MuTil – A Computer Based Training System for Apprentice

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Abstract

By creating (semi-)autonomous group structures in enterprises the work content of the workers changes. Workers are confronted with new working which are enriched by new technologies. Existing training tools for apprentices do not present the interaction between different tasks within a workshop. MuTil will implement a scenario with a complex combination of problems typically appearing in a workshop. The apprentices shall then solve these problems in a simulation environment. Through this learners will get a better understanding of working with computers, web based software etc. MuTil is a combination of teaching, learning and simulation. MuTil will force learners to apply their knowledge in a computer model of a workshop and to transfer their gained experience into real world environments.

Key words
Computer Based Training, Web Based Training, HTML, Java, ASP, Media Streaming, SQL, Authoring Tools, Virtual Facility, Visualization

1 Introduction

At the ifab–Institute of Human and Industrial Engineering, University of Karlsruhe the training tool MuTil (Multimediales Trainingstool für Industriemechaniker in der Ausbildung) is under development. Partners of this project are a training centre of a major machine tools manufacturer (DMG Trainings-Akademie GmbH, Bielefeld) and a vocational school (Carl-Miele-Berufskolleg, Gütersloh).

The goal of the training tool is the formation of the qualifications of mechanics in industry. In terms of occupation, these qualifications can be divided into the areas of technical, occupation specific and occupation spanning qualifications. The occupation spanning qualifications are often referred to as "key qualifications".

Belong to the technical qualifications which problem solving abilities can be assigned to occupation specific qualifications. The training in these areas concentrates on the development of technical and method competencies, together referred to as technical competence. This can be compared to the technical and occupation spanning qualifications. These concentrate on the interaction of the apprentices and their social environment. In this area, interaction abilities and the responsibility abilities are considered the central aspects to be promoted. The above-mentioned training focuses are referred to collectively as social competence.

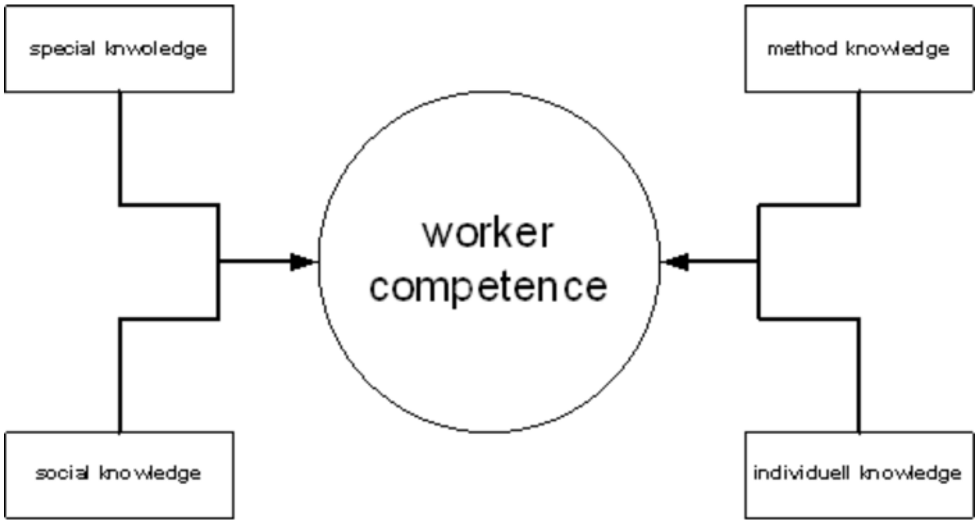

Fig. 1: Key qualifications

2 Goals of MuTil

The introductory comments about MuTil as a training tool show it as being orientated towards vocational training. It should be just as clear that MuTil as a computer-aided training tool touches on occupational action competencies through use of the computer. MuTil cannot promote all four competencies to the same degree. Thus, MuTil focuses primarily on the promotion of technical and method competencies within a comprehensive approach. However, the social and individual competencies are not left out completely, rather are reflected repeatedly, in particular in the system introduction phase.

