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ENVIRONMENTAL EVALUATION OF TECHNICAL OBJECTS – CONTEXTS

Increasing interest of different organizations in the environmental evaluation of products has caused the need of tools for its realization. Due to the great number of machines and devices in use and their total significant influence on environment, special concern should be focused on this group of technical objects. In this text, the contexts of different nature: technological, social, environmental and economical are discussed as other dimension of valuation analysis. The environmental context is chosen to more detailed consideration due to its importance and complex character, involving other contexts.

Keywords: evaluation, technical objects, contexts

1. TECHNOLOGICAL CONTEXT

It is obvious that the directions of the world development should be monitored. It deals also to the technology and it means that the whole development process should be assessed and deeply considered. The problem has the complex nature. Comprehensive description of the state of the art of a technology is necessary but not sufficient for accurate prediction of its future impact. The technology must also be projected along feasible paths into the future. In this projection possible alternatives to the technology must be identified and considered.

Technology description is often the assessment task for which the most concrete data exist, particularly if the assessment concerns an existing technology. There is sometimes a temptation to overdo the description at the expense of other tasks that involve more uncertainty. Thus some assessments deal with little other than technology description and economic feasibility. Armstrong and Harman [Armstrong,

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Hurman 1977] suggest that about 20% of the project resources should be spent on technology description and forecasting initially and that an additional 5% be devoted to it during the first iteration of the study.

Bright lists seven levels of the emergence and impact of a technology and suggests that forecasters be aware of which of these levels are to be addressed [Bright 1978]. The levels are presented in Table 1.

Table 1. Levels of emergence and impact of a technology [Bright 1978]

Phase	Level	Description
Emergence		
	1	Certain knowledge of nature or scientific understanding will be acquired by...
	2	A new technical capability will be demonstrated on a laboratory basis by...
	3	The new technology will be applied to a full scale prototype or in a field trial by...
	4	The first operational use or a commercial introduction (first sale) of the technology will be by...
Impact		
	5	The new technology will be widely adopted by...
	6	Certain social (and economic) consequences will follow the use of the new technology by...
	7	Future economic, political, social, ecological and technical conditions will require creation of new technological capabilities by...

The first four levels largely concern characteristics internal to the technology and thus, generally, have little effect on society, except as they foreshadow impacts that may occur at higher levels of emergence. Levels 1-4 are referred to as the emergence phase of a technology. The progress of a technology through the emergence phase is affected by the development of supporting, competing and alternative technologies.

Levels 5-7 are the impact phases of the technology and are the levels of primary interest in technology assessment. These levels cannot be forecast without attention to the attributes of the future society in which they will occur.

Bright [Bright 1978] claims that the time involved in moving from scientific hypothesis or speculation through level 6 can be on the order of 10 years for many technologies and is more likely to be 20-25 years for most. The length of this time holds two important implications for assessment:

1) it is probably unrealistic to consider alternative technologies that have not progressed at least to the latter stages of level 3 (i.e., full-scale prototype),

2) technology assessment studies should adopt time frames of more than 10 years (at least) for assessing technologies that have not moved beyond level 3 (to do otherwise would generally relegate major impacts to times beyond the study bounds).

Unless there are compelling reasons to the contrary, these appear to be reasonable rule of thumb. It is the case that the more massive the scale of the technology and the resources required, the more distant in time will be the significant societal impacts.

Each technology to be assessed will have different characteristics. They will affect the forecast of the technology's progress by producing different levels of political, social and economic sensitivity, and different relationships to other technologies [Martins 1973].

Table 2 summarizes how Armstrong and Harman [Armstrong, Hurman 1977] perceive four of the major assessment dimensions affecting technology description and forecasting. Problem-oriented assessments have been relatively rare; technology-oriented assessments are far more common. Project assessments usually relate to a single basic technology, although a variety of alternatives may be addressed. Assessments of physical technologies are usually based on technical and economic feasibility. Nevertheless, institutional and policy factors must be considered eventually, and may modify the initial selection of alternatives. Social assessments, on the other hand, typically focus on political and social feasibility and assign less importance to technical factors.

Let us consider an existing technology as one which has emerged to at least level 4, according to the classification placed in Table 1. Depending on the level of their development and the time elapsed since their adoption, their first and perhaps even their higher-order impacts may have been recognized. Typically, stakeholder groups have emerged and opinions have become somewhat polarized. For emerging technologies, the lack of general understanding of their nature makes description an uncertain task. If implementation of a technology implies major dislocations or changes in existing social or institutional arrangements, it is termed a major intervention.

