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MODELLING OF PROCESSES TEHNOLOGY DEVELOPMENT

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Abstract

New technologies are raising also serious problems and concerns that do not seem to get satisfying answers. To come to some understanding of this phenomenon, we built a simple model of processes, driving the development of new technologies. By analysing the model we came to the conclusion that problems and concerns accompanying the development of new technologies have a lot in common with inadequate quality assurance. It is shown that quality assurance introduced on the basis of a broader understanding of quality can diminish problems and concerns raised with new technologies development and provide users with technologies that are developed closer to their needs and expectations.

Keywords

modelling of processes, technology development, quality assurance, vision, problem

Izvleček

Nove tehnologije odpiranjo tudi nove resne probleme in pomisleke, na katere pa, kot kaže, ni povsem zadovoljivih odgovorov. Za vsaj osnovno razumevanje tega fenomena smo razvili preprost model procesov, ki vodijo do novih tehnologij. Analiziranje modela omogoča zaključek, da so ti problemi in pomisleki pogojeni z neustreznim zagotavljanjem kakovosti v razvoju novih tehnologij. Zagotavljanje kakovosti, uvedeno na osnovi poglobljenega razumevanja kakovosti, lahko zmanjša probleme in odpravi mnoge pomisleke, ki jih prinaša razvoj novih tehnologij, ter zagotovi tehnologije, ki bodo razvite bližje potrebam in pričakovanjem uporabnikov.

Ključne besede

modeliranje procesov, razvoj tehnologije, zagotavljanje kakovosti, vizija, problem

1. INTRODUCTION

New technologies are raising serious problems and concerns seemingly without a satisfying answer. It also does not seem possible to give accurate predictions of the influences (e.g. health problems caused by technology) new technologies will have on our lives. And there is also a growing evidence of technology abuse.

The rate at which technology development is taking its course seems to be so high that we as individuals and societies may not be able to adapt ourselves adequately to new complexities caused by technological development. This opens space for frustration, misuse and abuse.

Problems and concerns caused by new technologies may be an indicator that quality assurance is not an issue in technology development anymore or that our comprehension of quality is biased. If quality is assured, why then problems and concerns.

It is therefore essential to discover what prevents new technologies to be developed closer to our needs and expectations. A simple model of processes, which drive the development of new technologies and is presented in this paper,[1] is built to make it possible to discover patterns of behaviour that assure the desired outcome of technology development. But the model is also built to enable searching for patterns that can prevent the desired output.

By discovering patterns that can prevent the desired output we can search for means that assure the desired output. By achieving this, quality assurance can be reintroduced in technology development.

2. MODEL AND ANALYSIS

When examining behaviour of an environment, we usually decide the level of detail at which the behaviour is to be examined. By this the environment appears granular and its behaviour only resembles the behaviour of the original environment. In modelling the development of new technologies we use the concept 'process' as the level of detail at which the behaviour is to be examined.

There are many thousands of processes carried out in the development of new technologies. We cannot examine the behaviour of these processes, instead we decide to model these processes based on our knowledge about technology development processes and use the model to discover patterns of behaviour that assure the desired output of the technology development and also the patterns that prevent it.

In building the model, we use concepts (e.g. vision, existing situation, desired situation, problem) to set the basic semantics of the model. This enables us to develop comprehension of the model and its application in realistic situations.

Granulation and patterns of behaviour lead us to an abstract model. Discoveries in the abstract model cannot be automatically applied to real processes. A match between the abstract and real behaviour should be searched for. If a satisfying match is found, the abstract behaviour can be used as a template of real behaviour.

The model is built to provide patterns of behaviour that assure the desired output. We comprehend any difference between actual and desired behaviour that does not result in the desired situation as a problem. As a consequence any discovered problem is also a quality problem. Searching the model for the patterns of behaviour that can create problems is not sensitive to different classes of problems (e.g. design problem, ethical problem) but makes it possible to discover all problems that can arise in the model (Figure 2.1). In discovering patterns that can create problems we draw from knowledge about technology development processes.