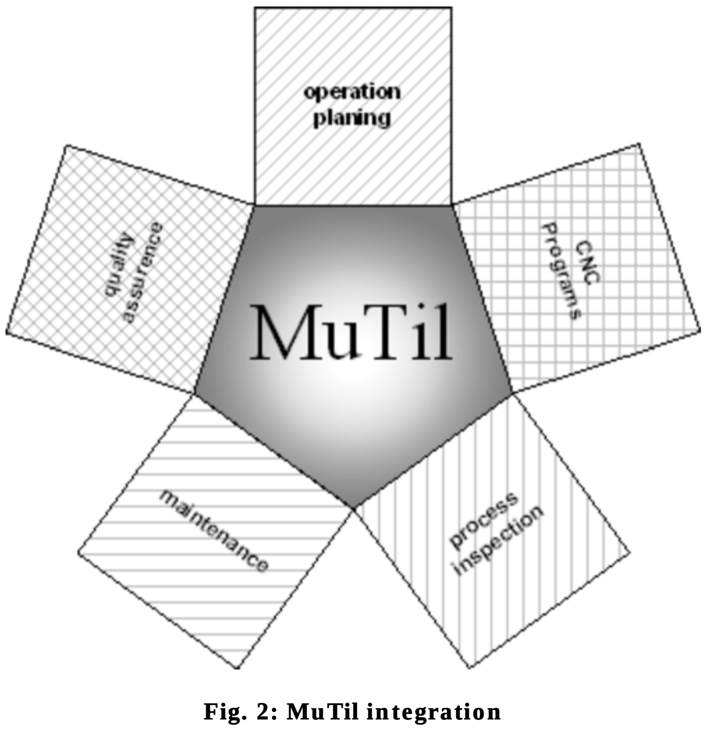

Fig. 2: MuTil integration

About the technical competence, MuTil aims to unite the previously individually handled learning content of operations planning, CNC-programming, quality assurance and maintenance. The comprehensive nature of the production process shall thereby be made apparent (s. Fig. 2).

Furthermore, MuTil should help to bring the fragmented knowledge together through integrating the practice orientation of an enterprise and the more theoretical orientation of a vocational school. Thereby: replaces the previous enumerative, additive qualification approach with the implementation of a comprehensive one. MuTil is not intended to relay new knowledge, rather the application of already acquired knowledge, thus expanding this knowledge and transferring the reality of the vocational and working world.

The starting point for this application is the creation of (semi-) autonomous group structures and new forms of organization within a workshop, leading to a change in the work content. This includes the operating of several machines as well as an operations planning, CNC-programming etc. Additionally, the related tasks, which arise due to increased use of computers, call for new competencies (see ZÜLCH, REIMANN, SCHEIB, STEININGER 2000).

MuTil could also promote problem-solving competencies as a further component of methods competence. The recognition of opposing goal criteria and coping with this dilemma of preferability is of central importance here. This aspect emerges in scheduling orders as well as in maintenance tasks. A high machine utilization level is in opposition with a throughput time-optimized order dispatching; in turn, both prohibit carrying out maintenance work. The trainee must come to terms, even in this simplified form, with this dilemma and develop methods for coping with these demands.

3 Methods, System Design and Implementation

Methodology refers to the study of procedures. Aside from the main question of "how" the question of "with what“, meaning the medium, is also included. Planning, implementing and controlling of an action are important in vocational training, so that this has already found a spot in the training plan. Action-orientated methods are particularly suitable for relaying these aspects. These methods differ from traditional teaching methods through a combination of goal setting, task definitions and problem solving using various media, which explains why one speaks of a multi-dimensional training arrangement and of complex methods. In the following, action-orientation as a methodical approach will be explained more in depth.

3.1 Action-orientated Learning

The term action implies first a physical activity. The holistic nature of human action, according to HACKER's action regulation theory, is given when the loop "preparation of the task, planning, execution, controlling (assessment)" is completely and sequentially, correctly carried out. HACKER then terms the action as one that promotes learning.

If one transfers this approach originating from occupational psychology to the training process, MEYER's action-orientation can be described as following: "Action-orientated instruction is a comprehensive and active student instruction in which the mental and physical work of the student create a balanced relationship with each other" (MEYER 1989, S. 402).

