

Andrzej ŁĄCZNY, Jarosław FRANCIK
Politechnika Śląska, Instytut Informatyki

David BROWN
Nottingham Trent University, Department of Computing

Pamela COOKE
Ann Craft Trust

THE VIRTUAL COURTROOM: A PRACTICAL APPROACH TO VIRTUAL REALITY ON THE INTERNET

Summary. The article describes a practical solution for the Virtual Reality on the Internet. The solution that is presented here is designed for a particular project – a flexible learning system for people with learning disabilities. The article takes the reader from the origin of the project, through its background, overview of possible approaches to the Virtual Reality on the Internet in order to finally tailor available technologies to achieve project objectives.

WIRTUALNA SALA SĄDOWA: PRAKTYCZNE ZASTOSOWANIE RZECZYWISTOŚCI WIRTUALNEJ W INTERNECIE

Streszczenie. Artykuł przedstawia praktyczne zastosowanie wirtualnej rzeczywistości w sieci Internet. Przedstawiono rozwiązanie przeznaczone dla konkretnego projektu: systemu wspomagającego nauczanie dla osób z upośledzeniami poznawczymi. Artykuł przedstawia genezę i podłoże projektu, zawiera też przegląd istniejących technologii umożliwiających realizację rzeczywistości wirtualnej w środowisku internetowym, by wreszcie wskazać optymalne rozwiązanie zaspokajające założone wymagania projektowe.

1. Introduction

The new legislation passed by the UK's Parliament in August 1999: The Youth Justice and Criminal Evidence Act 1999 [6] is, for the first time, offering vulnerable witnesses the

chance to give acceptable evidence to the court with the support of 'special measures', such as being allowed the assistance of an 'intermediary', and the chance to give their evidence-in-chief and be cross-examined either through CCTV live link or on a pre-trial video. This will be very helpful, but it is clear that, regardless of where the evidence is to be given, it will be a demanding experience for both adults and children with learning disabilities. Witnesses are often given the chance to visit the Court beforehand, but this will not prepare them to give a statement, answer questions on what they said in their statement in open court in front of many people, and face what is often quite aggressive cross-examination. Even if this is carried out in a separate room by live link or prior to the trial, it will present difficulties and raise anxieties in people with learning disabilities.

Recommendations in 'Speaking Up For Justice' [3], the Report of the Interdepartmental Working Group on the Treatment of Vulnerable Witnesses in the Criminal Justice System, has suggested that the Home Office develop further material to assist these witnesses to prepare for their attendance at Court (Recommendation 29). Following a Home Office Conference in November 1998 the Ann Craft Trust, in partnership with Trent University and a user group from the Shepherd School in Nottingham, which is one of the top institutions in the UK training people with learning disabilities, decided to prepare a video and a virtual reality programme for both adults and children. Such programme will present a courtroom interior along with the people you might find in a normal courtroom. The legal personnel would, when questioned, explain their roles in court. The programme would also show two or three short scenarios where a witness would give evidence, answer questions from the prosecuting barrister and also answering questions under cross-examination.

It has already been proven that young people with learning disabilities react well to the Virtual Reality learning systems and enjoy playing with them. David Brown with his research group have already produced such applications gathered under the title of *Virtual City* [2]. The software creation process was supported by the students as well as staff from the Shepherd School of Nottingham. The applications teach basic social and personal skills such as shopping, travelling, ordering food in a cafe and basic hygiene. Positive experiences acquired during development of *Virtual City* convinced David Stewart, head teacher in the Shepherd School, that Virtual Reality will have a huge positive influence on people with learning disabilities that are to participate in court trials as witnesses or victims.

Additional experience in the field of VR learning system development was acquired during the production of the Greenwich Travel Training application [1] (fig. 1). The software was made in co-operation with Greenwich user group - a group of people with learning disabilities that were employed work as staff on the international conference "Virtual Reality and Assistive Technology". The conference took place in London's Millenium Dome on 16,

17 and 18 of November 2000 and was organised by MENCAP. The aim of the Greenwich Travel Training Package was to make people with learning disabilities familiar with the way from the Greenwich city centre to the Millenium Dome, where the conference took place. The application took further ideas of the Virtual City by adding more realism thanks to the photo textures as well as making the application stand-alone, independent of any additional viewers. Those elements were at the base of Virtual Courtroom project, which was also presented at the mentioned conference.