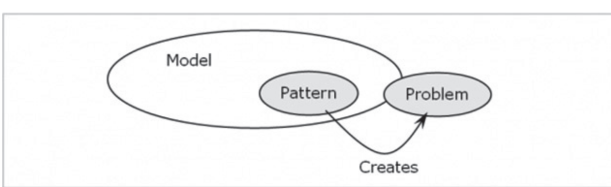

Figure 2.1: Searching the model for a pattern that can create problem

To determine to which class of problems a discovered problem belongs, we use decision patterns. Let us demonstrate how this approach works in discovering ethical problems. By applying:

1. the relation that an ethical problem is also a problem and
2. the decision patterns for identifying ethical problems in the set of all discovered problems

we can identify all the ethical problems in the set of discovered problems (Figure 2.2).

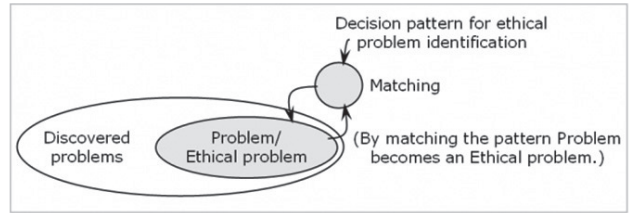

Figure 2.2: Ethical problem identification

When a problem is discovered and identified we should track it back to its place of origin. The process where the problem originated and also the processes that let the problem passed through them undiscovered should then be revised. This is used as a foundation on which problem removal should be developed.

Problems, discovered in an abstract model, are not actual problems but generalised ones. A match between the generalised and real problem should be searched for. If a satisfying match is found, the generalised problem solution can be used as a template in solving the real problem.

3. VISION DEVELOPMENT AND PROBLEM DEFINITION

Each development achievement is based on problematization of an existing situation. The problematization usually leads towards a vision of a desired situation that is at least partly free of problematic patterns of the existing situation. The difference between the desired and existing situation is a problem situation, which is the basis of problem definition (Figure 3.1). The problem is then conditioned by the vision.

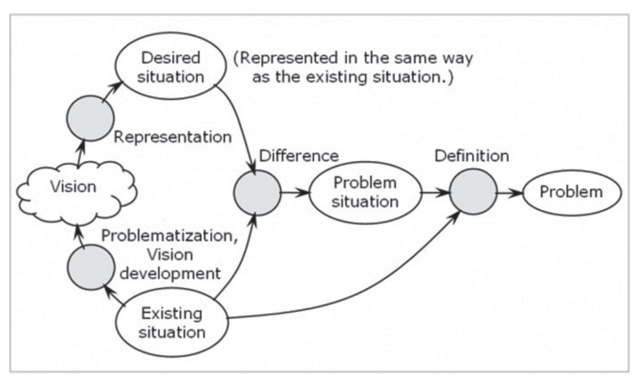

Figure 3.1: Vision development and problem definition

Consequences

3. There are as many problems over an existing situation as there are visions.
4. In such a model we cannot comprehend the problem as an objective category. The problem is conditioned by the vision.

Problem 3.1

Available resources are not sufficient to implement all the visions.

Usually, a selection among the visions takes place. The selected visions get their shares of resources for solving problems conditioned by them. However, such a selection can be justified if the desired situation caused by the visions is the desired situation of everyone involved.

The vision development process should result in a quality vision. By simulating the vision and representing the desired situation in the same way as the existing situation (e.g. by computer visualization), those, influenced by the vision, get more insight into what the vision brings about and they can propose changes. By incorporating changes, a vision that is adopted by those, influenced by the vision, can be developed (Figure 3.2).

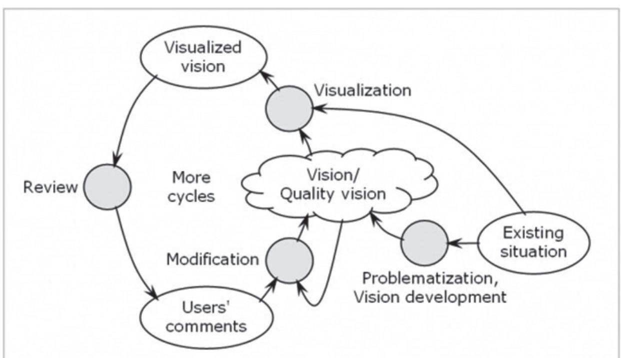

Figure 3.2: Quality vision development

Problem 3.2

An existing situation might have developed from many previous visions that did not produce the desired situation. Such an existing situation is not free of restrictions, which limit the development of new visions. In such a complex situation it may help to discover what visions failed to produce the desired situation and what prevented failures to be discovered earlier.

