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ENHANCEMENT OF EDUCATIONAL PROCESS USING EXPERIENCE BASED TUTORING APPROACHES

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Abstract

In any technological development we must always take into account very important set of equations:

Better vocational training = more skilled workers = better production = more competitive production = greater employability = reduce unemployment and its effects.

The equations clearly show that any technological development requires adequate preparation i.e. education of human resources for this development. Slovenia wishes to base its own development and prosperity mainly on knowledge. Therefore, the change and modification of education system became an imperative. Consequently, the following article deals with the demand: Slovenia has to fulfil in this process of transformation.
From the experiences of recent years, it seems clear that the existing education system in Slovenia, as a whole, is perceived as an ailing system that fails to meet the needs of a major portion of the society it serves. Every aspect of the educational process and system must be studied and reconsidered in light of new and different societal expectations. And for these purposes we would like to use all positive experiences from different systems in the world.
Key words: *technology education, quality enhancement, learning environment, intelligence.*

Introduction

We talk a lot about quality and excellence in regular life and also in education (Aberšek, 2004). This immediately brings into question what is meant by quality and excellence. *Webster's New World Dictionary of the American Language* defines quality as “the degree of excellence which a thing possesses” and excellence as “the fact or condition of excelling; superiority; surpassing goodness, merit” These definitions of quality and excellence imply that there is a direct link between quality and being *the best* at what you do regardless of what it is that you do. Quality improvement requires a change in attitude, and development of a new philosophy and new concepts. These concepts are simple, but the practice of quality improvement is far from easy.

The pressures for reform that began in America in the 1980s and continued into 1990s are different in intensity and duration from previous calls for change. During the early 1980s, educators experienced a wave of reforms that demanded that teachers and administrators do *more* of what they had been doing and do it *better*. This reform continues in the primary, secondary and high school and finish at university level with Bologna reforms.

Good practice suggests that the first step in any undertaking is to analyse what is known about the current situation. The following conclusions reflect the experiences of recent years:

- a quality educational system is essential to the economic, political, and social welfare of Europe and also of Slovenia;
- asking or demanding that people work harder and do more of what has always been done in the way it has always been done will not produce the needed changes or results in education;
- the current educational system is structured and organized to meet the needs of an age and society that no longer exist. The system must be restructured to meet the needs of a society at the beginning of the twenty-first century;
- there is no commonly held agreement about the purposes and outcomes of public education;
- the concept of restructuring-major changes in the rules, roles, and relationships in education-means changing the culture of the organization. People resist changes within the culture of an organization because causing change means giving up "what we know and how we have always done things";
- educators cannot make changes in public education alone. The "public" nature of the institutions makes education the interest of all citizens;
- the changes needed in education require the long-term commitment to improvement There are no quick fixes;
- school leaders and policy makers must be committed to the transformation of education or it will not occur.

Deliberation, which generates radical changes of the school educational systems on the threshold of millennium all over the Europe is mostly oriented into balancing which competences (capabilities) should educational system develop with the students, so they can successfully perform roles, that can be expected during their life, and therefore to create their own prosperity. In this context it is exceedingly important to see curriculum aims:

- **as global** as possible (and not as it happened at previous renovation; subjects dispersion). We have to think about a correlation of knowledge between the humanities, social sciences, natural sciences and technical fields and also their role (dimension) at forming entire personality for future grown. It is not possible to deny, that humanities, social sciences, natural sciences and their application: techniques are inseparable connected, because things are getting their practicability value (become logical) only in the field of application. (Foreign language, when or if we meet foreigner, mathematics, when we want to calculate something…). Natural science knowledge gets its meaning in application (technics and technology), and therefore gets its market value – that can led up to rise social welfare (prosperity). That however reflexively generates new impetus of society: art, culture, humanism…The circle is joined or even better, a vertical spiral is released (Figure 1) (Aberšek, 2008), and
- it is highly important to use methods in this process, that's support such curriculum aims. This paper will deal mostly with contemporary educational methods connected with learning environment and e-learning of self learning methods that are support philosophy: *better quality of knowledge's in shorter time*.

Past and Present Situation in Slovenia

Changes on the employment market became important in Slovenia with the beginning of the so called transition period, when the previous main conception of agreed socialism was starting to be substituted gradually by the conception of market economy. Erosion of the old conception which represented its own way of regulation of social relations first happened on the principle - ideological level, while on the formal - legislation and practical level it started to evolve in the second half of 80's, where it is actually still going on.