A sound approach for the description is to begin with a relatively broad coverage of the major aspects of the technology. A finer descriptive grid can be applied to those aspects that appear most important to the assessment after the major outlines have been traced. This approach provides directions for descriptive activities. It also increases the probability that the information will be in a usable form when the deadline for the task is reached.

Table 2. Effect of four assessment dimensions on technology description and forecasting [Armstrong, Hurman 1977]

Assessment dimension	Characteristics
Technology-oriented	Projection of a single technology along alternative paths
vs	
Problem-oriented	Comparison of characteristics of several different technologies; projection of several technologies
Physical technology	Technical feasibility limits alternative choices; policy not heavily involved
vs	
Social technology	Political feasibility limits alternative choices; alternatives often closely related to policy options
Existing technology	Feasible alternatives limited by polarization of interest groups; innovative alternatives difficult to introduce
vs	
Emerging technology	Possibilities of innovative alternatives; relatively long time frames necessary and hence high uncertainty in forecasts common
Major intervention	Technological alternatives interact strongly with social projections; policy thrusts likely to be inherent in alternatives
vs	
Minor intervention	Technological alternatives relatively independent of social projections

A logical starting point for initial coverage is to locate the technology along the dimensions suggested in Table 2. Next a tentative decision can be made as to which levels of emergence and impact (Table 1) best describe the technology.

Assessment process requires the projection of the future state of a technology so that its impact can be assessed. Projections always involve uncertainty that increases with their time span. Forecasting seeks reproducibility by increasing its reliance on what is known and systematizing the estimation of what is not. To do so, it must proceed logically from a basis of explicit data, relationships, and assumptions.

There are at least three rationales that support the assertion that technological progress and development can be forecast [Bright 1978] (Fig. 1).

Forecastability of technological progress and development		
understanding of technological innovation process	→	successful prediction of technological development
opportunity and need	→	technological development
examination of historical growth of technological capabilities	→	surprisingly ordered pattern of development

Fig. 1. Support elements of assertion concerning forecastability of technological progress and development [Bright 1978]

First, examination of the historical growth of technological capability (e.g., speed, power, capacity) reveals a surprisingly ordered pattern of development. Based on this observation, continuity of growth seems to be the norm and discontinuities are rare. The rationale of continuity provides the foundation for techniques such as trend extrapolation. Recognition of patterns, such as exponential growth, that characterize the behavior of certain attributes can be used as a basis for extrapolations.

Second rationale is that technological development responds to opportunity and need. It is also sensitive to the allocation of resources and to social control through regulation. By identifying and monitoring such influencing factors, technological progress can often be anticipated.

Third rationale asserts that an understanding of the process of technological innovation aids successful prediction of technological development. This process is reflected in the orderly progression in the levels of emergence (Table 1).

Expert opinions are currently more mundane than in the ancient days. However, “asking the person who knows” can produce a quick sense of the prospects in a particular subject area. Expert opinion can also be used to generate a more formal and credible assessment.

Two types of expertise can be identified as potentially useful in assessment [Mitchell 1975]. The first belongs to persons with an extensive special knowledge about a topic. The second rests in representatives of a subpopulation whose attitudes or actions influence the forecast topic. A critical concern is identification of “the expert”. Expertise may be “certified” by a variety of means-educational degrees, professional memberships, peer recognition and even self-proclamation. Mitchell et al. [Mitchell 1975] offer a useful way to clarify the nature of expertise by asking “expertise relative to what?”

Expert opinion methods involve four critical assumptions, drawing on the preceding considerations:

1) the forecast topic can be delineated to make possible the identification of pertinent experts,

2) the nature of the topic is such that these experts can predict the probable future course of developments,

3) a representative sample of experts can be tapped to participate in the study,

4) these experts will be seen as credible by both the study sponsors and study users.

Expert opinion methods range widely in elaborateness, costliness, time requirements, and expertise required to execute them. One considers four types of expert opinion forecast: (1) genius forecast, (2) survey forecast, (3) panel forecast, and (4) Delphi [Porter i in. 1980].