Developing a vision for an existing situation limited by restrictions can be very demanding. It may be more productive first to resolve problems that gave birth to restrictions. Afterwards the vision can be developed based on the resolved existing situation (e.g. developing a feasible e-government requires much more than building web based services).

Problem 3.3

An existing situation developed from previous visions that did not produce the desired situation may invoke requirements for control mechanisms to keep the existing situation bearable. Requirements for control usually give birth to restrictions to be built in the existing situation. By repeating such a practice the existing situation may gradually become unbearable. This opens space for extreme visions. The history of humankind reveals what can happen when such visions take place.

Setting a vision should be based on mature knowledge about the existing situation.

When a vision comes to implementation, new technologies can be embedded in the desired situation. This requires learning and skills development so that the desired situation (now the existing situation) will support user problem solving. Otherwise frustration, misuse and abuse can take place.

3.1 Influence of perception

A vision is based on perceiving an existing situation. The existing situation may not be perceived equally by perceivers. This leads to different visions and consequently a kind of reconciliation becomes necessary.

The reconciliation should ensure:

- a harmonious agreement regarding the visions (based on mature knowledge about the existing situation)
- sufficient resources allocated for the implementation of the harmonized vision

The harmonized vision should not build on resources that can prevent other contemporary visions to come to realization.

Before developing a vision it may be productive to specify patterns of behaviour that are problematized. Also such pattern sets can help reconcile visions. A better quality harmonized vision can then become a result of reconciliation.

4. IMPLEMENTING THE VISION

The vision is implemented by transforming the existing situation into the desired situation (Figure 4.1).

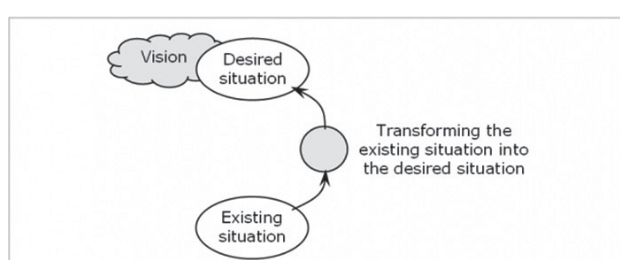

Figure 4.1: Implementing the vision

4.1 Solving the problem

The difference between the existing and desired situation is expressed by those objects that are not members of both situations (Figure 4.2).

5. We have to produce those objects of the problem situation that are not also in the existing situation.
6. We have to replace those objects of the existing situation that are also in the problem situation with the produced objects by outputting the replaced objects for reuse in other processes or for recycling.

We can conceptualize the problem solving process as comprised of:

- production process,
- replacement process.

The production and replacement processes transform the existing situation into the desired situation. To produce the objects we have to provide input to the production process from the environment (also from reuse). We also have to provide reuse or recycling for the replaced objects outputted by the replacement process.

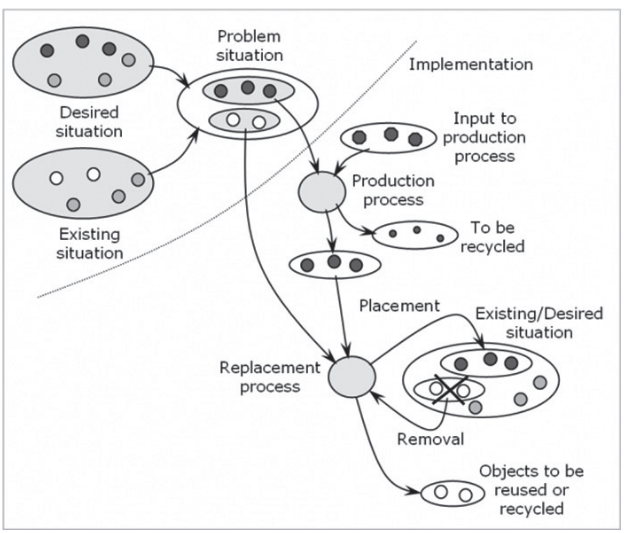

Figure 4.2: A schematic of problem solving process

The way we conceptualized the problem solving process enables us to view the production and replacement processes as sequential processes. However, in real-life situations these two processes can be intertwined.