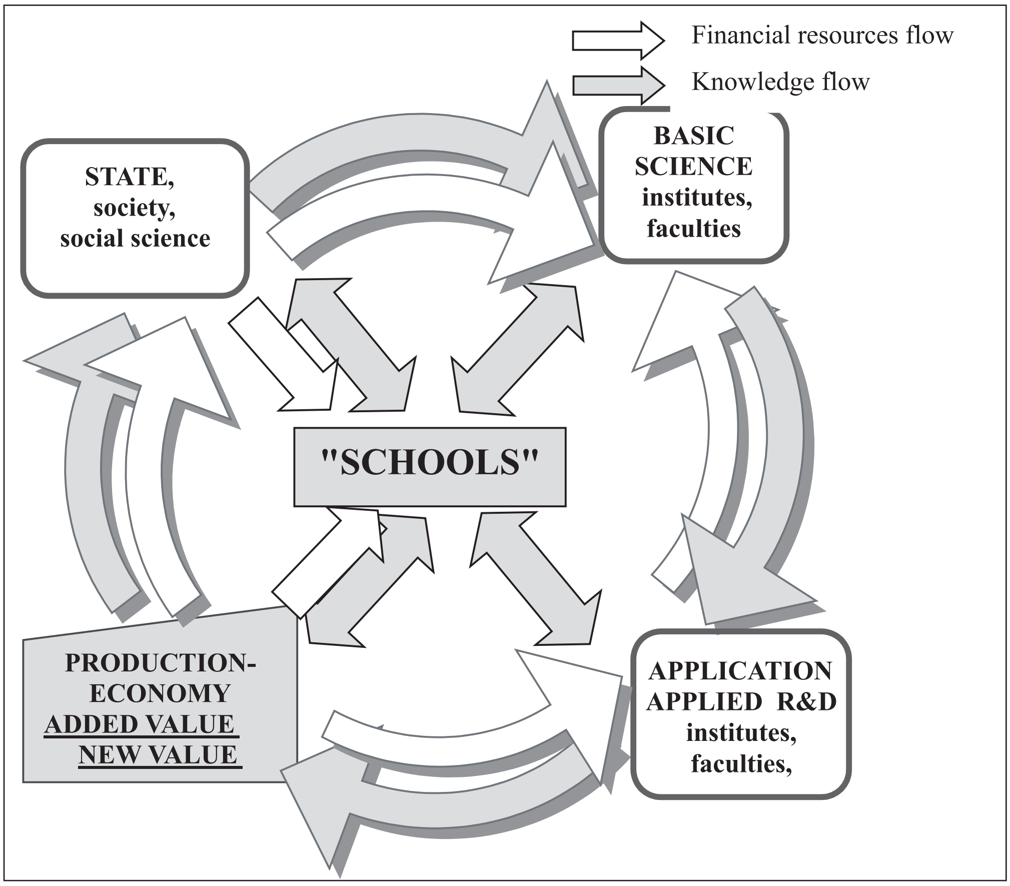

Figure 1. Social developmental circle (Aberšek, 2008)

At present the education in Slovenia (White Paper, 1996, Updating of school curriculums, 2006) is (again) in the process of intensive change and adjustment to new economic and social conditions. The present process is mostly featured by system adjustment to the needs of market economy and technological development.

Intensive reforming activities have begun as early as 1992 with a national conference on Systematisation regulation of education in Slovenia. At the conference, the established partners were confronted, i.e. government and educational representatives, accompanied by a third party students (Aberšek, 2004).

Therefore, the main aim of the reform is to relief the state of its dominant role in the educational system. At this time, the process is beginning to manifest its first problems which could have been foreseen, but of which the main actors were not entirely aware.

Proposed Changes

Education is currently undergoing a major transition and losing its edge in modern societies. Many authorities attribute this decline to serious limitations in the traditional lecture approach to education which places the student in a passive role. What influence student experience is briefly shown at the Figure 2.

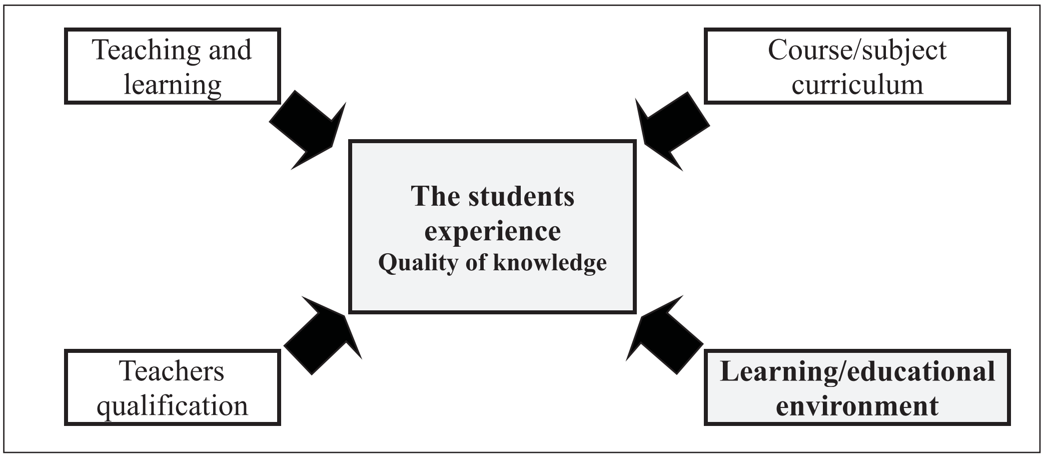

Figure 2. Four pillars of education system

In this paper we will put our attention only on the educational/learning environment, as they are the activity undertaken by each teacher (faculties influence on teacher methods only indirect thou teacher qualification).

Educational Environment

A wave of innovation is being stimulated by the Information Technology (IT) revolution that promises to revitalise our schools (Aberšek, 1996, 2005). Outcome-based teaching methods, electronic learning at a distance and collaborative group work are becoming popular phrases in today's progressive educational milieu. These changes are proving so effective that they signal the need for a major reconceptualization of the learning process. The goal of school system must focus on instilling that vital desire of "learning to learn" in today's students. To accomplish this, teachers must involve the student as an active, self-directed learner. Powerful new forms of IT are providing to create an information-rich learning environment in which students and teachers can explore and not only learn or teach. More than thirty studies have shown that this new approach improves learning over 50 percent compared to the traditional approach. Also from our research it is obviously that with computer tutoring system we have improved learning and get better knowledge (approx. from 20 to 40%, depend on type and generation of tutoring system) with our students.

