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**THIRD DIMENSION OF E-COMMERCE**

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**Summary:** The article provides an overview and analysis of various forms of commerce in the three-dimensional virtual worlds. It takes into account technological, economic and psychological factors. The article tries to classify business models based on the roles of actors involved in trade and on the nature of virtual worlds. These issues are illustrated from the transformation perspective of the Web 2.0 site, and in the future 3D Internet.

**Keywords:** e-commerce, 3D virtual worlds, multi-user environments.

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## 1. Introduction

The research goal of the article is an overview and analysis of the various forms of commerce in the three-dimensional virtual worlds. Three-dimensional (3D) vector graphics and the related image processing and image recognition techniques are attractive for e-commerce, offering to a client a fuller understanding of the product than the picture. Thus, every new 3D technology has been attempted to be adapted in the Internet commerce. Sometimes the novelty of the concept resulted in a disaster, as exemplified by the rise and fall of Boo.com [Han Bei Bei, Chaudhari, Patra 2005], other times it was an inspiring experience for businesses (shops in the virtual world Second Life [Ogórek 2006], [Świerczyńska-Kaczor 2008]) and the starting point for researchers. Not only technology but also the mismatch between the classical principles of design and marketing of online stores, and finally, habits and expectations create some barriers.

In this paper we present, first the main 3D technology used in e-commerce, as it constitutes the basis for online stores. Boo.com experience makes us aware that if technological limitations are not taken into account, the establishment of an efficient Internet store is impossible. The next chapter attempts to classify 3D applications for e-commerce. Then there are questions of the three-dimensional presentation of the

products at online stores, as currently there is only a practical application of the third dimension in e-commerce. The next three chapters are devoted to virtual worlds, the first one addresses social worlds, while the second and third one to virtual worlds created for individual stores, shopping centers and trade fair.

In our research we have based mainly on literature review, but also on our own practical studies, which relate to an interactive “rotation of products” (panorama 3D) and Augmented Reality (AR) technology. Using both sources of inspirations, we have tried to define implications of the newest information technologies on e-commerce in practice.

## 2. The 3D Technologies used in e-commerce

The first tool to create interactive three-dimensional models of space (e.g. architecture, urban planning) in which the user can move around, manipulate objects, play music and watch the animation was a Virtual Reality Modeling Language (VRML), created in 1995 by the Web3D consortium. Its extension is X3D – the standard in 2004, which allows encoding the model description in XML format to create a basic 2D and 3D content for web pages. Interactive models VRML/X3D were called virtual worlds, the action taken by the user – exploring the virtual world, and the user – a participant in or a resident of this world. A plug-in is needed for viewing and exploration of virtual worlds on the Web [Ortiz 2010]. Based on these two standards online shops were created and continue to arise [Han Bei Bei, Chaudhari, Patra 2005], [Mass, Harzberg 1999], [Sanna, Zunino, Lamberti 2002]. In 1999 VRCommerce was developed, which consists of the editor to create three-dimensional commercial and shopping centers and a set of tools necessary to ensure smooth navigation [Mass, Harzberg 1999].

Around the same time as VRML, one of the most promising Internet technologies – Flash appeared, developed by a company with several beds FutureWave Software (1993), and then developed by Macromedia and Adobe [Gay 2001]. Initially it was software to create vector graphics and animation, but after the acquisition by Adobe, it was added to the filters and effects for image processing features. Flash application can be created using visual programming tools or programmed in Action Script language. In 2008 it was introduced to the language of three-dimensional graphics, which gave rise to many graphics engines (such as Papervision, Away 3D). In November 2011, Stage 3D was available – low level of API for programmable 3D graphics on the graphics card Currently, Flash animations and applications dominated the advertising banners and multimedia. The advantage of this technology is that it provides complete integration of the media: the content of two-dimensional, three-dimensional audio and video.

