Features of the design of animation graphics of educational multimedia edition on the discipline "Draft Geometry"

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Abstract. The article describes the theoretical foundations and practical methods of designing animation graphics for educational multimedia publications on the subject of descriptive geometry. The use of animated graphics as an effective means of visualizing volumetric-spatial models is considered. The effectiveness of the educational multimedia edition with elements of animated graphics in the educational process is investigated, a comparison is made with the traditional methods of teaching the discipline.

1. Introduction

The analysis of modern trends in teaching graphic disciplines in universities shows that there has been a qualitative shift towards the widespread use of computer visualization tools. In computer visualization tools, animation graphics occupies a special place, being, undoubtedly, the most effective means of demonstrating complex spatial models and visualizing information.

The article is based on the practical experience of the staff of the Department of Integrated Engineering and Computer Graphics of the Ufa State Petroleum Technical University, in the development of a multimedia publication using animated graphics, in the discipline “Descriptive geometry”.

The study guide designed and created by the authors is a multimedia edition consisting of a series of thematic visualization lectures totalling one hundred and ten minutes. In each lecture-visualization, the viewer (student) is accompanied by a character (virtual teacher of the course, actor). All course material is broadcast via high definition video. The visual image of the teacher, captured in advance, was transferred by video filming into the three-dimensional virtual space of the video scene, in which the animation graphics are the connecting link of all elements of the composition of the multimedia publisher. In such a kind of virtual classroom, the character plays a double role - a teacher and an operator, interacting with the graphic images of the multimedia edition, methodically consistently revealing the content of the course to the recipient (student).

The volume of video scenes in which animated computer graphics were used exceeded 80% of the total time. It takes many resources to create and produce such an impressive amount of animated graphics. Moreover, since this directly affects such basic consumer properties as the ergonomics of the visual environment, the quality of functionality and aesthetic properties, all these challenges could not be resolved without an integrated interdisciplinary design approach.
2. Materials and methods
One of the most effective methods of teaching graphic disciplines is lecture-visualization, which is most consistent with the specifics of teaching these disciplines [1]. In traditional lectures, various kinds of demonstration material are used: posters, layouts, separate illustrated images, volumetric models, each of which performs its tasks and functions [2]. It is necessary to take into account many formative, compositional and stylistic features of creating a dynamic (unfolded in time) composition of a multimedia publication for integrating of all this material in a completely different format, where motion and sound are added to the usual, static graphic form. Thus, the authors were faced with the task of finding optimal solutions in matters of content-functional, design and figurative-aesthetic plan. Figure 1 shows a fragment of a scene from a multimedia educational publication on the topic "Axonometric projections".

![Figure 1. Example scene from the course](image)

3. Analysis of the content and functions of animation graphics of educational multimedia edition
The solution to these tasks is based on the use of the following three main types of animation graphics, which differ in technical means of production, functional purpose, and visual and aesthetic characteristics:

1) **Volumetric 3D**, which belongs to the category of animated images, the graphics of which are realized mainly in 3-dimensional space. This type of animation graphics was the primary tool for creating dynamic compositions for educational multimedia publications. Thanks to the means of three-dimensional animation, basic tasks of demonstrating volume-spatial models were performed, as well as the rotation of objects in space, visualization of sections and intersections of objects (Fig. 2).

2) **Plane 2D**, which represents animated graphic, digital images that have only two values in the visual space of the scene – height and width. This type of animation graphics based on production technology is more reminiscent of traditional frame-by-frame animation. A characteristic difference from three-dimensional animation is linear animation of the graphic elements of the composition when the movement of the graphic element occurs in one plane. When developing an educational multimedia edition, this type of animation graphics was used mainly for creating navigation and indication elements (pointers, arrows, highlighting and highlighting the necessary elements of the composition). The primary function of such animation is navigation, due to which the viewer's attention is transferred from one graphic element to another.
3) Combined graphics, which combines visual, aesthetic and functional properties of both volumetric and flat two-dimensional animation, depending on the compositional tasks to be solved. In the video scene of the lecture-visualization, a comprehensive communicative complex of animated graphics is involved, illustrations, text, photographs, video and interactive interface elements are combined into a common plastic form and unfold in the dynamic composition of a multimedia edition (Fig. 3).

4. Design principles and algorithm for creating animation graphics
Since the effectiveness of mastering the educational material of an online course depends on the quality of the communicative properties of the designed multimedia edition, then for the designer of animation graphics, the successful choice of graphic means and the construction of a sound-visual composition of the frame becomes extremely important. The success of this choice is determined by an integrated design approach – from the concept stage to implementation.

