THE FEASIBILITY OF APPLYING COMPUTER-AIDED DESIGN IN COMPETITIVE SPORTS EXERCISES

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The purpose of this study is to determine the feasibility of applying the principles of Computer-Aided- Design to research into human movement. It could be of considerable importance to future research in biomechanics to combine the technology of Computer-Aided Design (CAD) and computer image processing with the imaginative power, creativity and experience of instructors, athletes and sports science researchers. It is also critical to design fast and efficient competition exercises and to replace the traditional ways of design with advanced science and technology. This paper will introduce the design principle, the characteristics, as well as the structure of the system, the working environment, the technology of application and effect analysis.

KEY WORDS: Computer-Aided Design, 3-D molding, image processing system, interactive mode

INTRODUCTON: Computer-Aided Design (CAD) was first used at the end of the 1970's. This technique combines the computer's rapid and precise analysis of large amounts of data and its ability to study graphs with the designer's imagination, creativity and experience. CAD has been widely used to replace hand design in many industries for its economy, reliability, precision and high efficiency. If CAD can be applied to the design of competitive exercise, it will be a significant technological renovation and solution to the problem of replacing the traditional hand design with advanced modern science and technology.

METHODS: For this experiment, a CAD system is to be built which will combine the technology of computer-aided design and the technology of computer's processing graphs and pictures with the judgement and experience of coaches and researchers in the design of technological exercise. The images of competitive exercise are created by means of an interactive system between man and computer.

The hardware environment has been classified into two types, microcomputers and working stations, according to the types of the main computer. The preferable micro computers should be those superior to pIII450, internal storage 64M, hard copy 4.3G, that are equipped with a high-resolving power indicator, image accelerating card, 32X CD driver, pressure-solving card and an acoustic sound card. Its input system includes a scanner, a digital image-inputting board, a camera, a touch screen, a light pen and a mouse. The output system includes a printer and a mapper. If the main computer is a working station, a SGI picture working station which has a sun-vicom picture processing system would be preferable. A SGI working station and a sun-vicom picture processing system provide the main body of the picture imitating system for sports and can provide all the necessary services.

3D Studio (American Auto Desk Company) has been chosen to design the software. This type of computer software is simple to operate and therefore requires no special professional knowledge. It consists of five functional modules. The flow chart is outlined in Figure 1.

The flow chart includes: The drawing of a plane graph with 2D shaper; The drawing of a three-dimensional picture of the exercise with 3D lofter; Design of a background (for example, the ground, apparatus, equipment, etc) with 3D Editor; Processing of the effect at Material Editor; Editing of the key frame frequency pictures of key points of exercise with the key framer. After the first step, the system can automatically generate the linking and transitional movements, providing the picture with motion, rotation, rolling and variation. Some special movements can be obtained by redeveloping the software.

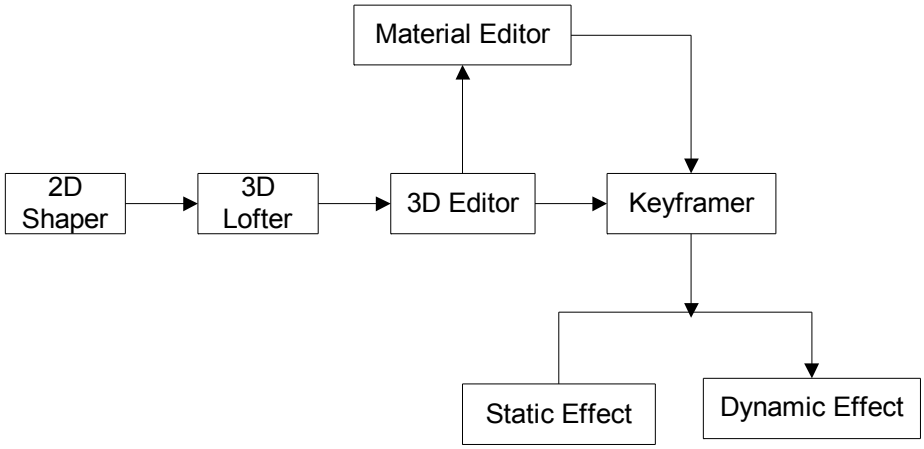

Figure 1 - The flow chart of 3D studio.

The computer image processing uses PhotoImpactse 3.0, which is image processing software in simplified Chinese that is designed for a microter scanner. PhotoImpactse has two programs: one is used for scanning, editing, lifting and adding special effect to images of human movements; the other is used for classification, skimming, management and switching of functions. The retrieval function provides each movement with 99 regretting chances before it is stored. If a SGI working station is chosen as the main body, the corresponding software should be SOFTMAGE 3D, which is compatible as a superior software system in creating three-dimensional movement. SOFTMAGE 3D makes use of multimedia technology, modeling and variation technology of movement, and simulating technology of dynamics. The computer-aided design system for competitive exercise is made up of a SOFTMAGE 3D (Figure 2), a SGI working station and a sun-vicom image processing system. This combination can satisfy all the requirements in regard to the speed of analyzing and processing of the pictures, the technological exercise and the effect of the designed exercise.