Already in November 1999, Flash technology has been used by the company Boo.com to sell designer clothing online in the eighteen countries of the world [Han Bei Bei, Chaudhari, Patra 2005]. Owing to the company it is easy and convenient to purchase from your office or home, to see the product from all sides (rotating it 360-degrees), see

the product details (zoom) and a mannequin dressed in clothes chosen by a customer. Virtual assistant Miss Boo advised choosing the right pizzazz. With these undoubtedly interesting news, an online store Boo.com had three serious flaws. The first of these was the need to install Flash Player plug-in. Currently it is in 99% of computers connected to the Internet [<http://www.adobe.com...>], but in 1999 it was not so popular and easy to install as it was restricted to the holders of the Macintosh. The second drawback was too slow loading of pages filled with large images and pop-up windows. From the standpoint of playing graphics a user should have a minimum 56kB modem, and many sites require wideband Internet connection, which is possessed by only 1% of users in Europe and 2% in the USA. The third serious problem was poorly designed navigation and sales procedure. Inattention during the navigation or product's selection causes the stall of computers e-consumers. The same questions needed to be repeated to the effect, if the product was not found in the sub-store. However, Boo.com was too revolutionary. As a result, potential customers are turned away from Boo.com, which in just 18 months have issued 135 million USD and in 2000 it was liquidated.

Another technology that drew attention to the creators of e-commerce network is derived from computer games MMORPG – Massively Multiplayer Online Role-Playing Games, in which players take on various characters. A simultaneous access of many players to the game is provided by the producer who puts it on their servers and collects fees from players. The dynamic increase of the game performance came after 2001, in which the standard pipeline of geometry and pixel processing, supported by the graphics card, could be replaced by the version defined by a programmer. In 2003, Linden Lab made the Internet game Second Life (SL) available, which “would be the answer to the question of whether it is and how much to imitate reality” (Philip Rosendale – founder of Linden Lab [Ogórek 2006]). Second Life quickly transformed from the entertainment in the virtual world parallel to the real one, in which young people do not just spend time, but also learn languages and entrepreneurship, while adults earn real money. Second Life has attracted many companies who have set up their shops there. The game reached a peak of expansion in 2007. But it turned out that there was no simple recipe for success, and many shops withdrew from Second Life. This time, technology was not at fault but the lack of intuitive ways of shopping, service standards, transaction mechanisms, and the study of customer behavior. This does not mean the abandonment of the concept of embedding online stores in the three-dimensional virtual worlds. Second Life followed the footsteps of researchers who had prototype stores in virtual worlds designed on the basis of computer game engines [Zhi-Cong Fang, Hong Cai 2009].

In the last ten years both the speed of Internet connections and graphics processing speed have increased. In 2010, the Khronos consortium, which includes AMD, Google, Mozilla, NVIDIA and Opera Software released the official specifications of the new technology – the WebGL, which renders the virtual world without a plug-in, on the HTML5 Canvas element [Ortiz 2010]. This is an important event because it eliminates one of the major disadvantages associated with the use of three-dimen-

sional graphics on the web. Users are reluctant to install additional software, either because they do not have the appropriate skills, or they do not want to waste time on something they believe is not necessarily going to work. The more they can take advantage of other online stores that do not have such requirements.

### 3. The classification of three-dimensional e-commerce applications

Among the eight trends that according to Webcredible agency would shape the face of Polish e-commerce market in 2011 were such social media as a channel of communication and sales, and multimedia presentation [Gurd 2011].

The concept of 3D virtual worlds consists in selling the actual products and/or virtual ones to customers, avatars, called VW-commerce (Virtual Worlds-commerce) [Świerczyńska-Kaczor 2008], VRCommerce (Virtual Reality Commerce) [Mass, Harzberg 1999] or Commerce to Virtual Worlds (C2V) [Zhi-Cong Fang, Hong Cai 2009]. The word avatar comes from Sanskrit, in which it means the incarnation of deity. In the virtual world avatar is the personification of the participant in this world that can design the look of ones avatar, such as skin, eyes and hair color, the shape of lips, clothes and additional items that will be added to it (weapons, jewelry, etc.) (Figure 1). In addition to that, every avatar is linked to a brief description. Among the social media it is the name, interests and membership of a group of users.

There are many types of virtual worlds that have different goal, graphics, the way of human-computer communication and communication among avatars, the way of transactions settlement. Some are only virtual shops or supermarkets, the other virtual worlds, social networking or entertainment, in which the stores are a form of active participants.