Problem 4.1

Removal from or moving objects into the environment can cause damage to the environment.

Removing from or moving objects into the environment should match the desired situation derived from a vision of the environment (e.g. sustainable development).

We tend to simplify the problem solving process by dealing with products instead of with desired situations.

Problem 4.2

By reducing the problem solving process to producing a product (e.g. a computer) the user has to take care of the replacement process.

In such a situation the user has to look for professional help in carrying out the replacement process. Many times users carry out the replacement process by themselves, which can result in new problems.

4.2 Specifications

To be able to produce and replace the objects they need to get their properties fully determined. This requires additional level of detailing. The determined properties of the objects are usually arranged in the form of a specification. Based on this production and replacement processes can be determined.

We have to:

- specify the objects to be produced,
- identify the objects to be replaced (they had been specified before they were produced),
- determine the production and replacement processes.

Methods to be used to produce the specifications should be verified to assure conformance with the problem and should enable conformance checking. In addition they should be suitable for the purpose (e.g. method should not require unnecessary activities, method learning cycle should not be long).

To produce specifications, sharing of work and specialization may be necessary.

Problem 4.3

Sharing of work and specialization can cause problems (e.g. those who produce the specifications of the objects may not be aware of all the technological limitations of production and replacement processes).

Because of this, the problem of quality assurance is open throughout the problem solving process. Normally, the specifications should be checked for conformance with the production and replacement processes.

When preparing specifications, two categories of knowledge appear:

- tacit knowledge,
- explicit knowledge.

Tacit knowledge is hard to transfer unless evolved into explicit knowledge.

Example 4.1

And make it small!

The one who sets such a requirement usually knows quite well what "small" really means. Perhaps a simple method to determine what "small" really means is by matching a few examples of small with "small". The example that gives the best match becomes a measure for "small". This enables conversion of tacit knowledge into explicit knowledge and can be done equally well by the one who sets such a requirement.

4.3 Production and replacement processes

We generally do not design and implement the production and replacement processes for solving one problem. However, we have to implement the vision by means of such processes. This sets the requirement for adaptability of these processes, which makes it possible that the same production and replacement processes, by just adapting them, can be used for solving different problems.

We decompose the production process into design and production (narrower sense) processes (Figure 4.3). This decomposition is justified by:

- designing the objects following the specification,
- producing the objects following their design.

Before subsequent activities are carried out, adaptation of the design and production processes takes place (Figure 4.3).

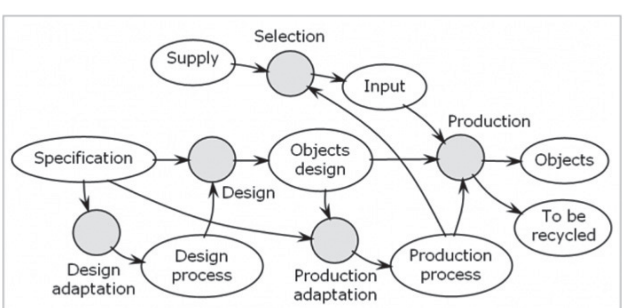

Figure 4.3: Production process decomposition and adaptation

The replacement process (Figure 4.4) is less known (except in the production of capital equipment) due to the reduction of problem solving process to producing a product, which is very common.

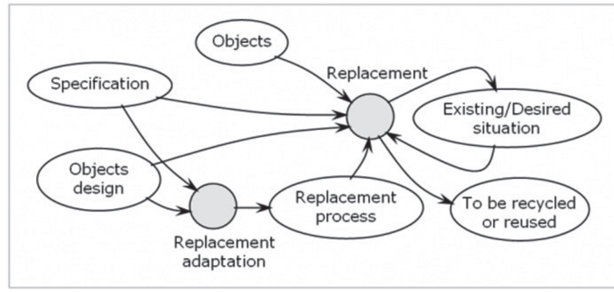

Figure 4.4: Replacement process and adaptation

The replacement process may require an adaptation of the existing situation before the replacement of objects (narrower sense) can take place. In such a case, the replacement process is decomposed to the adaptation and replacement (narrower sense) processes.