The multimedia training programme MuTil shows restrictions to MEYER’s assumptions. Manual work, aside from that of the computer input process, is not performed. However, an action product, even though only a virtual one, has been created for the purpose of action orientation. Providing a complete and comprehensive action with regards to the action regulation theory is a further point in the configuration of MuTil.

3.2 Computer-aided Learning

The term "computer-aided learning" expresses that the computer supports, in whichever way that may be, the learning process. This can include the function of the instruction medium as well as that of the work resource. The computer is primarily an instruction medium in the training tool. This refers primarily to tutorial instructions. The learner is e.g. presented, in a multimedia format, with an instruction content, which is then secured with comprehension questions. The work results of the learner can be saved and analysed by the instructional software and thus be used as a control of the learning success.

Practice programmes and training systems are a further form of computer-aided learning. They are orientated, in their basis structure, towards tutorial instruction and serve in particular the practise and consolidation of previous knowledge.

3.3 Simulation in Occupational Training

Simulation is the most comprehensive form of computer-aided learning. Here, the training system is continually placed, through intervention by the learner, in a new situation. Simulation is characterized by high learner activity as well as by a high level of control by the learner.

The above-described action-orientation as a methodical facet is reflected very well in simulation. The simulation of practical scenes for educational intentions is nothing new in particular in the form of practise machines and devices, whose application reach as far as practice enterprises, learning offices and the production school principles. This simulation of operational practise is only one application of simulation in occupational training.

In addition, there is already an array of different simulation games. In particular, the planning games (decision simulations) and role-playing (relationship simulation) have centre stage in occupational training. All forms of games have the aspects co-operation of the actors, definition of rules and the attempt to cope with a realistic problem situation in common. These aspects are also covered by MuTil's intentions. However, in this we are not dealing with a planning game, rather a simulation through media (s. Fig. 3: Simulation types).

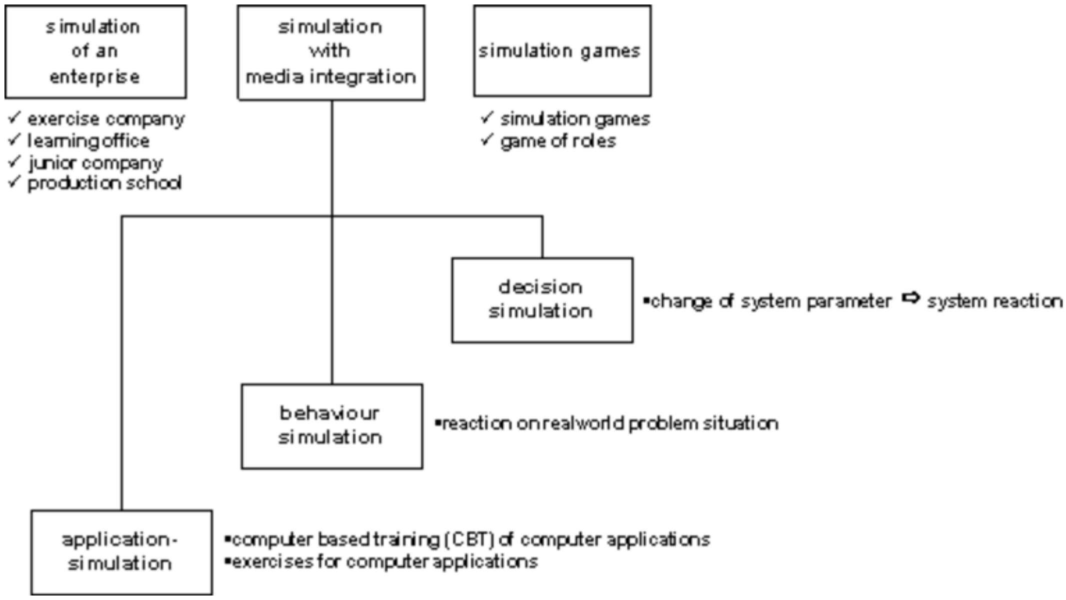

Fig. 3: Simulation types

The learning processes, which are stimulated by simulation through media, lie mostly in the area of proficiency and reaction skill. Computer simulations such as MuTil are also able to depict complex situations, which provoke comprehensive acting (comprehension of all aspects, conditions and possible consequences of an action).

