TECHNOLOGY IN HEALTH CARE — BLESSING OR CURSE?

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This paper looks at technology and health care in terms of processes (here defined as goal-related, autonomous and self-regulated arrangement of actions) and their interactions. Using this approach, technology is considered to be the quality of the processes we are trying to achieve. However, health care and the life around it is a complex network of closely interacting processes, and through their interactions, processes can influence each other in various ways. In many cases such interactions can result in unwanted, inappropriate interference and the implementation of unsatisfactory health care technologies.

The mention of technology invariably evokes an emotional reaction in people.[1] This is perhaps more noticeable in health care than in any other field. At the one end of the scale are those who revere technology and regard it as the major factor in the improvement of health during the present century. They really believe that all health care technology is a blessing and should be utilised without questioning. At the other end of the scale are those who point out that improvements in health have more to do with the general elevation in the standard of living than with technology. They consider the latter to be the source of most problems in health care, especially the spiralling costs experienced in most countries. For these people, most technologies are viewed as a curse.

The truth inevitably lies somewhere between the two extremes. Any technology that can be considered a blessing in one context has the potential to be utilised in such a way in another that it becomes a curse. It is therefore not possible to pronounce an all-encompassing judgement about technology as such. The aim of this paper is to examine factors that can lead to unsatisfactory health care technologies. Those technologies

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that are conceived and created to improve defined health care processes (here used in the sense of goal-related, autonomous and self-regulated arrangement of actions) in context, according to proper procedures, that are evaluated properly and utilised accordingly, mostly turn out satisfactorily. * However, those that are introduced without regard to context and genuine health care reasons are likely to cause problems.

The theoretical framework for this discussion is provided by teleonics, which is a process-based approach to complex living systems.[2-5] Teleonics posits that the important units in complex systems are processes. They are created within a certain ethos (meaning world view, beliefs, values, traditions, customs, superstitions, meaning, etc.) and have a definite goal (including other goal-related concepts such as destination, aim, target, set-point, attractor, etc.) but a variable action pattern (here referring to a dynamic sequence of events, behaviours, flow, change) and an even more changeable structure (the arrangement or configuration of matter-energy-information (MEI)). Furthermore, teleonics points out that processes are arranged in a specific pattern called the biomatrix (the totality of processes on earth on all levels, from atomic to world level) that stretches across the various levels of life on Earth, from subatomic to universal.[6]

According to teleonic considerations, those technologies that fit in with the existing patterns of the biomatrix, subscribe to a clear, commonly shared ethos and follow their defined goals can be regarded as a blessing. However, those that do not fulfil these requirements have the potential of becoming a curse.

WHAT IS TECHNOLOGY?

The role of technology is to improve the way we do things. The word 'technology' is derived from the combination of the two Greek words techné, which means 'art or doing', and logos, 'to know'. In short, technology is supposed to signify that 'we know what we are doing', or that 'we are mustering our best knowledge when we are doing something'. A very brief description may be simply 'optimised capability'. Thus, as our knowledge of the world around us improves, our way of doing things improves as well. In this way we are able to justify our intentional involvement in the natural processes around us.[6] Whether we are always right in such involvement is not so certain. However, this scientific and technological imperative is a part of us; it seems to be a natural force in our intellectual evolution.

Thus, according to the original meaning of the word, technology seems to concern itself with the quality of the processes we are involved in. However, not everyone understands technology this way as it is very difficult to think of the abstract concept of 'quality of processes'. It is much

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* Some words in this paper are used in a sense that is different from their normal usage. Each of these terms is defined in parentheses when it is first used in the text.

easier to think of technology as being human artefacts, such as machines, equipment, procedures and drugs in medicine. To our materialist world view, such a view of technology is much more appealing. We can touch it, see it, buy it, possess it, brag about it, polish it, sell it, make money from it and, especially in health care, satisfy our consciences by donating the obsolete 'it' to Third-World countries. Technology also has an aura of being modern and fashionable about it: if you have it, you are with it! To stress that we are dealing with the newest and most modern technology, as in the fashion industry we add the word 'high'. High fashion is synonymous with 'hitech' and branched artefacts like branded garments have the same ego-appeal.

Thus, there are at least two conceptualisations of technology, and one is free to use any one of these. What is important, however, is that one's attitude towards technology will depend on the view one subscribes to. In this article we hope to show that it is more useful to regard technology as the quality of processes rather than considering it as visible and tangible artefacts. As a start, consider the fact that artefacts are not always necessary for a technology. An improvement in the way of doing things can be achieved by removing an artefact, rather than by including one. For instance, it might be established by research that it is better to treat a patient with a certain heart disease by prescribing exercise rather than by using an expensive drug (i.e. a technological artefact). The good, technological intervention would be to discontinue taking the drug and to begin exercising. On the other hand, an artefact incorporated into a process could well enhance the quality of the process.