Genius forecast consists in finding a person whose cognitive powers cover the area of interest, and asking your questions. The answers constitute the forecast. Although its reliability is poor, it can provide a quick, perceptive and unambiguous view of an area. Genius forecasting avoids problems involved in achieving consensus. Informal contact with special experts can be especially helpful in describing a technology under assessment and understanding the prospects for future development.

Surveys imply polling a group of experts about their opinions. Surveys are useful when a group of appropriate respondents can be identified and when interaction among the respondents is not considered necessary. Surveys may be used in many ways in assessment for example, to forecast technological and social changes or to understand how affected persons will respond to a development or a particular policy.

Panels involve interaction among experts. Typically a group is convened, given a time limit and a budget, and asked to report on a particular topic. Panels are suitable when the subject under consideration requires discussion. This process is more interactive and costly than a survey. Panel studies are appropriate for identifying important problems, for preliminary microassessments, and for delicate policy analysis and evaluation. Dominant personalities and the bandwagon effect may affect a panel's deliberations.

Final expert opinion forecast technique is the Delphi method, named after the oracle of old. Delphi is a technique that interactively iterates the responses of surveyed experts, thereby combining some of the advantages of surveys and panels. Delphi has been a popular technique in technological and social forecasting, It can serve to generate systematic thought about future courses of events (e.g., technological breakthroughs) that are difficult to treat by other means. However, its credibility among assessment users is not high.

The Delphi technique has been a center of controversy. Some difficulties are the following:

1) it capitalizes on group suggestion to pressure toward consensus, yet it is unclear whether such consensus yields accurate forecasts,

2) the director's control in structuring the process may suppress other valid perspectives of the issue and yield biased results,

3) lack of item clarity or common interpretation of scales and feedback responses may lead to invalid results,

4) participants may become demoralized by the demanding nature of the process,

5) not exploring disagreements may also cause dissenting participants to withdraw, biasing the results,

6) Delphi practice has tended to be shoddy with respect to the principles of good survey practice [Porter i in. 1980].

To close on a general cautionary note, there are a number of points of concern that are common to expert opinion methods in greater or lesser degree. Whereas sociologists do not attempt to build bridges very often, engineers seem too willing to use expert opinion techniques with naivete and indifference to professional standards. Whether using Delphi, survey, panels, or even genius forecasting, assessors should beware of crude questionnaire design, poor planning for statistical interpretation, casual definition of "experts", short-cut approaches that are not validated and lack reliability measures, and illusions of precision.

2. SOCIAL CONTEXT

Assessment studies have generally focused on the description and forecast of the technology and have paid little attention to social context. The limited attention displayed tends to be static. Yet, when one is concerned with the impacts of a technological development 50 years in the future, it should be obvious that societal context will not be what it is today. Braudel [Brandel 1976] suggests three temporal perspectives for dealing with social context: (1) events-focuses on a time frame of years, (2) institutions-focuses on time periods of decades and (3) enduring patterns-changes over the course of centuries. Forecasting social context requires merging all of these. There are suggestions that certain enduring patterns of industrial society are changing, such as reductions in consumption of luxury goods. If this is correct, it implies a need for critical attention to future societal context.

Technological activity and the larger societal context of which it is a part interact through a complex and only partially understood system of relationships. As with most such systems, its operation can be better understood through the use of a simplified model. The model is intended to parallel reality bet, by eliminating some of the higher-order complexities of the real system, to limit analysis to the primary interrelationships. Such a model has been proposed by Wenk and Kuehn [Wenk, Kuehn 1977].

The model conveys the notion of a technological delivery system (TDS). Each TDS is specialized to deliver a specific product, whether aircraft or education. The TDS is assumed to be composed of all the institutions and individuals necessary to develop and control the ensemble of technical, legal, economic, political and social processes required for the functioning of the system. Most of these institutions, of course, interact with more than a single TDS.

The components of the TDS are institutions, each of which is designed, organized, and focused to perform a specific task. Connecting links between institutions represent channels of communication. These links indicate the flow of information upon which the institutions act within their constraints. The model is composed of four basic elements:

1) inputs to the system, including capital, natural resources, manpower, tools, knowledge from basic and applied research, and human values,

2) institutional and organizational groups, both public and private, that play roles in the operation of the TDS or the modification and control of its output,

3) system processes by which the institutional actors interact with each other through information linkages, market, political, legal and social processes,

4) system outcomes including both direct (intended) and indirect (unintended) effects on the social and physical environments.