Thus the spectrum of MuTil's educational goals range from the training of simple activities to the comprehensive action capacity in terms of a complex task while considering all relationships and interactions within a worth system solving.

3.4 Model of the Training Process of a Simulation

The model concept of the training process of a simulation is that of an opposing double funnel (Fig. 4: Training process of a simulation). Basically, the reality is simplified into the learning environment of a simulation in such a way as that the requirements of the learners are accommodated and that disadvantageous or dangerous effects are eliminated. First, the complex reality of the operational situation must be reduced through either transformations or representation so that it is manageable for the learner. The competencies that are to be promoted and trained in the simulation must then be derived from reality, or rather from the given occupation and work situation.

Likewise, the framework and general conditions, which are primarily related to the given competencies, must also be determined. Thus, the task at hand is to reduce the level of representation of reality, since, on the one hand, the inclusion of all influences in the simulation model is impossible due to the resulting complexity of the realistic systems, and on the other hand, because the comprehension of the correlation hinders the learning process. The recognition of the fundamental relations and the reduction can however lead to a distortion since it is at times difficult to discern which effects are being covered up by the activities.

Despite criticism of this term, a "didactic reduction" must be carried out. The most important function of the developer of the simulation programme and later of the teacher is thus to carry out this didactic reduction as little as possible and only as much as necessary.

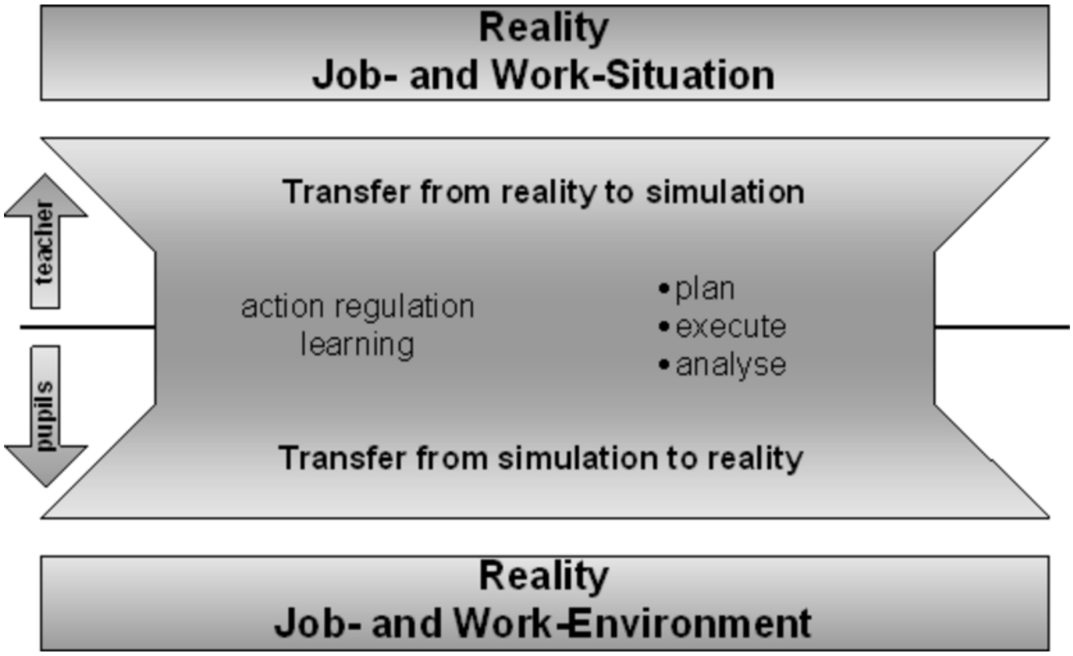

Fig. 4: Training process of a simulation

3.5 Sequence Diagram of the Simulation with MuTil

The greater portion of the learning process takes place in the carrying out of the simulation. It is at this point that the problem-orientation becomes effective. The simulation starts with an introduction in which the learner is familiarized, either by or in the simulation, with the learning environment and the system.

