Virtual environment use in e-learning

EGILS GINTERS, ARNIS CIRULIS
Sociotechnical Systems Engineering Institute
Vidzeme University College
4 Cesu Street, Valmiera LV-4200
LATVIA

VASILIY AKISHIN
JSC Valmiera Glass Fibre,
Cempu Street 13, Valmiera LV-4201
LATVIA

Abstract: - Quick and rapid changes in technologies are typical for developing knowledge society. Quick changes ask for reducing the training time and regular upgrade of knowledge and skills. Unfortunately, typical e-learning forms could solve the problems only partially because those are time consuming. Therefore Vocational Education and Training (VET) technologies moving accents from classical forms to m-training, m-consultation and further to m-Work applications with VR/AR use.

Key-Words: - Virtual and augmented reality, e-learning, learning management system, m-consulting, m-work, visualisation, agent-based simulation

1 Introduction

Rapid changes of ICTE technologies cause pressure on regularity of the knowledge renewal in areas with high technologies impact, nevertheless specialists have increasingly less time for training due to job intensity growing. Especially important and useful are interdisciplinary knowledge promoting easier introduction of complex operations and systems with high technologies dominance.

Unfortunately, classical e-learning (computer plus Internet plus Learning Management System (LMS)) is time consuming, but advanced e-learning (mobile terminal or weared PC plus wireless access plus heuristic selection of training material plus VR/AR solutions) often is not cost effective. One of the ways is moving the accents from e-learning to m-consultation using wireless and mobile cellular technologies, and use limited amount of the training material. However complexity of technological operations and wide variety of the serviceable equipment still cause the problems in training, therefore other way is virtual and augmented reality solutions use in working place and in real time.

2 Step by step in e-learning understanding

Quick and rapid changes in technologies are typical for developing knowledge society. Mostly these changes are related with introduction of the latest achievements of Information & Communication Technologies and Electronics (ICTE). The equipment and control systems became advanced and have great impact on quality of the manufacturing and provided services. Quick changes ask for reducing the training time and regular upgrade of knowledge and skills, therefore the specialists from Sociotechnical Systems Engineering institute are involved in designing the new training technologies a longer time.

The Leonardo da Vinci programme project LOGIS LV-PP-138.003 (2000-2002) [1] started in 2000. It was aimed to solving the problems mentioned above providing e-learning (see Fig.1) in classic form for the specialists in logistics, transportation and ICTE.

Unfortunately, typical e-learning forms could solve the problems only partially because there not a big difference to read the book or study material in electronic form with or without Internet access.

Important changes in mobile and wireless telecommunication technologies reduced the service costs and expanded the coverage. It given possibilities of Personal Digital Assistants (PDA) or Pocket PC use in m-training (see Fig.1). However, application area was limited due to screen size. Therefore, simple replace of the personal computer by PDA was rather difficult in situations with big amount of the study materials.

To reduce the training time the Vocational Education and Training (VET) methods must be modified. It was the main task of the next step Leonardo da Vinci project LOGIS MOBILE LV/04/B/F/PP-172.001 *"Competence Framework for Mobile On-site Accelerated Vocational Training in Logistics Information Systems"* aimed to introduction of m-consultation based on mobile communications [2].

Instead of comprehensive lectures and training book it was decided to prepare as compact as possible concise training dictionary in Logistics Information Systems. The dictionary was composed in wide spoken European languages – English, German, French, and Spanish. More than 600 terms most frequently used in Logistics Information Systems were involved in the dictionary. The dictionary also was deployed on the Internet and mobile solutions WAP/GPRS were used for the access to the explanations and checking questions (m-consultation) (see Fig.1).