How to solve the educational problems of young generations with technical and nature science knowledge? In this article I will hand out the concrete activities, that will indicate solutions above for mentioned problems. Important is that we use methods which enable students to actively participate in educational process while acquiring skills necessary to function in tomorrow's world, especially tomorrow technological society. As I mentioned previous I will restrict my attention in this paper only on one of four pillars (according to figure 2) of educational system, namely only on the **educational environment**.

Tutoring Educational Systems

There is no denying the appeal of computer especially if it's connected with video games. Their magnetic effect on children's (and students too) attention is all too familiar to parents and teacher, particularly when the alternatives are homework and household chores (Massey and Brown, 2005). Questions are:

1. *What is it about computer and games that make them so appealing?*
2. *What lessons might be learned from their construction that could be applied to other applications?*

Before we answer to these questions we must first answer to:

- *how does human intellect work and/or how does human percept individual information,*
- *how are computers and video games build and at the end*
- *how must be advance learning environment build up?*

In the main part of this paper I will try to explore these questions, offering several examples of how computer games ideas influence the architecture of systems not developed directly for entertainment (Aberšek, 2009).

For conventional software, design is usually driven by a **specification** of **set of requirements.** In game design, the driving force is the user's experience. Game designer try to **imagine** what players will experience as they work their way through the game, trying to deliver the most exciting and compelling experience possible (Langely, 2006).

Two key aspects of player's experience are the goals they pursue and the environment in which they pursue them. Game designer often seek to keep players engaged by creating three levels of goals:

- short-term, lasting perhaps seconds,
- medium-term, lasting minutes and
- long-term, lasting the length of the game.

A good story is not simply a sequence of things that happened but a carefully constructed tapestry in which events are juxtaposed and emotions peak and ebb. A good game is also highly interactive, deliberately generating tension between the degree of control the story imposes and the player's freedom of interaction. Two extremes are:

1. With no story and complete freedom of interaction players do what they want, but their experience can be boring.
2. On the other hand, if the story provides too much control, the experiences become more like watching a movie than playing a game. The secret of the solution is in balancing these two extremes. And this is also most important when we creating learning "game" environment. We must always live enough time and space for exploring!

The main goal of a game is entertainment. *But could be also learning pleasure? Could the same ideas be applied to application with more serious-minding goals?* (Jones and Beyron, 2007) We have identified two general classes of application that could benefit from a game-based design approach, namely:

1. The first we call **experience-based systems**. In game design, the main focus is the user's experience.
2. The second class involves using a game-based approach to **construct a testbed for emerging technologies**. A game world makes it possible to test emerging technologies in a comparatively rich environment before they are ready for the full-scale complexities of the real world. The game world can also provide an environment in which a number of technologies are integrated together while revealing interdependencies and emerging research issues. I will briefly show this class in our case – **eLAB.**

Experience-based Systems

All good computer games, from the simplest puzzle to the most complex strategy adventure, share ability to entice players and immerse them in the game experience. Traditionally, immersion and entertainment go hand in hand. Players are more willing to suspend their disbelief for entertaining games – the deeper the immersion the more entertaining the experience. Games designers thus craft every aspect of the players' experience to support the desired effect and avoid breaking their sense of immersion.

Immersion is a powerful shortcut also into users' minds with potential non-game users. In educational application, studies have shown that an immersive learning experience "creates a profound sense of motivation and concentration conductive to mastering complex, abstract material". (Dede, 1996) Interactive, immersive experience is also a powerful tool for communication and persuasion.

The key idea is that instead of introducing new technology into the complexity of the real world, the designers instead create an artificial "game" world and introduce people and technologies into that world. The fact that the artificial world is under the control of developer's changes everything, because it's content, as well as its scenario, can be manipulated to create a strong context limiting the range of possibilities the technology must support. Here we can put additional question*: do we need some components of the real world also in virtual world?* From our point of view and from our experience, the **answer is YES!**

While educational system seek to import knowledge or skills to users, experience based communication systems present them with a specific viewpoint in hopes of influencing their beliefs and attitudes. Like Sinclair Lewis 1906 novel *The Jungle,* which detailed slaughterhouse conditions and resulted in extensive workplace safety and food-hygiene reforms, experience based systems present their users with the developer's viewpoint under the guise of entertainment. However, unlike a novel, experience-based systems communicate that viewpoint from an interactive perspective (Myers, 1995).

Like all powerful tools, the experience-based design approaches must be applied carefully. Without a carefully designed experience and extensive testing, these systems could easily result in unwanted outcomes (such as negative training or increased phobia anxiety). Despite the promise of the early efforts, the best approaches to designing these experiences are still topics of research and debate.

First Generation of e-(smart) Tutoring Systems

Interactive computer programs typically consist of the following three basic components:

- context is a workspace for the problem constructed by the inference Mechanism from the information provided by the user and the knowledge – base;
- inference Mechanism, which monitors the execution of the program by using the knowledge - base to modify the Context;
- user Interface;
- explanation Facility;
- knowledge - Acquisition Module, as shown in Figure 3.

In order to make electronic education a reality, knowledge-based systems was and still are essential. Our knowledge-based system is a computer program that contains mainly knowledge and some possibilities for calculation- simulation of results (Aberšek and Popov, 2004).

