MULIMEDIA MANUALS FOR DESCRIPTIVE GEOMETRY
AND ENGINEERING GRAPHICS

Maria HELENOWSKA PESCHKE

Gdańsk University of Technology, Faculty of Architecture, Department of Visual Arts
ul. Narutowicza11, 80-952 Gdańsk, Poland
e-mail: mhelen@pg.gda.pl

Abstract. The article discusses issues connected with ICT (Information and Communication Technologies) implementation in descriptive geometry and engineering graphics education. The presentation of the issues is supported by the author's multimedia manuals made in Multimedia Flash MX and published in the Gdańsk University of Technology net. The main advantages of Flash technology in context of the descriptive geometry manuals are: interactivity (which for e.g. allows creating multistage drawings step by step like during a live lecture), visualization abilities (which for eg. allows animations off all kinds) as well as non-linear structure of publication (which allows hypertext features). The concept addresses many didactical postulates eg. individualization of teaching (a student can adjust a pace, a place and a time of study to his own capabilities). The discussed multimedia manuals can serve as an independent source of knowledge or a systematic and a comprehensive record of actual lectures as well as a self –study and exam preparation materials.
The actual didactical effect is difficult to measure as an overall effectiveness of study depends on varies factors eg. motivation, interest, foreknowledge. Undoubtedly the high users' opinion can be confirmed by the rapidly growing number of the visitors on the manuals' sites (e.g. *Exercises on Descriptive Geometry* has over 21000 visitors in two years).

Keywords: multimedia manual, e-learning, Computer Aided Instruction, descriptive geometry

Introduction

The real challenge facing educators today is, to establish learning environments, teaching practices, curricula, and resources that leverage what we know about the limitation of human physiology and capacity explained by the cognitive sciences to augment deep learning in students [1].

Information and communication technologies (ICT) at the academic level can be introduced in many various ways starting with complementing traditional teaching methods and finishing by the e-studies based on Learning Managements Systems. Practical aspects of e-learning can be divided into three groups: methods of distributing knowledge, ways of communicating, examination techniques. The first group includes materials available on line such as: text files, multimedia presentations, audio/video files, etc. The e-mail post, the internet platforms, forum communities constitute aid techniques which allow the user to ask questions and have a discussion. Tests, assignments and on-line exams are a way of knowledge verification and self control tools.

E-learning ranges over the issues of multimedia manuals for descriptive geometry (distributing knowledge). In the pedagogical literature there are distinguished the following notions: e-books, multimedia manuals and hyperbooks. The e-book is considered to be a content recorded in an electronic form possible to read with the aid of special computer programs. According to W. Walat a textbook in digital form enriched with multimedia files and single hypertext structures becomes a multimedia manual. The term –hyperbook - is used for an e-book with features of a hypertext and all the consequences of it – variety and richness in forms of navigation and theme links [2].

In this article the notion multimedia manuals means to me applications created by using one of the Internet or multimedia technologies (PHP, CSS, Flash, Java 2, xHTML) admitting interaction of the user and consequently constitute more than a digital record of a printed version or typical static internet pages.

With methodological aspects concerning multimedia instruction deals media pedagogy. This science is heading towards integrating theoretical and empirical knowledge generated by different academic disciplines: pedagogy, psychology, theory of communication, informatics and ergonomics etc. According to K. Wenta the temptation to substitute one's own effort with a program supports the opinion that computer techniques can evoke creative attitude as well as passive and reproductive. These functions are dependent on the methodological method for activating a learner stimulated by computer [3].

1. Technical and methodological aspects of multimedia manuals

Multimedia manuals on descriptive geometry are the result of my research on own and original method of using information and communication technologies in the field of descriptive geometry didactics. They were designed on the base of my considerable professional experience in teaching the subject, the general didactical rules, and the particular methodology of the subject as well as the latest empirical studies on e-learning characteristics reported in literature.

In the article the issues concerning the multimedia manuals is divided into two main groups 1) technical aspects and 2) didactical aspects.