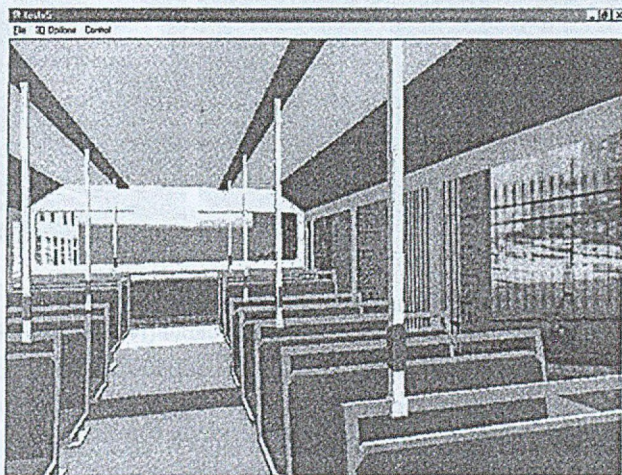
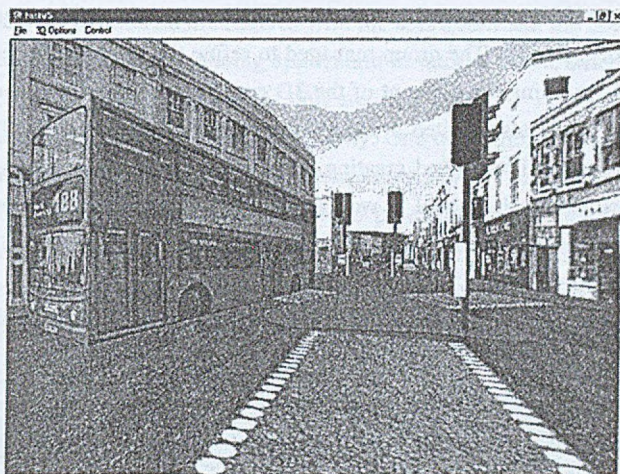


Fig. 1. Greenwich Travel Training Package Screenshots (stand-alone Windows application based on Realimation v5)

Rys. 1. Kadry z pakietu Greenwich Travel Training (aplikacja zrealizowana z wykorzystaniem pakietu Realimation v5)

2. Background

The project was supported by the Virtual Court Advisory Group from the very beginning. The group meetings gathered people with learning disabilities of various age, teachers from the Shepherd School including David Stewart, school's head teacher as well as Pamela Cooke, David Brown, software engineers from Nottingham Trent University based Greenhat Interactive research group dealing with flexible learning systems, including Andrzej Łączny. Those meetings have helped to identify some of the most important issues regarding the (also *autorzy albo honory*) project. The group managed to refine the learning objectives, the scope of the application including the element of the 3D environment as well as required software functionality. The group also visited a police station and a court (fig. 2). The information gathered during those visits allowed creating environment model, identifying key elements that should be included in the model as well as reactions of people with learning disabilities to the staff of the justice system. Also the scenarios, developed by Pamela Cooke, were revised by the Advisory Group.