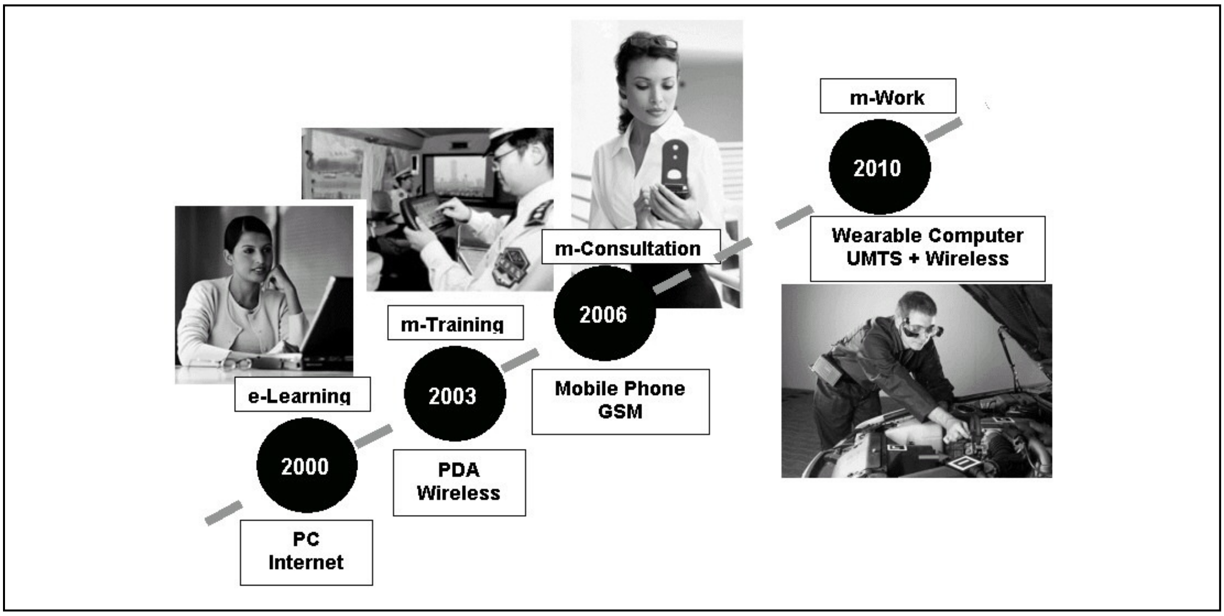

Fig.1. Training technologies development (Images have taken from [2, 3, 4])

But the main problem still remain, how to reduce the training time if we must explain the operation more detailed or many different variants of implementation of the current work exist.

Training systems development today is related with use of e-learning/m-training/m-consultation solutions combined with virtual and augmented reality (VR/AR) applications, and simulation.

Therefore, sometimes long-time studies can be reduced giving to employee general understanding of the field and some specific skills of computerised training-advising equipment use. If the special operations implementations in the working place are necessary or serviceable equipment changes, then wireless and/or UMTS (CDMA) network connected to the central unit are used for the new training or advising material download. During the session, the employee receives on-line step-by-step instructions from VR/AR solutions knowledgebase about how to implement given operation. It means that employee often can obtain the new skills during real m-Work session (see Fig.1).

3 Virtual environment for glass fibre operator training

At the beginning of 21st century, the use of VR/AR solutions for the training needs is still bothered by the set of problems [5, 6, 7]. The reasons are different. Most important reason is cost-effectiveness of the provided solutions. It means that the profit from the introduction must exceed expenses of the designing and maintenance. To achieve this goal the comprehensive costs of the operational hardware and software, and the possibilities of the prototyping of the scenarios and the training material must be ensured. The training material must be easy and quickly adaptable in conformity with the professional skills and perceptivity of the trainee, and portable as well. The gap related with the joint standardisation and compatibility of VR/AR products and technologies bother achieving the objectives mentioned above [8]. However, if introduction is well justified (m-Work case) then VR/AR use would be successful.

The VR/AR laboratory at the Sociotechnical Systems Engineering Institute serves not only for the preparation of the modern training material for the study programmes, but also as a basement for VR/AR solutions transfer to the regional industry. One of the collaborative partners is Valmiera Fibre Glass plant that is interested in both the introduction of the high-tech in the manufacturing and training of employees.

Glass fibre is used for production of technical fabrics, fabrics for electric insulation and air filters for automotive, but glass melting-oven is used in production process of glass fibre. The process is long and complicated, but now we are interested in one of the final phases, where participate fibre operators – the persons with some specific skills. Unfortunately, labour turnover is relatively high. Therefore expenses for operators training are the same, because the glass melting oven and fibre manufacturing have the special requirements of safety. VR/AR solutions are used for reducing the training time and combining the training sessions with real manufacturing.

The preparation of the operator training process involves some steps:

- The knowledge, skills, and rules specification;
- Designing the set of the allowed technological operations;
- Designing the agent-based simulation model of typical trainees;
- Elaboration of the typical scenarios of the training process depending on the level of the nature of a trainee;
- Designing the training protocols;
- Elaboration the mechanism for the information exchange and visualisation;
- Assembling and programming the VR/AR environment;
- Preparation the VR/AR training material;
- Verification and validation the results obtained during the steps mentioned above.

Each scenario consists of the set of the technological operations executable in the predefined order (see Fig.2).