Descriptive geometry manuals were complied in Flash technology and published in the Internet. This technology enables creating applications for accepting interactive reactions of a user as well as building hypertext non-linear structures covering definitions of mutual relations within the content of compilation. It also offers variety of graphical means, namely creating or importing vector graphics or raster images and animation of all kinds. Flash Player format guarantees that a user will see all the animations and will be able to interact with the application using a common Web browser. On the Internet the material can be published as one document with an inner system of navigation as well as separate websites connected with an outer system of navigation. In the latter variant the time of downloading data to a user station is shortened (download are only websites chosen by user). Moreover the structure of the document is more flexible – it is enough to replace websites that require modification or just add new sites to the existing manual on the server. What imposes limitations is the necessity to reduce the amount of data streamline in respect to the download time but the process of modifying and bettering in case of Internet publication is not limited in time.

Currently in the net of Gdańsk University of Technology there are available four multimedia manuals on descriptive geometry:
1. *Shade and Shadow Construction*, (in cooperation with A.Wancław) 2003/4, meant specially for students of architecture,
2. *Exercises on Descriptive Geometry,* 2006,
3. *Descriptive Geometry in Examples,* (in cooperation with A.Wancław), 2007, published both in Polish and English versions,
4. *Lectures on Descriptive Geometry,* part I, (in cooperation with K. Przyłucka), 2007/2008 part II under construction

All the specified multimedia manuals are complementing each other in terms of their merits and didactical function which are:
- distribution of teaching context,
- visualization of teaching materials (animations off all kinds are dedicated to those students who have low spatial visualization skills),

- reinforcement for the process of do it yourself tasks (specially in case of those students who don't like "collective thinking" and prefer to work at peace and solitude),
- reinforcement for the process of solving problems,
- individualization of teaching context, and learning scenario (student can chose: time, place and pace of his or her study in accordance to preferred learning style).

Particular methodological solutions (described in chapter 1.1 and 1.2) aim to transfer knowledge in the most effective way. They are designed in accordance with the principles of Cognitive Load Theory presented in *"Efficiency in Learning: Evidence-based Guidelines to Manage Cognitive Load"* . The book is intended for instructional professionals and aims at explaining how to improve learning.

1.1 Example I

Multimedia manual *Descriptive Geometry in Example* is a collection of representative examples covering the more important parts of the lectures on the subject. It can be used for self-study and lab or exam preparation purposes. Its content is being currently modified according to changes in the teaching programme and user's requests. Tasks were formulated in order to allow users to adopt general methods and schemes of task solving and at the same time to encourage them to reject thought patterns and algorithms.

The structure of the manual is non linear – the order of pages and the type of allowed actions is ambiguous. The tasks can be chosen from the index on the home page or by moving from one task to another. The geometrical multistage constructions are presented step by step like during the live lectures. Firstly student is provided with a task and spatial data. Then depending on her/his strategy of studying, prior knowledge and spatial abilities student can already apply obtained algorithms or follow step by step procedure leading to a solution. Navigation buttons allow user to move forward to successive stages of a construction or withdraw a step of the construction (the number of steps within an algorithm and a drawing depends on the complexity of the procedure). The successive stage of geometrical constructions is provided with a detailed description. Abstract 3D models and 2D animations are provided in order to enhance spatial ability and visual memory. This concept is meant to invoke geometrical reasoning rather than passive viewing/observing ready solutions.
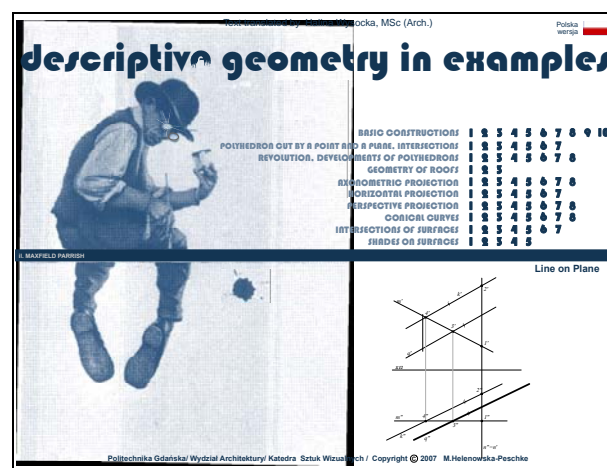

Fig.1: *Descriptive Geometry in Example* [www.pg.gda.pl/architektura/ztw/]

Besides utilizing visual illustrations and animations the solutions are supplemented by methodological guidelines (accomplished analogous tasks, consider specific spatial configurations.) The analyses of a learner's way of spatial thinking and of the difficulties

she/he might face are the basis of graphical means and hypertext structures choices. This multimedia manual is both means and methods which aim is to consolidate the material, compose knowledge, enhance the process of geometrical reasoning. The analysis of a geometrical task is not done only on the part of the result correctness but also due to the way of achieving the result which is an essential didactical situation.