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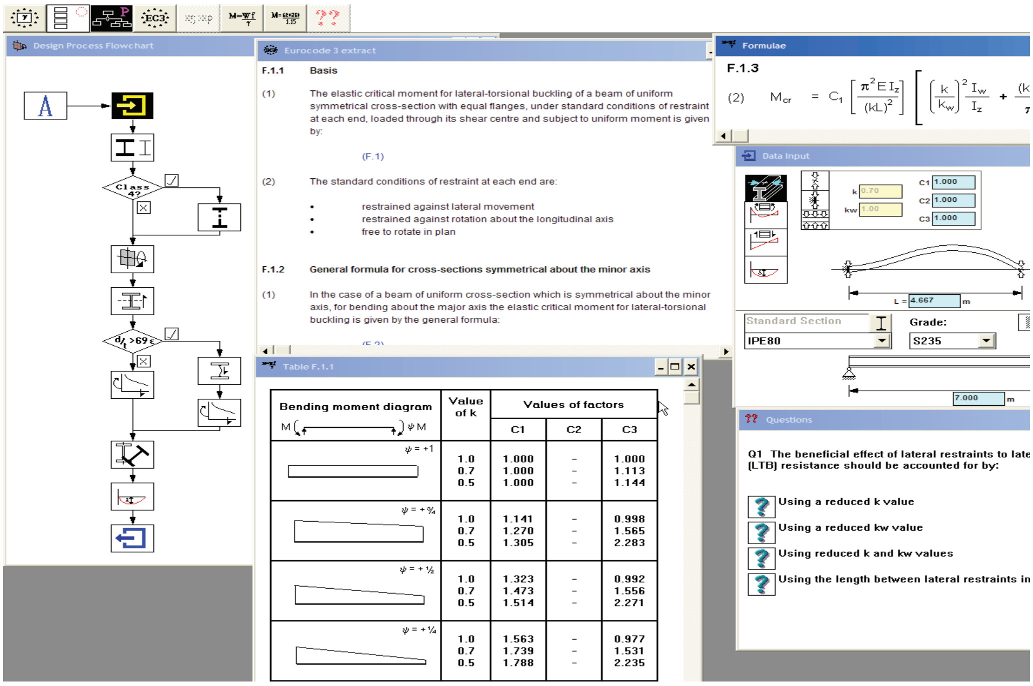

Figure 3. Tutoring system for steel construction lecture on the base of EUROCODE

Through this tutoring system, the student has been placed in an “active” role, as opposite to a “passive” environment of one-way lecturing. The teacher can then act as a facilitator instead of merely a one-way communicator.

Second and Third Generation – “Smart” Tutoring System

Knowledge - based ES are interactive computer programs which incorporate expertise and provide advice on a wide range of tasks. (Aberšek and Flašker, 2004). These systems typically consist of the following three basic components:

- the behaviour of the problem domain;
- context, is a workspace for the problem constructed by the inference mechanism from the information provided by the user and the knowledge – base;
- inference mechanism, which monitors the execution of the program by using the knowledge - base to modify the context.

In addition to the three main modules described above, the system should also be provided with a graceful:

- user Interface;
- explanation facility;
- knowledge - acquisition module, as shown in Figure 4.

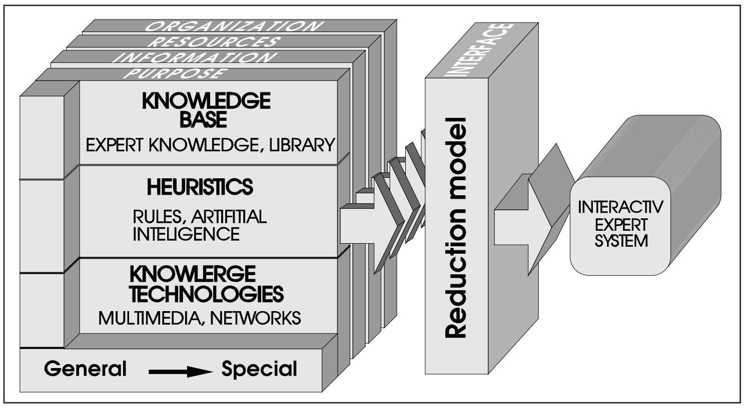

Figure 4. Configuration of the Expert System

Our knowledge-based system is a computer program that contains knowledge and heuristics (rules of thumb based on experiential learning) about a specific domain (Aberšek and Popov, 2004). New and innovative techniques must be developed that will allow the rapid and inexpensive design, production education, and distribution of instructional modules and packages. Knowledge-based systems is useful in bringing new and efficient processes into the analysis and design of the knowledge structures that eventually still find themselves programmed into an instructional module.

Knowledge-based systems could be linked also with some simulation tools for example on the base of VRML, to enhance education by tutoring students in selected subjects. Presented expert system is constructed for students of mechanical engineering for data analysis, and then simulated design and optimization (see Figure 4). Our intelligent tutoring system is able to adjust its questioning and tutoring according to the student's level of understanding.

Case Study 1 – STATEX

Presented expert system (STATEXS) (Aberšek and Flašker, 2004) is constructed for mechanical engineering for data analysis, and then simulated design and optimisation. Our intelligent tutoring system is able to adjust its questioning and tutoring according to the student's level of understanding.

Conventionally as all similar programs, the program STATEXS consists of pre-processor, knowledge bases, solver and postprocessor according to Figure 5. The pre-processor is intended for entering the data such as:

- module-*m*,
- number of teeth,
- centre to centre distance,
- coefficient of profile displacement,
- inertia moments of rotating masses,
- spring constants, and
- loading moments,

and is intended for interactive work by means of existing form. Appropriate knowledge bases, in which long standing experience and theoretical knowledge of a field are collected, are connected to the expert system.