In MuTil, this generally takes place before the actual simulation is carried out. The user (learner) has already accumulated the necessary technical knowledge during his training. The actual simulation commences with a presentation of the scenario (work task). In terms of problem-orientated learning, this forms the first step of the learning loop. The scenario in MuTil is e.g. a received production order. The user familiarizes him or her with the given task, which then forms an action occasion. The learner must plan his following actions.

Following this, further approaches must be planned and ultimately actions which lead to a goal attainment - that of the production of the ordered parts - must be carried out. The system answers the learner's actions with a reaction, which then influences the scenario. Thus, the simulation's cycle of effects emerges and continues until the goal "order finished" is attained (Fig. 5: Simulation sequence in MuTil).

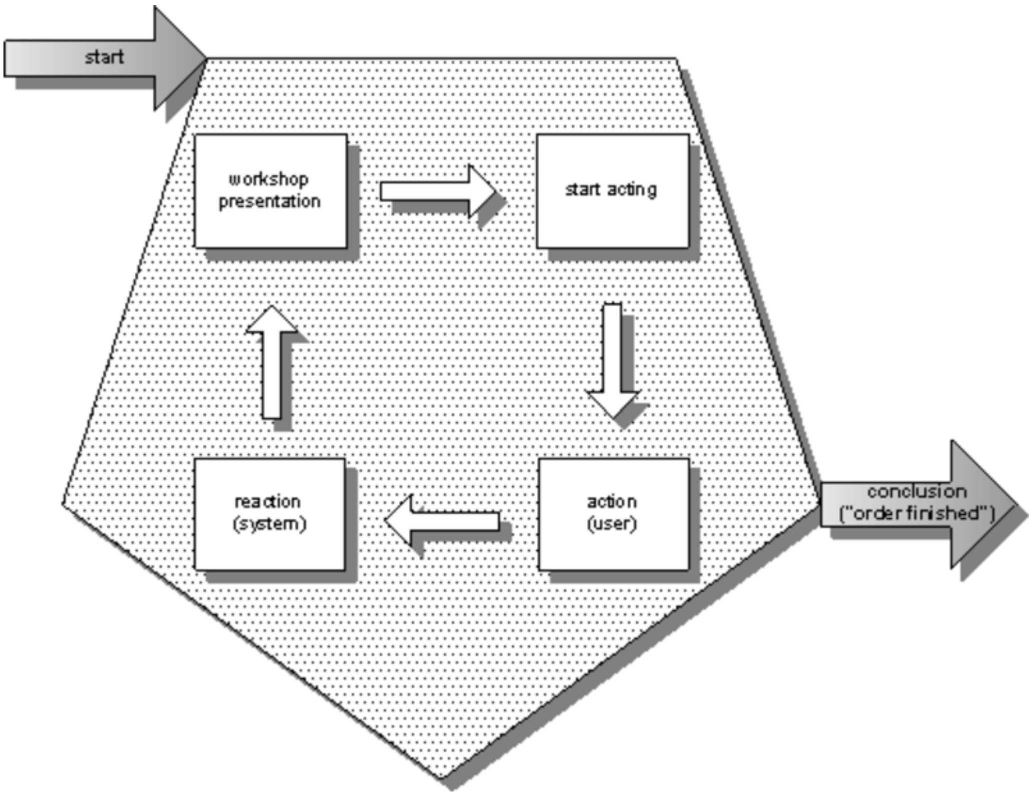

Fig. 5: Simulation sequence in MuTil

The learner's actions and the system's reactions are recorded and can be called upon for later evaluations. The system's reactions offer the possibility for objective examinations of the learner's performance since the reactions appear based on their probability of occurrence and thus are not the same for all learners. The possibility to use the recorded data to provide the learner with feedback, to support him or to adapt future scenarios to the knowledge level of the learner has also been contemplated.

4 General Conditions

4.1 Area of Application

Vocational schools and other vocational institutes are MuTil's area of application. However, MuTil does achieve far more: in particular, the tight connection between vocational training and school contributes to the balance of theory and practise. The target group consists of apprentices of all branches of industrial mechanics. Their later field of activity was taken into consideration in the configuration of MuTil. The implementation of the basic functions of MuTil however should not consider the activity fields. Therefore, the application is also conceivable for occupations beyond the boundary of industrial mechanics (e.g. milling worker, grinding machine operator etc.).