To understand better the TDS and its behavior, it is useful to consider its operation first in a static, i.e., time-independent, sense. Basic and applied research organizations in universities, industry, private think tanks, and government develop know-ledge and capabilities that provide a push for the delivery of new technological outputs. Consumers provide pull through their demand for goods and services. The push and pull are coupled through the management of the technological organization that senses demand and capability, gauges external constraints, and assembles and organizes the factors of production.

External constraints to the operation of the technological organization can be of a social, technical, economic and/or environmental nature. Social constraints include cultural or traditional factors, such as e.g. resistance to the development. They can also be institutional (e.g., union opposition to mechanization). Technical, economic and environmental constraints include, for example, simple lack of technical capability, competition for scarce factors of production, and air-quality standards [Henschel 1976].

Government institutions select and prioritize the value preferences of both the general public and individual stakeholder groups. Policies and programs then formalize these preferences. The performance of the technological organization and its output are strongly influenced by government through regulation, subsidy, research and development programs, and so on. The direction and output of the system has become increasingly a shared public/private responsibility in recent years. It is important to note that impediments to the delivery of desired outcomes can develop from within the government sectors of the TDS. Thus, factors such as conflicting value preferences, constraint of information flow, inadequate or inaccurate information exchange and bureaucratic inertia can constrain the delivery of goods and services.

The critical interrelationship between technology and society has already been emphasized. A technology introduced into different social structures would, in general, produce different impacts and different impacted parties as well as different approaches to control the technology. Both technology and society must thus be described before impact identification and analysis can proceed.

Adequate description of the whole of society would be an impossible task. What is needed is a delineation of those elements of the social context that are affected and affect the operation of the particular TDS.

Technology description has already indicated important components of the TDS such as the factors of production (e.g., capital, natural resources, specialized manpower, tools,), scientific disciplines, industries/businesses, professions and occupations, products, and supporting technologies. Government institutions and policies have been at least partially identified under the categories of institutional factors affecting development and application of the technology. Finally, the delineation of uses and applications has indicated some of tile impacts and impacted parties that proceed from the outcomes of TDS operation.

Not all important elements of the social context, however, have been dealt with by the technology description. There are also certain overarching concerns (threshold attributes) of the larger society that are of supreme importance to the state of society description.

Underlying the macrolevel elements are the finer-scale elements that are specific to each assessment. Those elements of the social microstructure that are central to a particular study should be identified and defined and, where appropriate, measures should be chosen to scale them. Depending on the focus of the valuation, these may relate to international, national, regional, or local conditions. Appropriate methods vary. National social description may be well served by quantitative social indicators; local description may demand qualitative, primary data collection.

The MITRE study [Jones 1971] listed six major categories for use in describing the state of society: values and goals, demography, environment, economics, social factors and institutions.

Social indicators are aggregate measures of various phenomena that collectively indicate the state of a society or some subset of that society. Bauer has defined social indicators as "statistics, statistical series, and all other forms of evidence-that enable us to assess where we stand and are going with respect to our values and goals, and to evaluate specific programs and determine their impact" [Bauer 1966].

Abt Associates [Abt Associates 1975] have delineated the following social indicator groups:

– mobility indicators, including birthplace, length of residence and region of residence variables,

– ethnic-composition indicators, including native language and parentage indicators,

– family-structure indicators, including parent presence and sibling structure indicators,

– educational-attainment indicators, including indicators of public versus private school populations and years of schooling completed,

– economic-structure indicators, including age of labor force, unemployment, income-source indicators and occupational profile data,

– poverty indicators, including the percent and nature of community families below the poverty level,

– income-structure indicators, consisting of indicators of the dollar income of community members,

– general demographic indicators, including sex, total population and housing- count data.

Armstrong and Hurman [Armstrong, Hurman 1977] list four common-sense principles on which the forecast of societal state rests.

The first is that social systems tend to exhibit continuity. Even during periods of extreme disruption (e.g., wars and revolutions), most of the elements of a social system continue to function without rapid or discontinuous change.

The second principle is that social systems tend to exhibit a self-consistency in their internal structure. Thus societies have strong cohesive forces that assure that different elements of the society cannot long pursue radically different courses.

A third principle states that stakeholder group divisions within the larger society produce tension and conflict that are the sources of change. One useful method to produce state of society forecasts is, therefore, to examine areas of conflict and tension to determine stakeholder needs and desires.

