Technology of Hope

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Introduction

A long time ago, when earthly life was free of trouble, the titan Epimetheus was busy giving positive traits to all the animals. When finally man would be given his positive trait, however, nothing was left. His brother Prometheus felt that man was superior to the other animals and should be given something that none of the other animals possessed and stole fire from Zeus. The upper god, of course, felt very angry and decided to punish both Prometheus and mankind. Prometheus was chained to a rock where vultures picked out his liver every day. For mankind, Zeus ordered to make a woman: Pandora, which means bearer of all gifts. She was beautiful, caring and a great singer, but also foolish. From Zeus she received a box with the strict order to never ever open it. After a while Epimetheus fell in love with her, and they married. And although she knew very well she shouldn't open the box, one day her curiosity got the better of her and Pandora opened it, releasing all the misfortunes of mankind: thievery, poverty, illness, etc. Realizing what she had done she quickly closed the box again, leaving only 'hope' inside. The world became a sordid place for an unspecified time, until Pandora reopened her box and 'hope' finally fluttered out (Wikipedia 2005).

To me it seems that there are many parallels with this ancient Greek myth and technological development. When mankind curiously opened "Pandora's box" of technology a large range of misfortunes slowly fluttered out: environmental deterioration, inequality, suppression, arms races, pornography, mass consumption, waste heaps and so on; until it was opened again in the seventies and eighties releasing 'hope'. A hope, inspired by Gandhi and Jules Verne, that technology could be a sustainable means to liberate the poor.

Appropriate Technology was the new magic word of Ernst Friedrich Schumacher (Riedijk 1987: 3). A plea for a new technology to satisfy the basic needs of existence, relations and growth, instead of accumulation of wealth and irrational mass consumption. A splendid idea with an awkward dilemma: who is going to decide what the real needs are? The poor themselves or western philosophy and social science? Appropriate Technology says the latter, while the Indian Honey Bee network states that the poor are perfectly well aware of their needs. But grass roots inventors need formal help to protect them and take their inventions to a higher level.

Though clear in targets and fed with good intentions, neither Appropriate Technology nor the Honey Bee network gives further insight of what technology really is. This appears to me as a vital insight: if you want to change something, you have to understand it. Therefore, we'll return to source of all technological flaws and hope: Pandora's box. Cleared from all the bad and good spirits it is safe to open and can be studied objectively. A glance inside the black box of technology will provide understanding of how technology works, which is essential to make it work for poor people.

Technological Hope

Before we open Pandora's box of technology we'll first analyze the spirits that fluttered out of it. Both Appropriate Technology and the Honey Bee network criticize western technology and state how technology should be. Both are concerned with need-based technology, but what is needed? In this chapter we'll determine need and thus set the targets to achieve. How to achieve those goals will be discussed later on in this paper.

Appropriate Technology

According to Schumacher the western industrial system is responsible for a deterioration of morality and ecology, victimizing the poor (Riedijk 1987:1). The engineer nor the artifact itself is to be blamed but the structure in which it is embedded. This so called "techno structure" is formed in a society which is structured on technology. The artifact carries "the code" of the society it comes from causing side effects in a different society: "the code" enforces a life-style. An anthropological study by Pelto shows the near destruction of an egalitarian and ecological society with the introduction of the snowmobile. Western technology seems to acquire a special structure of society (Riedijk 1987:5).

Observing the techno structure, Schumacher sees mass production. Mass production means the obligation to export and the creation of economical dependency in order to make profit. Mass production requires specialization and hierarchy: equality and self-management would destabilize the system. In order to accept the system of political and economic domination mankind must become "one dimensional". This hegemony of the system makes people believe that the techno structure is not bad, but it's desirable to climb in rank; making people spiritually dependent (Riedijk 1987: 5-6).

These assumptions lead Appropriate Technology to three major goals that technology should strive for. The first goal is self-sufficiency, which implies the maximum use of local recourses and techniques in order to achieve economic autonomy. Self management is the second goal aiming for political autonomy in which people possess their own organizations and means of production. The third goal is self development, meaning that development of individuals into persons, conscious of their own capabilities and needs, leading to spiritual autonomy (Riedijk 1987: 11-13).

