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FROM WORLD 3 TO THE SOCIAL ASSESSMENT OF TECHNOLOGY

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Abstract

The monodirectional model of development of technology, from science to market, reduces the role of society regarding technology to a passive element. The society is impacted by technology. The impacts could be good or not. We can identify and analyze (in advance) these impacts through the Technology Assessment methodology. Thus Technology Assessment is the same that Impacts Technology Assessment.

However, we could interpet the development of technology according to multidirectional models (for example, evolutionary multidirectional models). In these models the society could play an active role. Society is not only the impacted target for technological development. Society is also the factor *shaping* technology.

The second interpretation of technological development makes possible to propose and perform a methodology of Technology Assessment where relevant social groups (involved in or affected by the technology at issue) must be identified and their social behaviour has to be analyzed in situations of conflict (between groups) in order to detect the different technological options and their potential different impacts. It is the so-called Social (Strategic or Constructive) Technology Assessment.

Keywords: technology, technological innovation, models of development of technology, technology assessment, social technology assessment.

On Neutrality and Autonomy of Scientific Theories

From a well-known point of view, science could be deemed to be inhabitant of a world of objective entities ('World3') different from the objective world of material things ('World1') and the subjective world of minds or mental states ('World2'). This is an old trichotomy. Popper is its leading contemporary proponent.

Remembering Popper, science is an inhabitant of the World3, because:

1st. Science is a linguistic framework consisting of statements;

2nd. Statements express propositions or thoughts;

3d. Thoughts do not require any knowing subject to exist, since they are ideas – and, thereby, independent entities – that can be comprehended by anyone who is sufficiently familiar with the language or the totality of designations used.

Thus, Thoughts are not subjective; they are not bound up with a thinking individual. They enjoy a separate ontological status and are common property of many. Therefore, their objectivity cannot be disturbed by any corresponding mental states of knowing subjects. Nor can their neutrality be affected by biassed knowing subjects. Even if I am tight or bored, the thought expressed by $E = mc^2$ does not change while I am aware of it. Nor will it be modified because it is comprehended by persons with different ideologies.

The independence of World3 allows us to deem science as *autonomous* with regard to the physical, social and psychological world. Social or psychological characteristics of scientists could be *tales* attached to a scientific theory. On the one hand, they are not factors determining the *structure* of any scientific theory. The consistency of a scientific theory, for example, is there regardless of any mental states or the social status of scientists. A scientific theory is consistent when it is free from contradiction, in the sense that two formulae A and A cannot both be derived in the theory. That is all.

Neither psychological nor sociological elements are, on the other hand, factors relevant for *dynamics* of scientific theories. Scientific theories are refuted or corroborated regardless of the scientists' particular mental states or the kind of social framework at issue. The refutation or corroboration of a scientific theory depend on a 'yes' or 'no' said by the world to the theory.

Intuitions, beliefs, feelings, values, norms, are outside this range of relevant factors. They belong to the *external* history of science. They may be, then, affecting the way of making an assumption. In this context, it is not odd that anecdotes are told about the invention of certain hypotheses. It has been said, for example, that the chemist Kekulé had long been trying unsuccessfully to devise a structural formula for the benzene molecule, when, suddenly, he found an appropriate hypotheses while he was dozing in front of his fireplace. 'Gazing into the flames — Hempel says — he seemed to see atoms dancing in snakelike arrays. Suddenly, one of the snakes formed a ring by seizing hold of its own tail and then whirled mockingly before him. Kekulé awoke in a flash: he had hit upon the now famous and familiar idea of representing the molecular structure of benzene by a hexagonal ring'[1] It is true. But, one thing is inventing hypotheses and something else is accepting these hypothesis into the body of scientific knowledge. Hypotheses can be accepted into science if they pass

[1] Carl G. Hempel. *Philosophy of Natural Science.* Englewood Cliffs, N.J.: Prentice Hall, Inc. 1966, p. 16.

critical scrutiny, which includes, in particular, logic analysis and empirical testing. Therefore, appealing to psychological or social elements (appealing to *external history of science*) to account for the structure or dynamics of science is absolutely inappropriate.