The final principle is that social systems exhibit characteristics that suggest the operation of cause and effect linkages. This principle underlies the supposition that cross-impact techniques such as trend-impact analysis are appropriate vehicles for social forecasting.

Ascher [Ascher 1978] observes that social and political forecasting generally refers to actions and attitudes relating to the "deference values" (e.g., respect, affection and power) rather than to material wellbeing values (e.g., wealth and skill). Five distinguishing characteristics affect the conduct of such forecasting:

1) the topics of social forecasting are generally highly alterable through human volition because few constraints are imposed by limited material resources,

2) there is seldom a consensus on the preferred direction of changes: this provides a potential for more radical changes in trends than in technological or economic measures,

3) social attitudes are less cumulative than material growth patterns; the predominance of a value does not necessarily imply its future acceptance,

4) single, discrete events are often very central to social forecasts,

5) the meaning of one condition or event may depend on a whole constellation of other conditions.

One considers two general analytical approaches to forecasting future societal states. The first is to adapt the techniques of technology forecasting. In this approach these techniques are applied to the projection of social indicators or other important social parameters. Thus the advantages inherent in well-established techniques accrue to the forecaster. There are, however, disadvantages as well. Social indicator projections typically develop only the skeleton outlines of a future state. A general social theory to interrelate them, by explaining cause-effect relationships, does not exist. Thus many aspects of the forecast must be uncertain and unclear. Further, the task of selecting appropriate social indicators to forecast is not as well understood as the choice of the analogous technical system performance parameters. Obtaining sufficient data to define indicators and establish trends may not always be possible.

The second approach to forecasting future social states is the mechanism of the scenario [Porter i in. 1980]. A scenario is a descriptive sketch or chronological outline of a possible future state of society. It attempts to produce a holistic view of the pertinent social context as it relates to the technology being assessed. It seeks to define the major contextual elements and to depict their relationship to one another. Scenarios are usually presented in story form, making them easily read and understood. More about scenarios is later in this series of papers.

3. ENVIRONMENTAL CONTEXTS

It is often suggested that the environmental aspect should be treated in the early design activities in product development projects. The reason is that it is expected to yield substantial environmental improvements. Experiences from other DFX areas for instance Design for Cost (DFC) and Design for Manufacture (DFM), indicate that substantial improvements require conceptual changes of the product or the systems (for instance the production system), which the product meets during it's life [Kłos, Kurczewski, Laskowski 2000].

However, Design for Environment has, so far, mostly been applied in detailed design. The large degree of freedom at the conceptual level will allow for changes that can yield large improvements, both environmentally and commercially. Companies seeking to apply DFE at the concept level will need to be able to understand and describe the consequences of conceptual changes.

Environmental properties belong to the category of relational properties. The environmental aspects of the product will be visible when the product passes through its different life phases and meets the life phase systems. The life phase systems are for instance the production system, the distribution system, application system, service system, recycling system and disposal system. The environmental concept is therefore not only product aspect but relations between the product and the life phase systems.

Provided that it is possible to handle environmental aspects at the conceptual stage, the following hypotheses can be formulated:

– getting what you aim for, when making environmentally based conceptual changes, requires insight on the relations between the product, its life cycle and the environmental consequences,

– without "shared insight and pictures" of the product, its life cycle and the environmental consequences it will be difficult for the decision makers in a product development project to make the right environmental decisions.

It is most common to use product modeling concept at the early stages of a product development project. Before the realization of the product concept the management ought to "buy" the product concept. This decision point exists because the conceptual decisions have a dispositional effect on the properties of the product. For instance from Design for Cost it is known, as mentioned earlier, that the early decisions determine 70-80% of the product costs. The same rule is expected to apply to the environmental aspects.

The environmental aspect at the conceptual level has not been subject to much attention. But the product concept modeling has received considerable attention, [Pahl, Beitz 1984, Tjalve 1979].

From the environmental point of view one has seen life cycle modeling in Life Cycle Assessment (LCA). These models give a detailed overview of processes, inputs and outputs by means of process trees and flow-diagrams for existing products. These models are however useful to the environmental specialist only. The product developers can not make use of this type of modeling.

The mentioned modeling concept approaches are insufficient for application by product developers in DFE. The reason is that the environmental aspect has characteristics which separate it from other issues in product development. Among those are, according to [Keldmann 1995]:

– the product life cycle (environmental performance concerns all phases of the product life and not only manufacturing as in DFM),

– the two sided synthesis (in product development projects not only the product is synthesized but also the life cycle of the product),

– trade-offs (the environmental aspect can provoke different trade-off situations, for instance between environmental concerns and other concerns cost, quality etc., between different environmental aspects and finally trade-offs in the satisfaction of different environmental stakeholders).