In literature the concept of business models of 3D or business in the 3D virtual worlds can be found [Zhi-Cong Fang, Hong Cai 2009]. We propose the following classification:

- B2C (business to consumer) – a classic business model, but sold to real objects can be presented in the traditional way (text + photo) or using multimedia technology and 3D graphics [Pietruszka, Niedźwiedziński 2009], [Pietruszka, Niedźwiedziński 2010]
- marketing in three-dimensional virtual worlds [Barnes, Mattsson 2008],
- VG2A (virtual government to avatar) – a virtual economy in which the sale of virtual and real foods to avatars is one of activities [Han Bei Bei, Chaudhari, Patra 2005], [Świerczyńska-Kaczor 2008], [Zhi-Cong Fang, Hong Cai 2009],
- B2A (real business to avatar) – sale of real goods to avatars in the virtual world, which were designed solely for the purpose of trade [Han Bei Bei, Chaudhari, Patra 2005], [Mass, Harzberg 1999], [Noser, Stucki 2000], [Sanna, Zunino, Lamberti, 2002],
- B2VW (business to virtual worlds) – services for three-dimensional virtual worlds [Alpcan, Bauckhage, Kotsovins 2007], [*Virtual Trade...* 2010].



**Figure 1.** The most famous avatar: Anshe Chung impersonates Ailin Graef in the virtual world of Second Life.

Source: <http://www.theage.com.au>.

#### 4. Three-dimensional product presentations

In a traditional online store a product is presented with photographs and text parameters of the spec and price. When a single view is not able to give the appearance of an object it is sometimes placed in a photo gallery.

The report of the Webcredible agency rightly notices that “one of the barriers to Internet sales is still a problem with the prior review and touch the product, seen, as presented in the action. Certainly, a strong growing trend is the creation of video content, so the client has a better presentation of the offer and accurate information about its capabilities. Importantly, video materials also increase and improve results positioned in the web browsers. The video raises the visibility and recognition of the products, which may raise the value of their sales.” [Gurd 2011].

Currently, there are many companies offering to take photographs of rotating of product. A series of photos at full rotation of 360 degrees is made in the so-called object-oriented panorama. It is an animation that is stored in GIF, SWF or MOV files (Figure 2). GIF animation will be played on any platform without plug-in installation, but is limited to a palette of 256 colors and provides no additional options. QuickTime VR Panorama saved in MOV file enables an interactive “rotation of product” to the left/right and zoom in using the interface buttons or mouse. It requires from a user to have QuickTime Player installed. To play Flash animations saved in SWF file they need a Flash Player plug-in. This is the most comprehensive interactive animation.

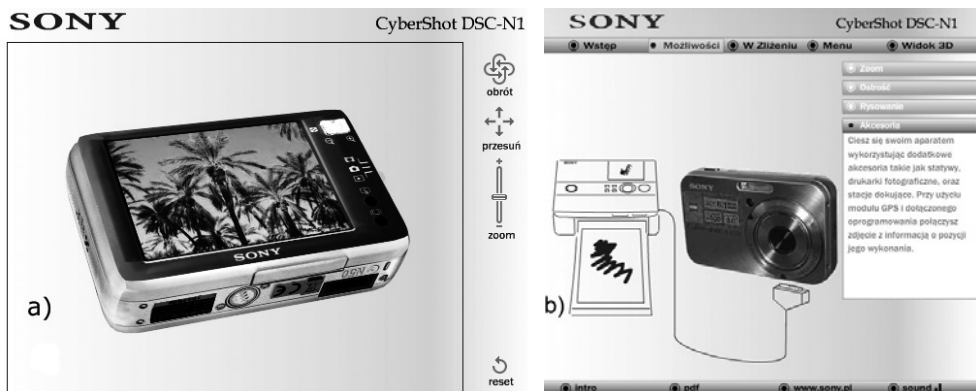
The Flash file can save not only photos but also a series of three-dimensional model of the product The user can freely manipulate with the mouse (Figure 3a).



**Figure 2.** Rotating pictures of the product: (left) presentation in the licensed browser with the function and high-quality full-screen magnification, (middle) an interactive Flash animation with basic functions and a zoom function, stored in a SWF file, (right) in the form of an animated GIF.

Source: <http://www.fotoanimacje.pl/>.

