity, juridical righteousness, and so on.

6.3.1.2. Analogical moments

Each of these aspects illustrated above furthermore reveals additional meaning-moments through their relationships with the other aspects. This can be expressed as analogical moments. It is also called ante- and retroci-pations: antecipations refer to aspects that follow while retrocipations refer to previous aspects. To illustrate ante- and retrocipations one aspect will be analysed in all its analogical moments.

The lingual aspect with the meaning-nucleus of **symbolic meaning** or **signification** is number 9 on the list.

1) In its retrocipation to the numerical aspect one can identify a meaningful moment of a unit of significance that could be distinguished from a unit of faith, for instance, or a unit of love. A word, for example, is the smallest unit of meaning in a language.

2) Furthermore, a word may have different meanings in different contexts,

which is evidence of a link between the lingual and spatial aspects of reality.

3) The special notion of linguistic constancy can be identified in the relative stability of the meanings attached to words. The meanings of words do not change abruptly but gradually.

4) Evidence of linguistic change or dynamics is found in the fact that words can gradually acquire different meanings or shades of meaning, can become stronger or weaker or can become obsolete.

5) The expansion of meaning and the need for new words show that lingual growth is related to the biotic aspect of reality.

6) The analogical link between the lingual and the psychical aspect reveals the possibility of sensitivity or emotion in signification. Words could display a certain 'emotion', as can be observed in euphemisms, where less emotive terms are used to describe sensitive issues.

7) The logical analogical moment of the lingual aspect is illustrated by a language observing its own analyzable protocol without it obeying the rules of logic in the same way as science. The question, 'Are you here already?' put to someone's whose arrival we awaited, is illogical.

Nevertheless, we all use it and interpret it correctly as being an icebreaker or a way of starting a conversation.

8.) The historical moment of power in the lingual aspect is illustrated by the fact that, in specific contexts, some terms or symbols have greater power of expression than others.

9.) The 9^{th} moment highlights the depth of meaning in its ante- and retrocipatory relationships. These different relationships indicate the possibility of disclosure that could be positivized by individual human capabilities.

10) A dialogue illustrates lingual interaction. Without it one cannot communicate. Communication is actually lingual interaction, either directly or by means of transcending immediacy through print.

11) The economic moment of the lingual aspect could be illustrated by the fact that terms or symbols could be succinct. An example is the single phrase advertisements in the motor industry that convey values, qualities and image. Another example is Occam's razor that requires one to choose the simpler explanation of two equally valid statements.

12) Lingual harmony in the aesthetical anticipation of the lingual aspect is

illustrated by the beauty of language as used in poetry.

13) The influence of the juridical aspect, among other things, can be illustrated by the fact that language could be used legitimately or illegitimately. The issue of what is lingually proper, correct or just is revealed by all languages. Even when a dialect develops it answers to certain lingual 'rules'.

14) The ethical moment in the lingual aspect is revealed through lingual integrity. It highlights the fact that terms and symbols and the usage of language could reveal integrity. Because of lingual integrity one can use the correct words in lingual harmony.

15) Lingual trust or certainty is the indications of lingual reliability or convincingness. If one is fairly certain that one is understood the result is expected to be a lingually reliable phrase.

It is important to realize that every entity (in nature and in culture, which in this sense includes societal aspects such as the social, economical, aesthetical etc.) as well as processes, functions in all aspects of reality.

This implies that technical activity will also display fifteen aspects in its own unique way. Furthermore, as is obvious in the above example, each normative aspect supplies a guideline according to which norms and values could be positivized or actualized, or an area in which this could occur. This also could be used as a sounding board. In the economic aspect it is appropriate to speak of the economical and uneconomical actions of people. In the social aspect one can identify social and anti-social behaviour. This is true of all the cultural aspects.

6.3.2. Structural order or structural cosmonomic order

The structural cosmonomic order points to the structural conditions of entities. All things, events and societal relationships belong to the concrete dimension of the structures of entities. Everything or every entity has a structural order or relationship. It is important to differentiate between the structure of an entity and the fifteen aspects within which all entities function, but one cannot analyse any structure without implicitly or explicitly using some of the aspects.

The functional cosmonomic order supplies a method or process to analyse and to classify entities in the cosmos. Any concrete structure has fifteen aspects but reveal them in a unique relationship. The aspects form the constant universal contexts within which entities function. Although the individuality of the structure of an entity could not be explained by the variety of aspects in which it functions, it has been found that the structure could still be recognizably expressed within the universal structure of the aspects.

(Strauss, 1998: 83). The fifteen aspects could thus contribute to a classification of types of entities.

For instance, we find that the biotic aspect qualifies all living things. This means that the biotic aspect indicates a unique or typical characteristic of all living things. Examples are trees and plants that are living things in contradistinction to material, things that are not alive.

Material entities, like atoms, molecules, macro-molecules and macro-systems are physically qualified.

The qualifying aspect is therefore the aspect that makes an entity unique, but it also identifies similarities to similar entities functioning within the aspect concerned.

Both cats and dogs are psychically qualified – they are 'sensitive' living things, but they differ in many respects, namely, in their respective vitality (from the biotic perspective), their respective strength (from the physical perspective), movement (speed) and size (form). Even in their psychical ability, which is the qualifying aspect, differences like different conditioning and sensitivities exist.

From the above it is also apparent that the qualifying aspect cannot describe the totality, or structure, of an entity. Before entities can be summarized, two other important elements need to be added, namely the foundational function and its subject-object relationship in reality.

Every man-made object possesses a historical technical foundational function because it was culturally and historically formed through controlled formative power.

6.3.2.1. Subject / Object relations

It is important to realise that entities reveal various subject and object functions in different contexts.

Water, for example, is physically qualified. This means that water is a subject according to the physical aspect of reality, but water does not have life. Therefore it is not actively involved in, or subject to, the biotic aspect or life cycle. On the other hand it could serve as a biotic object 'supporting' life in living things like plants. It could be a psychical object when it 'cools' a psychical subject such as an animal. It cannot think for itself but could be thought about as object in the logical aspect. It cannot talk as subject but is a lingual object to be talked about. It cannot make history but could have historical significance, such as the flood at Laingsburg. It cannot be social but could be a social object. It could be an economical object when sold. It could be beautiful although it cannot create art. It could be a legal object, and since one can believe that water would quench one's thirst, it can perform a certitudinal object function.