Project life cycles: sketching – at this stage, ideas of the concept of animation graphics were formed and formulated, the pedagogical experience of teaching graphic disciplines using "lecture-visualization" was studied; Prototyping – preparing a test version of an animated graphic model. Figure 4 shows a prototype of the "Lecture-Visualization" model made using animated 3D graphics. At this stage, the technical visualization tools were worked out; the Cinema 4D software package was chosen as the most optimal solution, it combined the convenience of modelling three-dimensional graphics with the ability to integrate tools and animation and video editing.
Figure 4. Lecture-visualization animation model prototype

Testing was carried out in a real educational process; at this stage, an experiment was carried out with the introduction into the educational process of fragments of lectures-visualizations using animated graphics. The results of the testing were recognized as successful and were detailed by the authors in the materials of the previous article [3].

The production is a project cycle divided into three main phases. The pre-production stage consists in preparing a calendar plan for the implementation of the project, a scenario of interaction with a working group of specialists (designers, animators, operator, director, scriptwriters, authors) was described. At this stage, a complete storyboard was prepared, which is a sequence of graphic frames presented in the form of pictures describing the content of the scenes, indicating the volumes of animation graphics, the number of combined scenes (video with a person in the frame and animation) and scenes with full animation visualization (without a person in the frame). At this stage, estimates were also made for video production. Figure 5 shows a drawing of a portion of a storyboard sheet.

Figure 5. Fragment of project storyboard

The production stage is the second stage. At this stage, filming work was carried out; video footage was filmed, then a primary animatic was prepared, which is a sequence of video with a person in the frame and images of animation thumbnails. This made it possible to correct the timing (broadcast time), as well as to make corrections in the functional and aesthetic properties projected objects of animation graphics.

The post-production stage is the third stage. At this stage, work was carried out on computer animation tools; graphic source video files were processed using Motion tracking technologies (motion capture, the process of recording the movement of objects or people), the illusion of holography of animation graphics elements in the frame was created, as well as work on colour correction and creation of special effects in After effects software package.
5. Analysis of figurative and aesthetic properties

Since the primary expressive and pictorial means of building the composition was animation graphics, the authors paid much attention to the spatial-visual environment, in which the elements of the animation graphics were placed. For this, the parameters of the mise-en-scène construction were taken into account, combining the synthesis of direction, camera work and sound-visual effects [4]. In most of the scenes, the person (the course teacher) placed in the frame performed the functions of an operator, didactically guiding the viewer along with the internal elements of the scene, manipulating various graphic models in the virtual space of the stage. Pearson also performed the functions of an actor who introduced the necessary plastic accents into the composition of the frame. So, for example, for better contrast and readability of animation graphics elements, the structure of the frame's mise-en-scene was taken into account; colour and light, sound effects (noises) and musical accompaniment, word and movement. All these components were aimed at creating a harmonious visual and sound environment [5].

Colour and light were technically realized with the help of coloured soffit lighting, which was an important part of the composition; lighting schemes were selected in such a way as to give depth to space and to unite all the elements of the composition stylistically into a single harmonious connection. A backlight (key light) was used for the main cut-off picture. Modelling or fill light was used for softening the shadows created by the key light.

Sound is an essential part of dynamic composition, used for indicating various states. For example, to complete the construction of communication lines in a graphical plot, the technique of sound accompaniment was used, which noticeably increased the attention of students in the process of watching a lecture-visualization [6].

Word and movement is the integration of word and movement in the frame. The project actively used elements of kinetic typography (font animation) with the appropriate soundtrack. It should be noted that kinetic typography plays a vital role in animation design, combining a complex of communicative, artistic, and expressive means [7].

Stylistics of animation graphics. In this project, a synthesis of "line art" and "isometric" style was used, this combination allowed effectively combining the graphic aesthetics of drawings with volume-spatial forms of axonometric projections. These stylistic properties were also embodied in the visual packaging of the educational multimedia edition (design elements, splash screens, information windows, scene navigation elements, and font).

6. Results

In practical terms, thanks to the means of computer animation, the effect of realism were achieved. The effect of realism allows the teacher (operator) getting the opportunity to virtually move graphic objects in space, demonstrating their various properties.

In the synthesis of anthropomorphic, textual and graphic images of movement, animation graphics are the primary means of expression and a connecting link that unites all elements of the composition of an educational multimedia publication.

The following criteria for the quality of animated graphics were identified and achieved, affecting the speed of learning the material and visual ergonomics of the educational multimedia edition:

- Visibility – communicative properties when demonstrating volumetric-spatial models;
- Consistency – hierarchy of graphic elements of animated graphics that make up the overall compositional structure of an educational multimedia publication (3D animation, 2D animation, combined);
- Variability – the versatility of the use of animated graphic elements of the educational multimedia edition was taken into account for various areas of training (architects, designers, engineers);
- Aesthetic – the formation of a visual image of an online course with its unique style (splash screen, identity, packaging, font).
7. Conclusion
Visualization lectures with elements of animated graphics have a high degree of relevance and relevance at the present stage, as they are the optimal tool for distance work and online learning.

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