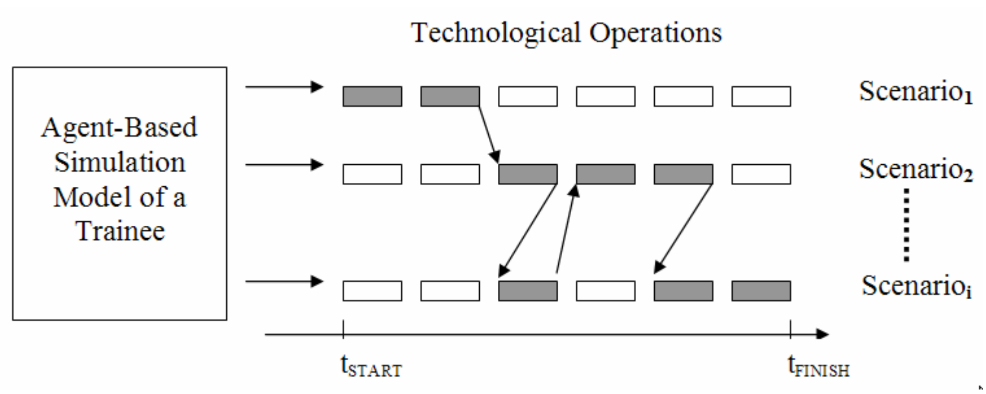

Fig.2. The protocol of the training process

Each trainee has various perceptions and nature, therefore the human model respects the individuality each of the trainee giving the facilities for the managing of time of the training session and determining suitable set of the training scenarios.

Therefore training is based on the trainee agent-based simulation model working in the real-time domain. Although the training process begins with the base scenario, always after the fixed time slot the feedback form the simulation model of the trainee is used for checking the quality of the obtained skills necessary for the implementation of each technological operation. The model recommends with the calculated probability to continue the current scenario or switch to other more suitable scenario and training material describing the same or other technological operation.

4 Visualisation techniques

Augmented Reality (AR) enhances a user's perception of and interaction with the real world. The virtual objects display information that the user cannot directly detect with his senses. The information conveyed by the virtual objects helps a user perform real-world tasks. AR could apply to all senses, including hearing, touch, and smell. However mostly visual perception is used as basic sense. For controlling of fiber glass production AR's visual sense is used overlapping the real work environment by the generated images of the weared computer. AR uses display technologies such as see-through head-mounted displays (HMDs) to combine computer graphics with a user's view of the real world (see Fig.3).

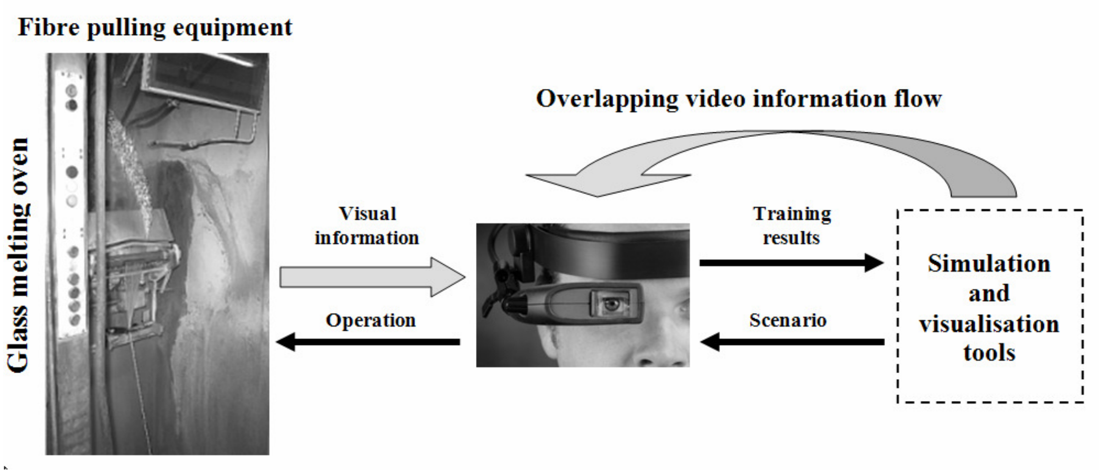

Fig.3. Optical see-trough visualization approach (Image have taken from [9])

The see-through HMDs with single panel for one eye are used. See-through technology is very portable and it doesn't reduce user's field of view. Standard closed-view HMDs do not allow any direct view of the real world, but a see-through HMD lets the user see the real world with virtual objects superimposed by optical or video technologies.

Optical see-through shows a user the real environment through a half-transparent mirror and the virtual environment reflected on the half-transparent mirror. The optical combiners usually reduce the amount of light that the user sees from the real world. Since the combiners act like half-silvered mirrors, they only let in some of the light from the real world, so that they can reflect some of the light from the monitors into the user's eyes.