Such a model is created in 3D program (such as 3ds max, Maya) and converted to a Flash movie, which adds a virtual camera and interaction. Usually, to transform 3D model into interactive Flash movie there are used specialized commercial programs such as Blaze 3D, Swift 3D. The advantage of Flash technology is that it provides complete integration of the media: the content of two-dimensional, three-dimensional audio and video. An example of the combination of 2D animation with 3D in a Flash movie for multimedia manual instruction is shown in Figure 3b.



**Figure 3.** Videos Flash: a) 3D model of the camera can be manipulated with the mouse or the use of the tools menu, b) animated guide to connect a printer to the camera.

Source: [Pietruszka, Niedźwiedziński 2009]

In 1994 Paul Milgram and Fumio Kishino have promoted a concept of VC (Virtuality Continuum) [Milgram, Kishino 1994]. On one end they have located a real world, on the second – a virtual world. Between them a mixed reality is situated, combining real and virtual objects in one picture. If reality predominates in the pic-



**Figure 4.** Use of Augmented Reality for creating of interior furnishings: a three-dimensional lamp's model is visible on a smartphone in a place where a black and white marker is situated.

Source: [Szajerman, 2012]

ture, we deal with AR (Augmented Reality), whereas virtuality predominates in the picture we deal with AV (Augmented Virtuality).

In Internet shops AR is used for presentations of three-dimensional models of products in a real environment. To this end computers and smartphones equipped with cameras are used [Pietruszka, Niedźwiedziński 2010]. A lot of people have no spatial imagination, but thanks to AR technology they have a chance to see as an example an element of furnishing in a place of its destination (Figure 4).

## 5. Second Life and the other social networking virtual worlds

Second Life is based on the VG2A model. It is a game in which trade is one of the player's activities. It is necessary for them to become residents in Second Life and appear in it as avatars, so they must register. The registration is free, but then an avatar buys goods (virtual clothes, shoes, food, cars, houses, flats, etc.), lots (virtual land, islands), and computer graphics services, DJs and programmers (Figure 5). He pays by virtual currency called the Linden Dollar (LD), which actual value is converted to U.S. dollars. Its course is variable, because it is based on law of supply and demand. Linden Dollars can be purchased using a credit card, PayPal or online auctions such as eBay or Allegro. By the end of 2008, users could also buy them in the virtual Second Life banks, but because of the fraud occurring, it was forbidden.

The most successful providers have had useful services inside Second Life, the condition was also to hit in the tastes of the inhabitants of the virtual world. For example, Reebok does not sell real shoes in a virtual store, but shoes offered by virtual avatar which can be to your liking. A service such as Vodafone InsideOut allows avatars to send and receive texts and voice calls within and outside of Second Life. Coldwell Banker which practices in real estate trades rents and sells virtual property. For such trade Ailin Graef, known as an avatar Anshe Chung, the first earned million U.S. dollars in Second Life, starting to invest \$ 9.95 [Ogórek 2006].

It seems that Second Life can also be a good place for prototyping projects. The company Starwood Hotels (Sheraton brand owner) before building a new Aloft hotel chain, set up their three-dimensional prototype in Second Life and invited residents to it (Figure 5a). Their changes and opinions have been included in the actual construction of hotels that are a mirror image of the prototype of the virtual world.

Social world of Second Life in which multiple users both may be present and communicate is also a good platform for educational services (e.g. British Council, Harvard and Oxford University), services related to recruitment of the staff (e.g. TMP Worldwide conducted the recruitment for the Royal Bank of Scotland and Hewlet-Packard), organization of meetings of employees (e.g. IBM), presenting a new product. In addition, many companies (Dell, Mazda, and Sony BMG) have noticed a real opportunity to promote a brand in virtual world. Placing the actual product model in 3D space helps to build brand awareness and convince users about the benefits of a product, and sometimes buy the real version (Figure 5) [Barnes, Mattsson 2008].

All these experiments are technically interesting, but they do not necessarily help to do shopping. It is significantly easier and faster to find a music album or a book on a company website. Security of transactions can also pose a problem. Therefore, companies usually use Second Life as a platform for the selection and presentation of goods, while a customer is then redirected to a web site to make a safe transaction. According to Gartner report, Second Life and other virtual worlds have reached their peak of popularity in 2007 [<http://www.gartner.com...>]. A year later there was a sharp decline in their interest (Figure 6).