1.2 Example II

Lectures on Descriptive Geometry constitute a multimedia manual for the Architectural Faculty. Current manual covers one term range that is 30 hours of lectures (targeting for two term material). The material divided into modules can be independent source of knowledge (use exclusively and without following the actual lecture program) or a kind of well-weighted notes (as an addition to attending the real lectures for self study). The content of individual lectures is divided into pages including two levels of information. On the first entrance on the page information reduced to the essentials or information on higher level of generalization are given or ? (eg. in a form of pointed list). More detailed information, commentary visualizations are available at a user's request at the chosen moment (in didactical literature that structure is referred to as upside down pyramid). The connection paths (hypertext options) are used for supplementing and helping to structuralize teaching material. This way of arranging pages content allows for individualization of a display depending on a level of prior user's knowledge. It also allow learner for self-control (he is encouraged to undertake a geometrical task by himself). It is up to the user in which directions analysis should be carried on. Similarly like in the manual discussed prior all the multistage geometrical constructions are organized in step by step manner. The text is supported by animations and visualizations to enhance student's spatial geometrical reasoning.
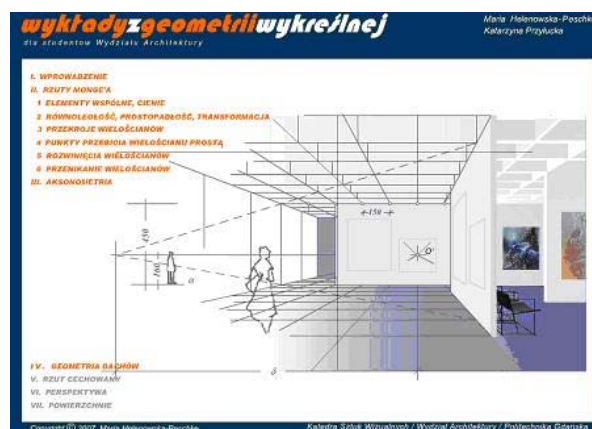

Fig.2: Home page from *Lectures on Descriptive Geometry* [www.pg.gda.pl/architektura/ztw/]

2. Graphical aspects of multimedia manuals

The visual design of multimedia manual's pages for descriptive geometry is determined by an information capacity of a computer screen, the general rules of a graphic composition and a colour scheme. They manuals have got - intuitive and simple interfaces and graphical solutions commonly utilized on web. In both discussed above compilations the fixed elements on a website are navigation buttons placed on the top toolbar of an interface. They allow a user to go through successive pages of a manual or chosen chapters. There is no