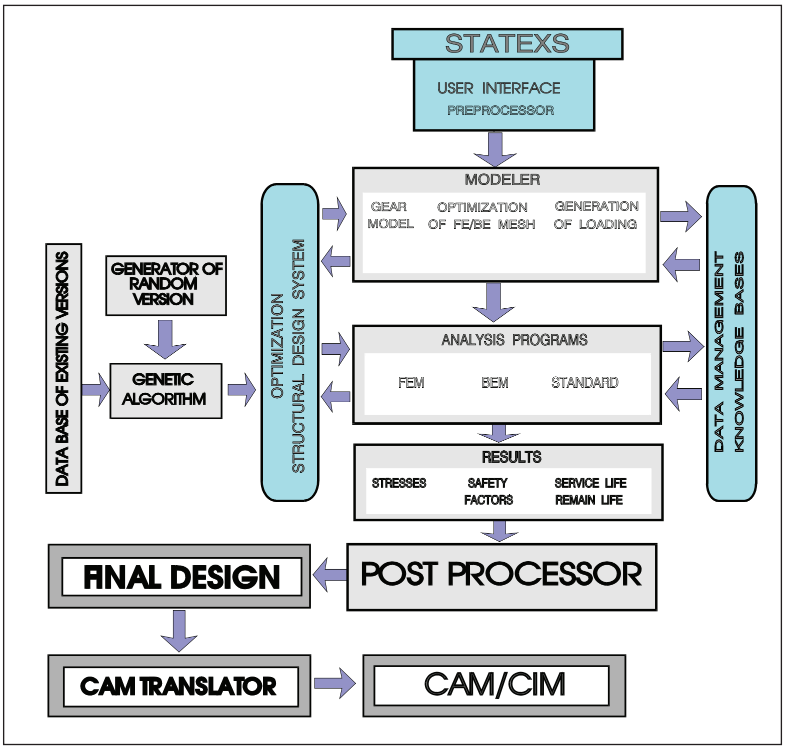

Figure 5. **Expert System STATEXS**

As in all programs also in our case an important component of program is the solver, which consists of:

- **Automatic generator of mesh for gears** it consists of two parts:
  - generator of tooth flank shape and/or the generate the contour of model for FE method,
  - discretizer of the generated model. It makes a model of finite elements according to prescribed lows, serves as in input data in the program FEM.
- **Simulation** is organized in the form of a subprogram which can be used at various levels of calculations and/or for theory of the simulation Monte Carlo, genetic algorithm, fuzzy logic and other AI methods is shown.
- **Loadings on gears - Generator of equations of motions** The gear is loaded mainly dynamically by a loading of variable amplitude as a time-dependent process and whose direction, size and point of application vary.

We incorporated in our program STATEXS the possibility of generating the loading by means of a mathematics model of a random gearing. In addition, the loading due to residual stresses are taken into account in the program.

- FEM program.
- Fracture mechanical module.
- Optimization module.

The postprocessor serves for interpretation of results. They are presented in the form of tables and/or diagrams as follows:

- crack length - number of cycles/time,
- *da/dN* - Δ*K*,
- force – time and stress – time.

Case Study 2 – eLab (Third Generation)

Undisturbed functioning of technical systems is a prerequisite for effective operation of industrial processes. Therefore, a constant and efficient maintenance is crucial. (Ploj Virtič and Aberšek, 2008)

The mathematical model as shown in Figure 6 is consisting of three modules that use acoustic responses to enable the diagnostics data of single stage gear wheels. The comparison of simulated and measured sound frequency spectrums has shown that the simulated value is a good indicator of the shifts in the spectrum caused by the tooth root notch. This developed model can be used to learn how to analyze the gear wheel tooth damage and – based on these and ES STATEXS – to estimate the remaining service life and/or maintenance process.