6.3.2.2. Classification of subjects and objects (Typology)

So far four types of subjects or objects have been identified:

a. natural objects;

b. natural subjects;

c. cultural objects;

d. cultural subjects.

An example of each is listed below.

Natural subjects – such subjects would be stones, plants, animals, and so on, each qualified in their own aspect within the natural aspects (the first 6). This classification contradicts the positivistic idea that every natural thing is an object. However, since these things are *subject to* specific laws, they ought to be *subjects* as far as their qualifying function is concerned; though they can also stand in many object relationships, as explained above. For example, a nursery that sells flowers actualises the economic object function of flowers and a flower arrangement actualises the aesthetic object function of flowers.

Natural objects – these would be bird's nests, beehives, and so on: objects that were developed by natural subjects such as animals. Although the wax of a beehive is physically qualified and therefore a physical subject, it acts as a psychical object as far as its qualifying function is concerned; it should rather be seen as a psychically qualified object interlaced with a physical (subject) structure It can be empirically verified that a beehive is not equal to the wax alone, but is the wax in a specific spatial form or structure.

Cultural objects – examples of these would be chairs, tables or other artefacts made by humanity. They are physical structures, and therefore physical subjects, but also culturally or societally qualified objects, implying they could be of different natures and qualified in any of the nine cultural aspects. A pen, for example, would be recognized as a lingual object although as far as its materiality is concerned it is a physical subject, since it is subject to physical laws like the law of gravity. On the other hand, pens also have object functions in all the other cultural aspects: they are economic objects to people who sell pens, aesthetic objects to artistic collectors or historic objects if they were used to sign an important agreement or peace settlement, for instance.

Cultural subjects – an example of these would be language, which has no natural structure; that is, a physical structure. It is a lingually qualified structure and subjective or active as a form of life in a society. Without belabouring the point one can state that cultural subjects are also called forms of life and actively operate in the cultural aspects and are qualified by a cultural aspect. One could call it a cultural relationship. For example, a family is a relational structure of parents and children with an authority structure and an identifiable unity.

6.3.2.3. Types of Cultural Subjects

Three types of relations can be identified: consociational collectivities, communal relationships and coordinational relationships.

A consociational collectivity has a character of solidary unity and a permanent structure of super- and subordination (authority). By solidary is meant that a structure has a distinguishing character and continuity in spite of the fact that the members in the relation may change. Britain is still Britain in spite of the fact that a whole generation may die. The government further has authority over its people, which you might not find in other relationships.

Communal relations have the characteristics of either solidarity or authority. In a family, for example, all the members form a solidarity unit but each household has its own authority relationship, parents over children for instance, no uniform authority structure for the whole family therefore exists.

Coordinational relationships have neither a solidary nor authority character, for instance, friendships, doctor and patient relationships or lawyer and client relationships.

6.3.2.4. Enkapsis

When the internal nature of an interwoven entity is retained it is indicated with the term enkapsis. It can briefly be explained as follows. Entities may embrace differently qualified (sub-)*structures* that are interlaced, but nonetheless retain their intrinsic sphere of operation. An animal, for example, has:

a. a physical substructure

b. a biotic substructure and

c. a sensitive-psychical structure

In this case the first two intertwined structures are qualified by the psychical structure – animals are known to be sentient creatures.

It is important to realize that the physical structure that already encompasses structural totalities (molecules and macro-molecules) also serves as foundation for the biotical structure in what is called a one-sided enkaptic foundational relationship.

It should be clear that the enkaptically bound structures are serviceable to the enkaptically encompassing totality without losing their individualities.

6.3.2.5. Totality

The term totality is used to indicate an enkaptical interlacement of unequal structures into a 'unit' or 'whole'. This term is preferred to the part/whole concept where the part has the same nature as the whole. An example here would be salt ($NaCl$) consisting of Na (sodium) and Cl (chlorine) that forms a totality from 'parts' that do not display a salt structure ($NaCl$) on their own.

The point is that an insight into enkaptical relationships and totality structures '… uproots the unqualified way in which, especially in modern system theory, literally everything in reality is spoken of in terms of a whole and parts' (Strauss: 1998, 87).

6.4. Anthropology

Techno-practice exists as cultural activity. This presupposes humanity and human activity. An understanding of human nature and inherent capabilities could clarify some misconceptions about science and the technical activity.

Humans are multi-capable and also have multi-contextual knowledge to utilize in multiple contexts. In essence it means that a person could acquire knowledge through science and then re-contextualize this knowledge in other contexts and different applications.

As it is beyond the scope of this thesis to develop or even defend a theory of the nature of human beings, only a model of those aspects relevant to this thesis will be described.

Human beings defy the limits of any specific discipline. What is really required is a philosophical view of man in all its relationships in reality and therefore also a view of reality itself.

It is important to illustrate that people have more than the two classical ways of knowing namely through logic or through the senses.

Polanyi (1978: 266) states that St Augustine brought his history of Greek philosophy to a close by declaring that all knowledge was a gift of grace. But Polanyi further argues that faith then declined and demonstrable knowledge was considered superior to it; by the end of the 17th century Locke declared that faith is not knowledge but mere personal acceptance, which falls short of empirical and rational demonstrativeness.

In distinction to any dualistic view (logic-sensory, logic-belief or rational-ethical dualisms) an attempt will be made to illustrate that the ability to acquire knowledge lies outside the sensory or logical or ethical or belief capability. The view of enkaptical interlacement will also contribute to the explanation in the following model of human capabilities.