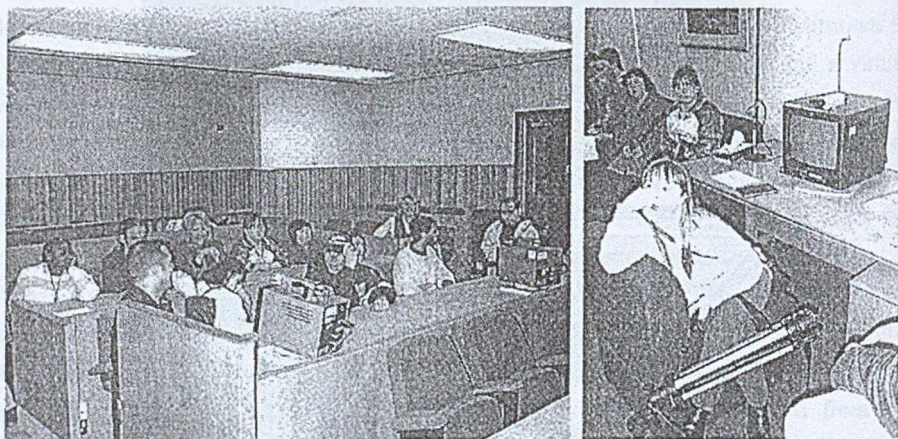


Fig. 2. The User Group from Shepherd School, Nottingham, visits Nottinghamshire's Crown Court

Rys. 2. Grupa użytkowników z Shepherd School (Nottingham) odwiedza budynek sądu hrabstwa Nottinghamshire

Since the application is meant to be didactic the learning objectives were designed. The issues pointed out by the Advisory Group are as follows [15]:

1. Familiarity with the courtroom.
2. A knowledge of courtroom personnel, who they are and what they are there for.
3. How to give statements, at the police station, on video, in court.
4. How to respond to being examined on the statement by own counsel in court or on video.

5. How to respond to being cross-examined on the statement by defence counsel in court or on video.
6. Understanding 'aggressive' questioning.
7. Understanding that you can ask questions to be repeated, say you do not understand and say 'you don't know'.
8. Understanding that there are people there to help you, identifying the support people. You can tell them if you have any worries or ask them any questions.

The users should familiarise themselves with the courtroom and the court personnel. This can be achieved mainly through running application in tutorial mode, where they can see and hear and learn what particular members of staff are there for.

The key issue in application design is usability. One of definitions describes usability [8] as the joint function of the system and user. Therefore it can not be fully analysed, understood and evaluated (usability problem). The cognitive psychology could be the tool, which can help us overcome the usability problem. It is often defined as the term referring to the scientific study of acquisition, storage and use of knowledge by the individual [8]. The amount of work done in this subject shows that there is still a lot to be done in this field. In the meantime more practical development approach was used in the Virtual Courtroom project. The developers co-operate with the staff of the Shepherd School in Nottingham in order to overcome the usability problem. The staff is trained and well experienced in psychology, which puts them in place of intermediaries between the development team and the target user group. The Virtual Court Advisory Group also provides the developers with accurate information about the requirements as well as feedback from people with learning disabilities. The programmers themselves participate in meetings of the user group to learn more about the environment they develop software for. All this action may not eliminate the usability problem, however should limit it significantly.

The development process also needs to be tailored to the conditions the application is being built in. The appropriate approach in the case of the Virtual Courtroom is dynamic requirement redefinition [9], which is a part of the iterative development model. The iterative approach is the kind of the incremental model and is also known as prototyping approach. The idea of providing people with learning disabilities with a learning tool based on VR and multimedia technology is not new. However the outcome of such project is always hard to evaluate. Since the application must be highly user-centred the prototyping approach was chosen for development purposes. Such approach is used mainly in user interface design. It allows evaluate human-computer interaction aspect of computer applications quite accurately. However it has several drawbacks. It may take quite a long time till the application has been approved by the user. It also requires support from the group of potential users that perform

actual evaluation. Such support has been provided for the Virtual Courtroom project by the students from Nottingham based Shepherd School.

3. Why the Internet?

The stand-alone application that is being developed as a main objective of the Virtual Courtroom project is not the only element of it. The growing popularity and accessibility of the Internet may be the issues to take advantage of. People with learning disabilities quite often have additional physical disabilities, which disallow them to travel without additional support. The Internet could be the "mean" of travelling for such people.