Problem 4.4

Adaptability of processes opens space for mistakes and abuse.

Methods for process adaptation should be verified to provide the right solution and should be traceable, which makes it easier to correct errors.

Problem 4.5

Production and replacement processes are generally built on sharing work and specialization, which can cause problems (e.g. those who produce the objects may not be aware of all the technological limitations of the replacement processes, especially when the problem solving process is reduced to producing a product).

Because of this, the problem of quality assurance is open throughout the production and replacement process.

By carrying out the production and replacement processes successfully, the vision is implemented.

Problem 4.6

An object of the desired, now existing situation malfunctions or breaks down.

Such a possibility requires a maintenance process throughout the object lifecycle. This opens again the problem of quality assurance.

The maintenance process should be capable of maintaining the desired, now existing situation until retirement. It should also provide some improvements (e.g. software security updates, basic upgrades of software and hardware and extensions).

Problem solving is commonly incorporated into a business process. The business process can influence the problem solving process in many undesired ways. As we have learned by now the problem solving process has inherent properties, which should not be compromised to get to a solution.

Production, replacement and maintenance processes can be arranged in different organizational structures, which may not be equally supportive to quality assurance (e.g. organizational structures based on intense competition).

Problem 4.7

There is a basic controversy between the business and engineering processes (i.e. production and replacement processes). The business process tends to increase the income even at the cost of lower quality while the engineering process tends to solve the problem even at the cost of lower income.

This controversy should be balanced very carefully. There is no business process without an engineering process and vice versa.

4.4 Unresolved problems tend to grow bigger

Discovering a problem anywhere in problem solving processes requires backtracking to its place of origin. This enables the problem to be solved and any consequences it caused removed. Otherwise, the problem will persist. Figure 4.5 shows a fictitious situation of a problem that originates in a vision and spreads across the processes.

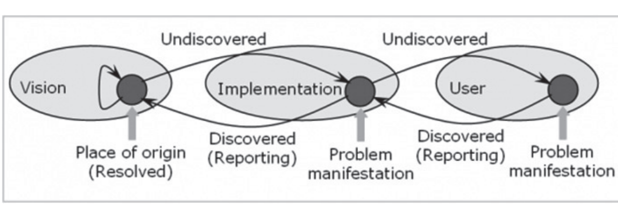

Figure 4.5: Spreading of a problem across the processes

Example 4.2

A program for making presentations based on screen captures may not facilitate saving all presentation parameters. This is not a problem if the number of presentations to be produced is low. However, it is very annoying when one has to make over two hundred short presentations (e.g. of the length of 30 to 180 seconds) with the same presentation parameters that have to be set again and again.

Such a problem originating in a vision will most likely be discovered by users of the program for making presentations.

An undiscovered problem can spread across disciplines. Figure 4.6 shows a fictitious situation of a problem, spreading across disciplines.

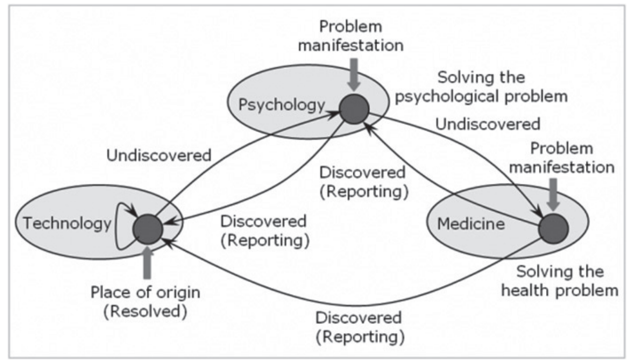

Figure 4.6: Spreading of a problem across disciplines

Example 4.3

It is well known now that persisting stress can result in a serious health problem. There are countless situations in technology where stress situations had been ignored for years until they resulted in serious health problems (e.g. it took many years for office chairs to become more adapted to humans).

To avoid such situations, there should be a well developed collaboration among disciplines and awareness of how much it really costs to ignore stress caused by inadequate technology.