DFE belongs, as Design for Manufacture, to the group of DFX-tools. Concept modeling in DFM is a source of inspiration for making a suggestion for contents and form of the environmental part of the product concept.

Product design directs the life cycle of the product. In the synthesis of the product life cycle there are a number of means for directing the products life cycle. For instance the choice of functional principle, structural principle and principle choice of materiel determine the interaction between the product and the life phase systems. It may for instance make the product appeal to the user for a certain behavior or even control the behavior of the user by making the environmentally appropriate action the most easy and straightforward behavior with the product. Another way would be the use of economical motivation in controlling the interaction between product and life phase systems.

It requires insight in the life phase systems to disclose the relations between the solutions and environmental consequences. Exploitation of this insight is made difficult by the continual change of the life phase systems. It must be accepted that due to these changes the life cycle of a new product is partially unpredictable. For the different paths there will be certain probability distributions. However, to gain a higher level insight on the meetings between product and life phase systems, it is necessary that the environmental concept model makes it possible to see:

– environmental relations between the product and the life phase systems, so that one can disclose consequences of different design suggestions,
– environmental load types and their sources, so one can identify the type of problems and courses,
– magnitude of the environmental loads, so that the level can be compared to a reference.

It is important to make substantial environmental improvements, and that one exploit the power of product development in achieving these improvements. Addressing the environmental issue at the concept stage gives the frame for making these improvements but it requires support.

4. ECONOMICAL CONTEXTS

The industrial system does not yet recycle all its inputs. The current industrial system starts with high-quality materials extracted from the earth, and returns them in a degraded form. This is an unstable situation, and one of the main challenges to making our current production structure sustainable is closing of the industrial substance cycles [Ayres, Simonis 1994, Cramer, Quakernaat, Bogers, Don, Kalff 1992, Kurczewski, Lewandowska (red.) 2008]. Several authors underline this demand over the next 50 years by at least a factor of 10 to 20 reduction in environmental impacts per consumption unit (see e.g. [Daly 1992, Ehrlich, Holdren 1971, Weterings Opschoor 1992, Kurczewski, Lewandowska (red.) 2008]). They illustrate this with the following formula [Ehrlich, Holdren 1971]:

$$E = P \times W \times I$$

where: E – environmental impact,
P – population,
W – consumption per capita,
I – environmental intervention per consumption unit.

It is generally expected that the growth of the world's population will be at a factor of 2 to 3 in the next half century; welfare growth may be at a factor of 5 to 6. On this basis, it has been estimated that the environmental impact could increase by a factor of 10 to 20. The obvious conclusion is, that even to keep the environmental pressure on earth at a constant rate over the next decades a factor 10 to 20 reduction in the environmental intervention per consumption unit is required. As an interim goal for the medium term, von Weiszäcker, Lovins and Lovins proposed to adopt a reduction of a factor 4 in their recent message to the Club of Rome [Weizaecker, Lovins, Lovins 1995]. Making use of available data on population and consumption per capita in a region, the current income for 12 world regions is calculated. In the year 2040, an ideal saturation consumption per capita of $35000 is assumed to be reached in each region [Kłos, Kurczewski, Laskowski 2000]. Under these assumptions, the future world consumption in 2040 would be a factor 16 higher than in 1990. Thus, the impact per consumption unit should diminish by a factor of 16 to compensate economic growth. It should be noted that under the assumptions made, the total environmental impact in the world will not decline, but the share of each region will dramatically change. This scenario is only one simplified picture of what might happen; but it shows far-reaching aims of sustainable development. Statistical data indicate for each environmental issue the dramatic shifts in "environmental budgets" per region demanded a sustainable society. In terms of markets, the changes are obvious. Raw materials and energy will be consumed mainly outside the current markets: Europe, Japan and North America. The same applies to the allocation of emission budgets.

Of course, this is a rough indication, showing a number of main driving forces rather than a clear-cut estimate of future environmental demands. There are environmental issues demanding higher reductions, and demanding lower ones.