About Basic Science and Applied Science

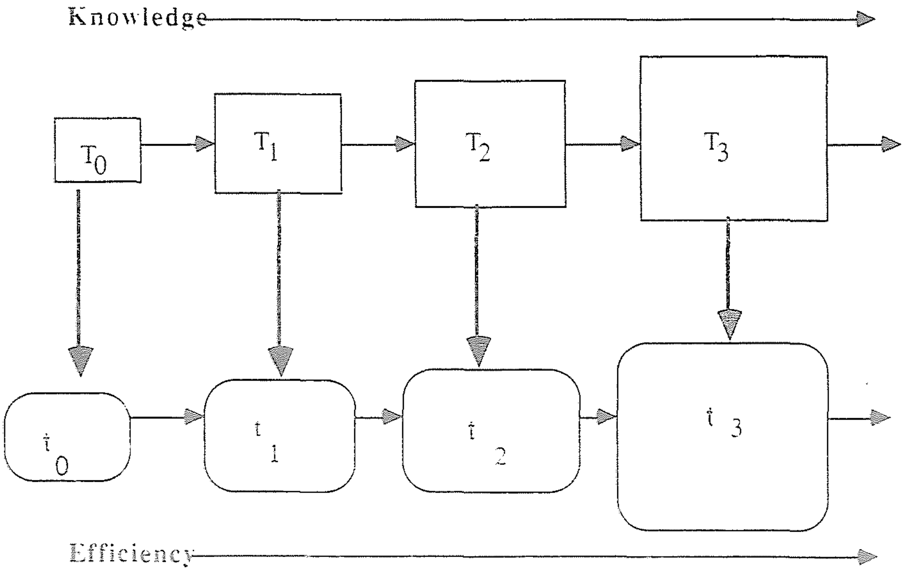
This traditional understanding of science is supplemented by a widespread distinction between pure science (or basic research) and applied science. Scientific theories belong to pure science. Scientists do research into pure science without necessarily thinking of applications. They try only to satisfy the need to know. At times, some theories are applied. Applied science, then, is simply applied scientific theories.

If a scientific theory has been applied to a technique, the result will be a technology. From this point of view, technology is technique with a remarkable trait. Let me explain.

Techniques are arts and crafts. There are arts and crafts without an underlying scientific theory. Then, theoretical ignorance is attached to practical knowledge: the practitioner knows *how* to do something, but he does not know *that something*. The practitioner can successfully control events, while ignoring the nature of these events. He, for example, can produce beer, ignoring the existence of brewer's yeast. Technology is, on the contrary, technique *with* an underlying scientific theory. This theory provides scientific knowledge about the events early controlled by techniques without underlying science. Such theory is like the *eye* of technique: an eye that can see the events controlled by the technique. In technology, theory guides technique. It means that technology will successfully control events previously scientifically explained. Thereby, unlike technique, technology's success – its *efficiency* – does not result only from increasing practical knowledge. Technology's efficiency depends on underlying scientific theory. Let me explain it.

Once a technology t_0 results from the application of a scientific theory T_0, t_0 will evolve in parallel to the evolution of T_0. On the one hand, the sequence $T_0, \ldots, T_n$ means that there is an increasing improvement of scientific theories: scientific knowledge grows. It is the so-called 'Scientific Progress'. On the other hand, 'Technological Progress' is called the technological evolution, that results from a continuous replacement of worse technologies by *better* ones. Improved theories bring about better technologies. In advancing science, we advance technology. Thereby it can be said that, sometimes, scientific progress is paralleled by technological progress.

Graphically,



(where T_i are theories and t_i are technologies).

Fig. 1. Dynamics of Scientific Theories and correlated Technologies

But what does it mean that technologies are replaced by *better* ones? There are different criteria accounting for the progress of technology. However, there is a theme common to them all: a technology is better than another one if it is more *efficient* or *effective*. Technological progress means an improvement of the rate or measure of *effectiveness*, and effectiveness means to work better with lower costs. A technology works better as it has an increasing capability to detect and control events (or their causes). As its capability for detecting and controlling events increases, technology multiplies and diversifies its good effects. In particular, new technology (better technology) entails improvements in nature, culture, and society.