5. QUALITY

Obtained results imply that quality assurance should span from vision development to solution retirement. It has been decomposed into three processes to meet the characteristics of these processes.:

- vision development and problem specification,
- implementation,
- maintenance.

If the retirement is not a part of the replacement process, it should be carried out in the same way as the problem solving process.

By assuring quality, business and other systems succeeded during previous decades to compensate influences (including business process rigidity) that might have compromised their outcomes. We have learned that in a perfect environment, problem solving process produces the desired situation. However, in real-life situations problem solving may be influenced by so many factors that some control is needed to assure the desired outcome. This leads to quality assurance.

Problem 5.1

The reduction of the problem solving process to producing a product gives birth to a tendency to reduce quality assurance to quality of the product.

This cannot only pose problems to the user of the product (e.g. undetermined replacement process) but also to persons influenced by such a solution. If a solution opens new problems, it is not a quality solution.

Problem 5.2

As any other concept, the concept of quality too can be abused.

Quality assurance denotes a set of well defined interrelated processes, which enable problem specification and its transformation to the desired situation. We learned that a lot of things can go wrong before the desired situation is obtained. Assuring a user that we provide quality does not mean much. The user may not have an insight into the reality of our processes, which may be far from quality processes. But the user has an understanding that quality means fulfillment of the requirements. In such a situation the concept of quality may be in support of abuse. The whole set of the interrelated processes is abstracted to "quality processes" which opens an enormous space for misunderstanding and abuse.

As users we have many means to check the credibility of claims regarding quality assurance. However, we should be aware of the means and should know how to use them.

Users should be involved in problem specification, problem solving and solution evaluation processes. Otherwise quality is compromised. The points of involvement should be well defined and should not compromise these processes.

Problem 5.3

It seems that business processes are raising increasingly difficult ethical problems (e.g. marketing in schools). Business process should be in support of problem solving and should strive for quality solutions (e.g. providing what the users need and not what the business process wants to sell them). This situation shows that there is a relation between ethical problems and quality.

5.1 Ethical problems and quality

Solutions to ethical problems are quality solutions. A solution that incorporates an ethical problem is not a quality solution. Unresolved ethical problems incorporated in a solution should then be treated in the domain of quality problems. Why? Ethical problems arise in non-quality solutions. Increasing evidence of ethical problems can merely be an indicator of failure in providing quality solutions.

Relations:

- an ethical problem is also a quality problem (e.g. an identity theft on the web is also a quality problem of the web – users do not want their identity to be stolen),
- a quality problem is not necessarily also an ethical problem (e.g. a wrong delivery is usually considered only a quality problem),

enable us to position ethical problems in regard to quality problems.

Example 5.1

Spam (unsolicited bulk electronic messages) was made possible because user requirements were not considered. (Quality norms, however, are based on the consideration of user requirements.)

There is a simple solution to the spam problem and does not require any advanced technology: "Do you wish to receive our advertisement messages?" (A copy of such a message can be attached). If there is no answer or the answer is no, the e-mail address is deleted from the mailing list. It is not a problem to develop a mailing system with such a capability. But what if there is no legal obligation? What mailing systems will advertisers prefer to use?

When an ethical problem requires participation of more professions (e.g. ethical, legal, technological), an overall solution has to be developed (technological solution alone does solve the problem but can expose the producer to a serious business problem – unethical solutions may be sold better than the ethical solutions).

Spam is an example of how a simple quality problem can become a problem of global scope with serious ethical, legal, business and other consequences.

In dealing with ethical problems there must be well defined and elaborated patterns for identifying ethical problems and well developed methods for treating them during the vision development, problem definition and implementation processes.

A quality vision does not prevent quality and ethical problems in the vision implementation process. Interpretation of the vision (removing abstraction) that is necessary for the implementation can be a cause of quality and ethical problems.

Treating ethical problems should be independent of any particular model of quality assurance but should be seamlessly integrated in it. Ethical problems reflect through the desired situation that does not perform as envisioned. They can be resolved by vision redevelopment and vision reinterpretation – at their places of origin. Because vision interpretation is carried out in the vision implementation process and usually results in the specification, the specification could be the source of ethical (and quality) problems.

