VISUALIZATION OF SPATIAL ISSUES IN ADOBE ACROBAT 3D PDF

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Abstract. The article presents the use of 3D PDF technology for visualization of selected spatial issues, which can be used in teaching materials, as well as during lectures of Descriptive Geometry. Currently, it became possible to view 3D models in a widely used, free Adobe Reader (from version XI). Spatial models can be constructed in various CAD and BIM programs and then exported as 3D PDF or U3D file using a separate toolkit utility. The article focuses on the technology of creation of 3D PDF models, the comparison of available programs considering the selection of functionality and the quality of the final results. The presented models were constructed in AutoCAD 2014 and then converted to 3D PDF files. The article concentrates on problems connected with preparation of the model in AutoCAD, predefined settings for viewing in 3D PDF file (Adobe Professional) and free viewing options by the user (Adobe Reader). The 3D PDF files can be inserted into the pre-existing PDF files thus they might significantly enrich the visual presentation. From this point of view, the described technology can improve the existing teaching materials without the need for total reconstruction. It seems that the described technology will quickly find wide application in engineering education.

Keywords: Descriptive Geometry, AutoCAD, 3D PDF, visualization

1 Models as important teaching aids for learning descriptive geometry

Teaching materials (teaching aids) are items that provide student specific sensory stimuli that shorten and diversify the learning process, create impressions and insights which allow to transmit more messages in shorter time [1]. In descriptive geometry the spatial issues are presented in various methods of projection, which are often difficult to understand for a beginner student. To enhance student`s spatial perception it is recommended to use physical models which can be viewed from all sides (Fig.1) [2, 3].
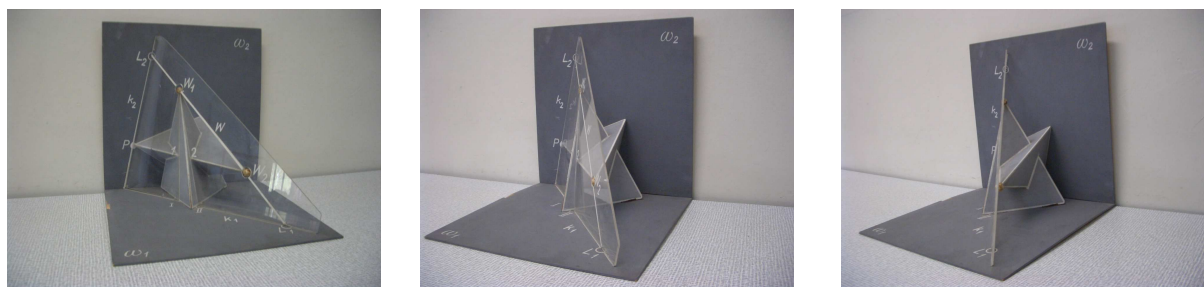

Figure 1: Physical models as teaching aids for descriptive geometry. They may be observed from different directions, they may be moved or rotated, what may help to construct the projections

From the author`s didactic experience it appears that the physical models are mostly useful to present the Monge`s projection at the early stage of geometric education. The physical models are instrumental in understanding various spatial issues, for instance:

determining visibility, application of additional planes in order to find a piercing point or an intersecting line. While observing the model, students may change the angle and direction of viewing, what helps them to notice spatial relationships between the elements as well as the projection processes.

Currently digital models created in CAD and BIM applications are gaining more and more significance, as they can be available online at any time and from any place, not only during classes. Virtual models may be viewed on screen in a strictly planned mode or freely. The first mode occurs during a „step by step" presentation of predefined views or during an animation, where the transition between the scenes takes place in a smooth manner. The viewer may only decide which stages of the presentation to repeat. Free manipulation of the model is available in the source file or in the appropriate browser (e.g. in AutoCAD and in a free browser Autodesk Design Review DWF). However, in this case the software should be installed on the recipient's computer.

Recently, it became possible to view 3D models in a widely used, free Adobe Reader (from version XI). The digital, geometric models are shared with students without a need to install any additional software. Students may manipulate the model on screen, what gives quite similar experience to the personal contact with the physical model.

2   Available software converting AutoCAD drawing into 3D PDF file

This article centers around the possibility to convert the 3D models prepared in AutoCAD 2014. The conversion of files into 3D PDF may be conducted in several ways. The easiest options of creating 3D PDF files are available in the commercial versions of AutoCAD Professional and Adobe Acrobat 3D – then no additional software is necessary. This case is not considered in the paper, as the author had no access to those programs. This article compares options of creation of 3D PDF files for programs available for the majority of academic teachers – meaning the educational version of AutoCAD and Adobe Acrobat Professional. In this case it is essential to have a separate toolkit for conversion. The available programs (listed in alphabetical order) were considered for the comparison:

A. Bentley View V8i [4],
B. PDF 3D ReportGen from Visual Technology Services Ltd. (trial version) [5],
C. ProgeCAD and export to PDF 3D (trial version) [6],
D. Tetra 4D applet - 3D PDF for AutoCAD (trial version) [7].