Unfortunately the poor are already hypnotized by western marketing and therefore not capable to determine their real needs. Already influenced by the western hegemony, they will want western technology. Therefore unprejudiced outsiders are needed to make base groups aware of their real interests. This inevitable top-down approach is considered a necessary but contemporary evil (Riedijk 1987: 14-19).

The Honey Bee network

The Honey Bee network from India starts the other way round and state that local people are perfectly well aware of there needs. Local inventions arise from everyday problems and therefore grass-roots innovations are always need-based, simple, cost-effective and sustainable. Solutions provided by western technology often do not match the local needs or these solutions are out of reach for poor people.

These grass roots innovations, however, are often limited in terms of design, given the lack of financial and technical resources, needed for technically well functioning device. The Honey Bee network links grass roots innovations with the formal technical and commercial sector and protects the intellectual property of grass-roots innovators in order to generate wealth. Patents are sold at the Sristi website to entrepreneurs who would like to put them into production (NIF India 2005: 1; Sristi 2005; Honey Bee 2005).

An interesting approach, but after sixteen years of hard work, the outcome seems rather disappointing. None but one of the success stories is connected with one of the three basic needs or ecological sustainability. Most of the innovations are machines to increase agricultural production, westernized by formal technicians, commercialized and produced in factories (NIF India 2005: 3-6). In my view, this is feeding the monster you wanted to kill, by creating a new techno structure, still unreachable for the poor masses and benefiting some relatively rich people.

At least in theory it appears that neither top-down, nor bottom-up approach towards technological development leads to a liberation of the poor, though at this moment Appropriate Technology will be given the benefit of doubt. Trying to catch the spirit of hope is nice, but it may be wise to investigate its source and try to find out how technology works. It's time to clear sight and to look at technology objectively.

Social Construction of Technology

Within his dissertation Wiebe Bijker tries to develop a theory to explain technological change. Dissatisfied with previous theories he sets four requirements for his own. The first requirement is that there must be room for the coincidental character of technological change, secondly not only change but also stability and continuity must be explained. This explanation has to be done symmetrical, the third requirement sounds, which means that also technical failures are to be included and that the 'working' of a device is not an explanation, but rather that the 'working' is the variable that has to be explained. The fourth requirement refers to the strategies of all the individual actors and social groups related to the artifact and structural conditions in which they live (Bijker 1990: 21-22).

Relevant social groups

When an artifact develops its way into the world, different people have different opinions about it. People with the same interpretation of the artifact are considered to be a 'relevant social group' (1990: 53-54). Bijker takes the Ordinary[1] as example and reveals two relevant social groups: affluent young men and older women. Riding the Ordinary is difficult and dangerous with a very real change toppling over, hitting the earth head first. Therefore the Ordinary was a perfect bicycle for "young men of means and nerve" to show of for the opposite sex and to race their bikes on the racing track. For older men and women the Ordinary was just an unsafe bicycle, though they saw advantages of efficient transportation without muddy feet (1990:56). In other words: for the young men the Ordinary "worked", for older women it didn't "work". This short example clarifies that "working" is not an inherent technical property, but "working" is socially constructed (1990:82-83).

The very same bicycle can now be sociologically deconstructed into two socially constructed artifacts: the "unsafe bike" and the "macho bike". Observing the history of bicycle development, the socially constructed "unsafe bicycle" gave rise to new designs solving the safety problem. The end resulted in the safety bicycle we still use today. The "macho bike" developed into an even faster but riskier bike. Bijker concludes that: 1) there are as many artifacts as there are social groups and 2) a social group constitutes the artifact (1990: 84-85).

After the sociological deconstruction of the artifact into many artifacts, closure and stabilization occur. Several closure mechanisms have been identified. One is the rhetorical closure mechanism in which certain events convince the audience. Another mechanism is a redefinition of the problem. "Closure, in the analysis of technology, means that the interpretative flexibility of an artifact diminishes". After closure history is rewritten and the flexibility that once existed is hard to recapture (1990: 94-95). While closure is focused on interpretations of different social groups, stabilization is related to artifact itself within one relevant social group. This process is the construction of facts by attaching or withdrawing modalities. For example a fact can stabilize like this: "the experimenters claim to show the existence of X → The experiments show the existence of X → X exist." Stabilization is a matter of communication and is relevant for intra-group analysis, while closure is relevant for inter-group analysis (1990: 94-96).