6.4.1. A model of human capabilities

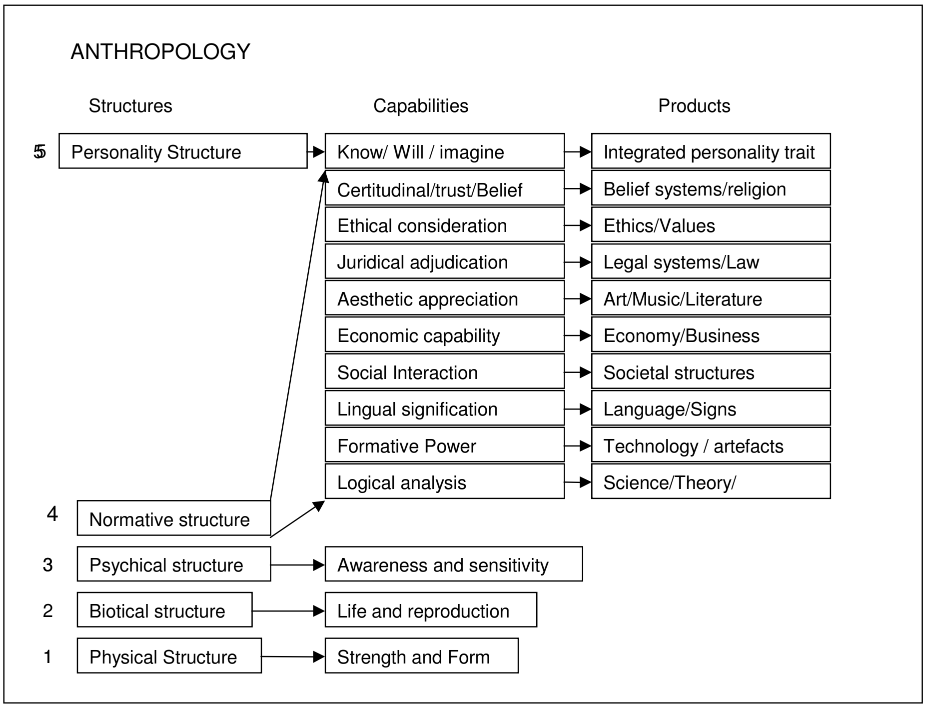

Fig.9 Human structures, capabilities and applications.

In this model the human being is depicted as a totality with five unequal structural elements, listed in the first column. The first three will briefly be mentioned only to provide a complete picture.

The first structure (indicated as 1 on the diagram) is the physical structure. Every human has a physical molecular structure consisting of molecules, macro-molecules, acids, elements and chemical processes that would be of interest to organic chemistry. This structure is enkaptically interlaced in a foundational relation to the following structure, which implies that none of the following structures can exist without this foundational structure.

The second structure listed is the biotical structure. This should not be confused with the 'biological' structure, which indicates a theoretical image that includes physical, biotic and sometimes psychical sensory structures. The biotical structure indicates the life structure of cells and organs, as well as systems like the reproductive system. This structure requires the physical structure as a support structure without which it cannot exist.

The third structure is the psychical structure of sensory awareness and sensitivity. This structure is in a one-sided enkaptic foundational relationship with the previous structures and cannot exist without their support. This means, for example, that no person that has lost his or her biotic function can be psychically aware.

The fourth structure can be called the normative structure. This structure encompasses all our cultural capabilities from logic to faith. It pre-supposes the previous structures in the same fundamental way as a one-sided enkaptic foundational relationship. To illustrate one can just consider one of the capabilities in the normative structure. Analysis, for example, as indicated in the logical aspect of reality, pre-supposes the awareness capability of the psychical structure. How would one be able to identify and distinguish something without an awareness of it?

The normative structure illustrates concisely that all humans have certain capabilities. Although we have the capability, we still need to use or positivize it. This furthermore implies that one can, of course, neglect it or even act in an anti-normative way; for instance, instead of socializing one can act anti-socially.

It is revealing that all humans have the ability to analyse. This ability might not be developed to a high degree, but at least humans can identify and distinguish things in everyday life. Everyone can form or make things, which indicate the formative capability, signify meaning through signals and language, socialize, and have a notion of frugality or be a spendthrift. Appreciating beauty in an aesthetic sense is uniquely human and not found among animals.

Almost all human beings have a notion of right and wrong; even gangs have codes of honour determining what should or should not be done, because humans have the capability to love and to act in ethical consideration of others. Lastly humans have the capability to believe – not only in a religious sense, but also in daily life we trust or have confidence in our artefacts and our senses.

The last structure is called the personality structure. This structure is the final node or centre of the human personality and acts as an integrating and unifying motivational point. This is the symbolic 'heart' of the person. The capabilities in this structure are willing, knowing, imagining and so forth.

These three functions are always present in all human actions as direction-giving motives or directives. To illustrate this we can consider the communication process. If one does not want to listen to a message it would negate all efforts of the sender. If the *will* is directed to the desire to listen it will call upon *knowledge* and *imagination* in order to concentrate on the message. Using knowledge, the listener will take cognisance of the message and try to store it in memory. Here the imagination will recreate the message as a recognizable image and place it in a framework of reference.

The interesting point is that someone can know (and imagine and want) logically, technically, lingually, socially, economically, aesthetically, juridically, ethically or certitudinally.

If someone knows that the economy is going to slow down, the knowledge can be logically analysed, expressed in language and socially responded to.

Knowledge from one context can be re-contextualised and utilized in other contexts. This allows of an endless, indeterminate permutation of possibilities in human endeavours. One can analyse the result of the action but cannot predict it[147].

6.5. Epistemology

As was the case above with anthropology it is beyond the scope of this thesis to develop or defend an own epistemology. Therefore only a summary of relevant issues will be given. The important point to be highlighted correlates with the anthropology summarized above. Human knowledge allows of infinite possibilities since it can be acquired logically, lingually, ethically or through faith, and can be re-contextualised infinitely.

As epistemology concentrates on knowledge and the conditions of knowledge, humanity's ability to acquire knowledge would be an acceptable starting point.

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[147] The advantage of an anthropological view here could possibly explain how a human can 'mix-up' scientific and technical knowledge because of the capability to re-contextualise knowledge.

6.5.1. The human ability to acquire knowledge

The anthropological model of the previous section assumes that people have the ability to acquire knowledge. In the previous section this capability is placed in the central node of humanity that integrates the total personality. It was also illustrated that knowledge is always in a relationship with the will and the imagination as if they were three different directions or choices available to a person. The smallest piece of information involves simultaneously the will (to take note, to remember and so on) and the imagination that recreates this information as an associative image or framework in the knowledge base. When one recalls something that one knows, the will to recall and the imagination to recreate the knowledge as an image are therefore just as involved as the ability to acquire knowledge.

This might also explain the link between the paradigmatic idea-framework that is required before conceptual knowledge can be acquired even on a personal level. The imagination needs to 'create' a framework in which facts and concepts could be interpreted and understood or known.