method which allows to determine optimal amount of information, which a single educational page should contain. It is widely acknowledged that if a screen has too extensive or too poor content a typical user's reaction is discouragement and lack of further perception. Because of the peculiarity of the descriptive geometry, in which technical and demonstrative drawing are a subject of teaching, it was appropriate to avoid navigation buttons in a form of graphic symbols. The hypertext links are indicated by the means of differentiated words in the text or item lists. It results in various navigation possibilities through the manual.
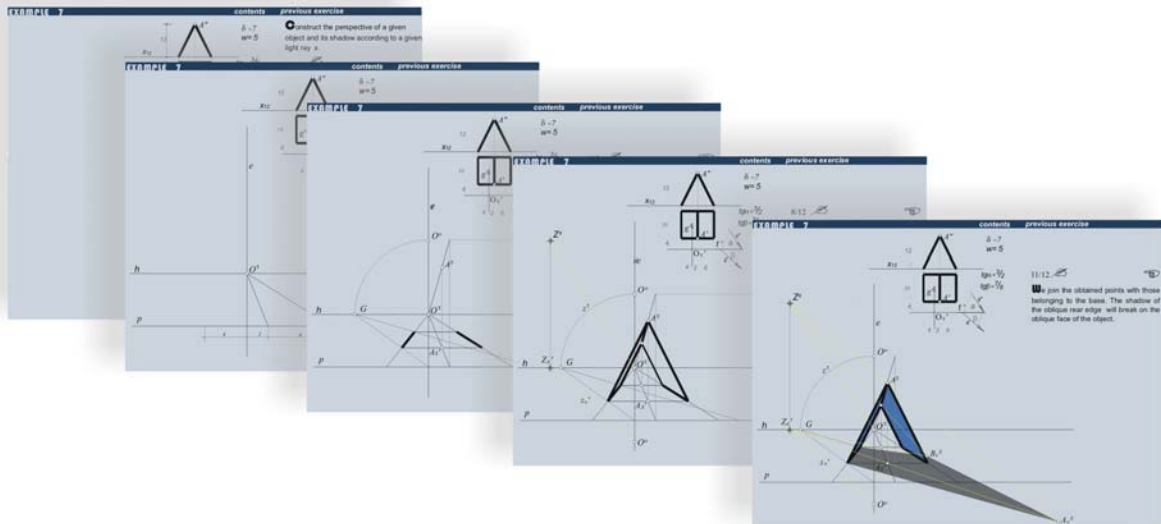

Fig.3: Stages of geometrical construction . Example 7 from *Descriptive Geometry in Exercises*

Actually geometrical constructions which are highly precise vector drawings are film clips (film frames are sequel construction stages display of which is controlled by a user). They are monochromatic like in traditional manuals whereas the colour is used sporadically in order to improve legibility of a construction. To achieve this effect auxiliary elements, which are not important at a given construction stage, are removed or blurred. Whenever it's methodologically justified animated 3D models and "flat" animations referring to practical drafting activities are used to stimulate spatial ability and visual memory.

3. The evaluation and the betterment of multimedia materials

The multimedia manual should be valued by its communicativeness, clarity, and attractiveness in formal terms as well as the didactical effectiveness. The latter results in the range of obtained knowledge and in the amount of time necessary to learn given material. This data is difficult to obtain as overall result of learning depends on various factors, eg. prior knowledge of the learner, the complexity of the content, and interests of the learner, his motivation to study. The knowledge on how in reality the students use multimedia manuals, what are their expectations, which of offered aids appeared to be the most helpful is in practice difficult to obtain. Available research methods which enable evaluation of methodological and technical solutions of the manual are: an observation, a survey and an interview. The point is that the observation can be made only under experimental conditions, whereas it would be recommended to decide how the manual functions in everyday conditions - that is when a student uses them freely at his discretion and has a choice of alternative means of work.

The discussed manuals contain links which allow a user to send his opinions on the manual to my e-box. Received opinions are highly positive. The amount of visits on the manual website is probably the best confirmation of users' regular learning activities. For

example the manual *Exercises on Descriptive Geometry* published in 2006 was visited over 21 000 times (till April 2008). What is more, students' e-mails revealed that its content is universal and the manual is used by students from different Technical Universities in Poland.

The distinctive feature of the internet manual is that its expansion and betterment can be permanent and doesn't involve costs but time and determination on my part. At present the modifications of the material consist of extending hypertext functions (that is non-linear structures enabling individual learning paths leading the learner through the learning material) and implementing 3D interactive models.

Summary

Along with the Internet, multimedia manuals for descriptive geometry are used in GUT in order to provide students with the ultimate learning environment in view of enhancing the overall service quality of academic studies. They are the result of author's desire for modernizing teacher's workshop and - updating teaching methodology. The use of multimedia manuals doesn't eliminate existing educational methods (traditional classroom activities) and didactical theories. However, it allows for realizing didactical requirements such as comprehensive education, matching with individual characteristics. Concept allows to chosing studying conditions individually, thus increasing the possibility of self controll of the learning process. A student sets a pace of presentation, place and time for study according to her/his preferences. The manuals are especially dedicated to those students who find "collective thinking" impediment to their work and put in more effort while working in solitude and quietness. The multimedia manuals can be used in variety of ways depending on the didactic concept the educator has in mind.

