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Analysis on the Characteristics and Content Arrangement of Presentation Video for Mechanical Subject Competition Works

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Abstract: *Subject competitions are the touchstone for cultivating students' abilities, and they play an important role in the integration of expertise and innovation, as well as in innovation and entrepreneurship education. For discipline competitions with relatively high participation of students majoring in mechanical engineering, corresponding design explanations and action demonstrations are required for the participating products, so that the judges can quickly obtain information on the research background and significance, functional actions, technical principles, innovation points, and other aspects of the participating products. This article introduces the role of subject competition videos in subject competition projects. Taking the National 3D (three-dimensional) Digital Innovation Design Competition as an example, the production principles, main content, and content arrangement of high-quality participating videos are analyzed. It provides a reference ideas for the production of subject competition demonstration videos.*

Keywords: *Subject competitions, Competition videos, Product display*

1. Introduction

Subject competitions have the characteristics of comprehensiveness, practicality, and complexity. It provides a good platform for cultivating innovative thinking and practical abilities of college students. In recent years, subject competitions have been increasingly valued in the field of higher education, achieving deep integration with professional teaching in various universities [1, 2]. The number and frequency of competitions are gradually increasing, which also puts forward higher requirements for the quality of subject competition works. Students need to have stronger practical abilities, and guidance teachers should do a good job in quality control. Taking mechanical related discipline competitions as an example, in the process of product design, PPT usually plays an important role due to its advantages of simple operation and clear expression. However, on the other hand, PPT also has certain limitations. It cannot effectively display the 3D (three-dimensional) information of the product. Therefore, it can only be used to display the design ideas and development process of the equipment. More complex content such as the overall layout of the equipment, visual aesthetics, feasibility of the complete working process, assembly performance of mechanical structures, mechanical performance simulation calculations of important components, and mechanical processing performance of components require the use of 3D simulation animations and related videos to complete [3]. The 3D digital design of mechanical products has enormous advantages compared to 2D (two-dimensional) mechanical drawings, which can significantly reduce the design workload and facilitate the search for details. Simultaneously, it can also achieve virtual prototype functional demonstrations of designed mechanical products, which can make it more intuitive to check the correctness of mechanical product design and the effectiveness of functional implementation [4-6].

In addition, in recent years, subject competition works have gradually developed towards multi-dimensional disciplines and complex processes. The design difficulty has also been continuously increasing. In numerous mechanical related discipline competitions, traditional PPT based work display is far from meeting the requirements of work effect demonstration. It should be accompanied by video animations which is used to introduce the functional principles of the work. The 3D animation videos are the foundation of competition videos, which not only effectively reduce design difficulty and period in the design process of subject competition projects, verify the feasibility of the project, but also clearly present the functional principles of the works to the evaluation experts. Therefore, it is particularly

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important to conduct motion simulation and functional display of the competition works, which requires the production of relevant videos for the competition works. This paper takes the requirements for works in mechanical related discipline competitions as an example to illustrate the video production, which provides a production method for displaying videos in discipline competitions.

2. Basic Features of High Quality Competition Videos

Competition videos are actually a type of product display videos, and their production methods can also refer to the product display videos of enterprises. However, due to the fact that product display videos are usually aimed at consumers, display videos usually only include content such as product appearance and performance, while competition videos are aimed at works evaluation experts of subject competition. Taking mechanical related competitions, the National 3D Digital Innovation Design Competition, as examples, in addition to displaying the above content, it is also necessary to display the digital design process, design principles, assembly process, rendering effects, motion simulation, and application effects of the work. Therefore, it puts forward higher requirements for the production of competition videos. High quality competition videos should typically have the following basic characteristics.

2.1. Complete Story and Background

In order to achieve good display effects, both competition videos and product display videos need to have sufficient attractiveness to attract judges or audiences to immerse themselves. Therefore, their primary feature is to have a complete storyline. It is similar to a microfilm or a new product launch of a company, which must have a complete storyline. All content arrangements need to have strong purposefulness and directionality. On the other hand, the design and development of subject competition projects serve the purpose of product application in actual life, agriculture, industry, tourism, etc, and therefore must be carried out in conjunction with the actual environment. In terms of background, it is necessary to have a dynamic background that fully matches the actual application environment of the current project and a static device usage environment background. There should be a clear contrast between the background and the core content displayed.