Table 1: Brief comparison of features of available software converting AutoCAD files into 3D PDF

	1. Bentley View V8i	2. PDF 3D	3. ProgeCAD	4. Tetra 4D applet 3D PDF for AutoCAD
Supports files	15 file formats	80 file formats	dwg, dxf file format	dwg
Printing time	Quick print	Very quick print	Takes time	Very quick print
Viewing	Very good viewing	Strong viewing, 3D objects and lines	Unstable viewing	Unstable viewing, Lines not visible some planes vanish
Model	3D objects and lines visible	3D objects and lines visible	Only 3D objects, no lines visible	Only 3D objects, no lines visible
Price	free	390 €	Free for educators under some conditions	200 €

Examples				
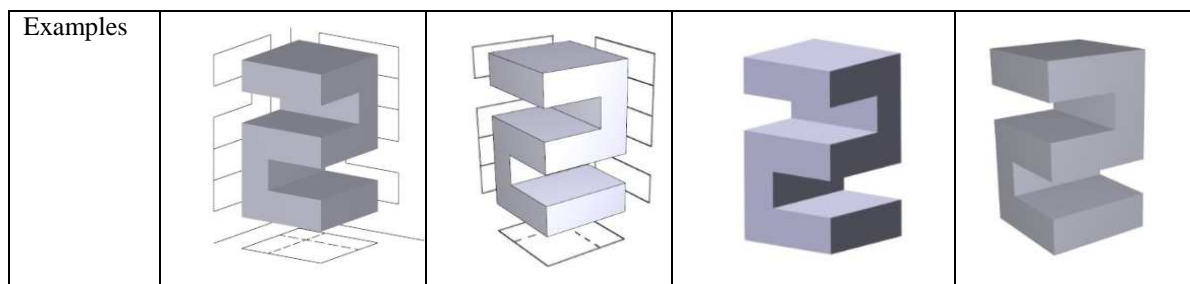
The easiest among the listed programs is Tetra 4D, the program creates 3D PDFs with one click. It is a plug-in, which after installing appears in the `Add-ins` toolbar. In all other cases it is necessary to open DWG file in the given program and convert it to a desired format.

The results were tested on only few examples, undoubtedly the best result was obtained using PDF 3D – the trial version by PDF 3D Visual Technology Services Ltd. Very good results were produced by Bentley View V8i, which allows to open MicroStation files and AutoCAD DWG/DXF files and enables to plot to a 3D PDF file. All the remaining programs do not read lines, only 3D objects, which is a certain inconvenience in case of descriptive geometry models. The differences in the process of creating 3D PDFs using all the programs are compared in Table 1.

3 Predefined settings for viewing 3D PDF models in Adobe Professional

In both Adobe Reader and in Adobe Professional the model can be visualized and manipulated in many ways, it can be rotated, moved, zoomed in. Moreover the rendering mode, lighting and the background color can also be changed. However only Adobe Professional program allows to define views by choosing model`s settings, by a group of visible and transparent elements, by lighting type (etc.). The list of views is available in a window of a model tree. The creation of consecutive views may reflect the successive stages of geometric construction. Similarly, all the layers, objects and comments are visible (Fig. 2).
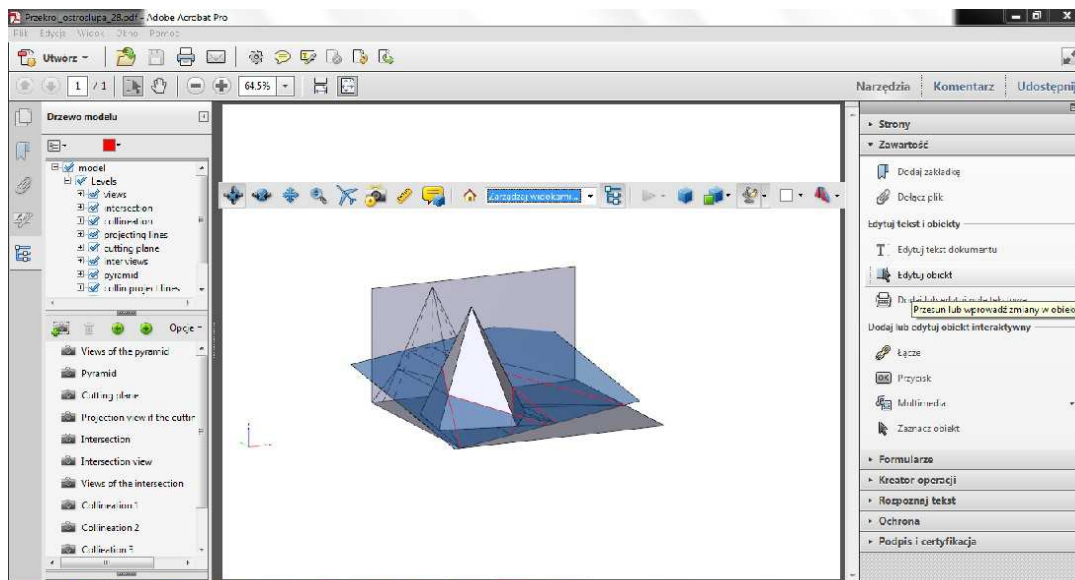