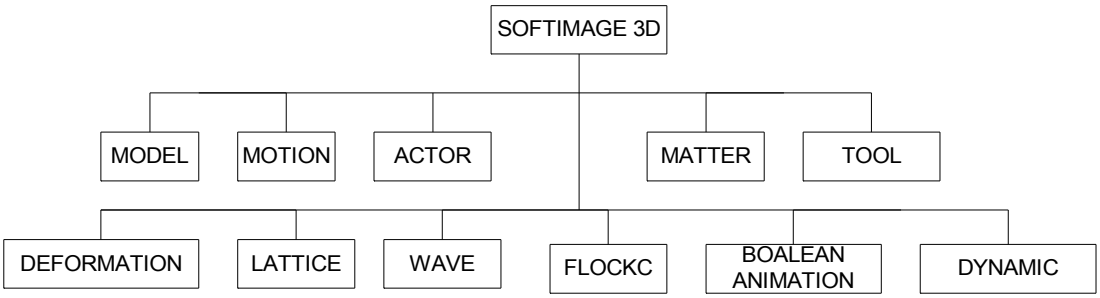

Figure 2 - The functional modules of SOFTIMAGE 3D.

Modeling the human body should be carried out according to sex, stature and weight. The modeling can produce a geometrical model of the human body. A two-dimensional graph only contains a horizontal axis and a vertical axis. However, sports exercises are completed in a specific space. So a space depth axis is needed to formulate three-dimensional motion. The designed exercise models can be divided into two kinds: interactive models and programming models. The former models are natural working patterns. Input from data and graphs are recorded by using the keyboard, light pen and touch screen to generate the software to finish the modeling. The effect of the picture can be observed on the screen. As for programming models, the programmer makes programs to generate joints of the modeling document to achieve the model. This technique can be applied to the kind of

modeling with which the interface can not cope.
In order to describe the dynamic position of exercise in space, it is necessary to set the path of movement first, then proceed to deal with dynamic design, and finally set the locus of the human gravity center. Some key points control the locus. For example, the variation of the body in the path of movement is determined by the time when it reaches each key point at which the speed, rotary angle and duration of time are prescribed and the key frames are edited. The movement of the human body is carried out through each joint. The description of the movement of the joint is in three stages: The drawing of the exact central axis of each skeleton, determining its length and the confines of the movement of a joint. Modeling the outline of the muscles adhered to each skeleton in precise proportion. Description of the movement of the joints and the building of a functional bank of classified standard movements that can be easily combined.
The film of technological exercise of experienced players, which are entered through the input system, are stored and managed in the graph bank for the designer's reference. These pictures are first sent to the picture processing system for dynamic analysis, and then stored in the graph bank together with the information from analyzing data and characteristics. When they are presented, these images can be designed and easily combined on the screen. If there is no picture processing system, a video frequency card can be placed into the computer by using multimedia technology to transform video frequency signals into digital signals to be stored in the computer. The images can be displayed by using a color printer, mapper or hard copy machine. They can also be produced onto videotapes to be used in different places by means of picture transmission after appropriate terminals are inserted. As for other technological exercise carriers such as film and CD, images are entered in the same way as they are recorded.
A light pen and a touch screen are used in addition to the keyboard and mouse so that the system can be easily operated. This new interactive technique makes man-machine dialogue simpler and more visual and strengthens the interface affinity. The operation is flexible and convenient and provides the user with a graphic image.
The SGI graph working station of the system is equipped with a series of multi-medium databanks like the video frequency bank, voice frequency bank, graph and picture bank, etc. It can be used in developing multi-medium applied software. The pictures of exercise are multi-unit data information including characters graphs and pictures. Therefore the graph bank of SGI is particularly suited for storing and managing exercise pictures. The core of the bank is a three-dimensional graph bank, which consists of a Graph Back IRISGL and a Graph Bank Open GL. These data banks enable the users to create three-dimensional models, clearly express the notion of three dimensions and change them into vivid high-resolving pictures with many properties. GL has many high graphic functions such as many multicolored partial light resources and the generation of model-curved surface and vein casting. The language description of open Gl has a strong function and excellent transferability. GL and Open Gl graph banks combined with the multi-medium bank can provide means of producing pictures, graphs and voice frequency. These systems fall into the category of applied software.

CONCLUSION: The functions of the system directly depend on the functions of its software such as the picture generation software and the specifications, qualities of analyzing and simulation applied software. For that reason, only the highest quality software should be chosen.
The use of CAD and picture processing technology to design competitive exercise is not only feasible but an essential tool for the future. The current real-sense technology employed in designing software focuses on scanning algorithm that is quick in calculation, but not ideal in its sense of reality. The other techniques used for the same effect are light-tracing method and the radiation method, which are true to life but are now impractical.
Limited by the functions of the present software, the current design of competitive exercise is not sufficiently realistic. Conversely, the present technique can not automatically generate all the new technological exercises that will incorporate the full range of the designer's plans

and imagination.
The images of exercises designed by computers are usually inferior to those designed by working stations in terms of quality and sense of reality, but the latter are operated at a considerably higher cost.
From the angle of originality, the designer's creativity gives full play to the functions of the present system. With the constant development of computer science and other relevant disciplines, and the development and application of the software, the system will gradually evolve into a proficient design system.

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