MuTil's simulation, in its complete form, is structured into the third year curriculum of apprentice mechanics. Theoretical knowledge is already present at this stage and the students should posses a corresponding experience in order to be able to cope with the transition from simulation to real occupational situations.

The production process is centred around the components of the EU Leonardo-Project "CREMMET“, which produces “pair of gripper jaws”; spec. fence, jaw chuck, cylinder piston and separator. This EU project was chosen because an extensive data (technical drawings, CNC-Programs etc.) are available and can be legally published for all parts.

5 Implementation

5.1 Guidelines

The Microsoft® Windows® (32-bit) platform was chosen in agreement with the other project partners for the implementation of MuTil. Preferably, Windows® 2000 should be used. The program system was transferred, after several test implementations, which were implemented as a monolithic system, to a client/server environment, which is based on internet technology (Fig. 6: MuTil start page, Fig. 9: Content creation, Fig. 10: System design of MuTil).

Fig. 6: MuTil start page

Thus, the possibility for “absolute” media integration arises since no integrated development environment can work with types of media as well as a browser can (Fig. 7: Media integration).

Fig. 7: Media integration

The Microsoft® Internet Explorer (version 5.5x or higher) was assumed in order to avoid the difficulty of different browsers with various programming models (Netscape® is also possible, but with a different “look and feel”).

About the server, the Windows® 2000 server/advanced server is used. This has the advantage that the necessary software products for video or sound streaming are already included in the provided operating system. Thus, the corresponding school had no extra costs since at least their networks are installed on a Windows® 2000 base.

5.2 Content

The software system consists of HTML (HTML 4, DHTML, XML etc.), scripting (VBScript, JScript, JAVA applets etc.), embedded objects (Flash, Director, Authorware etc.) and video/audio (Fig. 6: MuTil start page, Fig. 7: Media integration, Fig. 8: Production Planning and Control System of MuTil).

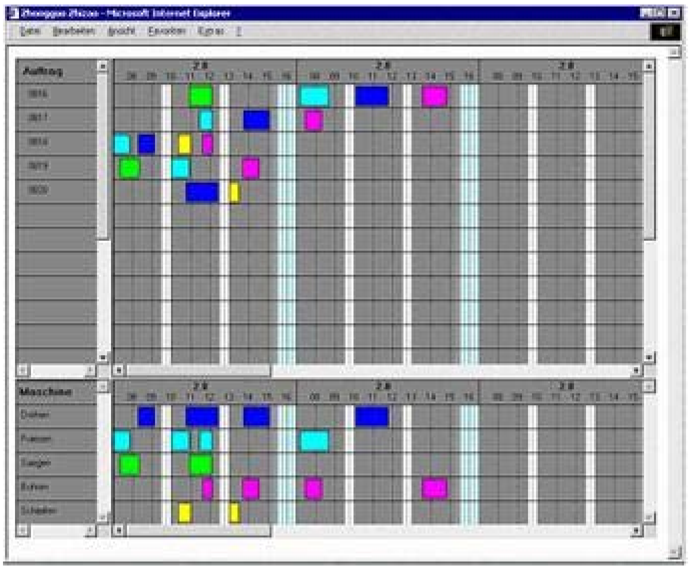

Fig. 8: Production Planning and Control System of MuTil

All curriculum items are stored as „objects“ in the content database (SQL server). This server can be identical to the web server.

The use of a content management system is a possibility, but has thus far not been implemented. A content repository based upon the SQL database, which references the curriculum items, is also available. Thus, the possibility for changing the curriculum during a simulation arises since the referencing of content repository does not need to be congruent with the content itself.

In order to record the system and user activities a logging-database shall be applied. This is however not currently being used (debugging exception only).