Technological frames

Analyzing the development of Bakelite, Bijker signifies technological frames. A technological frame built up during the stabilization of Celluloid and provided problem solving strategies for standard problems. On the other hand the technological frame hindered the solution of unorthodox problems like the condensation reaction between phenol and formaldehyde. Leo Hendrik Beakeland had a lower inclusion in the Celluloid frame and looked at the problem with fresh eyes using different solving strategies. He succeeded because of his marginal position in the technological frame (1990: 109-122).

Elements of the technological frame concept are goals, practices of use and current theories. Within different social groups, different elements are important. Therefore a technological frame is to be understood as "frame with respect to technology", which provides a wider view, including also non-engineers. It is a way of communication, located between actors, not in or above actors, creating thought styles. People can be member of more than one technological frame. Their level of inclusion has a different influence on the technology. High inclusion means the expert level and capability to alter the artifact, while the public level of low inclusion influences by the possibility to reject or accept the artifact as a working device. A

[1] the typical bicycle with the very large front and small rear wheel, popular in England late nineteenth century

technological frame builds up when the interaction around the artifact starts. Without interaction the technology is bound to disappear. (1990: 122-124).

Though slightly broader, the concept of technological frames looks familiar with the paradigm concept published in 1962 by Thomas Kuhn. Within his interpretation of the nature of science he argues that "particular coherent traditions of scientific research" – which Kuhn called "normal science" – are unified by and emerge from "paradigms" (1964:10). "Paradigms are universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners." (1964: x). Kuhn conceived of a paradigm as being "global" and almost impossible to describe completely (1964: 43). It includes "law, theory, application and instrumentation together" (1964: 10) consisting of a "strong network of conceptual, theoretical instrumental and methodological commitments" (1964: 42). It is, he claimed, "the source of the methods, problem-field, and standards of solution accepted by any mature scientific community at any given time" (1964: 102).

By extending the knowledge of certain facts matching the paradigm's predictions, the paradigm itself is further articulated (1964: 24). In the course of such articulation, however, "anomalies" arise, which, after repeated efforts to resolve them have failed, give birth to the kind of situation in which a scientific revolution can take place (1964: 90-91).

Invention

The theory of the social construction of technology already demystifies the heroic inventor. The precise dates of great inventions, that flashed ready-made into the mind of the genius, cited in popular histories are under attack. Ogburn and Thomas argued in 1922 that once the "necessary constituent cultural elements" are present, inventions simply must occur. "Given the boat and the steam engine, is not the steamboat inevitable?". Therefore many inventions were made independently by more than one person (McKenzie and Wajcman 1985: 7-8).

In addition Thomas Hughes demonstrates that the work of heroic inventors, like Thomas Edison and Elmer Sperry, wasn't a sudden flash of inspiration. Rather, invention is "largely a matter of the minute and painstaking modification of existing technology. It is a creative and imaginative process, but that imagination lies above all in seeing ways in which existing devices can be improved, and in extending the scope of techniques successful in one area into new areas." (in McKenzie and Wajcman 1985: 8).

Connected with Bijker's theory it is to say that invention arise from pre-existing technological frames, with three possibilities for stabilization. The first situation is the lack of a dominant frame, where variation tend to be radical and hardly any detail of the artifact is taken for granted. Enrolment is an important stabilization process, in which a social group tries to propagate their variant by the enrolment of other social groups, gaining support for their artifact. A way of doing this is the redefinition of the problem (1990: 34-35).

Within the second possibility only one technological frame is dominant, which means the artifact already being stable. Inclusion is the variable to assess within this situation. High inclusion produces conventional inventions generating little more than slight improvements. The frame is sensitive for functional failure, meaning unsuccessful attempts to solve other problems with the existing techniques. In Kuhnian terms this is the "normal technology" facing unorthodox problems, leading to revolution. Change in technological frames can also come from new participants. Often young engineers, who have a low inclusion and signifies different solving strategies and problem identifications. These actors might come up with presumptive anomalies, a notion of future problems for the specific technology (1990:135-136).