Figure 2: Defining the views in Adobe Professional, the list of views is located in the model tree. The sequences of the chosen views respond to the consecutive stages of geometric construction

As all the layers and elements are visible for the user in the model tree, the whole model should be carefully planned. The concept of the model should meet the didactic

objectives precisely. The final result can cover only the spatial model, the model and the views, the projecting planes, the projection process, the stages of solution, visibility. In the article descriptions and comments are not considered, still it is possible to enter them in 3D PDF file. Now the 3D content in a PDF file does not retain its non-geometric properties, so the file does lose part of information e.g. textures.

Moreover, only in Adobe Professional the 3D PDF files can be inserted into pre-existing PDF files thus enrich the visual presentation. From this point of view, the described technology can significantly improve the existing teaching materials (Fig.3).
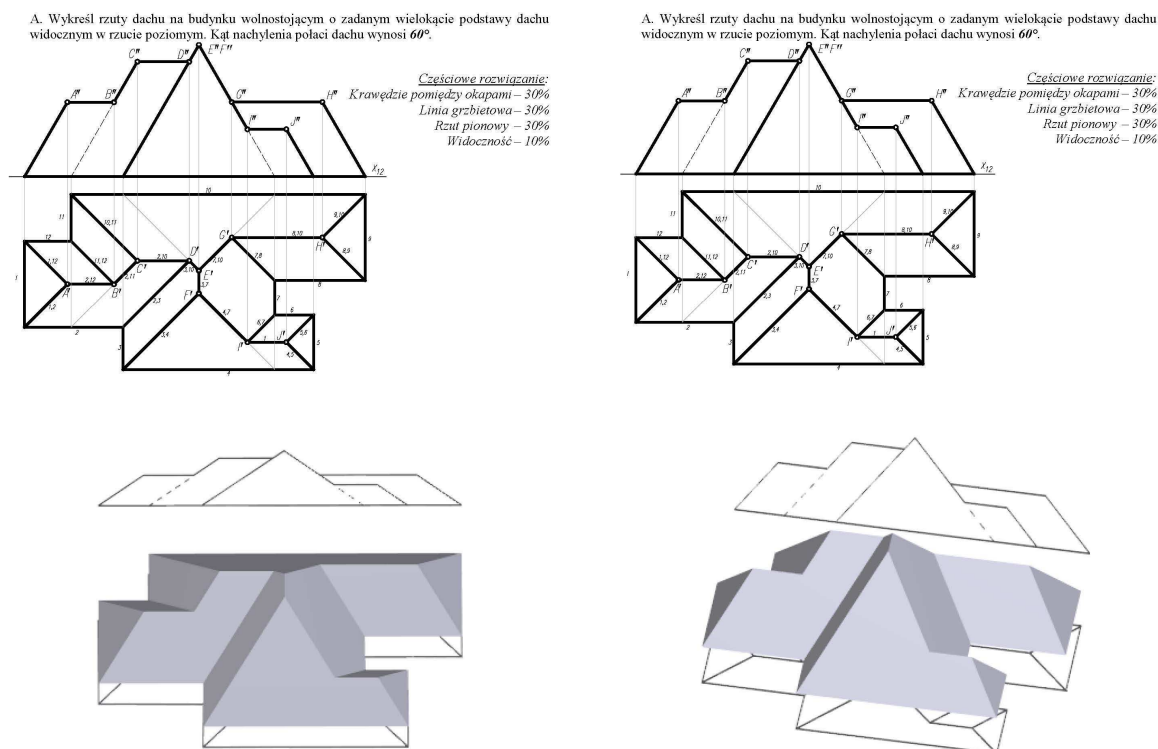

Figure 3: Updated teaching materials – the 3D PDF model of the roof was inserted into old PDF file presenting the Monge's projection