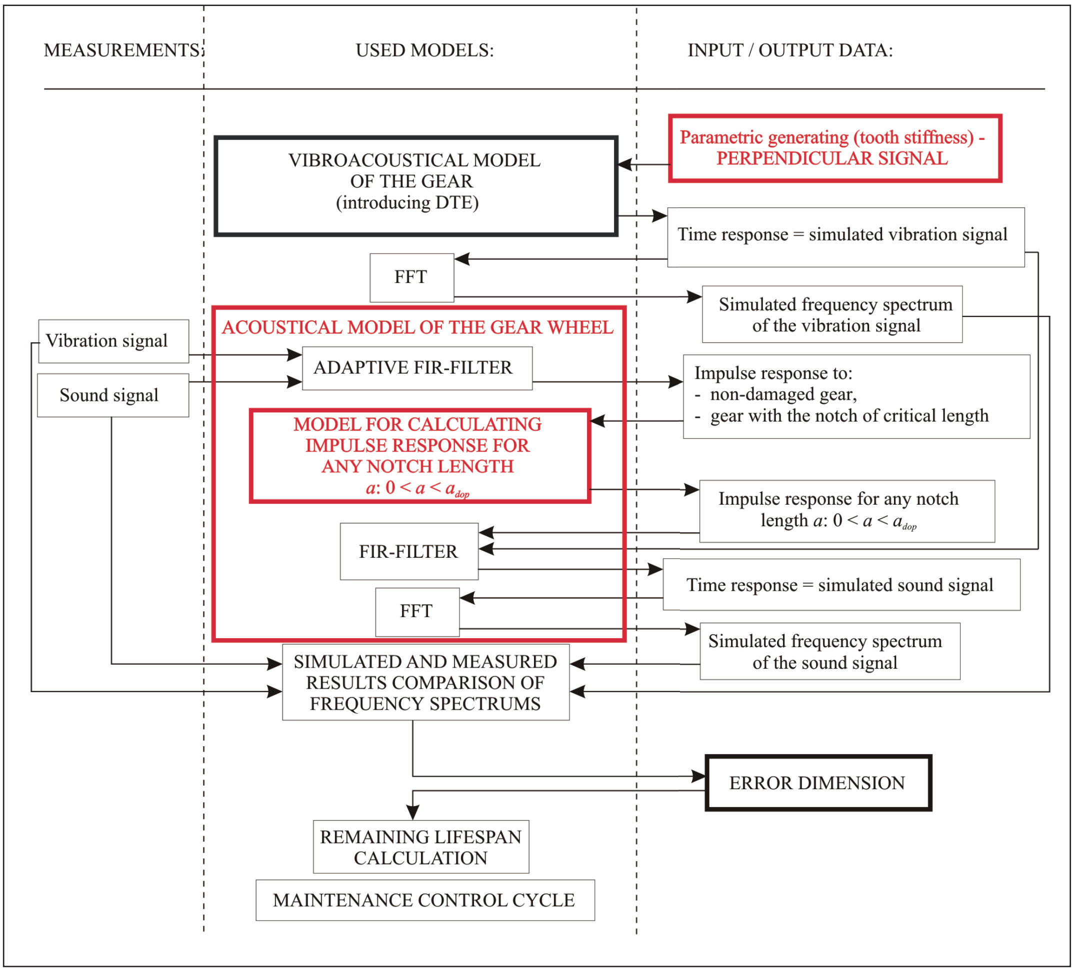

Figure 6. e-Lab diagnostic system

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This includes not only replacing the damaged and worn out parts and regular refits, but the use of various maintenance models that are based on surveillance and diagnostics of the current condition of technical systems. Such models of preventive maintenance use the method of condition maintenance. This means they help to discover damage (defect) in its early stage, i.e. in the initiation phase. Apart from considerable savings, this approach also ensures a continuous and reliable course of the technical process without unnecessary interruptions. For control and diagnostics of the technical system in question, sound and vibration are two key parameters.

We can get data from the experiments or we can tray to simulate it. The mathematical model simulation produces a frequency spectrum of the simulated sound signal, which enables an analysis of the error that can be used for calculating the remaining service life and/or determining the control cycle of maintenance. The system is an optimal means for error detection, and it can be considered a starting point for controlling the remaining service life of the gear or for calculating control cycles on the basis of acoustic responses.

From Smart to Intelligent Self Learning Tutoring System – a Hasty Glance in the Future

Learning, knowledge and intelligence are closely related. Although there is no universally accepted definition of intelligence, it can be roughly defined as follows:

Intelligence is an ability to adapt to the environment and to solve problems.

Nowadays, most of the researchers agree that there is no intelligence without learning, so learning-adaptation takes place in almost all living beings, the most obvious in humans. Learning by a living system is called *natural learning*; if, however, the learner is a machine – a computer, it is called *machine learning*. The purpose of developing machine learning methods is, besides better understanding of natural learning and intelligence, to enable the algorithmic problem solving that requires specific knowledge. In order to solve problems we obviously need knowledge and the ability to use it. Often such knowledge is unknown or is used by a limited number of human experts. Under certain preconditions, by using machine learning algorithms we can efficiently generate such a knowledge which can be used to solve new problems.

Even the whole natural evolution can be regarded as learning: with genetic crossover, mutation and natural selection it creates better and better systems, capable to adapt to different environments. The principle of evolution can also be used in machine learning to guide the search in the hypothesis space through so called *genetic algorithms*.

1. Artificial intelligence

A long term goal of machine learning research, which currently seems unreachable, is to create an artificial system that could through learning achieve or even surpass the human intelligence. A wider research area with the same ultimate goal is called *artificial intelligence*. Artificial intelligence (AI) research deals with the development of systems that act more or less intelligently and are able to solve relatively hard problems. These methods are often based on imitation of human problem solving. AI areas, besides machine learning, are knowledge representation, natural language understanding, automatic reasoning and theorem proving, logic programming, qualitative modelling, expert systems, game playing, heuristic problem solving, artificial senses, robotics and cognitive modelling.

In all AI areas machine learning algorithms play an essential role. Practically everywhere one has to include learning. By using learning techniques, the systems can learn and improve in perception, language understanding, reasoning and theorem proving, heuristic problem solving, and game playing. The area of logic programming is also highly related to inductive logic programming that aims to develop logic programs from examples of the target relation. Also in qualitative modelling the machine learning algorithms are used to generate descriptions of complex models from examples of the target system behaviour. For the development of an expert system one can use machine learning to generate the knowledge base from training examples of solved problems. Intelligent robots inevitably have to improve their procedures for problem solving through learning. Finally, cognitive modelling is practically impossible without taking into account learning algorithms.

2. Natural learning

Humans learn throughout whole life. We learn practically every day, which means that our knowledge is changing, broadening and improving all the time. Besides humans, also animals learn. The ability to learn depends on the evaluative stage of species. Investigation and interpretation of natural learning is the domain of *the psychology of learning* and *the educational psychology*. The former investigates and analyses the principles and abilities of learning. On the other hand, the latter investigates the methods of human learning and education and aims at improving the results of educational process. Educational psychology considers attention, tiredness and motivation to be of crucial importance for a successful educational process and carefully takes into account the relation between teacher and students, and suggests various motivation and rewarding strategies. All those are of great importance for human learning, however, much less important for the (contemporary) machine learning.