One of the most obvious characteristics of technology is that it brings about (or inhibits) changes in nature. The technological changes brought about on nature by human beings are addressed to the satisfaction of our necessities, or better, to the abolishing of necessities. 'The necessities – Ortega[2] says – are imposed on man by nature; man answers by imposing

[2] José Ortega y Gasset. *Thoughts on Technology* (in C. Mitcham & R. Mackey (eds.) *Philosophy and Technology. Readings in the Philosophical Problems of Technology.* New York: The Free Press, 1972, 1983, pp. 290-313).

changes on nature'. These changes are technological. Nature is reformed by technology. This reformation means that nature is adapted technologically to human being. Such adaptation involves technologically abolishing the aspects of nature that place us in need. In removing necessities imposed on human being by nature, we can create increasingly new welfare possibilities.

Since the Industrial Revolution at least, such well-being has depended mainly on the application of technology to industry. Applying technology to industry means applying scientific knowledge to the production. That entails that science guides the production procedures and increases their measure of effectiveness. The result is higher profit with lower cost. It implies yielding more wealth. As more wealth is yielded, it seems that more wealth can be socially distributed.

About the External History of Science and Traditional Technology Assessment

Science has an inner logic of development, independent of psychological or social elements. Applied science equates with technology. Technology provides man's scientific control and use of his natural environment. This scientific control and use entail social progress. Thus, science developed according to its inner logic is the source of social progress. Thereby, neither science nor technology must be impeded by external factors. We should not interrupt or disturb the successful inner workings of science and technology by contextual interventions from society. *Social progress assumes that science and technology must be allowed to run by themselves – without social intervention –*.

Another point is argued. During the Industrial Revolution not only technology has been applied to industry but a new form of economic market has emerged. It is the *free market*. This market, like science and technology, demands freedom and thus blocking any influences from outside controls. Therefore: science must be free from external constraints, technology (applied to industry) must be free from external constraints, and the economic market must be free from external constraints. 'External constraints' and 'contextual interventions from society' are synonyms here. The global consequence: the alliance *'science/technology/market' without contextual interventions* from society implies social progress. Social progress assumes that society does not contextually disturb the inner working of science, technology and market.

Sometimes (the traditional argument continues) the specific *autonomy* of technology is argued out because uses of technology are confused with technology. However, in speaking of the using of technology, it is conceded that technology is something by itself. Technology is only applied scientific theory, not necessarily used. One may possess a technology and not use it. Thus, the use of technology is, on the one hand, extraneous to technology. And, on the other, the use of technology may be ethically right or wrong. Therefore, technology by itself is ethically neutral (as neutral as scientific theory). In short, there is nothing inherently either good or bad in technology. *Its use may be good or bad*[3].

Identifying the uses of a technology with a technology by itself leads people to blaming neutral technology for negative impacts raised by its wrong use. The only way of avoiding these impacts seems to be, then, relinquishing the technology at issue. It is the current behaviour of Luddites.

On the contrary, not confusing technology's uses with technology by itself allows us to *assess*[4] *applied* technology.

The first step in a Technology Assessment process is to *identify* positive and negative impacts.

These impacts may be categorized by disciplinary lines enabling the assessment to draw on specific expertise (e.g. sociologists to treat sociological impacts, economists to treat economic impacts,...). It is the so-called categorization EPISTLE (Environmental, Psychological, Institutional/Political, Social, Technological, Legal, and Economic impacts).

In a strict sence, this approach (technological *impact* assessment) must assume that a technology has been applied. You may only assess effects of causes that have already occurred: effects of a technology that has been applied[5].

There is certainly a somewhat more *farsighted* version to this approach. Potential technological impacts may also be predicted. In fact, early warning and forecasting was the main original role attributed to Technology Assessment. However, forecasting does not entail here that *society is* then *better enabled to chart the course of events*. Because the traditional conception of the complex science/technology/free-market as neutral sources of social progress enhances the idea that society must not disturb the inner workings of the method, social constraints have tradi-

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[3] 'Ethically, technology is neutral. There is nothing inherently either good or bad about it. It is simply a tool, a servant ... '. This text is found in an advertisement for the United Technologies Corporation (see Steven L. Goldman. Science, *Technology, and Social Progress*. London: Associated Univ. Press, 1989, p. 297).

[4] See, for example, Alan L. Porter, Frederic A. Rossini, Stanley R. Carpenter, A. T. Roper, Ronald W. Larson & Jeffrey S. Tiller. it A Guidebook for Technology Assessment and Impact Analysis. New York/Oxford: North Hollands, 1980.