Video see-through HMDs work by combining a closed-view HMD with one or two head-mounted video cameras. The video cameras provide the user's view of the real world. Video from these cameras is combined with the graphic images created by the scene generator, blending the real and virtual. The result is sent to the monitors in front of the user's eyes in the closed-view HMD.

Analyzing optical versus video and evaluating our needs, the optical see-through approach is chosen, because operator or trainee needs to receive two dimensional data for controlling the fiber glass hardware. Optical blending is simpler and cheaper than video blending and there is no almost time delay which is very important when you work with operating hardware. Important parameter is also resolution. If virtual object's resolution could be reduced, then the operator's view of the real world could not be degraded. Also in most configurations of video see-through method the cameras are not located exactly where the user's eyes are, creating an offset between the cameras and the real eyes. This difference between camera locations and eye locations introduces displacements from what the user sees compared to what he expects to see. Such situation is not acceptable working or training in aggressive or danger environment.

There are lots of companies producing HMDs for virtual reality applications. Although the choice for AR and especially optical see-through devices still is rather pure. Reasons are different; mostly there are problems related with the objects registration, focusing and contrast. The main parameters set which should be considered at the physical level are interface, resolution, field of view, display size, eyeglass count, weight, display technology, systemic software (drivers, libraries, and compatibility), manufacturer and 3rd parties support, warranties, dissemination area etc.

One of the most important problems at the logical level is information exchange and control of VR/AR visualisation processes to ensure the real-time operation and higher performance of the programming and prototyping the provided solutions. Unfortunately most of existing solutions and environments are still unique. Therefore elaboration or adaptation such protocols at macro level is the important task of next issues.

5 Conclusion

Rapid changes of ICTE technologies cause pressure on regularity of the knowledge renewal in areas with high technologies impact, nevertheless specialists have increasingly less time for training due to job intensity growing.

Unfortunately, typical e-learning forms could solve the problems only partially because those are time consuming. Therefore VET technologies moving accents from classical forms to m-training, m-consultation and further to m-Work applications with VR/AR use.

VR/AR introduction is limited by compatibility and relatively high cost of the environment. Therefore, each introduction must be well justified and intelligent VET must be used, because simple changes of the environment does not give the expected benefit. It means that sociotechnical, psychological and social aspects of the human involved must be respected and the real-time simulation models for training process management must be introduced.

Visual sense is one of the most important perceptions; therefore well designed visualisation environment is critical for successful VR/AR solution introduction.

References:

[1] E. Ginters and L. Krecere, LOGIS Network for Knowledge Dissemination in Logistics Information Systems, HMS 2003, ISBN 9984-32-547-4, Riga, Latvia, September 8-20, 2003.

[2] E. Bluemel et al., Mobile Technologies Use in Services Development and Training in Logistics Information Systems, In Annual Proceedings *ICTE in Regional Development*, Sociotechnical Systems Engineering Institute, ISBN 9984-633-03-9, December 2006.

[3] HEA Akademie, http://www.hea-akademie.de/inhalt/e_learning/index.php, 12.10.2007.

[4] MATRIS - Markerless real-time Tracking for Augmented Reality Image Synthesis, http://www.ist-matris.org/, 12.10.2007.

[5] M. Schenk, Virtual Reality und Augmented Reality zum Planen, Testen und Betreiben technischer Systeme, In: *9. IFF-Wissenschaftstage 2006*, ISBN: 3-8167-7124-6, Stuttgart, Fraunhofer IRB Verlag, 2006.

[6] E. Blümel and M. Endig, Entwicklung innovativer Produkte und Dienstleistungen unter Nutzung von VR-Technologien für KMU des Maschinen- und Anlagenbaus – ProDiMA. isw-Akzente, Nr.14, 2003.

[7] E. Bluemel and M. Schumann, Using virtual design, test and training platforms during the life cycle of complex technical systems, In: *COMPIT '05, 4th International Conference on Computer and IT Applications in the Maritime Industries*, Hamburg, 8 - 11 May 2005, ISBN: 3-00-014981-3, 2005.

[8] E. Ginters et al., VR-Solutions Use in Training of Glass Melting Oven Operators, in *10. IFF Wissenschaftstage: Virtual reality and Augmented Reality for Engineering, Testing and Operating Technical Systems*, Fraunhofer Institut Fabrikbetrieb und –automatisierung, ISBN 978-3-8167-7383-2, June 27-28, 2007.

[9] Liteye – Enhancing Human Vision, Velcome to Liteye Systems, http://www.liteye.com/, 12.10.2007.