As previously shown, Duintjer argues that humans do not acquire individual facts or experiences only, but requires a framework as a basis for interpreting and understanding individual experiences or facts. All theoretical activity therefore requires an individual as pre-theoretical condition and a theoretical idea of reality as a transcendental condition in order to be able to direct the theoretical thought process (capability) towards something in this reality. (Kock, 1975: 47-50)

It is important to stress that scientific activity, though typically logically qualified as logical analysis, is not the only way to obtain knowledge. This interaction between the will, imagination and knowledge acquisition allows knowledge to be obtained from many contexts and imaginatively re-contextualised and utilized in other contexts. One therefore can know scientifically as well as non-scientifically. The knowledge obtained through science can be re-contextualised in other contexts like techno-practice, techno-science, techno-knowledge, education, management, the economy, military, stories, art and various other contexts as paradigm shifting insights in the development of society.

When scientific knowledge is re-contextualised as educational knowledge, for instance, it is not scientific any more but becomes educational. The reason is almost too obvious to mention. If this were not the case, all *scientifically* acquired knowledge that has been 're-contextualised' would remain *science* and would therefore NOT be re-contextualised. This implies that one context would not be able to share information with another, and that knowledge could not be re-contextualized.

The interesting issue here is that contexts would in that case not have any unique, identifiable characteristic, which negates the ontic principles of *orderliness* and *order for* as well as *constancy* and *uniqueness* that are required for the possibility to know.

The theory of enkapsis and the interlacement of the psychical, normative and personality structures imply that human knowledge is supported by awareness, normative experience (such as formative power, logical analysis, lingual signification and so on) and the human ability to know, will and imagine things. These enable people to form logical concepts as well as idea frameworks within which all of experience can be interpreted and understood.

Strauss (2006: 51) states that a scientist has two options; one either gives an account of the philosophical presuppositions with which one works, in which case one is working with a philosophical view, or one implicitly and uncritically proceeds from some or other philosophical viewpoint, in which case one is simply a *victim* of a philosophical view.

6.5.2. Is reality knowable?

The above issue in epistemology is focused on the idea that knowledge is possible because people have the ability to acquire knowledge. This implies that it is the person that knows. The title of Polanyi's 'Personal Knowledge' (1978: 17) indicates that the act of knowing includes appraisal as a personal coefficient, which shapes factual knowledge and strives towards universal standards.

The question of the reliability of this knowledge arises. How can we be 'absolutely' sure that what we know is the truth and not false or incorrect? In the history of philosophy this has been considered from various angles.

What might be of interest is that in contemporary philosophy this problem can be related to the idea of confirmation as well as the problem of distinguishing science from non-science. Hess (1997: 18-20) compares Carnap and Popper: Carnap favours verification and tries to explicate good reason in terms of a theory of confirmation while Popper urges falsification and argues that rationality consists in method and that science commences with problems. Popper rejects the view that scientists induce theories from observation but it is now generally accepted that theories shape, constrain or colour observations. Feyerabend and Kuhn defend the view that observations are theory-laden[148].

[148] This also correlates with the capabilities indicated in the anthropology above concerning the interaction of the will, knowledge and imagination. Knowledge is imaginatively recreated into a theoretical framework or idea-framework.

The next issue in epistemology can be indicated as the nature of something that is knowable or the requirements for its being knowable. It is assumed that *similarities* and *differences* exist to indicate *uniqueness*, which makes something identifiable. If something cannot be uniquely distinguished it cannot be known.

Furthermore, for something to be known requires a *constant* recognizable structure that allows *change* on the basis of, or within, what persists or endures. If something could change its *nature* it would not be recognizable and therefore not knowable.

These two requirements are ontic in nature[149].

The assumption of an idea-framework[150] as paradigmatic requirement for concepts is inherent in the knowledge process itself. This implies that certain motives or beliefs acting as idea-framework cannot be known factually or conceptually, since they are idea-frameworks themselves and would require an even more fundamental idea-framework to allow conceptualisation. This implies that our most fundamental assumptions cannot be further explained

[149] This implies that it is inherently part of the orderly reality and is a requirement for all knowledge.

[150] Refer to 6.5.1

and are thus in a sense not to be analyzed further. This highlights the limits of the human cognitive abilities and not the limit of the cosmos.

6.6. The proposed model of techno-practice in its different contexts

In this section a model will be described that explains the technical activity in different contexts. The basic contexts identified are ontological, anthropological, epistemological and societal. We will start with the ontological model, as it will link the technical activity to what is ontically given.

6.6.1. Ontological context

Just to recap, reality consists of a functional and structural dimension, and the functional dimension consists of fifteen aspects or modes. These modal aspects are neither functions of things nor properties of things but cohere with the dimension of structures since they co-determine the existence of structures or entities in the sense that entities function within the aspects of reality. This implies that an entity can be identified by a typical or qualifying mode that acts as a typical or type-law for the entity.

Techno-practice seems to be qualified by the historical-technical aspect with its meaning nucleus of controlled formative power. This implies that techno-practice differs from other types of activities on the basis of this typical function. When artists form, they form under the typical law for art, namely the aesthetical function. They use (aesthetical) artistic techniques that are distinguishable from other types of techniques like economic or technical techniques. The difference between an artist and engineer is therefore *not* merely a construction of the mind but a distinction based on reality.

To summarize some of these implications, a model is designed to illustrate some of the aspects of techno-practice. To keep in line with what is ontically given, the first column indicates the aspects of reality. The next column contains the aspects of techno-practice as well as analogical moments associated with each aspect. The qualifying aspect of techno-practice is indicated as the historical-technical with the nucleus of formative power. A short description of each aspect and analogical moment will follow.