The advantage of considering technology as the 'quality of process' is that it highlights its changeability with time and circumstance more easily than is the case when technology is considered as an artefact: artefacts tend to perpetuate themselves even when their need has ceased to exist. Furthermore, it highlights the fact that technology is much more than an artefact. It has to do with processes or human action in its fullest sense and is therefore much more complicated than a lifeless box of tricks. Because this view of technology has to do with human beings in action (processes), it also has a much more profound impact on our lives than lifeless artefacts have. Technology then is about life itself and has a lot to do with not only the way we think, but also the way we feel about and act in the world around us. Through technology, we connect our intentions to the lifeless things around us and infuse them with life.[5] If it is the quality of our actions that defines technology, then we do have a great say in what it can do for us.
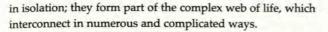
HEALTH CARE TECHNOLOGY

In this paper we shall use 'technology' to mean the quality of processes or human action: 'the best way we can do things according to our present knowledge'. Devices, equipment and procedures will be referred to as 'technological artefacts'. According to our definition, 'high-tech' or 'hitech' indicates a recently developed complex technological artefact, which can in fact be bad technology if it does not improve the way we execute the process it is intended for.

With the above view of technology in mind, a teleonic definition of health care technology is now presented. Health care technology is defined as the quality of a set of societal, individual and cellular processes, the aims of which are to promote health as well as to prevent and manage disease, with the ultimate purpose of ensuring a better quality of life for all individuals in society.[7,8] Health care is thus a set of processes. Health care technology is the way we develop, organise and optimise the above processes, by using the best possible knowledge available to us at the present time. Technology then should help us in our quest for a better quality of life and a decreased cost for the efforts expended in achieving it.

However, it is not always easy to quantify an increase in the quality of health care processes. First of all it is very difficult to measure an improvement in the quality of life, which is often a subjective but nevertheless a very real experience. Secondly, even though monetary inputs are easier to measure, it is difficult to decide what should be included on the balance sheet and how to control the included items in this emotionally laden area of human activity. It is, however, a fact that health care costs are running out of control throughout the world. Many sceptics claim that this is due to the excessive use of 'technology', while the optimists among us, especially the manufacturers and distributors of 'technology', predictably deny this charge. They are able to show convincingly enough that the direct cost of 'technology' is actually small compared with other costs in the health care process. However, in most cases what they call 'technology' is simply the technological artefacts and not the total effort expended in improving the quality of the processes when using the artefact. If one does a total monetary costing of the artefact as it is integrated into the health care process, one can show that these costs can be considerable. Furthermore, there are other costs apart from monetary ones, which are extremely difficult to measure. How does one quantify hair loss or permanent organ damage in a person undergoing chemotherapy? Although there have been attempts to quantify costs and benefits, they can never be fully expressed in numbers and translated into economic language.

Our contention is that the collective term health care technology is a concept concerned with the quality of a great number of complex processes, some of which fulfil the requirements of efficiency and efficacy eminently, while others fail to do so. A blanket statement praising or condemning health care technology therefore does not make sense. Each technology has to be evaluated on its own merit within the process it is supposed to improve. Both monetary and non-monetary costs and benefits should be evaluated in total context. As mentioned earlier, the processes of life do not exist

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in isolation; they form part of the complex web of life, which interconnect in numerous and complicated ways.

The processes of health care can be sorted into three main groups, viz. health promotion, disease prevention and disease management. The processes in the first group are aimed at pro-actively improving the quality of life even when there is no disease present. Those in the second group are arranged to fight against a particular disease when it threatens. The last group manages disease when it has already established itself, by trying to cure it or at least to reduce its effects. Each health care technology must therefore be developed for and evaluated against one of these processes.

Unfortunately, medical schools do not teach doctors about the processes of health care and the technologies relating to these processes. The use of these artefacts is invariably not related to process outcome, but to sub-process outcome. It is simply assumed that an artefact (medical device, say) incorporated into a diagnostic or treatment procedure will be beneficial without actually asking how it will influence the entire process.