At the current stage of development it is not unlikely to think that ethical problems discovered in the vision implementation process can be resolved by applying quality norms along with engineering norms, technology norms, legal norms and norms of other disciplines. Engineering disciplines are used to standards, specifications, recommendations and other forms of norms. It may become a requirement to treat ethical problems through norms because this would enable ethical problems to be solved in an unobtrusive way. Special ethical norms may not be needed; patterns for ethical problems identification may suffice. Based on the already acquired knowledge norms of other disciplines may be effective in solving ethical problems.

The model gives us a picture of how problems including the ethical ones arise, beginning with the vision development, problem definition and throughout the implementation processes. We did not completely separate ethical problems from other problems partly because of no commonly accepted patterns for ethical problems identification and partly because of the fact that all problems have to be solved.

6. TECHNOLOGY

To implement the vision we need technologies. In our model we comprehend technology as knowledge, skills, and resources necessary for implementing the vision.

The design and implementation of the production and replacement processes may require new technologies.

We may not develop new technology for solving one problem only but for solving a class of problems sharing some common characteristics. This leads towards adaptability (e.g. modularization, extensibility, configurability, openness, programmability) of technology. The more adaptable is the technology (e.g. computer, internet) the greater are the possibilities of its application, misuse and abuse.

Adaptable technology requires a capacity to be adapted for a particular purpose. Methods for technology adaptation should be verified and traceable to make it easier to correct errors.

Problem 6.1

We tend to solve problems with inappropriate technologies (e.g. Internet technologies of the nineties were not mature to serve the beginning of massive commercialization).

We have to either choose the right technology to solve the problem or develop new (complementary) technology.

We may convert the design of objects into the design by adaptable (e.g. modular, extensible, configurable, open, programmable) objects. This can significantly decrease the number of different objects to be designed and correspondingly increase the number of the same objects to be produced. Significant decrease in the number of different objects to be designed and correspondingly significant increase in the number of the same objects to be produced can assure high quality objects.

However, before use, such an object must be adapted to emulate the required object.

Problem 6.2

If the object adaptation is not supported with the same level of quality as when produced, it may become a poor quality object after adaptation.

Verified methods of objects adaptation can prevent such situations.

When the existing situation is turned into the desired situation, it enables the user to carry out processes determined by the vision. The user's knowledge, skills and the objects of the desired situation become the user's technology for problem solving. The desired situation turns then into the existing situation.

Problem 6.3

The desired situation changes just after having turned into the existing situation or even before.

Such a situation justifies adaptability of objects (e.g. computers). Adaptability of the objects may enable the desired situation to be changed in an unobtrusive way.

Problem 6.4

Non-existing collecting, reuse and recycling processes can cause accumulation of obsolete objects elsewhere.

When new technology is developed, collecting, reuse and recycling technologies should also be developed (or identified if they already exist).

6.1 New technology

The design and implementation of the production and replacement processes may require new technologies. Before new technology is developed, there is an existing situation (lack of technology). The necessity for new technology creates a vision of this new technology. The vision enables to create the desired situation. The difference between the existing and desired situation is a problem situation, which is used to define a problem. This is exactly the situation from which we began to build our model for analysis. The development of new technology is according to the model in no way different from solving the problem.

Example 6.1

We have to develop sensors to be used for discovering illegal food products at international airports.

In this way the problem is specified through a solution (sensors). Specifying a problem through a solution narrows our options and may prevent us to get to a more satisfying solution. Instead we could specify the problem: "we need to discover illegal food products at international airports". Such a specification broadens the space of possible solutions (e.g. Beagle Brigade).

Problem 6.5

It seems that new technologies are raising increasingly difficult ethical problems (e.g. identity theft).

Technology is a means to solve problems and should provide quality solutions. The development of new technologies predominantly in the direction of technological excellence by measuring technological excellence only in relation to other technologies may result in a situation where user needs may not be considered anymore. In such a way technological excellence becomes a driving force of technological development not harmonized with user needs. This may result in inappropriate technologies which may not allow for quality solutions.

7. EDUCATION

Developing visions and implementing them require well educated and trained personnel.

We have discovered several issues that may have to be addressed in professional and vocational education:

- vision development and problem definition,
- well defined methods of problem solving,
- a balance between knowledge about methods of defining and solving problems and knowledge about technologies,
- knowledge of evolving tacit knowledge into explicit knowledge,
- knowledge about quality assurance.