The last possibility for stabilization is one of multiple dominant technological frames. This is a situation continuous battle without victory (1990:137).

The presumptive anomalies of the current technological frame of mass production are the undesirable side-effects of subordination and environmental deterioration. Though heavily tried, the techno structure is incapable to solve these problems inflicting mankind and experiences functional failure. The attempt of the Appropriate Technology movement to set up a new technological frame failed, because interaction around it halted. Illustratively, Riedijk (1987: i) wrote in his introduction that, though untrue, "To outsiders it is nothing more than a name identified with hobbyism, smallness and low efficiency." But times have changed.

Open Source

Today we live in an era with two important different situations compared with the eighties. The enormously increased communication network through the internet and the growing awareness of the problem – widened by the UN millennium development goals, Live 8, One Man, etc. ; deepened by Naomi Klein, Noreena Hertz, Amartya Sen, UNDP and others – arises new possibilities for hope. People all over the world are more and more able and willing to share information, creativity and knowledge. This may appear to some like an idealistic miracle, but in fact it is quite natural.

Mutual aid.

Though nature cannot provide moral values for mankind, we, like every species, also have a need to survive. The "struggle for existence", described in Darwin's Origin of Species (1859) is often explained in terms of "survival of the fittest" and "the battle of all against all", breeding fear and protest among ideologists. This is, however, only one part of the struggle for existence. Biologist and revolutionary anarchist Petr Kropotkin observed a different survival mechanism in the harsh climate of Siberia: mutual aid, in order to exist. He wrote his book Mutual Aid in 1888 claiming that the struggle for existence usually leads to mutual aid, rather than combat. Therefore society should be organized naturally, formulating a moral order to bring peace and prosperity to our species. These ideas, foolish or not, provide useful insight. The struggle for existence, Darwin also noticed, is the struggle of species against species, but also the struggle of the species against the outer world (Gould 1992: 325-339).

Transplanting this notion to today's world of technological development we can see a situation of survival of the fittest in a capitalistic market setting, but also on of cooperation and sharing when it comes to open source software development and the struggle against Microsoft. Interestingly these programmers are no woolly altruistic good-doers give away time and knowledge for the benefit of mankind, but they are normal people with normal economic interests. The development of the freely available Linux operating system attracts our interest for a model of technological development. After all mankind is confronted with problems greater than itself. Poverty and environmental deterioration threatens the existence of mankind and the earth as a whole. Therefore cooperation is needed and natural, but why would people, who are used to competition, cooperate?

Economics of sharing

The economic scientists Josh Lerner and Jean Tirole attempt to understand the 'strange economics' of open source. Usually companies pay their workers, manage their efforts and control the outputs and intellectual property. Open source projects, however, provide a body of original information, publicly available, that can be used freely under certain conditions. Contributions are mainly unpaid and contributors can work on any subject they feel attracted to (2004:2).

The most prominent example of open source production is software, with open source server software already dominating the commercial alternatives. With 78,000 listed open source software projects, questions need to asked about the incentives and roles of the actors, and the applicability for other disciplines (Lerner and Tirole, 2004: 3-4).

Software consists of a source code and a binary code. The source code is written in languages like Basic, C and Java, which are understandable for (some) human beings. This source code is compiled to 1s and 0s, the binary code, which is the actual computer program, directly communicating with the computer. To protect their intellectual property, commercial software firms only provide the binary code, which is difficult to interpret or modify. This means that no one but the firm can alter the software (Lerner and Tirole, 2004: 4-5).

Disgruntled by these developments in the industry with a tradition of sharing and cooperation, Richard Stallman set up the Free Software Foundation in 1983. Their philosophy is that software should be free to use, free to modify, and free to distribute. They introduced a formal licensing procedure, called GNU, to preclude the assertion of copyright or patent rights concerning cooperatively developed software. This kind of license is sometimes called "copyleft", because if copyright seeks to keep intellectual property private, copyleft seeks to keep intellectual property free and available (2004: 4-7).