EPR (Extended Producer Responsibility) is an environmental protection principle, aiming at reduction of total environmental impact from a product by making producer responsible for the entire life-cycle of the product, especially for the post-consumer phase of life. EPR concept gained more attention in 90s when it was introduced into the Swedish Ministry of Environment and later made know in other countries.

Advantage of this principle lays in the expected feature, that EPR through economical and administrative measures stimulates changes in the product design, its consumption and disposal. In fact, such a characteristic can place EPR as an important part of any national environment protection strategy, since it is solving, developing in th world, waste problem and related product design problems, to some extent.

5. CONCLUSIONS

All main factors, with their elements, building the structure for valuation of technical objects are located in Figure 2.

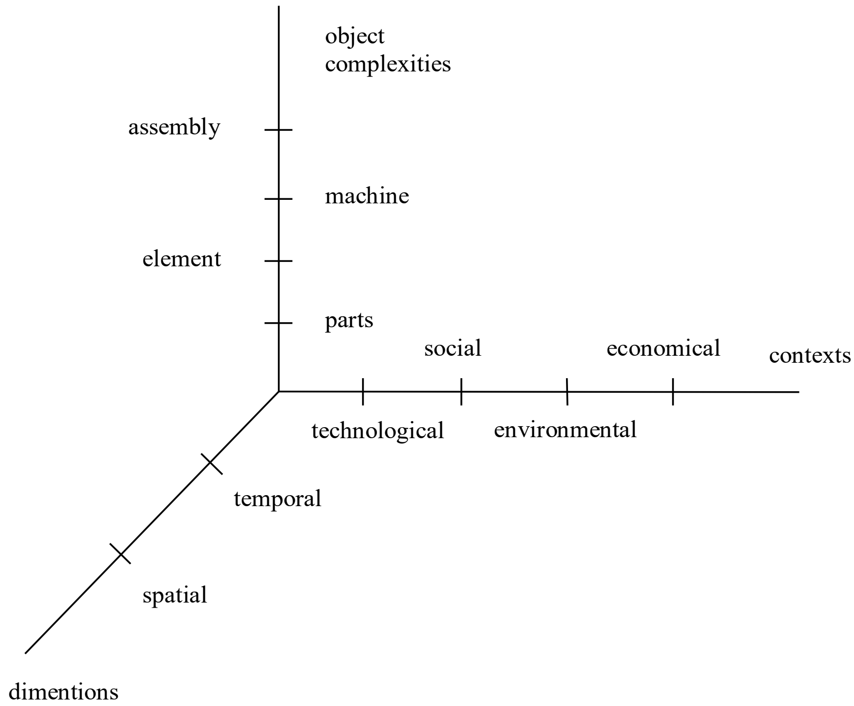

Fig. 2. Framework for valuation of technical objects - machines and appliances

Sustainable development is now on the political and business agendas. In Germany, Schmidt Bleek of the Wuppertal Institute expressed forceful views about the significance of LCA in sustainable development. He argued that LCA would be infuture essential in the transition to more sustainable lifestyles and products – and noted:

“Firms that are not well on the way to developing and selling sustainable products will be cut out of the market over the next 10 to 20 years” [European Environment Agency 1998].

From the earliest methodological studies, the importance of understanding and forecasting the technology being assessed has been recognized. Sufficient information must be gathered to describe the state of the art of the primary technology, supporting technologies, and alternative technologies. Further, primary and macroalternatives must be projected into the future along feasible paths. These projections must be made with an awareness of social forces developed in complementary social projections. Intelligent bounding limits the scope of technological description and forecasting to areas that are consistent with both the technology and the state of society.

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ŚRODOWISKOWA OCENA OBIEKTÓW TECHNICZNYCH – KONTEKSTY

Streszczenie

Wzrastające zainteresowanie różnych organizacji środowiskową oceną produktów wywołało potrzebę powstania metod w celu jej dokonania. Pewne próby w tym zakresie już podjęto, a dotyczyły one głównie przedmiotów codziennego użytku. Ponieważ w użyciu jest duża liczba maszyn i urządzeń oraz wywierają one sumarycznie znaczny wpływ na środowisko, specjalna uwaga winna być skupiona na tej właśnie grupie obiektów technicznych. W tym tekście analizuje się różne konteksty wartościowania antycypacyjnego: techniczne, społeczne, środowiskowe i ekonomiczne. Jako ważny, a zarazem mający złożoną naturę, uwzględniający również inne konteksty, do dalszych rozważań wybrano kontekst środowiskowy.