In general education there should be a balance between the acquired knowledge and problem solving capabilities. Otherwise knowledge is of little use.

A user can use technologies (also because of their adaptability) for a purpose they were not developed for (e.g. the same web technology can be used to spread knowledge or hate). General education dealing with:

- correct use of technology,
- technology abuse and the consequences of abuse,
- ways to protect yourself from abuse,

can be far more reaching than commonly anticipated.

More disciplines (e.g. sociology, philosophy, psychology, medicine) point out serious problems caused by technological development. These problems may be merely manifestations of the problems caused by the ways we envision, develop, deploy and use technologies. In situations like this it is important to backtrack to the place of problems origin. By treating the manifestations of problems we can change only the forms of problems manifestation. However, the problems will persist. By backtracking to the place of problems origin the disciplines can react more accordingly and provide us with more satisfying solutions to the problems.

The results of our analysis show that ethical problems belong to the class of quality problems. However, we cannot claim that quality problems are the place of origin. By not underestimating the contribution of the fathers of quality assurance we can say that quality assurance was re-invented in the middle of the last century because of new complexities caused by technological development. Knowledge of that time was simply not sufficient to cope with the new situation. Quality assurance was essential for catching up with the technological development. Would the technological development have persisted through centuries, with the absence of quality before quality assurance? No. This shows that due to technological development our knowledge and ability to govern technological changes for meeting our needs and expectations may be at stake. Similarly, severe ethical and quality problems we are facing now could merely be an indicator that our contemporary knowledge may not be sufficient to cope with new complexities introduced by the latest technological development.

Ethical problems are not new to technological development (e.g. building of the Panama Canal). Such situations indicate biased comprehension of quality (e.g. quality of the mega structure only).

Many professions are facing severe ethical problems. This indicates the discrepancy between expectations and achievements, which leads us back to the meaning of quality in a much broader sense – can disciplines provide knowledge and technologies that will support the quality of life to a greater extent? The results of our analysis show that this is not unachievable.

As users we have the right to satisfy our needs. However, when satisfying our needs we should not prevent others from satisfying their needs and we should be able to know what we really need and what we believe we need.

8. CONCLUSIONS

One may claim that most technological achievements were not due to user set requirements but to visionary individuals. This can be true but it is also true that the technological achievements not meeting user needs and expectations could not survive. No significant evidence was found that user problems were systematically collected, elaborated and analysed in the past. We cannot expect users to set elaborated requirements (e.g. we need calculators, computers, the Internet). More likely they will express their needs and expectations through problems (e.g. our calculations are so extensive that we cannot completely avoid errors, our data collections cannot be managed successfully by established means anymore). By collecting, elaborating and analysing the problems users have, realistic visions can be developed. This requires a more elaborated communication among stakeholders.

Problems discovered indicate discrepancies that cannot be resolved by sticking to established patterns of technology development. The problems are not so hard to solve; however, they persist. Why? Complexities caused by new technologies and increased specialization of knowledge make it hard to recognize problems that manifest differently in different disciplines, which in addition may not have well established communication among themselves.

It was not our goal to use the model as a model for quality assurance. However, the quality assurance turned out as the most basic problem in technology development.

It is a significant recognition that even simple models like the one presented can be effective in discovering and solving real-life problems. Such a model enables us to focus our attention on important issues. However, it can also misleads if not properly built and manipulated.

Problem removal requires backtracking to its place of origin. Ever growing body of knowledge and increased specialization require more elaborated communication among processes and professions than ever to completely remove a problem. Treating only problem manifestations can lead to a situation controlled by restrictions to keep it bearable.

Technology development should always be accompanied with the development of knowledge and skills to enable productive use of new technologies and protection against technology abuse.

Assuring quality lowers the level of problems. Biased comprehension of quality can be a source of new serious problems. The discovery that all problems are quality problems requires collaboration (not competition) of everybody involved to come to solutions.

Quality assurance is not a promise of an ideal world. However, by striving towards quality, the level of problems can be reduced. One cannot imagine a better promoter of a technology than the technology itself helping users solve their problems. However, we were not able to find any technology of the past and present that would not also create problems, no matter how well developed it was.

Footnote

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