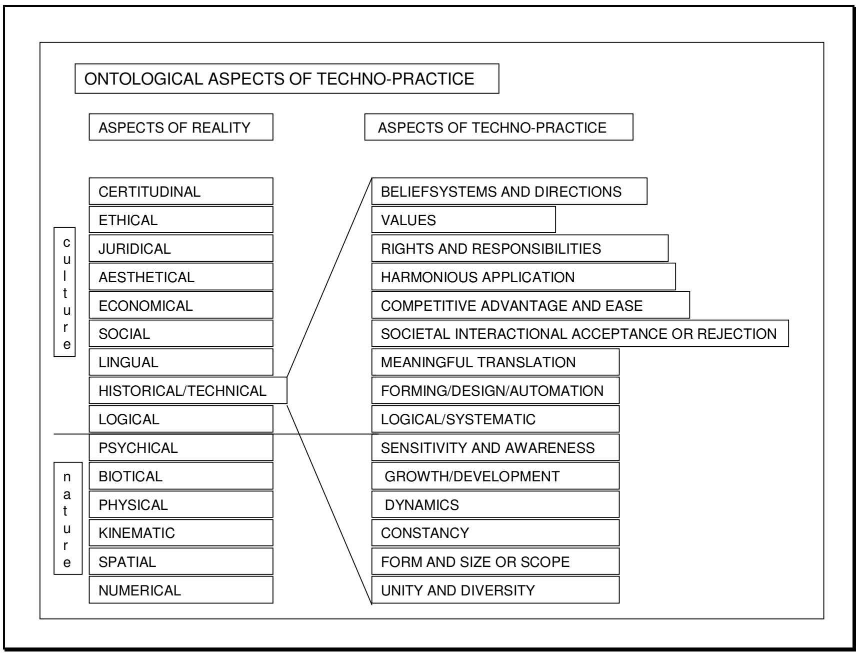

Fig.10 Ontological aspects of Techno-practice

1) The numerical aspect could indicate the unity and diversity of techno-practice. This calls to mind Latour's notion that artefacts are composed of various parts in a black box, until it breaks down and one is left with one part too many or one broken part too many. The only difference here is that artefacts are seen as the result of technical processes and not as the same as or inherently part of technical processes. The unity and diversity of techno-practice as an entity needs to be distinguished from the numerically orderly moment of the technical aspect, which indicates a norm to be positivized through human intervention, implying that normative technical activity will adhere to the order of processes.

2) The spatial aspect indicates a techno-practical context, which would differ from a scientific context. A techno-practical context always pre-supposes an artefact as the result of a techno-practical action. To be identifiable, this artefact should have its own identifiable spatial form and size. In a techno-practical context the goal is the production or forming of artefacts. The analogical moment of the spatial aspect would indicate *part* and *whole* or a *system* of technical activity where processes could be identified as sub-systems or sub-assemblies of larger systems.

3) The motion aspect would indicate constancy or durability. This derives from the principle of constant motion in the sense that the motion of a body remains constant, unless changed by some force. This implies the constancy or durability of techno-practice as far as this aspect is concerned, as well as the norm of technical consistency in the analogical moment. Schuurman (1980: 29) indicates that consistency or durability is one of the norms in the production process.

4) The physical aspect indicates the dynamics of techno-practical projects and processes. The relative dynamics of techno-practice indicates the changing nature of techno-practical processes, which is in a sense the opposite of the constancy of the previous mode. The norm in the analogical moment of the physical aspect could be identified as technical change in opposition to volatility or stagnation.

5) The biotic aspect indicates growth or development. Is it controlled, healthy growth or 'cancerous' growth or perhaps stagnation or even disintegration? The idea of a developmental framework and the notion of *systematic development* have only become clear in modern techno-practice. The norm of technical development (differentiation and integration) seems to be an obvious choice as one of the norms to be indicated in the biotic analogical moment within the technical aspect.

6) The sensitive-psychical aspect indicates sensitivity to, or an awareness of, techno-practice. This could range from ecological ‘insensitivity’ (from nuclear waste and accidents, to eliminating ecological sensitive areas for the sake of ‘development’) to unanticipated successes where balance in nature has been restored. It is this issue that is debated in the evaluation of techno-practice. Some believe that a return to a smaller scale of techno-practice will make greater sensitivity to nature possible, implying better control and less damage to the environment. The norm for technical activity could be technical sensitivity, derived from the sensitive-psychical analogy of the technical aspect.

7) The logical aspect of techno-practice indicates the analytical side of techno-practice, which should be distinguished from scientific or economic analysis. Techno-practice therefore has its own type of logic. The analogy of the logical in the technical indicates the *systematics* of a logical foundation in techno-science and modern techno-knowledge that is utilized to identify and distinguish problems or parts of problems in order to create solutions. This logical *systematics* differs from science, because the focus is to solve a *technical* problem through systematic analysis, therefore re-contextualising logical analysis as technical analysis.

8) The historical or technical aspect of controlled formative power is the qualifying or leading motive uniquely identifying techno-practice. Here we find the intrinsic character of design and development of the artefact (involving engineers) as well as the production line to produce and form the artefact (involving technicians). Here the motive of automation and control from a distance has also been discovered. Techno-practice consists of technical design and production, the maintenance and management of the production process, as well as the management of the design and development process. There seems to be a distinction between these two processes in the engineering field as indicated by the terms 'engineer' (who designs and develop as well as manages the development process) and 'technician' (who produces and maintains the production process).

9) The lingual aspect indicates what is technically significant in techno-practice, which was found to be in the production of an artefact as a result of the technical forming and designing process. We also found that artefacts could meaningfully translate goals and achieve different aims in different relationships, revealing different meanings in diverse contexts. The analogy of the lingual moment in the technical aspect indicates the norm of technical significance, which makes it possible to identify more and less significant technical activities. The notion of techno-literacy which refers to the literate or illiterate usage of artefacts

and its potential in every day life does not fit here as it is not part of techno-practice or of the technical process, but it does form part of the level of capabilities or skills of individuals in society.

10) The social aspect indicates techno-practical interaction with, amongst others, society, science, the individual, the economy, politics and the state. This issue is strongly emphasized by the notion of acceptance or rejection of artefacts by society. The norm of technical interaction between different subsystems and processes in the production of an artefact is derived from the social analogical moment in the technical aspect. The whole issue of technical transfer between societies or groups is also indicated by this analogy. The artefact resulting from the techno-practical process is the most visible structure that interacts with society and is mistakenly identified as 'technology' itself.

11) Philosophers warn against techno-practice being the 'handmaiden' of economics. Sociologists indicate that no techno-practice is possible without an inherent economic, political or other motive that 'balances' and pays the economic bill. Artefacts or new techno-practical processes can on the other hand bring competitive advantage and ease, which was not possible before. The internal norm provided by the economic analogical moment in the technical aspect could be indicated as technical economics, in the sense that technical

processes should follow the most 'economic' route without excess. This includes not only monetary values but also shorter or simpler solutions in a technical context, indicating an Occam's razor for technical processes: the avoidance of excessive techno-practices.

12) The aesthetic aspect points to the beauty and harmony that can be achieved by techno-practice as opposed to the disruptive, disharmonious or ugly and non-acceptable effects it may have. The internal norm found in the aesthetical moment of the technical indicates harmonious solutions or processes in the technical activity.