2.2. High Definition and High Degree of Freedom

One of the main functions of competition videos is to visually and clearly display various details of the competition works. Therefore, video animations must have the characteristics of high clarity, excellent image quality, and high simulation. The clarity, pixels, and image quality of the video must meet the display and aesthetic requirements. If there is a physical prototype display, it is more important to fully display the operational effect of the physical object in high-definition. In addition, in order to provide a comprehensive explanation of product features, it is also necessary to use lens language to create videos from multiple perspectives. So that it can achieve free switching between multiple angles of view, distant and close shots, picture in picture, and slow footage of the video.

2.3. Comprehensive Application of Digital Technology

In recent years, with the deep integration of subject competitions and professional teaching, the design of competition projects has gradually shifted towards interdisciplinary intersection. Therefore, in order to clearly display the working principles and application effects of the competition work, competition videos also need to pursue the comprehensive application of multiple technologies such as motion simulation technology, image rendering technology, finite element analysis, virtual machining, virtual assembly, virtual debugging, etc. In addition, it is also necessary to provide real-time feedback on the corresponding motion data involved each action through screen splitting, picture in picture, and other effects at each analysis stage. They should be expressed in a curve graphical manner.

3. Main Content Arrangement of Competition Videos

The specific content of subject competition videos varies depending on the complexity of the project. Generally, competition projects can be classified into complex and simple project videos based on the number of process actions, work positions, and equipment involved.

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3.1. Video Content Arrangement for Complex Projects

A complex project refers to a production line composed of multiple workstations and equipment with multiple process actions and complex structures. These videos should include the following aspects in the order of playback.

(1) Opening part of the video

The purpose of the opening credits is to provide information on the competitions, project titles, production teams, and more. It is advisable to use a dynamic background that matches the completed content of the project. It can be produced by referring to some company's product display videos or various movie opening special effects. The information should be clearly displayed in the middle of the screen from far to near, and the time should be controlled at around 10 seconds.

(2) Overall layout display of virtual prototype

Here, a static rendered high-definition image should be displayed, using a dynamic background similar to the beginning of the video (should use the same set of dynamic backgrounds throughout the entire video to ensure a consistent style). It is applied special effects from far to near to display the high-definition rendered image. Firstly, the overall situation of the production line should be displayed from multiple perspectives. And then it should point out the various subsystems of the production line, respectively. Finally, the components will be displayed in sequence. A text to explain the image name should be added below each rendered image. The display time of the video for this section should be controlled at around 20 seconds. In addition, in this process, it should be noted that the decomposition of the production line should be reasonable and hierarchical. The production line should be decomposed into components with independent functions. Meanwhile, due to the large number of parts, there is no need to display individual parts separately.

(3) Workflow display of virtual prototype

This section is the focus of the entire presentation video, where motion simulation will be used to smoothly express the complete working process of the production line from beginning to end. It is appropriate to set a static and not dynamic background here due to the emphasis on showcasing the motion process of the device. The virtual three-dimensional background of the factory building under the actual working conditions of the production line should be used for the video in this section. The video of this stage should display the motion simulation of the complete production process. It should start from the loading position of the processing object (semi-finished product), and pass through multiple intermediate stations in sequence, until all processing actions are completed.

Due to the large length of the entire production line, it is necessary to take into account the details of individual work position, so the footage should switch between near and far range in a reasonable manner.

For example, when displaying the loading system, it is necessary to bring the camera's perspective closer to display the full view of the loading system, and then display the complete feeding process of the processing object. When making videos, it should be noted that if the mechanism action is too complex, a disassembly and assembly animation of a single system can be added here to fully introduce the structure composition. If the material (Machined parts) enters the equipment and is not visible from the outside, the outer shell parts of the equipment need be transparently visualized, and the internal movement process should be seen through perspective. If the device moves too fast, slow footage display should be used. In addition, it is necessary to add some parameter information such as the quantity of materials added to the storage bin at once, the specification information of the processed object's semi-finished product, and the speed information of the feeding process in the form of a floating frame scrolling display.

For another example, when displaying the main processing work positions such as the work position for the extrusion deformation of the mold, the work position for the cutting processing of the tool, and the work position for the main packaging, as these are the significant working positions of the equipment, it is necessary to focus on expressing the change process of the processing object under the action of the mold or tool. When making videos, it should be noted that if there is a significant force during the machining process, a finite element analysis of the working process can be added here to analyze the force on the cutting tool and mold. When simulating the machining process, particle effects should be added to simulate the process of cutting chips falling. The information such as cutting tools, rotational speed, feed speed, and cutting depth during the machining process needs to be displayed in digital form. If it is only a mechanism for action execution, it is necessary to specify the type of selected components,

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motor type, moving distance, motion speed, etc. In addition, when simulating the curves of mechanism kinematics and dynamics, it is necessary to simulate the real-time motion curves of process actions such as displacement, velocity, acceleration, and changes in load (force and torque).