4   Viewing options of 3D PDF models in Adobe Reader

In the free version of the Adobe Reader the 3D PDF model can be viewed in many ways, but the geometry of the object cannot be changed and it also cannot be re-exported to the source software. The model can be visualized and manipulated in many ways, it can be rotated, moved, zoomed in. Also the rendering mode, lighting and the background color can be changed. The layers of original drawing and the elements of the model can be freely switched on and off, it is possible to add comments and create dynamic cross-sections or even to make measurements (Fig.4). The freedom in setting the model supports understanding of the geometrical problems and the projection processes.
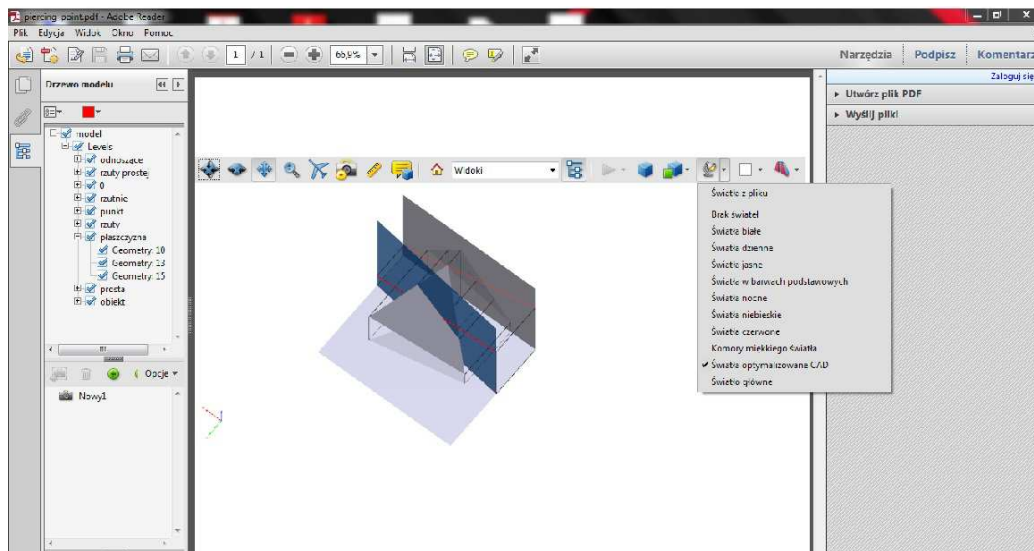
Figure 4: The 3D PDF model inserted into the pdf file – a student can freely manipulate the model by changing angle, direction of viewing as well as other parameters

5   Conclusions

The ability to capture and embed model information in a 3D PDF file and subsequently share it for free is highly needed in the education of descriptive geometry. The described technology and in particular inserting 3D models into the other files can improve the existing teaching materials. The strongest point of 3D PDF technology is that the model can be visualized and manipulated in multiple ways by viewers which enhance the spatial vision. The receiver sees not only the final result but also all the components used in its construction therefore the model should be planned in detail.

Now 3D PDF files can be obtained with various software products – free or commercial. Slight differences concern the time of creation the file, visibility of the lines and objects in a model. Judging from the multiplicity of the software available, the 3D PDF technology is currently needed to transmit visual information online. It seems that this technology is still in the stage of development, since textures and materials are not available yet. From the educator`s point of view the best option would be conversion of the model into 3D PDF directly from the educational version of AutoCAD and it is believed it will soon become possible.

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WIZUALIZACJA ZAGADNIEŃ PRZESTRZENNYCH W ADOBE ACROBAT 3D

W artykule przedstawiono wykorzystanie technologii 3D PDF do wizualizacji wybranych zagadnień przestrzennych, które mogą znaleźć zastosowanie zarówno w materiałach dydaktycznych, jak i podczas wykładów geometrii wykreślnej. Obecnie staje się możliwe przeglądanie trójwymiarowych modeli w szeroko stosowanej, darmowej przeglądarce Adobe Acrobat Reader (od wersji XI). Modele przestrzenne mogą być konstruowane w różnych programach CAD i BIM, a następnie eksportowane jako pliki 3D PDF lub U3D z użyciem dodatkowego oprogramowania. W artykule skupiono się na technologii tworzenia modeli 3D PDF, porównaniu programów do ich generowania ze względu na wybrane funkcjonalności oraz jakości efektów końcowych.

Prezentowane modele konstruowano w AutoCAD 2014, a następnie konwertowano do pliku 3D PDF. W centrum uwagi znalazły się zagadnienia związane z przygotowaniem modelu geometrycznego w programie AutoCAD, wyborem ustawień widoków przeglądania modelu 3D PDF w Adobe Professional oraz możliwością swobodnego przeglądania modelu przez odbiorcę w Adobe Reader.

Pliki 3D PDF mogą być wstawiane do istniejących już uprzednio plików PDF i w ten sposób wzbogacać istniejące wcześniej prezentacje wizualne. Z tego punktu widzenia przy pomocy opisanej technologii można w znaczący sposób wzbogacić istniejące już materiały dydaktyczne bez konieczności ich całkowitej przebudowy. Wydaje się więc, że opisana technologia szybko znajdzie duże zastosowanie w dydaktyce inżynierskiej.