The multimedia materials developed at the Faculty of Architecture at the Gdańsk University of Technology are free to use for everyone. They are accessible at the University net http://www.pg.gda.pl/architektura/ztw (September 2008) or http://www.wbss.pg.gda.pl

References

[1] Report Multimodal Learning Through Media: *What the Research Say by Metiri Group* 2008 - http://www.cisco.com/web/strategy/docs/education/Multimodal-Learning-Through-Media.pdf.
[2] Walat W.: *Podręcznik multimedialny*. *Teoria, metodologia, przykłady*. Wydaw. Uniwersytetu Rzeszowskiego, Rzeszów 2004.
[3] Wenta K.: *Trening twórczego myślenia przy komputerze*. Informatyka w Szkole, XV, Katowice 1999.
[4] Wenta K.: *Telepraca nauczycieli akademickich w społeczeństwie informacyjnym*. IV Międzynarodowa Konferencja Naukowa „Media a edukacja", Poznań / Zielona Góra 2002.
[5] Clark R., Nguyen F., and Sweller J.: *Efficiency in Learning: Evidence-based Guidelines to Manage Cognitive Load*, Pfeiffer 2006.

PODRĘCZNIKI MULTIMEDIALNE DO GEOMETRII WYKREŚLNEJ i GRAFIKI INŻYNIERSKIEJ

W artykule przedstawiono problematykę związaną z wykorzystaniem technologii informatycznych i komunikacyjnych (ITC) w edukacji z zakresu geometrii wykreślnej i grafiki inżynierskiej. Prezentacja została oparta na doświadczeniach wynikających z

zaprojektowania w technologii Multimedia Flash czterech autorskich podręczników multimedialnych opublikowanych w sieci Politechniki Gdańskiej. Najistotniejszymi zaletami technologii Flash w kontekście nauczania geometrii wykreślnej są: interaktywność (umożliwiająca budowanie wieloetapowych konstrukcji geometrycznych krok po kroku tak jak się to odbywa w czasie wykładu na żywo), bogactwo środków graficznych (umożliwiające tworzenie wszelkiego rodzaju animacji), oraz nie-linearna struktura publikacji (umożliwiająca tworzenie hipertekstów). Szczegółowe rozwiązania metodyczne zostały oparte na metodyce przedmiotu, ogólnych zasadach dydaktycznych oraz najnowszych osiągnięciach pedagogiki multimedialnej. Koncepcja prezentowanych podręczników multimedialnych pozwala na realizację wielu postulatów dydaktycznych, jak np. indywidualizacja nauczania - student wyznacza sobie tempo prezentacji, miejsce i czas nauki zgodnie z własnymi preferencjami. Równie istotną zaletą podręczników publikowanych w sieci jest fakt, iż proces ich udoskonalania, aktualizacji i rozbudowy może trwać nieprzerwanie.

Prezentowane autorskie podręczniki multimedialne do geometrii wykreślnej są dedykowane studentom wydziałów architektury, obecny zakres obejmuje aktualny program nauczania na Politechnice Gdańskiej. Mogą stanowić samodzielne źródło wiedzy, pełnić rolę przemyślanej notatki z wykładu lub materiału do samodzielnych ćwiczeń.

Weryfikacja przyjętych rozwiązań metodycznych w podręcznikach multimedialnych stanowi trudność praktyczną i metodologiczną, jako że na rezultaty nauczania składa się wiele czynników np. motywacja, zainteresowania, wiedza uprzednia. Niewątpliwie pozytywny odbiór potwierdzają e-mail'e od studentów z różnych polskich uczelni technicznych oraz liczba odwiedzin na stronie. Opublikowany w 2006 roku skrypt „*Ćwiczenia z geometrii wykreślnej*" był przeglądany prawie 21 000 razy (stan z kwietnnia 2008).

Prezentowane publikacje multimedialne do geometrii wykreślnej są wolnodostępne pod adresami   http://www.pg.gda.pl/architektura/ztw   (dostęp   wrzesień   2008)   lub http://www.wbss.pg.gda.pl