The Internet opens new possibilities for development multiaccess solutions. Such solutions may be easily maintained and supported since they are based on n-tier architectures. Although there is no direct need to take advantage of n-tier architecture in case of the Virtual Courtroom project, the fact that the resources are placed on server and browsers (clients) with little support from various plug-ins may access data that are stored there. Changes and maintenance of such data is easy since it is placed in one point and every time the user wants to take advantage of the system he/she must access appropriate web site. As it can be seen, the distribution of changes as well as the product itself is simplified, however limited to people with Internet access. Such approach is important if we consider people with learning disabilities, which quite often suffer from physical disabilities and whose access to some real-life, remote resources may be difficult. The Internet becomes the window to the world for them. There is a good opportunity to enforce licensing rights by the providers of the system if required as well.

Some solutions are more applicable for cross-platform approaches and some are less. Some products such as Realimation are oriented for one system platform and some of them such as Virtual Reality Modelling Language (VRML) are standardised on the higher level of abstraction leaving space for different implementations for different systems.

The development approach that was decided to be based on prototyping methodology can be quite easily put into practice. Prototypes may be evaluated by the larger group of people on the web.

4. Technologies Available

The first thought about virtual reality on the Internet could be the VRML standard, still not quite popular as it may seem it should be. Especially that it has been around for some time now. This is mainly due to still serious hardware requirements of the VR systems.

Many companies have released VRML viewers stand-alone as well as plug-ins for various web browsers. One can download and use freely almost all of them. The example of such plug-in is CosmoPlayer by Cosmo Software. The 2.1.1 version of the viewer is VRML97 standard compliant and offers all the functionality mentioned above [13].

Furthermore if there is a need for additional functionality, open-source products can be obtained and customised to the needs of the developers and users. Open-source projects such as OpenVRML are provided for various system platforms mainly thanks to the fact that the project team is open for new developers and the Internet is usually the communication medium for them. The open-source solutions may be modified freely under the condition that those modifications will also be distributed freely.

If there is a need for a VRML based commercial product, one can take advantage of commercial Software Development Kits (SDKs) such as Cortona by ParallelGraphics, which offers viewers as well as VRML and web authoring tools.

One thing that the users may be almost sure of is the standard of the script language describing 3D environments. Every product mentioned above should comply with the standard set by the VRML Consortium [7]. On the other hand there are many companies that offer products based on their unique standards. They also provide authoring tools to create 3D environments. Such solutions may be more or less flexible for the developers. A good example of such solution is Realimation package by Realimation, which is the platform for the development of the stand-alone Virtual Courtroom application. The Realimation makers provide free plug-in RealiWEB for Internet Explorer as well as Netscape Communicator, which is capable of viewing stand-alone Realimation files (full window mode) as well as those embedded in HTML pages (in specified size) [11].

Other solutions include Superscape plug-ins [14] and Java applet based web browser plug-in Contact blaxxun3D, which is, according to its makers [12], compatible with web browsers that support Java 1.1. Due to the fact that it is based on Java, the plug-in may be used on various systems. The makers recommend Windows 95/98/NT (Netscape Communicator 4.x and Internet Explorer 5.x), Mac OS ver. 8.6 (IE 5.x) and Linux SuSe 6.1 (Netscape Communicator 4.x). Indeed the variety of supported system platforms is large. However let the reader note that Java is not a strong competitor in terms of performance thanks to the cross-platform trade-offs. Finally it is worth mentioning that Blaxxun Interactive

recently submitted their own 3D environment description standard called Core X3D to the VRML Consortium.

5. The Choice of the Technology

Since the Virtual Courtroom 3D model has already been developed using Realimation authoring tools therefore only two possibilities will be taken under consideration: RealiWeb and VRML plug-ins. These are the deployment options of the Realimation v5 Designer and developing new environment using any new package may not be time and cost effective. Even using advanced export functions there is always a need to correct the results. The Table 1 presents the results of analysis of both the approaches.