(4) Workflow display of physical prototype

For the aspect, if a physical prototype has been completed, the physical experiment videos, images, data, and processing results can be displayed. This section can also be inserted into the third part. The content will form a "virtual reality" comparison with the motion process of the virtual prototype, emphasizing the rationality of motion simulation.

(5) Behind the scenes footage on the development of digital prototype

The screenshots and screen recordings in the entire research and development process will be required for the contents in this part. The contents mainly includes the use of 3D modeling software, the modeling process of complex structural parts, the assembly process of 3D equipment, the motion simulation process of the equipment, the finite element analysis process of important components, the virtual simulation processing process of important components, the editing process of overall videos and the production of PPT, and team communication and teacher-student communication throughout the entire process. In addition, according to the division of labor in the team, the names of personnel who complete the work should be annotated in text, similar to the ending of a movie screening.

3.2. Video Content Arrangement for Simple Projects

A simple project refers to a production line with a few process actions, relatively simple structure, and a single automatic machine. Due to the relatively small number of components in this type of project, it is necessary to conduct separate simulation and force analysis on the assembly process and key components of the virtual prototype. Therefore, after completing the workflow display of virtual prototype, it is necessary to add three steps of assembly simulation of virtual prototype, force analysis on key components in virtual prototype, and processing simulation on key components in virtual prototype. The remaining steps are basically consistent with complex projects. The following will focus on analyzing the content arrangement of the three links.

(1) Assembly simulation of virtual prototype

The purpose of assembly simulation is to verify the rationality of equipment assembly process. Due to the compact structure of the equipment and the limited number of components, the assembly process can be fully displayed. The integral equipment for competition work should be assembled entirely based on the principle of "bottom-up, inside-out" and the actual assembly relationship. The background should be static and similar in style to the dynamic background style at the beginning of the video.

(2) Force analysis on key components in virtual prototype

It is necessary to verify the rationality of the structural design of the components by using finite element analysis method. In this stage, the strength, stiffness (deformation) changes of a complex component under various different stress conditions (force magnitude, direction changes) should be analyzed. The analyses should be displayed in animated form instead of a single analysis image. The background should be a static background similar to the dynamic background style at the beginning of the video, with an appropriate duration of 10-20 seconds.

(3) Processing simulation on key components in virtual prototype

The purpose of this link is to verify the machinability and the processing technology of designed components by simulation processing. The machining processes of complex components from rough to finished products will be demonstrated by using numerical control simulation machining methods. The focus here is on the trajectory planning of the machining tool, with a suitable duration of around 20 seconds.

In short, there is relatively little content that can be displayed on a single device. The video for a single device needs to highlight the proficient and reasonable application of various 3D digital methods.

4. Conclusion

The videos of subject competition can present the design principle, working process and other contents of the competition works in the form of a story by using clear camera language. The expression

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and explanation of the competition project in the shortest time can be completed by the videos, which should be paid attention to in the competition for students who participate in competition. The basic characteristics of mechanical product display videos should be followed in the videos of subject competition. The contents in the video should be arranged reasonably from front to back in accordance with the basic process. The integrity of the display videos and the difference between the contents of the complex projects and the simple projects should be ensured and considered, so as to improve the display efficiency and effect as much as possible.

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References

[1] Niu, H. L., Fan J. L. and Yan H. P. Research on the Integration of Subject Competition and Professional Course Teaching Mode Based on OBE Concept. Frontiers in Educational Research, (2022) 5(16), 21-25.

[2] Li Y. L., Zhang D. Q., Man D. H., Du D. M. and Luo H. M. Reform and practice of the integration of discipline competition and basic course teaching of mechanical design-taking Jiujiang University as an example. Southern Agricultural Machinery, (2022) 53(16), 171-174.

[3] Wang Q. Design of 3D Animation Special Effects in Animation 3D Modeling Teaching Based on QFD Theory. International Journal of Emerging Technologies in Learning (iJET), (2017) 12(07), 90-90.

[4] Suteewan K. O. and Suwich T. The Efficiency of Simulation Animation on a Science Lesson: A Case study of a Lesson on Digestive System. International Journal of Computer and Communication Engineering, (2012) 1(4), 458-461.

[5] Gao X. R. 3D Animation Technologies and Efficiency. Applied Mechanics and Materials, (2013) 2728 (421-421), 681-684.

[6] Tarshizi E., Sturgul J., Ibarra V. and Taylor D. Simulation and animation model to boost mining efficiency and enviro-friendly in multi-pit operations. International Journal of Mining Science and Technology, (2015) 25(4), 671-674.