[5] 'After the bulldozer has rolled over us, we can pick ourselves up and carefully measure the treadmarks', says L. Winner (see *The Whale and the Reactor*. Chicago & London: The Chicago University Press, 1986. p. 100.

tionally not been proposed as appropriate solutions for potential problems raised by a technology. Thus, according to the traditional image of science/technology/market, these problems should not be solved by social intervention, but through *better* science, *better* technology, and *better* market[6].

With the impacts identified, the second step in a Technology Assessment process is to study or analyze its magnitude.

That is the goal of *impact analysis*. The magnitude of the impacts is usually determined by cost-benefit analysis in agreement with the traditional conception of technology. Respecting this, I would like to add two remarks.

Firstly, attention to negative social impacts (be these real or potential) has not been usually paid. The reason is easy to understand: even if it would seem that particular persons win or lose, the sum of all technical application benefits humankind as a whole, since 'man without technique — Ortega says — is not man'. It means that, in contrast to the common adaptation of the living being to his environment, man reacts upon his environment, adapting it to him. The adaptation of his environment to man assumes that man reforms nature that places him in need. That reform means that man successfully abolishes the necessities raised by nature. The way of doing it is *technically* to construct a new nature — 'a supernature interposed between man and original nature', Ortega says — . If that assumption is true, technology would be a better servant to produce this supernature than a technique. For technology is scientific technique, and scientific technique is more efficient than technique in shaping an artificial milieu.

Secondly, the cost-benefit analysis of impacts on nature assumes that nature is a set of *economic goods*. It means that everything in nature has a price[7]. Environmental values (e.g. the value of clean water, clean air, wilderness, ...) are then somehow expressed in dollars. The magnitude of an impact, then, depends on the price of the affected natural factor. That price, in turn, depends on how much you are prepared to pay for this unaffected natural factor. It means that one has ready answers for questions like these: how much are you prepared to pay for clean water? or how much are you prepared to pay for preserving endangered species? Perhaps

[6]'Better science' implies 'more knowledge'. 'Better technology' implies 'more efficiency'. 'Better market' implies 'more free business'. They do not entail 'more social control'. On the contrary, as social control is increasing, less knowledge, less efficiency, and worse market are produced.

[7]See, for example, L. Winner. *The Whale and the Reactor*. Chicago & London: The University of Chicago Press, 1986, pp. 123–127.

it would be difficult to determine prices like these, but, according to the traditional image of science/technology/market, that procedure would be the only appropriate way of allocating the natural factors (as economic goods) in a rational manner. That allocation would allow us to compare the benefits of a technology (in particular, a technology applied to industry in free market) to its negative natural impacts, and *to take rational decisions about controls.* For example, as Thurow says, 'the basic problem in our national debate about pollution controls is that neither side is really willing to sit down and place a value on a clean environment and then do the necessary calculations to see whether it can be had for less than this price'[8].

Once the impacts identified and analyzed, it is only *policy options* for dealing with the desirable and undesirable consequences that remains.

Minimizing undesirable consequences (if possible) would optimize desirable effects. It would promote, in turn, *positive public perception* and acceptance of technology.

This last aspect is very important. For today, there is evidence of an increasingly broad social concern with the deleterious (direct or indirect) effects of technology. Since technology is applied science, this concern affects science. Thus, science is heading further and further away from cornucopia to disastermaker. Science is less and *less entrenched in society.* This increasingly negative social perception of science could be the source of the current crisis of scientific vocations and of today's difficulties in finding innovation managers.

The supporters of the traditional image of science, technology, and technology assessment blame the crisis on the fact that there is a set of technocatastrophists who are almost paranoid opponents to science. Many philosophers, radical environmentalists, feminists, ... belong to this set. They are a kind of neo-Luddites who are scientifically illiterate and uninformed about relevant technological issues[9]. Their problems with science and technology are reduced to a matter of lack of information on science and technology. Thereby it is necessary to supply society with more scientific and technological information.

I do not agree. The issue is not more information on science and technology, but *Education on Science/Technology/Society.* Let me explain.

[8]Lester Thurow. *The Zero-Sum Society: Distribution and the Possibilities for Economic Change.* New York: Basic Books, 1980, p. 105.

[9]See, for example, W. Häfele. 'Energy', in C. Starr & P. Ritterbush (eds.). *Science, Technology, and the Human Prospect.* New York: Pergamon, 1979. p. 139.