Financial fraud and money laundering, facilitated by the anonymity of avatars perhaps partly contributed to this decline. In 2008, it was banned to prevent the business of taking deposits from users in return for interest rates. Gambling was also banned and transactions began to be monitored.

The decrease in popularity of Second Life does not mean giving up the idea of creating a virtual world that mimics human community. Singapore government, the organizer of the 1st Youth Olympic Games (YOG) in 2010, wants to leverage the latest information technology to create a platform based on 3D virtual world, dedicated not only to 4000 athletes, but also to thousands of other peoples who may not be present in Singapore.





**Figure 5.** Various forms of the activity of residents in Second Life: a) the prototype room Starwood Hotels, b) Dell computer is configured in a special position, then it is possible to buy it, c) in the virtual studio, Sony BMG avatar takes note of the album and buys it, d) avatar can become the owner of the virtual model of Mazda Hakaze or get a free test drive, e) camp is a place where residents can enjoy their time and money. This could be at the same time an interesting place for tourists, a shopping center, or a place to earn money. Often earned money seems to be in the same place, f) the billboard is used to teleport to another location or on the Web site.

Source: <http://secondlife.com/>.

The goal of YOG was education, socialization, tourism and exhibition, and virtual retail business [Zhi-Cong Fang, Hong Cai 2009]. Youth Olympic Games were divided into roles and scenes. Next the planar graph was created, and transformed to

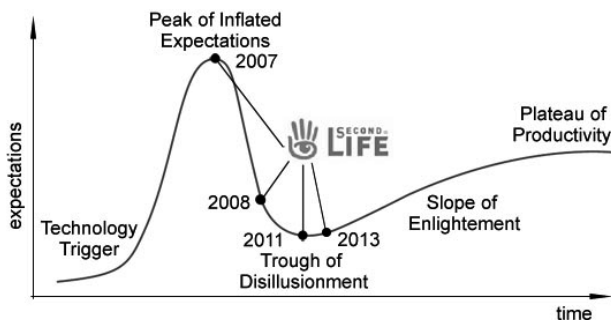


Figure 6. Second Life in Gartner’s hype cycle for emerging technologies.

Source: own.

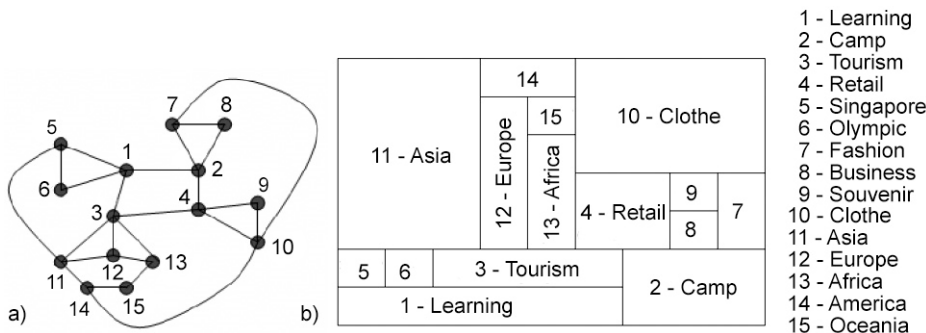


Figure 7. The structure of YOG – Youth Olympic Games: a) numeric adjacency lists and the planar graph, b) the blueprint of active areas.

Source : [Zhi-Cong Fang, Hong Cai 2009].

the blueprint of activity areas (Figure 7). Four key areas were distinguished inside the game, marked with "Camp", "Learning", "Tourism" and "Retail". The user starts visiting the virtual YOG village from the bottom right, and enters a YOG camp, which is the community meeting place. From there, an avatar can go to "Fashion Community" (7) or "Business Community" (8). From key area marked with "Learning" (1) avatars can go to other areas to learn Singapore history (5) or Olympic history (6). The area marked with "Tourism" allows visiting interesting places on five continents. "Retail" (4) is the center of virtual shopping. An avatar can go to "Souvenir Store" (9) or "Clothes Store" (10).