An example comes from South Africa during the early 1980s, when a new diagnostic procedure for detecting learning disabilities in children was investigated in the rural areas of what is now Northern Province. The diagnostic technique or sub-process proved excellent. It clearly diagnosed the type of learning disability in the children of the community and could do so in a very short time. One was inclined to say that this was an excellent technology. However, the evaluation of technology only has meaning within the total context of the health care process, which in this case was the identification and correction of a specific learning disability on a community-wide basis. What the diagnosis did was to bring the problem to the fore. The community wanted the medical authorities to act and to provide special teachers who could deal with the learning problem. As the result of a shortage of resources these remedial teachers were not available. Thus, even though the diagnostic technique was excellent it only aggravated the problem. Health care processes clearly should be regarded as complete systems and dealt with as such.

THE DEVELOPMENT OF HEALTH CARE TECHNOLOGY

This section deals with the main issues concerning the development and redevelopment of technology in general. Development occurs when a completely new process is placed into operation. Redevelopment, on the other hand, concerns the upgrading of a process that has been necessitated by a change in circumstances, by a general dissatisfaction with the way things are running, or by simply having a bright idea about possible improvements. Since most health care processes have existed for many years, many of the present activities concern incremental improvements (redevelopment) of the processes.

This, of course, does not mean that the development of new processes should not be considered. In what follows we shall be concentrating more on processes that have technological artefacts incorporated within them.

Dostal and Járos[7] have described development and re-development as having four main phases, namely, the conceptualisation, realisation, evaluation and application phase. The conceptualisation phase is divided into four additional sub-phases, viz. clarification of ethos, definition of goals, definition of action patterns, and design of structure. These phases basically provide answers to the questions: 'Is it right and proper that we should do this?' and 'What are the means for getting there?'.

During the realisation phase the structure of the process is actually physically constructed. Artefacts are put in where necessary (or removed where they are no longer useful), procedures are put in place and control systems are initiated. If the prescriptions of the conceptualisation phase are faithfully followed, generally not many problems will occur. However, it is not always possible to follow the design to the letter, and replacement of components and alterations to rules at this stage can cause many unforeseen problems.

During the evaluation phase and even continuously during the final application phase, the technology has to be evaluated against the ethos, goals and action patterns that were defined during the conceptualisation phase. The questions above may now be more focused and related to the planned intervention.

If an existing technological action pattern or a technological artefact is introduced into an existing process, it should be fully evaluated. If the artefact meets the requirements of ethos, goals and action patterns, but does not perform the required actions efficiently, only restructuring or structural redevelopment will be needed. However, if action patterns are also unsatisfactory, a functional redevelopment has to be undertaken before structural redevelopment can be proceeded with. If goals are also unsatisfactory, new goals will have to be found. For each type of redevelopment, one needs to refer back to the ethos for guidance. The ideal development of health care technology thus consists of the continuous redevelopment of health care processes, according to the best knowledge we have at a particular time. As the environment changes and as our knowledge increases, the processes have to be redeveloped continuously.

INCORPORATION OF ARTEFACTS IN EXISTING PROCESSES

Some health care technologies in fact follow the abovementioned ideal procedure with a well-defined intention to increase the overall efficiency and efficacy of a particular process in the context of its total environment. Appropriate questions are asked about the ethos and goals of the particular situation and the designs define the most optimal action

patterns and structure to meet the particular goals. However, most health care processes do not develop this way. Artefacts that originate from other technologies are often brought in for reasons that are sometimes unrelated to the goal of the process. While it is possible for some of these artefacts to fulfil the criterion of improving the quality of the processes into which they are placed, this does not always happen. Such intrusions often only satisfy the pressures that lead to their introduction. In health care, these pressures include financial incentives, peer pressure, patient demand, journalistic sensationalism, scientific imperative, moral, ethical and legal concerns, all of which have nothing to do with the quality of life of the patient. These pressures originate from other processes that form the complex fabric of life around us. We are often not even aware of their existence, and if we are, we do not realise their real significance. In most cases they can actually be detrimental to the efficient functioning of the health care processes that they are supposed to improve. This is due to inappropriate interference with the process whose self-regulatory mechanisms can be disturbed from the outside without sufficient knowledge of the dynamic state of the process at the time of intervention.

THE ROLE OF ARTEFACTS IN LINKING DIFFERENT PROCESSES

When someone has an idea about making a device it is done with a certain goal in mind. However, an artefact will not necessarily be confined to the role originally allocated to it during the initial design. For example, many well-known devices, such as the telephone, the CD player and mobile phones, had different purposes when they were first developed, and many were initially used as toys.[9] However, as artefacts become generally accepted, they become incorporated into different processes. Industry and commerce, knowing the love of humans for material artefacts, soon pick them up. The artefacts thus become incorporated into the processes of making profit, which have proved to be extremely strong throughout history. Of course, the very existence of these processes of profit making depends on the production and selling of as great a quantity of the artefacts as possible. Capital is thus invested into such ventures with the hope that they will eventually produce a positive financial return. Some processes are very strong in the pursuit of their goals, and profit-making processes are especially so. This is, in fact, an important ingredient of our technological progress and should be encouraged. We should indeed place the development of our technologies in 'the dispersed, independently generating engines of the free market'.[9] However, at the same time one must be alert and ensure that artefacts driven by profit do not get incorporated into health care processes for the wrong reasons.