3. Learning, Intelligence, Consciousness

As we already stated, intelligence is defined as *the ability to adapt to the environment and to solve problems*. Learning alone, however, is not enough. In order to be able to learn, a system has to have some capacities, such as sufficient memory capacity, ability to reason (processor), ability to perceive (input and output) etc. These abilities do not suffice if they are not appropriately integrated or if they lack an appropriate learning algorithm. Besides, for efficient learning one needs also some initial knowledge – background knowledge, which is inherited in living systems. By learning the abilities of the system increase, therefore intelligence also increases (Dennett, 2005).

4. The amount of intelligence

The systems cannot be strictly ordered with respect to the amount of intelligence because we have to consider various types of intelligence (abilities): numerical, textual, semantically, pictorial, spatial, motor, memorial, perceptive, inductive, deductive etc. Lately, even emotional intelligence became widely recognized. Some authors describe more than one hundred types of human intelligence. A system (a human or a machine) can be better in some types of intelligence and worse in others and vice versa. When speaking about artificial intelligence we do not expect from an intelligent system to be extremely capable in only one narrow aspect of intelligence, such as for example the speed and the amount of memory, the speed of computation or the speed of searching the space or (almost optimal) game playing – nowadays computers in each of these aspects already have very advanced capabilities. We expect from an intelligent system to be (at least to some extent) intelligent in all areas which are characteristic of human problem solving. It seems that we need an integration of all different types of intelligence into a single sensible whole (a kind of supervisory system) so that during problem solving it is possible to switch appropriately between different types of intelligence. Anyway, most of the speculations about artificial intelligence do not take into account yet another level: consciousness (which seems to be a good candidate for the supervisory system).

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5. Limits of symbolic computability

Theory of computability reveals that only a tiny (one could say a negligible) part of all problems, which can be formally described, can be algorithmically solved.
Nowadays the science uses the following formal symbolic languages for describing (modelling) reality:

- mathematical logic,
- programming languages,
- recursive functions, and
- formal grammars.

All these formalisms have equivalent expressive power and they all have equivalent limitations: they can partially describe the phenomena in the discrete world (discrete functions), and practically a negligible part of the continuous world (continuous functions). Therefore, if the world is indeed continuous, then most probably it is undescribable by any of formalisms which we are able to use with our (rational) mind. This would implicate that any knowledge that can be reached by science, described in books or by teachers, cannot be ultimate, as it is always only an approximation of the reality.

In all years from the very beginning of electronic computers we cannot notice any crucial progress towards the ultimate goal of creating an intelligent machine by using machine learning algorithms. Anyway, we can mention some important steps:

- Lenat's Automatic Mathematician - an interesting system for discovering new concepts in mathematics,
- great successes of computers in complex games, such as checkers, backgammon, and chess,
- artificial neural networks for modelling the cognitive processes in the brain,
- ACT-R, cognitive model of brain and brain function (Anderson, 2007)

But the principal limitations for programming languages and other formalisms, described above, that stem from the computability theory, hold also for any ML algorithm, no matter how advanced and complex it is. Very strict limitations are posed by the theory of learnability. The latter is derived from the computability theory – the machine learner is necessarily an algorithm. As it may be expected, all the limitations for computability hold also for learnability.

6. Possibility of artificial intelligence

Practically all research of artificial intelligence methods tries to develop systems that behave intelligently and are able to solve relatively hard problems. The developed methods are often based on imitating the human problem solving. The human mind is what emerges from the actions of number of largely independent cognitive modules integrated by central control system (Anderson, 2007). Figure 7 showed some approach for the organization of these information processing modules. To achieve the rapid processing required for functionality of the mind, different information-processing functions are computed as much as possible by different independent modules associated with different brain regions. However, the need for coordination requires a communication among these modules.

As a long-term goal we are interested whether computer intelligence (capability) can indeed achieve or even exceed the human intelligence. Important aspects for understanding the abilities of artificial intelligence are the impact of learning on intelligence, the speed of problem solving, the principal limitations of algorithms, and the imitation of intelligent behaviour.

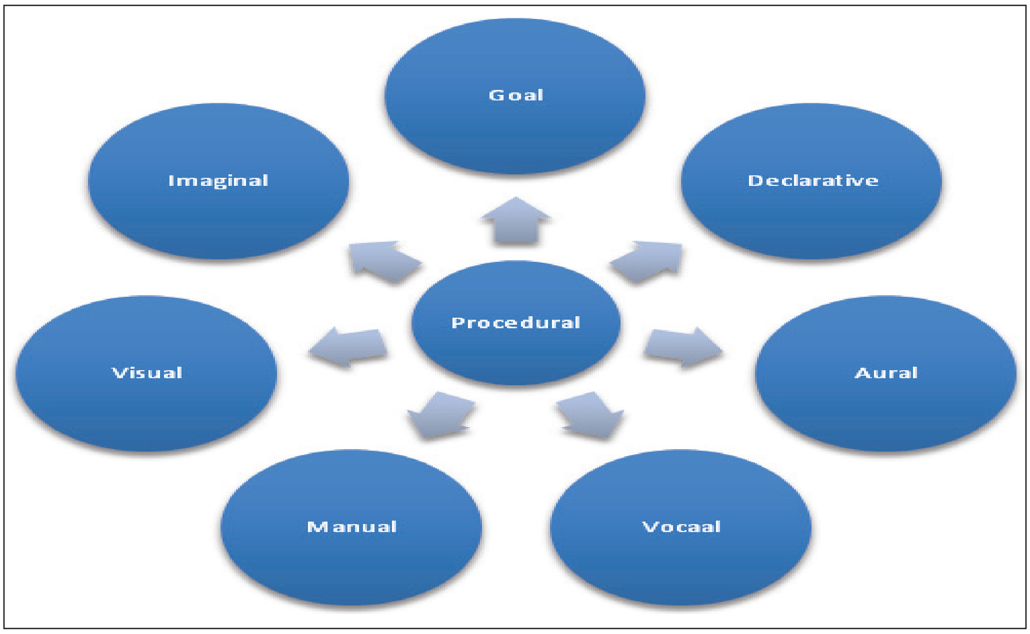

Figure 7. Modular architecture of human mind (Anderson, 2007)

Impact of learning on intelligence: By learning the capability of the system increases, therefore also its intelligence increases. Human intelligence is dynamic and is changing throughout the whole life, mostly increasing. However, when determining the amount of intelligence one has to take into account numerous different types of intelligences.