### 6. Virtual shops and malls

Many virtual 3D shops and markets, whose purpose is exclusively selling real products based on VRML/X3D technology, has long dominated the Internet. The architecture of virtual store, its equipment and surroundings are usually modeled in pro-

grams dedicated to computer graphics modeling, such as 3ds Max, then exported to a WRL format designed for VRML files [Han Bei Bei, Chaudhari, Patra 2005]. The database is usually created based on MySQL [Han Bei Bei, Chaudhari, Patra 2005], [Remolar et al., 2010], and the store website using PHP and HTML. There are also applications that use other database engines like Oracle [Sanna, Zunino, Lamberti 2002].

HAVS is a virtual shop where the rooms are dynamically created for the presentation of products and buildings searched by a user [Sanna, Zunino, Lamberti 2002]. In each room a virtual salesperson to help users in further exploration is placed. Thus shopping becomes more intriguing and realistic. The user can rotate and move objects and activate the animation. If you click on the form of a virtual dealer, this approaches the search form and shows a product (Figure 8 left). A virtual store is composed of five web sites. The first menu shows retailers and a catalog of prices, registration of new users logging on and a shopping basket. The second page is used to search for products and is generated by the servlet. The user can specify the name or description of the product or take a virtual assistant.

On the login page a user begins to use a secure connection, while the registration page allows adding a new user to the database using the security protocol. The last page consists of two frames: the left is a list of wanted products and a link to an order, the right – VRML scene (Figure 8 right).

Market Hikageya contains four stores, two on each of two floors. The lobby and podium combined shops contain four stores at each level, two on each on two floors [Han Bei Bei, Chaudhari, Patra 2005]. A sold product has an identification number, description, price and status of the transaction, as well as unique attributes of each class, in a MySQL database. Each store has a name, description, address



**Figure 8.** HAVS – virtual 3D shop: (left) a side of virtual dealer and product search form, (right) final page.

Source : [Sanna, Zunino, Lamberti 2002].

and a date of registration. Client information contains a unique, auto incremented id, name, gender, address, status, account status, password, avatar's name and a date of birth. The user-avatar "wandering" through a virtual store can affect the three-dimensional objects that are animated models of products sold, which have links to additional information text, graphics, audio, video and 3D which are available through the Web page.

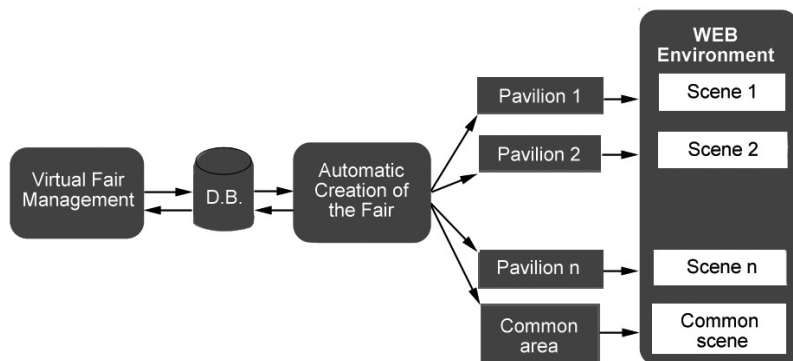
The creators of the virtual markets also thought about the convenience of those users who wanted to choose quickly a product in a traditional way integrating three-dimensional and two-dimensional market to do shopping in one of the websites. Two-dimensional website not only provides logging, but is also regarded as a three-dimensional backup store of photos and descriptions of sold products. Customer's profile includes personalized e-consumer data, as well as the related persons (e.g., the same age group). Thanks to this, virtual market has to offer potentially interesting products to them. A client profile is updated.

## 7. The virtual trade fair

In [Remolar et al., 2010] there was presented an interesting proposal for a virtual exhibitions online. It was assumed that they must have the characteristics of interest to the business world. This is achieved by providing the multiple ways of advertising a company, to present its activities and products, and automatic creation of three-dimensional content. A computer game engine Torque 3D was used to make it possible for many users to interact with each other at the same time on the markets. This resulted in a high degree of realism. At the same time this software brought many benefits: very realistic lighting, shadows, collision detection, animation, etc. Virtual trade shows are available through a web browser. When a user first visits the page, the browser automatically downloads and installs the plug-in that provides a virtual world.