Science and Technology as Social Products

I would like to re-examine the traditional conception of science/technology/market/Technology Assessment (TA).

1st. What does it mean to say that technology is applied science?

It means that technology results from the application of scientific theories. What is a scientific theory applied to, when a technology is produced? Technology results from applying scientific theories to early techniques.

Technique is historically developed without the benefit of science. Technique arises empirically either by accident or as a matter of common experience[10]. Its improvement depends then on concrete experiences of trial and error.

Technology is scientific theory added to technique. At this framework, scientific theory explains the causes of events that were controlled by technique. The improvement of technologies does not depend on having concrete experiences, but increasingly better scientific theories.

2nd. Then, among the factors involved in a technology, what is earlier: scientific theory or technique? Usually, it is technique. Asking for the real causes that are controlled by a technique is, in general, the first step in the search of appropriate scientific theories.

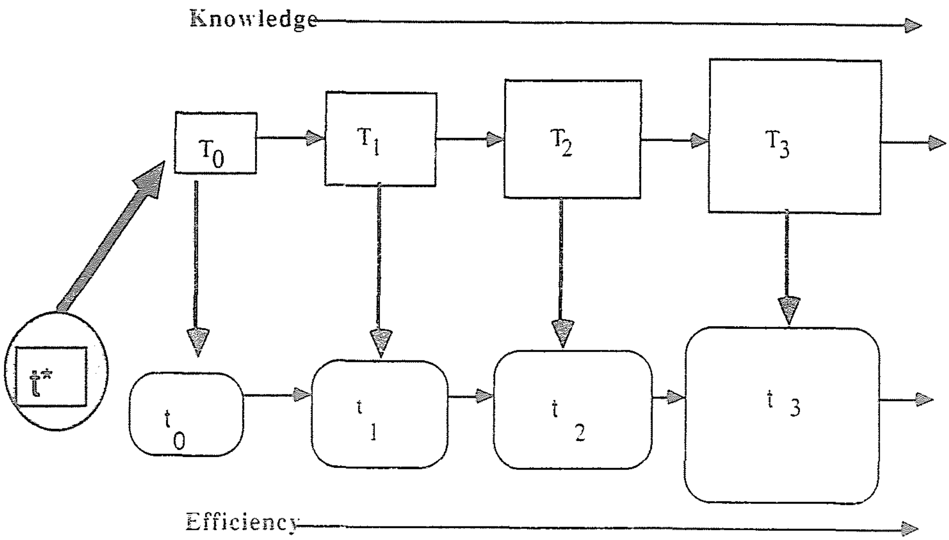
Thereby it is necessary to complicate *Fig. 1* by introducing technique.

But neither genesis nor development of technique have the same inner logic as scientific theories. The improvement of scientific theories depends on increasing our knowledge of efficient causes, while the origin and development of techniques depend, on the contrary, on fulfilment of final causes. The improvement of techniques, in particular, depends on employing trial and error to satisfy needs or goals. According to results, structural changes may be introduced in technique. These changes could improve the function of a technique, even if one still ignores what precisely occurs or why this improvement in the function of a technique is really produced.

3d. It raises, at least, two questions. On the one hand, when a technique becomes a technology, do the intentions, purposes or goals, fulfilled by this technique, stand outside the technology? On the other hand, why is a certain technique for the application of science?

I will try to answer these questions altogether. The fulfilment of intentions, purposes or, in general, *goals* presides at the development of technologies, too. Usually, these goals are the same ones fulfilled by the respective techniques. The main difference between technology and technique is that the first was vastly accelerated in efficiency by having been

[10]See James K. Feibleman. 'Pure Science. Applied Science, and Technology: An Attempt at Definitions' in Carl Mitcham & Robert Mackey. *Philosophy of Technology*. New York: The Free Press, 1972, pp. 36–38.



(where T_i are theories, t_i are technologies, and t* is a specific technique)

Fig. 2. Technique + Scientific Theory = Technology

brought under applied science[11]. It entails that a technology fulfils definite goals better than the respective technique. It does not entail, then, that technology is goal-free.

> The goals of technologies are framed by social contexts. Within them, *values* are normally guiding the formulation of the ends of technology. In that sense, technology is called *values-laden.*

But, if this hypothesis is right, then society is not the element that occurs in the last step of the process that starts with pure science. Technology, as science applied to technique, is not something autonomous regarding society. Technology by itself is not free from social factors. In sum, the social framework in which technology occurs decisively affects technology.