13) The juridical aspect has to do with patents, rights and recourse to the law. This legal framework allows of the regulation of individual and community interests concerning techno-practical use and misuse. Furthermore, the analogy of the juridical moment also points to the ‘right’ and ‘wrong’, or the ‘correctness’ and ‘incorrectness’ of the technical processes themselves, and in a sense indicates that more correct or less correct solutions could be found for technical problems.

14) The ethical aspect highlights the sympathetic and empathetic utilization of techno-practice versus unethical misuse or abuse. This is highlighted in various articles on ethics in various technical fields. The internal norm of the ethical moment points to technical preference of or

aversion to certain solutions or support, technical processes or tools. An example here would be the Linux versus the Microsoft usergroups.

15) The certitudinal aspect points to commitment and trust in techno-practice; not only the 'quasi-ideological' type of belief of the technocrat but also the everyday trust everyone has when getting into a lift, an airplane, a car and so on. Sometimes we entrust our lives to artefacts without even acknowledging it. The internal norm of the certitudinal moment in the technical aspect indicates technical reliability that should be the guideline for technical solutions.

After the above short summary of the place of techno-practice in reality, a short description of techno-practice in relation to our human capabilities needs to be given.

6.6.2. Techno-practice in an Anthropological framework.

Tentatively the historical aspect with its meaning nucleus of 'controlled formative power' indicates historical technical production, which could be used to indicate any artefacts or tools made in any civilization. The next model tries to illustrate the nature of techno-practice as a technical activity within a framework, which indicates the relationship with human nature.

In the following model it is assumed that the technical activity is a human activity and therefore human capabilities actualised in processes are indicated in the second column. In the last column the context of each step in terms of product and/or capability is indicated.

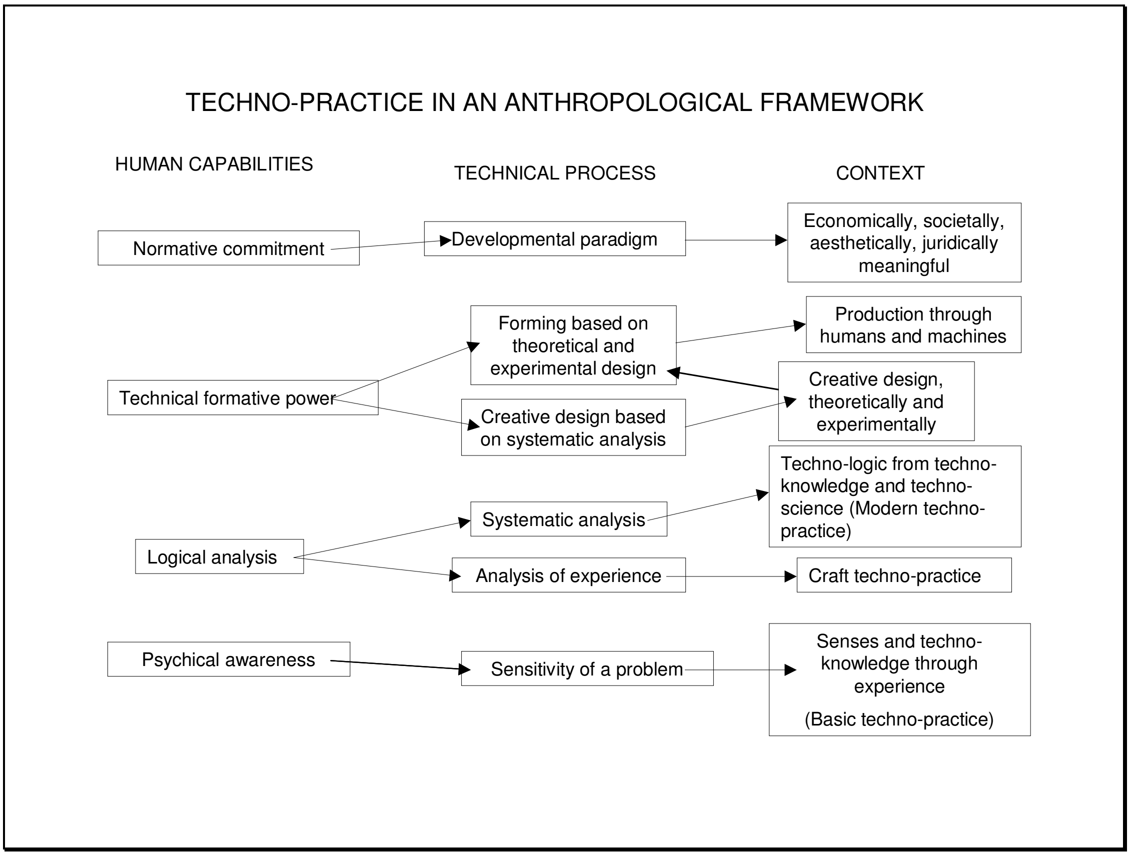

Fig. 11 Techno-practice in an anthropological framework.

Human psychical awareness is the fundamental or first capability assumed where a problem is sensed that could be solved through formative power. Through senses and experience the problem is identified and sometimes intuitively solved. This would be on the basic level of techno-practice.

After sensing, systematic logical identification and distinctions are made. Here our basic logic capability is employed to develop craft technics or techno-practice through experiential techno-knowledge not specifically derived from scientific experience. This could explain craft techno-practice.

Our systematic analysis, enhanced by our 'techno-logic', which is derived from our techno-knowledge and techno-science background, indicates the systematics (as one part) of modern techno-practice. This techno-logic differs from scientific logic as its focus is on the solution of a technical problem. Both are derived from the original logical capability and contextualized in an own context or framework.

These are the foundations of our formative power, of our ability to create a design, to describe it theoretically (lingually) and/or practically (experimentally) and then to proceed by forming (manufacturing) through human activity or production through machines.

During the designing (process), interaction with societal needs should be anticipated, since the acceptance of the artefacts that result from this process will depend on societal values in terms of economics, aesthetics, meaningfulness and legitimacy.

The next issue is the question of whether or not techno-practice is an active subject or a passive object. Techno-practice is more than just the *tools* or *artefacts*. It seems to be a totality, an interlacement of human activities and knowledge as cultural subjects, resulting in artefacts as cultural objects in societal structures, or forms of life, which are also cultural subjects. One must conclude that it is not only a cultural subject or form of life but also a totality.

Techno-practice is a cultural subject, qualified by the historical (technical) aspect with its meaning nucleus of controlled formative power, a totality consisting of an interlacement of knowledge and the application of knowledge through techniques of design and production. Societal support through societal acceptance, usage and structures guides techno-practice.