Table 1

The Comparison of Realimation and VRML97 Technologies
with Regard to the Virtual Courtroom Project

| Standard | Realimation v5 (RealiWeb v5) | VRML97 (Cosmo Player 2.1.1) |
|------------------------|---|--|
| File Size | Version 5 introduced compression of binary Realibase files (original version of VR courtroom: 1,5MB) | The text nature of the VRML may lead to quite large file sizes (VRML version of VR courtroom: 3,5MB) |
| Speed | Thanks to the fact that the file was created by the Realimation Designer 3D authoring tool additional optimisations dedicated for Realimation viewers could be applied therefore the environment tends to be faster than VRML version | Slightly slower than the RealiWeb |
| Availability (license) | RealiWeb is available free of charge. However in order to take advantage of all the functionality developers should contact Realimation to obtain special versions of additional Java classes that support this functionality (under special license agreement) | VRML standard may be used free of charge. Cosmo Software however reserves the right to approve solutions taking advantage of their products (10 days before releasing) [13]. |
| Cross-Platform | Versions for MS Windows platform available only. Support for IE and Netscape browsers. Recently problems with IE plug-ins were reported (when using Realibase v4 files instead of v5) | As a standard VRML is cross platform. Viewers for all system platforms available. |

Table 1 (continued)

| | | |
|--------------------------------|---|--|
| Optimisation Techniques | Design-time: cells and portals for dividing scene into smaller pieces that are faster to process, pre-lighting objects, levels of detail Run-time optimisation related to the choice of display drivers. | Design-time optimisation can be hard, if we have e.g. 3,5MB text file to optimise. Therefore usage of additional authoring tool is recommended. Links between VRML files possible as well. Run-time optimisation is related to viewer capabilities. In case of CosmoPlayer one can choose between different display drivers. |
| Control Panel | No control panel as such. Controlling avatar via mouse requires good mouse handling skills. | CosmoPlayer control panel is more advanced than RealiWeb therefore may be confusing. However it allows better customisation of the viewer. The previous configuration is not stored anywhere so the options must be adjusted every time plug-in is started. |
| The Final Look | Since the 3D model was developed using Realimation authoring tools it looks closest to the created model when shown by Realimation viewers. | Some differences occurred between the original Realimation 3D model and the model after exporting to VRML. Also they may be differences when using different VRML viewers. |
| Interactivity | Realimation itself introduced so called <i>triggers</i> to start the actions when users move the avatar in a certain place, however RealiWeb does not support it. | CosmoPlayer supports interactive elements such as triggers that can start action when a certain condition occurs. |
| Multimedia | Realimation does not directly support video textures. Also video and may only be played by separate applications. | VRML also does not support video, but supports audio. Also it allows having external links to the elements such as streaming video and other Internet technologies available. |

The lack of triggers mechanism in RealiWeb plug-in is a serious disadvantage of this system since this functionality was applied in the stand-alone Virtual Courtroom. Obviously some of the elements of the stand-alone application cannot be implemented in the Internet version of the software, however these elements should be regarded as not relevant or at least not harmful in regard to the learning objectives.

Furthermore VRML and Cosmo introduce sound, interactions between page environment and the plug-in as well as moving 3D objects. Only the last mentioned element has been implemented in RealiWeb plug-in.

On the other hand VRML is not the original platform for the development of the 3D environment in the Virtual Courtroom stand-alone application. Realimation's export facilities have been tested and are considered to be accurate enough however may be differences

between the understanding of the standard by the producers of the VRML viewers. On the other hand, since most of them are distributed free of charge the developers may recommend the viewer they recognise to be the most appropriate and perhaps include downloadable version on the project web site.

The other issue mentioned in comparison between the RealWeb and CosmoPlayer (VRML) is the optimisation of the 3D model. This issue is quite important in regard to Virtual Reality systems. It must be assumed that the user does not possess the top-shelf equipment to run the software, therefore 3D environment should be highly optimised. Quite often a trade-off has to be met between the realism and performance. Realimation Designer allows developers to perform such trade-offs. Let the reader note that the optimisation of the environment in case of the Virtual Courtroom may not be performed in VRML but in Realimation. The export facilities may be then used to produce optimised VRML file. Unfortunately some work still needs to be done on the VRML version of the model since interactivity and perhaps additional multimedia elements must be introduced into it. Although actions can be exported with addition of a special Java class provided by the producers, this is as far as we can go. No triggers can be exported by the package. There is however a possibility to create a special component based on SDK within the Realimation Designer and attach it as a plug-in. Producers introduced such functionality in the version 5 of the software. Such component could be responsible for export all the elements the standard Realimation's export facility could not handle. The export could be done based on XML support and DOM to simplify and standardise the approach.