1st Consequence

Thereby, it is not legitimate to say that technology provides social progress if its own logic is not disturbed by social elements extraneous to its essence.

[11]ibid.

It could be replied that social elements shape the *uses* of technology, not the technology by itself, because the uses are to satisfy needs, goals or purposes. But, it is necessary to review the distinction between technology and the use of technology.

In this context, the term 'technology' usually refers to *tool*. The other potential references are excluded. Certainly it is much easier to distinguish between a tool and its use than between a social organization and its use (if possible). The apparent *straightforwardness* of the distinction between tools and uses rests, in turn, on the conventional concept of use. According to this conventional concept, people think that, as Winner says, 'once things have been made, we interact with them on occasion to achieve specific purposes. One picks up a tool, uses it, and puts it down. One picks up a telephone, talks on it, and then does not use it for a time ... The proper interpretation of the meaning of technology in the mode of use seems to be nothing more complicated than an occasional, limited, and nonproblematic interaction'[12].

The problems about technology are then constrained to solve the question about how the things are made, how they work, and how they are used. 'How things are made' and 'how things work' are the domain of technologists. The appropriate answers are yielded in terms of materials, principles or scientific procedures. To answer 'how the things are used', it is enough to list the different ways in which these things are used to aid in human activity.

The tasks seem very easy. However, this conventional concept of technology and use is not right. Even if we consider that 'technology' and 'tool' are synonyms, it is obvious that technologies are not merely servants of human activity. In general, 'technologies are also powerful forces acting to reshape that activity and its meaning'[13]. The very act of using certain technologies — like phones, computers, faxes, etc. — reshapes the human activity at work and its meaning. These technologies may raise new human activities and, at last, become *forms of life*, because 'life would scarcely be thinkable without them'[14].

2nd Consequence

The interpretation of technologies as forms of life entails that it is not right to see technologies as things which, once they are made, we have

[12] See, for example, L. Winner. *The Whale and the Reactor*. Chicago & London: The University of Chicago Press, 1986, p. 6.

[13] ibid. p. 6.

[14] ibid. p. 11.

an occasional interaction with. On the contrary, the only existence of certain technologies (for example, computers), beyond their occasional use, is introducing vast transformations in the texture of life.

Take the case, for example, of the introduction of computers in our society. Computers are not only increasing productivity; they are radically changing the process of production. Computers are not only used to do banking transactions, to write papers, or, through networks, to send mail; they are radically changing our concepts of time and space. Thereby, it is not then enough to list occasional uses, on answering the question 'How is a technology used', or, better said, 'How is it going to be used'. Furthermore, it is necessary to clarify the transformation of human activity and its meaning by the mediating role of technological devices[15]. In other words, it is necessary to scrutinize the technology, not its occasional uses, to understand how it could affect the same texture of our life. Forecasting is required.

Certainly, as I said, early warning and forecasting has been the main original role attributed to traditional Technology Assessment. However, as I said, forecasting does not entail here that society is then better able to chart the course of events. Because technological innovation — without unjustifiable social intervention — is the basic cause of the social progress, one assumes traditionally that technological innovation will be carried out, that is to say: the effects or impacts of this technological innovation are going to happen in any case. Forecasting the impacts helps us then to conform to them. As the Guidebook of the Chicago's International Exposition (1933), dedicated to a 'Century of Progress', asserted: 'Science finds, Industry applies, Man conforms'. Forecasting means then that it would be convenient to know the potential effects of a technological innovation. Thus, one will be ready to adapt human societies (even the same nature) to technological impacts.

But

3d Consequence

If technology is goals-laden, social intervention, or better said, social *mastery* of technology is not only justified, but required.

It means that forecasting potential effects of a technological innovation need not imply the necessity to conform to them, but the requirement to chart the course of the events. A potential event is the generating of a new form of life. Thereby, it is not enough on that score to analyze po-

[15]This transformation affects from concepts of self to new social relationships.

tential uses of the technology at issue. It is necessary to identify potential new forms of life which could be produced.