The following figure summarises the structures involved in techno-practice as synthesized from the above. Each of these structures indicated in the second column has its own fifteen aspects, which could be further analysed.

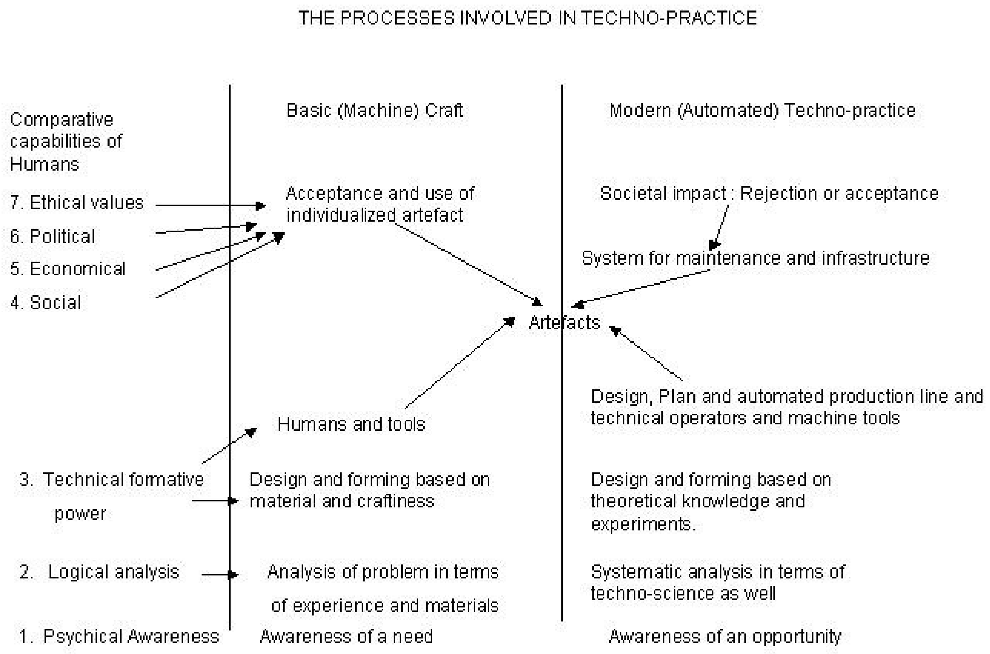

Fig. 12 Overview of processes involved in Techno-practice compared to human capabilities.

6.6.3. A comparison between basic and modern techno-practice

In (Fig12) the similarities and differences between basic and modern techno-practice are also indicated in two different columns. The model should be read from the bottom to the top.

The technical part or the technical process first of all consists of an awareness of a problem that could be solved technically. (Point 1.)

After identification, the problem or parts of the problem is systematically analysed and described. (Point 2). Obviously, different in basic techno-practice compared to modern techno-practice.

The creative designing process is based on this systematic analysis. (Point 3.) Here the designing function differs in basic and modern techno-practice. In modern techno-practice the design of the artefact and the production process are established – at first theoretically and sometimes experimentally – resulting in a form of artefact and production line based on the design. Many artefacts never go into production because of economic constraints or public sentiment. It ends with the forming of a prototype.

The production process is based on this design and prototype. It is guided by economic and societal acceptance, and proceeds with human aid and mechanical support to the manufacture of artefacts. Some machines can even become automatic operators that can be controlled from a distance.

The result of this process is an artefact. Various types of artefacts are techno-practically produced. Types of artefacts can be identified by their destinational or qualifying function. We find artefacts in all aspects of reality.

At point 4 the societal aspect of the process in modern techno-practice indicates societal acceptance through systems developed to support and maintain acceptable artefacts. For example, the systems of support for motorcars would include roads, petrol stations, services and parts, legal guidelines and law enforcement, insurance schemes, financing services of banks for purchasing of cars and so forth.

In a sense a society agrees to the usage of an artefact if it supports and develops the infrastructure for it. Many artefacts fail because the infrastructure has not been adequately supported.

Society has a second more dynamic method to indicate an acceptance or rejection of artefacts and their support structures. According to the literature surveyed there is a triangle of political will, economic advantage and societal value and belief systems. These structures can be lobbied to support or reject certain artefacts and their support systems.

A last point to consider is the societal context of technology.

6.6.4. Societal context

Sociologists point out that societies play a crucial role in the development and usage of artefacts.

This brings the place of society in the life of humanity to the fore. As has been stated, humans live in communities and cannot live without culture. Although the dualist view of the *factuality* of society and the *values* of culture should be avoided, the structure of society needs to be considered.

All our cultural products and structures are actualized in society. People in a society create language. Economics and business operate within a society. Even churches are for a community of believers. This suggests that all aspects of reality are actualized by society, in which we see the emergence of societal or cultural products and structures.

The following diagram attempts to illustrate this.