Faster is more intelligent: Adaptation to the environment and problem solving are better (more efficient) if they are faster. Therefore, intelligence is highly related to speed and time. All tests of intelligence are timed as are also all examinations. Therefore, we can conclude, in that sense, that faster computers are more intelligent than slower ones that parallel processing is more intelligent than serial one, etc.

Limitations of intelligence: If humans were equivalent (degradable) to a computer algorithm then all the limitations posed by the computability theory would hold also for humans - this would have strong impact on the abilities of human intelligence. If, however, we assume that humans are stronger "machines" than (digital) computers (for example continuous and not discrete machines) then the human activity is undescribable. The consequence of this assumption is that it is impossible to algorithmically derive an artificial intelligent system which would completely reproduce the human behaviour.

Imitating intelligent behaviour: Nowadays the technology of movies, multimedia, computers, robots, and virtual reality is very convincing and suggests that it is possible to imitate just everything and induce the sensation of reality.

Therefore, if we omit the consciousness, a machine can in principle be intelligent enough (for example by huge amount of memory, containing the solutions to all possible situations) to induce the sensation of artificial intelligence. If we add also extraordinary processing abilities (super parallelism with super-fast processors), algorithms for efficient search of huge spaces and machine learning algorithms that would enable online improvements of algorithms and heuristics, then such a machine could rightly be named "intelligent" - it could outperform the humans in many if not in all "practical" tasks. Of course, such a machine still lacks consciousness.

7. (Im) possibility of artificial consciousness

In principle, we are able to determine (detect or objectively measure) any system that has certain learning capabilities and that has a certain level of intelligence. Opposed to learning and intelligence, consciousness is much different. It is necessarily related to subjective experience and any objective observer has no means to verify it. Although nontrivial, it is objectively possible to determine the ability to learn, the amount of acquired knowledge, the ability to (intelligently) adapt to the environment and solve problems. Various tests of intelligence are able to measure only specific types of intelligence and the results are typically only partially reliable. On the other hand, in principle it is not possible to verify the consciousness of the system. Whether a (biological or artificial) system is conscious or not is known only to the system itself – in the case that it is conscious. An observer from outside has no way to verify it. You can speak about consciousness only if you yourself are conscious and if you assume that systems, similar to you, are also conscious. Any conscious system can be imitated with an unconscious system to arbitrary (but always incomplete) resemblance; therefore any objective observer can be fooled.

In the following we speculate about some interesting viewpoints. A system can be more or less intelligent but without consciousness (such as robot or in an extreme case a human zombie) or a system can be conscious but much less intelligent (such as less intelligent people, animals etc.). Consciousness seems to be fundamentally related to the following notions: *life, intelligence, and free will*.

Consciousness = life? Humans are conscious, dogs and cats are conscious (typical claims of pat owners), and even amoeba may be conscious to some extent. Nowadays science is still not able to explain the origin of life. By materialistic assumption life appeared by chance (which is highly improbable) or it is a result of the complexity and self organization of the matter. Another theory states that life came out of the space (amino acids on the meteors), but then we have to ask, where and how were those amino acids created. By ritualistic assumption, on the other hand, the life was created by a higher force – a universal consciousness.

Does more intelligence enable higher level of consciousness? Although consciousness is not objectively verifiable nor measurable we can speculate that with greater capabilities, i.e. greater intelligence, the higher level of consciousness can be achieved – we can assume that less developed species are less intelligent than more developed ones. Of course, you can have obvious counterexamples: have a super intelligent system (for example a highly intelligent man) and remove consciousness (such as brain washing or simple blindness with his or her own ego), you can obtain a highly intelligent system (for example a fanatic or an extremely avaricious man for money or power) that is not conscious of his or her actions. If we paraphrase: a child (in the sense of lack of consciousness) is playing with a nuclear bomb. The consequences can be catastrophic.

Does consciousness implicate free will? If a system only reacts to outside stimuli then its responses are determined and unconscious. A conscious system can by itself, without any outside cause or stimulus, decide for an action (and not reaction) which means that it has free will. Various researchers and philosophers still argue whether free will exists at all, however, it seems sensible to assume that if consciousness exists then exists also free will.

Conclusion

Information technology, through networking, knowledge-based systems and artificial intelligence, interactive multimedia, and other technologies, play and will in future play even more an increasingly important role in the way that education is taught and delivered to the student.

For this reason we present in this paper some ideas of such learning-training environment for education. Like the researchers in other countries we tend to develop a user-friendly general system particularly for solving problems based on experience-based tutoring systems primary for executing better lessons and for students self learning.

Like all powerful tools, the experience-based design approaches must be applied carefully. Without a carefully designed experience and extensive testing, these systems could easily result in unwanted outcomes (such as negative training or increased phobia anxiety). Despite the promise of the early efforts, the best approaches to designing these experiences are still topics of research and debate.

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