The new tasks of Technology Assessment, or better said, *Social Assessment of Technology* are very difficult to carry out. But the social entrenchment of technology seems to currently depend on it. Only when society begins to play its role in the technological decision making, society will begin to see technology as something else. To fulfil this objective, it is necessary to enhance new ways of *democratic decision making.*

A possible procedure is the so-called 'Constructive Technology Assessment' (CTA). In order to put technology under democratic decision making, this procedure consists of technology assessment, modified by three new elements:

1st. An *assessment* of the potential impacts of a new technology that would be brought forward by the social groups concerned or representatives of the society at large. Here, Specific Technoethics Committees could be useful.

2nd. Entities (parliaments, research units, corporations ...), which the technological innovation at issue may be concerned with, will develop possible technological and, if need be, organizational solutions to be problems identified by 'experts' as well as social groups.

3d. Procedures for feedback from social interpretations to technological design[16].

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[16] See Paul Slaa & E. J. Tuininga. 'Constructing Technology with Technology Assessment' in Miguel A. Quintanilla (ed.) Evaluación Parlamentaria de las Opciones Científicas by Tecnológicas. Madrid: Centro de Estudios Constitucionales, 1989, pp. 99–111. Slaa and Tuininga add there two examples of CTA. The first is a summary of an extensive case study carried out by Jaap Jelsma for the Netherlands Organization for Technology Assessment (NOTA) about recombinant -DNA experiments. The second is a recent project on the 'Integrated Services Digital Network' (ISDN) — an integration of the telephone, telex and datanetworks — . to be installed EC-wide in the course of the 1990s. According to some leading consumer and privacy organizations, this new technology is a threat to individual privacy and to the principle of uniform public access to the telephone service. Thereby, the NOTA has carried out a CTA on this project. Firstly, an overview was provided of social concerns and proposed modifications (these are reported in Paul Slaa. *ISDN As design problem.* The Hague: NOTA, 1988). Secondly, these concerns and changes were discussed by all groups involved (industry, trade unions, consumer representatives, government) in a workshop. Thirdly, based on these discussions an advisory report was brought to parliament in which political and organizational proposals are made [See Paul Slaa and E. J. Tuininga, op. cit., pp. 105–106].
In José Sanmartin. 'Genethics: The Social Assessment of the Risks and Impacts of Genetic Engineering', in Carl Mitcham (ed.). Philosophy and Technology: Spanish Philosophy of Technology. Kluwer (in print), a Social Assessment of Genetic Screening Tests is intended.

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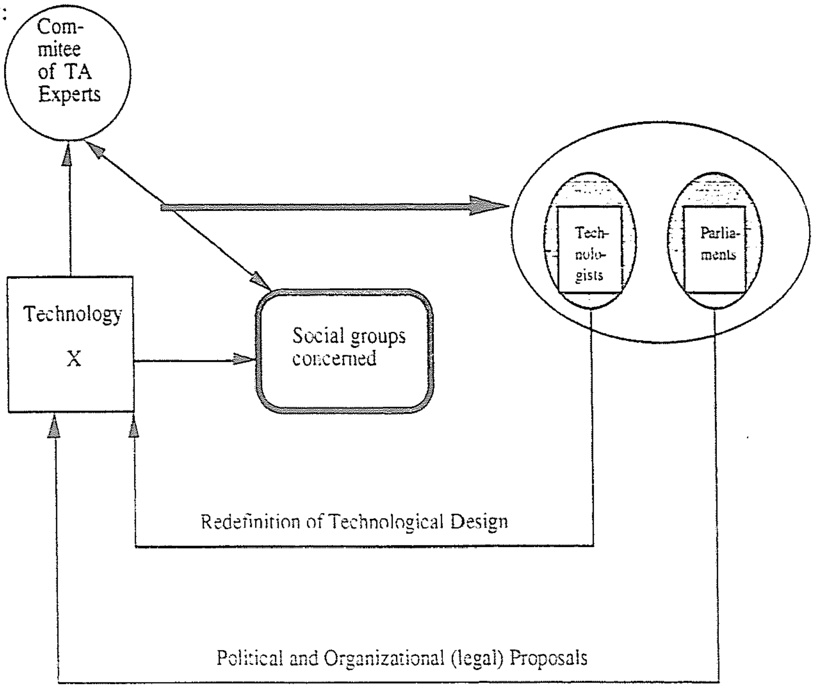

Fig. 3. Social Assessment of Technology

This kind of procedure could raise a *positive* public perception of a technology and help technology to solidly establish in society.

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