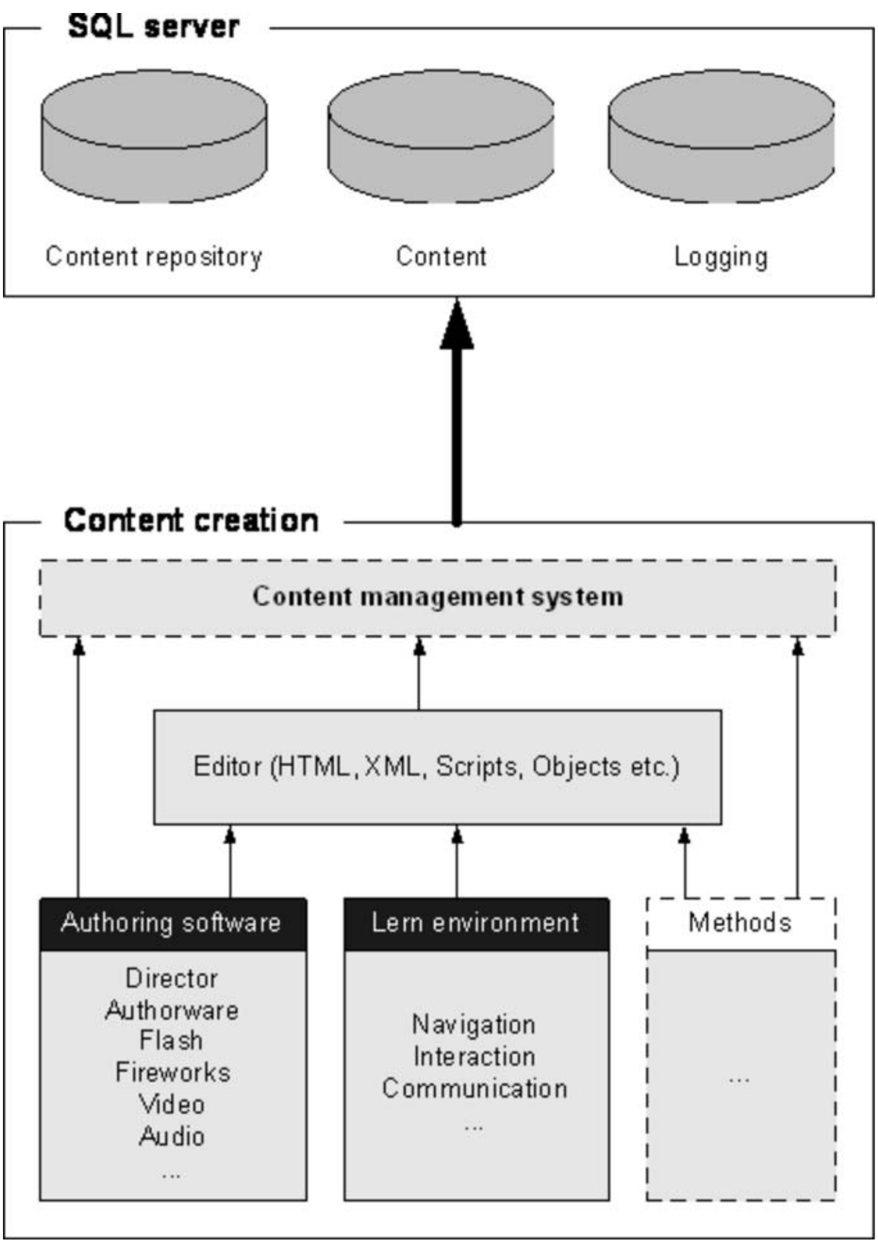

Fig. 9: Content creation

The creation of a certain curriculum is not integrated into an application and is carried out in individual steps in the various products mentioned in Fig. 9: Content creation. The created scenario is inserted, either integrated or separately, into the content database with the help of an "editor".

5.3 Using the System

The learner starts the system by activating the browser and connecting to the server. Each user is referenced to by a unique ID, which represents him during his entire use of the system. The learner addresses exclusively HTTP request to the server and receives data exclusively through HTTP in return. The uses of audio and video data, which are sent from the server with Microsoft Media Services (MMS) using streaming technology, are one exception.

The web sites are dynamic and based on Active Server Pages (ASP) with VBScript on the server's side. These web sites are connected to the server process for workflow, simulation and management with an Application Programmers Interface (API). One can use the logging process from all process levels.

Server processes and ASP web sites send request and receive answers from the content repository or rather content database with XML. Only the logging process runs, for reasons of simplicity, with pure ASCII data.