The application is divided into three main modules of different tasks (Figure 9).

Virtual fair management module has two types of users. The role of the fair administrator is to enter into the database of general information about the activities of the company and to assign user's names and administrator's business passwords community to access the application. The administrator also manages the location of the stands in the pavilions, choosing from a matrix dividing the area of trade fairs in the field, any number of empty fields corresponding to the size of the stand. The business administrator can customize their virtual stand by adding pictures, drawings, contact information, etc., and then the program generates the code needed to create them, and the inclusion of a virtual world stand in the market. There can be added interactive objects to the stand, such as advertising catalogs of products. All information gathered in the management module is stored in a MySQL database. The content of the module is implemented in Flash and HTML, and database access is done using PHP.



**Figure 9.** The organization of the virtual markets application modules.

Source : Remolar I. et al., 2010.

The automatic creation of the fair is also implemented in PHP and uses MySQL database. It is responsible for creating buildings with the pavilions which are allocated booths (assembles data needed to generate 3D objects), based on information previously entered by the company. The pavilions are independent virtual worlds, which in the terminology of computer games are called missions. Finally, some information objects in the stand are assigned a link to the business web site, where the end user can obtain more information about their products and services. When this process is finished, the creation of the file structure is necessary for the game engine.

The WEB module environment is implemented by using multiple technologies such as HTML, JavaScript and PHP with a MySQL database. Its task is to control access of visitors to the world of 3D. All the users must be registered and are represented by avatars.

The final integration of the virtual world with a Web page is done by client-server module. The client is the WEB environment, however, the server is the game engine with virtual pavilions, where graphics can be created using the OpenGL or Direct3D. The communication between the client and the server is done by using TCP and UDP network protocols. Information such as user's name, avatar model, the combination of color, position and orientation of the avatar in the virtual world are transmitted through a client-server module to the game engine. XML file, which enables the user-avatar to be combined with the proper pavilion is generated from this information. The user can navigate through it using the keyboard or by selecting from the catalog of the fair stand. It can also communicate with other users by text chat.

## 8. Conclusions

”The World Wide Web, which has started as a document repository, is rapidly transforming to a full fledged virtual environment that facilitates services, interaction, and communications. Under this light, the Semantic Web and Web 2.0 movements can be seen as intermediate steps of a natural evolution towards a new paradigm, the 3D Internet” (Deutsche Telecom Laboratories [Alpcan., Bauckhage, Kotsovins 2007]). Already, hardware and graphics software allows creating complex virtual worlds for shops, malls and trading fairs. The key problem is to ensure security of transactions and communications and intuitive user interface. Security problems are predominantly found in the worlds of social games, as game engines do not have the appropriate mechanisms. The most difficult task to solve is the lack of standards for shopping in 3D space. Young users raised on video games wanted to and were able to navigate through the three-dimensional space virtual store and interact with products offered in it. The elders cannot accept that. Therefore, the interesting idea is the Hikageya virtual market, which integrates 2D and 3D versions of the store, leaving the user to decide which one to chose [Han Bei Bei, Chaudhari, Patra 2005]. It seems that this is a natural transition from the traditional e-commerce stores to their dimensional counterparts. This process accelerates such ideas as the three-dimensional presentations of products and mannequins.

We think that in the future the most promising field of the third dimension’s application in e-commerce is connected with mobile devices. That is why we plan to concentrate our future research on Augmented Reality (AR).

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## TRZECI WYMIAR W E-COMMERCE

**Streszczenie:** W artykule zawarto przegląd i analizę różnych form handlu internetowego w trójwymiarowych wirtualnych światach. Wzięto pod uwagę uwarunkowania technologiczne, ekonomiczne i psychologiczne. Podjęto próbę klasyfikacji modeli biznesowych opartej na rolach podmiotów biorących udział w handlu i na charakterze wirtualnych światów. Zagadnienia te ukazano z perspektywy przekształcenia WWW w Web 2.0, a w przyszłości w Internet 3D.

**Słowa kluczowe:** e-commerce, trójwymiarowe światy wirtualne, środowiska multi-user.