As a technological artefact becomes established, other processes are created around it apart from the abovenamed profit-making processes. For example, there is a process consisting of the development, manufacture and marketing of the artefact itself. If it is incorporated into the health care process, it immediately becomes incorporated into other processes as well. Examples are the processes relating to personal pride and advancement of the medical personnel, the processes of striving by the patient for the most modern medical treatment and the process consisting of the procurement, maintenance and eventual discarding of the artefact. Since all of these processes are self-regulatory, each will have a dynamic behaviour that tries to minimise its uncertainty about reaching the goal. (Uncertainty is related to the probability of a process reaching its set goal. It can be expressed numerically, viz. uncertainty of 1 denotes maximum uncertainty, whereas with an uncertainty of zero, there is complete certainty, with grades of uncertainty between these two extremes. Uncertainty can be transferred between processes and between levels within the biomatrix.) Since the artefact is a part of all the processes it can serve as a channel for the passing of uncertainty between processes, and thereby causes havoc with their dynamic behaviour. In fact, it is the interaction between self-regulatory processes that can cause complex chaotic behaviour in which none of the processes actually reach their goal, but simply encircle it in an irregular manner. Such complex process networks maintain a relatively high level of uncertainty that is shuffled between the various processes. The entire system then behaves in a fashion that is too far from equilibrium.

Let us examine some of the processes that come into contact with the health care processes through technological artefacts and transfer their uncertainty into them. It is when this uncertainty becomes too great, causing the health care processes to fail, that the technological artefact becomes a curse instead of a blessing.

PRESSURES TO INTRODUCE HEALTH CARE ARTEFACTS

Industrial pressures

One of the most common ways that uncertainty can be transferred into a process is by incorporating an artefact that was not originally designed to be part of the process. For example, someone may have an idea for performing some isolated action within a process of health care, say a simple method for measuring blood pressure at home. A device is developed without actually being evaluated within the context of all the processes into which it might fit. This device could possibly fit into the process of improving the quality of life of patients who suffer from heart disease. However, being able to measure blood pressure more easily and at home might not make any difference to the outcome of the process. In fact, too frequent measuring might cause anxiety in the patient, leading

to a higher blood pressure and thus a worse prognosis for the disease. A company then invests money to commercialise the device, and some health care process has to be developed or redeveloped to incorporate it. In such a situation the commercial processes are joined to the health care processes, creating a situation that is very suitable for the transfer of uncertainty.

Clearly business needs to be encouraged to invest in medical technologies and to make a profit out of these activities. However, they need to be made aware of some of the unwanted uncertainty transfer that can take place as result of the interaction between the commercial and medical processes. What would create a situation for the transfer of uncertainty is if the medical person prescribing the use of a device also had a financial interest in the particular device. Which process is driving the person at any particular time? He would really have to be a very strong character to put his financial interests out of the way when making such a decision. There is nothing that can be done about the same artefacts being involved in both the health care and the commercial processes, but involving the same people in both processes can lead to technologies being viewed as a curse.

Making of money by the private practitioner

Being financially involved in health care artefacts is not restricted to developers, manufacturers and distributors. A medical practitioner can be financially involved by obtaining a piece of equipment for medical purposes and regarding it as an investment for making additional income. To own a piece of equipment requires an investment of money. It is quite natural and legitimate to recover the costs of the investment by charging the patient for the use of the equipment and thereafter to profit from the equipment. However, there are strong incentives for including high-technology methodologies in diagnosis. In such cases one can charge a substantially higher fee for a short examination using this sophisticated equipment than for a thorough non-technological examination. To obtain sophisticated equipment is therefore a good financial investment, while there are no rewards for not using technology. In addition, medical insurance usually pays for claims involving 'high-tech' equipment without questioning the need for it.

The temptation to use such equipment in more instances than are absolutely necessary in order to pay for the machine in a shorter time and thereafter profit from the artefact is very strong indeed. The process into which the equipment is introduced in this way generally becomes more expensive. If, however, the process also becomes more effective and efficient, to the extent that the artefact's benefits outweigh the increased costs, the technology will be worth while. The main question to ask is: 'Is the quality of life of the patient going to improve by using the equipment?' or 'Will more people be treated when using this device, as a result of saving time?'. If this is the case,

the charge per person should indeed decrease or at least stay the same. However, this is not always the case and the charges when using the device generally increase.