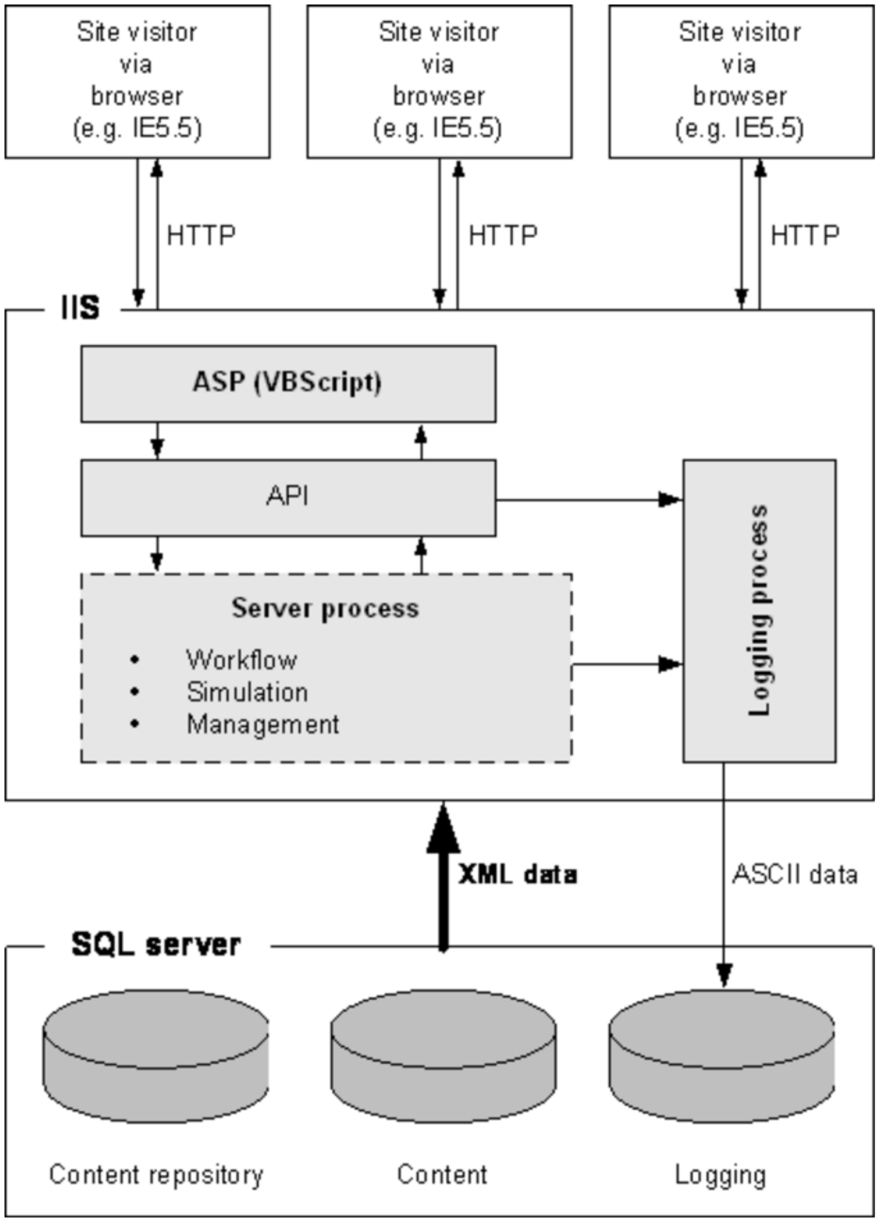

Fig. 10: System design of MuTil

6 Outlook on further activities

The employment of new technologies may build ideal learning environments. Simulation is used to implement a real world scenario. Further development for collaborative training could be done by implementing a collaborative training environment. One student drives only one part of MuTil and so on; so that e.g. five pupils build up the simulation of workshop.

The biggest step will be the transfer to real students (users). We have to transfer MuTil from the developing lab to the “customer”. This will show which of our assumptions are right and which are wrong. Students will test the browser interface, the content, the simulation etc. Feedback will be given for further activities and other research projects in learning.

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