Key actors are individual contributors and for-profit companies. The decisions to contribute without pay to freely available software may seem mysterious to economists. However, the standard framework of labor economics can be adapted to capture the economic activity in the open source environment (Lerner and Tirole 2002).

The unpaid programmer faces the cost of time that could also be spend on wage labor. Companies face the costs of programmer not focusing on profitable tasks, but several short-or long-run benefits may counter these costs. First, open source programmers may improve rather than reduce their performance in paid work. System administrators, for instance, looking for specific solutions for their companies. Second, the programmer may find pleasure for "cool" open source projects are more fun than routine tasks. Third, open source contributions may lead to future job offers and ego gratification from peer recognition. Long-term incentives are stronger when: the performance is visible to a relevant audience, the performance has a high impact, or when the performance informs about talent (Lerner and Tirole 2004: 7-9).

Software only consist of information and therefore is easy to share and to edit. Hardware has to be materialized after acquiring the shared information and new insights has to be converted back to texts and drawings again. This, however, was not a problem for the employees of competing steel companies mid nineteenth century. In 1983 Allen was the first to discover the new phenomenon of sharing knowledge applicable to this industry, which he called collective invention (Von Hibbel, 2005: 78). Studying historical records, he noticed that the innovations of higher chimneys and a higher temperature of the air flowing into the furnace, were revealed deliberately in meetings of professional societies and in published material. Profit-seeking and competing firms shared their design improvements on their furnaces and related performance data publicly, resulting in a rapidly increasing energy efficiency of iron production.

Allen's initial observation, others began to search for free revealing among profit-seeking firms. Nuvolari (2004) showed that Richard Trevithick developed a new type of steam engine in 1812 after the expiration of the Watt patent. Trevithick made his design available to all for use without charge. Soon this engine became a new standard, successively improved by others, monthly published in the Leans Engine Reporter, a journal founded with the explicit intention of aiding the rapid diffusion of the best practices among competing firms (Von Hibbel, 2005: 78-79). More recently free revealing can be seen within semiconductor manufacturing by IBM (Lim, 2000), automated clinical chemistry analyzers (Von Hippel and Finkelstein, 1979), the lithographic equipment industry (Mishina, 1989) and of course the above cited software development.

While Lerner and Tirole described a more actor focused benefit of sharing in terms of happiness and value on the labor market, Von Hibbel adds the advantages for the product itself. More than forty years of study shows that patents are judged to be relatively ineffective, by the innovators themselves. With some exceptions, neither patents nor copyrights prevents imitation because it's not possible to keep it secret. Especially small companies and individuals gain small, if any, benefits from legally protecting their innovations (Von Hibbel, 2005: 84-85).

Discussion

A certain global desire exists to alleviate poverty. This desire is, for instance, translated into the Millennium Development Goals of the UNDP. Many problems of poverty are related to the material world, but, apparently, after half a century of developmental aid, existing technological solutions don't work and working solutions do not yet exist.

Technology is socially constructed and constituted by social groups. This is why the existing solutions often do not work, because they come from the western technological frame of the techno structure in which the relevant social groups of the poor do not interact. Therefore Schumacher, along with others, argued a new technology of democracy. The social group with respect to this new technology consist of basically anyone presumes the anomalies of the techno structure.

The quality of this new technology is vital to start the interaction, which, in return, is of the highest importance to quality. Without quality barely anyone would be interested and Von Hibbel stated that cooperation leads to a higher quality, much faster, remembering that sharing is a sound economic activity.

This active participation in a technological frame needs high inclusion to be able to change an artifact and not only to reject it. Therefore the frame should be easily accessible by freely revealing the information in a clear and efficient manner. Because the information is related to the physical world, materialization must be easy requiring little financial resources.

Applying these outlines to the real world, I think it might be a good idea to implant Appropriate Technology in existing networks like the Honey Bee network. The latter enjoys a good centrally organized communication network, but is still influenced by the techno structure of mass production and intellectual property protection. A high quality Appropriate Technology that is freely shared via these networks will inspire grass roots innovators to improve it furthermore and hereby joining the technological frame of AT, from which they can innovate a higher quality in a different manner for the benefit of all.

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