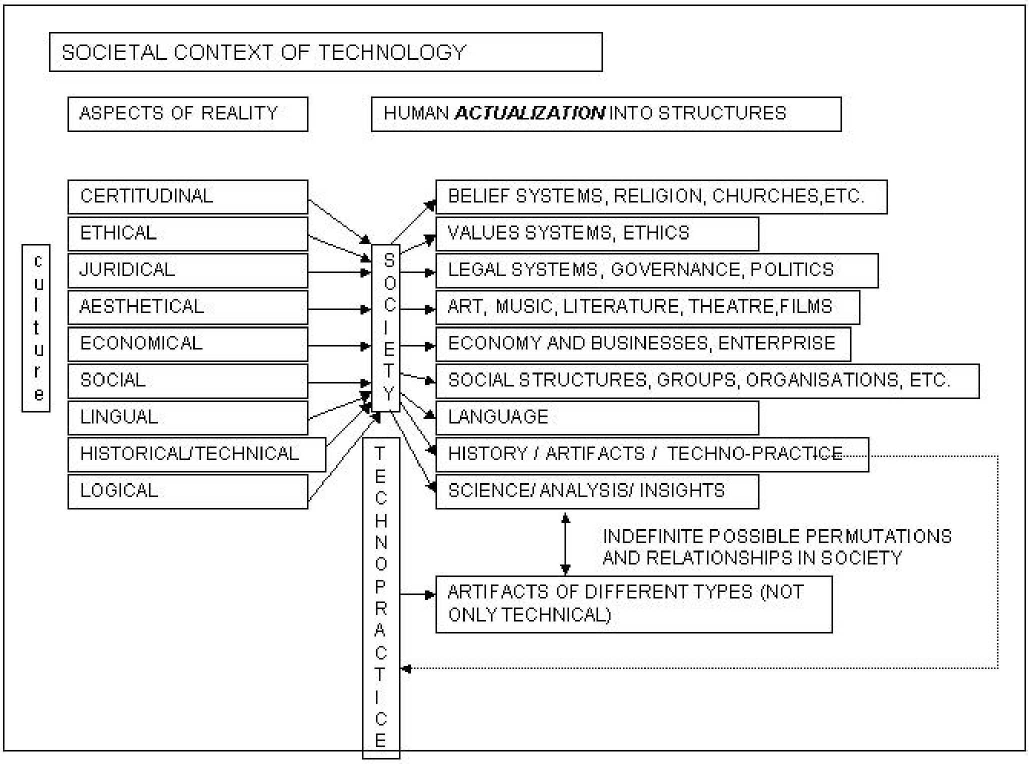

Fig.13 Techno-practice in a societal context.

To explain this diagram briefly: one has to observe that all the cultural aspects are actualised within the functioning of a society, resulting in cultural or societal products and structures. For example, the logical aspect of reality can be actualised by humans in a society in the form of a wealth of analytical insights and logic classifications – keeping in mind that not all societies manage to develop science.

Another example is found in the economical aspect that could be actualised by humans in the establishment of firms and other (general) economic activities. Again, not all societies develop similar economies.

The ethical aspect helps societies to develop their own peculiar value systems that differ from society to society. The belief aspect finds expression in diverse religious convictions, religious systems and churches.

The historical technical aspect of reality enables the actualisation of a techno-practice that differs from society to society. The techno-practice is indicated by the dotted line to show that the result of the technical formative activity is an artefact. It is important to understand that not only technical artefacts but artefacts of all kinds are indicated.

These artefacts are used in various relationships in the societal structures. This explains why artefacts can be instruments in science as well as language and the economy. An indefinite permutation of contextual possibilities for types of artefacts can exist.

The above diagram makes it clear why some-one can argue that structures in society are *'socially constructed'*, especially if the link to the transcendental conditions is not considered. If one does not bear in mind that society *actualises* given possibilities in structures it could easily lead to the misconception that society as *autonomous* force constructs itself and its own structures. Such a notion of *social construction* focuses only on the right hand side of the above diagram, but does reveal that different possibilities can exist. This is more clearly illustrated by the term *actualisation.*

6.7. Conclusions

In this study the aim has been to illustrate how the need for a transcendental-empirical analysis may be fruitful for an understanding and development of significant theoretical notions of empirically given phenomena. Only through an ontic framework could other frameworks be anchored and transgressions of these frameworks identified.

The fear of a 'master-narrative' in postmodern thought has unfortunately also inhibited the possibility of a transcendental-empirical input into our theories. Here Latour's suggestion of a 'servant-narrative' should be adopted.

The transcendental-empirical approach reveals that, within modern society, techno-practice consists of development and design on the one hand and production and maintenance on the other. It also accounts for artefacts as the *result* of the techno-practical process and the fact that not all artefacts are *technical* in nature. The modern idolization of electronics and more specifically of micro-processing where micro-processors control almost all specialised artefacts, should rather be designated more precisely as *electronics* or *micro-processing* rather than *technology*, which is a non-empirical, ontically unreal term. Anyone indicating *artefacts* as *technology* is equating an empirically valid reality with an empirically inappropriate term.

The term *technology* in the German context is correctly reserved to refer to the scientific study of the technical. A suggestion about the origin of the term in English is given in an explanation of the rationalistic legacy (Strauss, 2006: 162) where it has been pointed out that instead of identifying the ontically given reality of the *biotic* or *social* we indicate such phenomena as *biological* or *sociological,* which suggests a confusion in our understanding of reality.

Sociology studies *social* phenomena and not *sociological* phenomena. *Sociological* in the above sentence indicates a reflection on the scientific status of *sociology* as a scholarly discipline. The question regarding the nature of the *sociological* belongs to the philosophy of sociology and not to sociology itself. We have repeatedly highlighted the transgression of contexts by designating them as contextual fallacies. Such contextual fallacies have been found numerous times in the studied literature.

Furthermore, the lingual activity of *coining a phrase* or creating a term is not identical to logical conceptualization. Therefore it is possible to create a term without clear, precise conceptualization. Latour states that *technical* is a good adjective but that *technology* is an unsatisfactory noun. Furthermore it has been shown how technology was viewed as an intensification of technics without an explanation of what exactly is meant. No clear definition that distinguishes it from the ontically given technical mode of reality has been found either. It has been pointed out that in every instance where the term *technological* is used, it could be replaced by the term *technical* without any loss of meaning. This is a sign of insufficient conceptualization.

Finally, particular sociologists do not account for the ontic nature of the phenomenon of the technical activity. They are instead interested specifically in the interaction with or influence of the technical activity on society. They therefore operate in a framework that already presupposes the technical as well as the societal and therefore they have to make assumptions about the technical process. It is therefore easy to concentrate on *artefacts* as the result of techno-practice in order to analyse their impact on society. It seems as if the term techno-practice is empirically clearer regarding the nature of the technical activity and the fact that it clarifies the confusion of viewing artefacts as the outcome of techno-practice instead of seeing the artefacts themselves as similar to the process.

We may conclude that distinguishing between techno-practice, techno-knowledge, techno-science and techno-literacy on transcendental-empirical grounds not only seems to clear up the prevailing terminological confusion but may provide for a better systematic understanding of the nature of and interrelations between diverse types of techno-involvement found in our global village. In essence it implies that only through a transcendental empirical approach can ‘theoretical constructions’ be tested and verified to gauge its adequacy. Constructions without verification will lead to ‘figments of imagination’ which has no place in scholarly discourse. In a certain sense a paradigm shift is proposed where the ontic (transcendental) orderly reality is placed in focus again for all specialised (disciplinary) sciences. Furthermore the orientating link of philosophy for the disciplinary (special) sciences was highlighted again. All disciplines require a philosophical orientation to gauge its place in reality but also to guard against contextual fallacies. Contextual fallacies mostly occur in disciplinary (limited) contexts that do not correlate with ontical facts or contexts

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