Furthermore, the charges to patients do not fall away after the equipment has been paid off, and the equipment, or rather its frequent use, becomes a source of revenue that is unparalleled in most other professions. There are, of course, also the kickbacks as rewards for using a device or a drug from the device manufacturer or pharmaceutical company. Paying for 'working' holidays in some exotic location with expenses also paid for spouse or partner are not uncommon.

Medical aid and third-party payments

In normal everyday life an individual can avoid buying things that he or she does not need. This choice does not exist in health care, where the payment for services is made by a third party such as an insurance company, medical aid society or the government. This is like introducing an additional profit-making process into the system of processes that already exist. The medical aid society will gladly pay more for a health care process as increased payments increase its turnover and therefore profits. If the medical aid companies find that they cannot cope with payments they simply increase the premiums of the members concerned. There is obviously a limit to what members are prepared to pay, and these companies therefore have to indulge in a delicate balancing act. Clearly the conflict of interest in this system works against keeping the cost of health care technologies down.

Hospitals

The introduction of medical devices or technological artefacts into private and public hospitals is again driven by different pressures. In the case of private hospitals it is regarded as imperative to have the latest, most modern equipment. This is in order to cater for the requirements of those reasonably affluent patients who can afford private health care. Those hospital also has a need to amortise and profit from the investment and the pressures to over-service are indeed very real. Public hospitals, on the other hand, which are often maligned for the misuse of public funds, do not actually charge patients according to equipment use. They are therefore not generally subject to the same pressures as private hospitals to over-use equipment. Over-use of equipment in public hospitals is often fuelled by other forces such as academic peer-pressure and patient demand.

Peer pressure

Most medical doctors and other health care personnel are trained in modern, so-called tertiary care centres. These usually have all the most modern, hitech equipment incorporated into their processes. Unfortunately, medical schools give insufficient attention to the working of such technologies and their

limitations and dangers. A recently graduated doctor might use an apparatus out of fear of being criticised for not doing so, and an insufficient knowledge of the technology and of the cost-benefit equation only compounds the problem. Academic peer pressure resulting from the requirement to 'publish or perish' also demands the best and most modern equipment, which again may have little to do with improving the quality of life of patients.

Patient pressure

When sick, patients want the best treatment possible and associate the best with the most recent and the most written about in newspapers and broadcast on television. Yet few patients are capable of deciding what really is best for their problem. We assume that technology undergoes a continuous improvement. We do not realise that a newer device does not necessarily mean that the health care process actually gets better by incorporating the device. Unfortunately, the popular press is largely to blame for highlighting spectacular part benefits of technology without giving sufficient coverage to the state of development, side-effects and limitations in the context of the entire technological process. It is the duty of the developers and the users to point this out to the popular press. Unfortunately, the news of the side-effects of a new form of cancer therapy, for example, would be difficult to compete with the news of the technological brilliance of the treatment itself. However, this is slowly changing, as people become much more aware of the unwanted side-effects of technology. This is particularly evident in the growing trend for people to try herbal and natural remedies before taking pharmaceutical drugs.

Legal pressures

Fear of litigation resulting from possible erroneous diagnosis or inadequate treatment adds a tremendous financial burden on medical doctors and drives up health costs. The high incidence of litigation results in very expensive legal insurance premiums, and these force doctors to pass on these costs to the patients and to practise defensive medicine. This in turn leads to excessive diagnostic testing using the best technological artefacts available. This decision has nothing to do with the outcome of the health care process but a lot to do with the possible legal processes a doctor might have to contend with. These factors also serve as a deterrent for young doctors to enter certain high-risk medical specialties, such as obstetrics and gynaecology or neurosurgery.

CONCLUSION

In this article technology has been considered to represent the quality of our actions. Technological interventions are aimed at doing things the best way possible according to the best of our current knowledge. Since life is a network of numerous interacting and interconnecting processes, improvement in a sub-process does not always lead to an overall improvement in overall actions. The development and particularly the redevelopment of health care technologies have four main phases, namely conceptualisation, realisation, evaluation and application. During these phases there has to be a continuous examination of the ethos, goals, action patterns and structural requirements of the process. If this is done, it is likely that the technology will be successfully integrated into the relevant process and technology will become a blessing. However, when one succumbs to pressures from other processes, such as those aimed at financial interest, peer pressure, patient demand and legal concerns, which can override the self-regulatory mechanism of an efficient and effective health care process, the implemented technology might well become a curse.

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