Finally the VRML seems to be the solution that satisfies the requirements. It would need more work, but the result will be closer to the expected. The results of first trial implementations can be seen on fig. 3. Those trial implementations were based on VRML files exported from the Realimation Designer v5 application and viewed in Internet Explorer 5.5 as well as Netscape Navigator 4 by the CosmoPlayer 2.1.1 plug-in. The Virtual Reality elements were also combined with streaming audio and video placed on the same page. The results were very promising. The streaming audio and video technology was provided by the RealNetworks' software.

6. Conclusion

The need to implement web enabled Virtual Courtroom application is clear. As it can be seen the possibilities are wide and the choice must be made wisely. On the one hand there is a variety of commercial solutions, on the other we have open-source. Again on the one hand

there is VRML standard, on the other one can distinguish many company standards. All these approaches have their advantages and disadvantages.

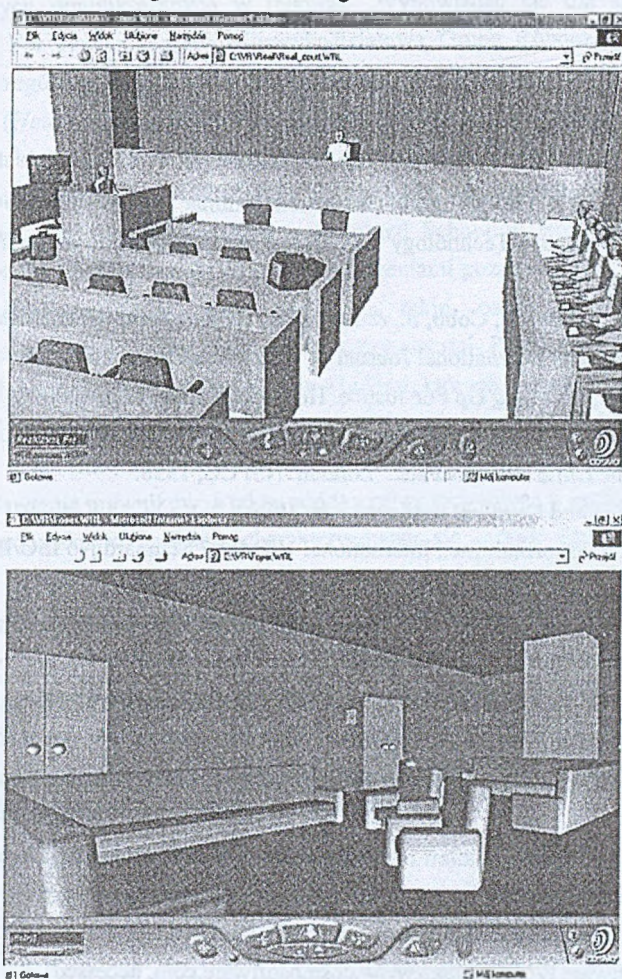


Fig. 3. Virtual Courtroom and court building foyer (VRML97 version) as seen through CosmoPlayer 2.1.1 plug-in for IE 5.5

Rys. 3. Wirtualna sala sądowa i poczekalnia (wersja w VRML97) wyświetlana za pomocą CosmoPlayer 2.1.1. – wtyczki do IE 5.5

Fortunately the previous developments done on the stand-alone application have directed the project towards two possible solutions: Realimation v5 web browser plug-in and VRML standard web browser plug-in. The choice was made however still a lot needs to be done to design the layout of the whole site. Let us remember that Virtual Reality is not the only element of the discussed Internet application. The whole site structure should be designed,

security measures undertaken if the application is to become commercial. To enhance the level of realism audio and video must be incorporated. As one can see still a lot of choices to be made to create an Internet flexible learning system.

BIBLIOGRAPHY

1. Veart A., Lewis J., User Group in Greenwich, seminar at the conference "Virtual Reality and Assistive Technology", 16-18 November 2000, The Millennium Dome, London, UK
2. Brown, D.J., Neale, H., Cobb, S., & Reynolds, H., Development & Evaluation of the Virtual City. *The International Journal of Virtual Reality*. In Press.
3. Home Office, Speaking Up For Justice. Home Office, London.
4. Home Office (in draft). Memorandum of Good Practice. Home Office, London.
5. NSPCC. The Child Witness Pack. London: NSPCC, 1998.
6. Youth Justice and Criminal Evidence Act, 1999.
7. The VRML Consortium Inc., International VRML97 Standard No ISO/IEC 14772-1:1997, The VRML Consortium Inc., 1997
8. Gardiner M.M., Christie B. (eds.), Applying Cognitive Psychology to User Interface Design, John Wiley & Sons Ltd. 1987
9. Redmond-Pyle D., Moore A., Graphical User Interface Design and Evaluation. A Practical Process, Prentice Hall, 1995
10. Datapath Ltd., Realimation: Space Time Editor User Guide, Datapath Ltd., Derby, UK, 1995
11. Realimation Ltd., Realimation v5: Release Notes, Realimation Ltd, Derby, UK, 2000
12. Blaxxun Interactive (2001), http://www.blaxxun.com/products/blaxxun3d/blaxxun3d_demoversion.html, accessed: 2001-03-27
13. Cosmo Software (2001), <http://www.cosmosoftware.com>, accessed: 2001-03-16
14. Superscape Plc. (2001), <http://www.superscape.com>, accessed: 2001-03-26
15. Virtual Court Advisory Group (2000), Meetings minutes

Recenzent: Prof. dr hab. inż. Andrzej Grzywak

Wpłynęło do Redakcji 7 kwietnia 2001 r.

Streszczenie

W wytycznych opublikowanych w raporcie „Wypowiadać się dla sprawiedliwości” („Speaking Up For Justice”) przez Międzywydziałową Grupę Roboczą ds. Traktowania Świadków Szczególnie Wrażliwych zasugerowano brytyjskiemu Ministerstwu Spraw Wewnętrznych (*Home Office*) wzmożony rozwój środków i materiałów wspomagających przygotowanie takich świadków do wystąpienia przed Sądem (wytyczna nr 29). Zgodnie z tymi wytycznymi w listopadzie 1998 fundacja Ann Craft we współpracy z Uniwersytetem Nottingham-Trent i grupą użytkowników z Shepherd School w Nottingham – czołowej brytyjskiej instytucji edukacyjnej dla osób z upośledzeniami poznawczymi – podjęły decyzję o realizacji oprogramowania wspomagającego takie osoby. Podstawą działania oprogramowania są techniki video i wirtualnej rzeczywistości. Przedstawia ono wnętrze sali sądowej i innych pomieszczeń sądowych, wraz z ludźmi, których normalnie można spotkać w takim miejscu. Personel sądowy na życzenie wyjaśnia swoją rolę w sądzie. Oprogramowanie prezentuje też dwa (lub trzy) scenariusze, w których świadkowie składają zeznania, odpowiadają na pytania prawników, a także poddawani są krzyżowemu ogniovi pytań.

Stworzona początkowo aplikacja charakteryzowała się jednak szeregiem ograniczeń: uzależnieniem od pojedynczej platformy systemowej, dostępnością dla potencjalnych użytkowników itd. Stąd też wypłynęła decyzja o przeniesieniu wirtualnej sali sądowej w nowy wymiar – wymiar Internetu. Zalety takiego kroku należy skonfrontować z nowymi wymaganiami i wyzwaniem – co prowadzi do wytworzenia pewnych kompromisów. Wartykule szuka się odpowiedzi na pytania dotyczące możliwości realizacji projektu w Internecie, biorąc pod uwagę, że jego celem jest stworzenie – w krótkim czasie – praktycznego, działającego i funkcjonalnego zastosowania.