A Multimedia CD of Mechanical Devices

Shih-Liang (Sid) Wang
Department of Mechanical Engineering, North Carolina A&T *State* University, Greensboro, NC 27411, USA, Tel (336)334-7620, *Fax (336)334-7417, wang@ncat.edu*

Abstract: Visualizing mechanisms in motion is an important aspect of an engineer's design ability and is also one of more challenging aspects to many engineering students. Students today generally have less experience with machinery, mechanisms, and "tinkering" than engineering students of the past, making it more difficult for students to visualize the motion of mechanisms. On the other hand, students today are comfortable and familiar with interactive software. So using modern software for motion visualization both fills a need for the students and generally suits their background and learning styles.

Most textbooks and classroom teaching are intuitive, verbal, deductive, and sequential, and this environment cannot meet the needs of some students who are sensing, visual, inductive, active, and global learners. A multimedia CD presents a learning environment to reach this group of students based on an easy to use, powerful, and robust software Working Model 2DTM (referred as WM2D) which allows a user to play "what-if" scenarios – important for active learners.

Over two hundred WM2D simulation files of mechanical devices form the kernel of this reference CD. These simulation files cover a wide range of mechanical devices including linkages, gears, cams, tools, machinery, construction equipment, farm machines, and furniture. Sources of these devices are from textbooks, reference books, catalogues, service manuals, U.S. patent documents and technical papers. To organize these simulation files in an easy-to-use manner, a web browser is used to navigate hyper-linked HTML files containing text, picture, photo, video, Matlab and WM2D files.

This CD can supplement textbooks in kinematics, machine design, and introduction to engineering. The CD can also assist students as well as practicing engineers to review existing designs and to stimulate new design ideas.

Keywords: multimedia, courseware, case study.

1. Introduction

Visualizing mechanisms in motion is an important aspect of an engineer's design ability and is also one of more challenging aspects to many engineering students. Students today generally have less experience with machinery, mechanisms, and "tinkering" than engineering students of the past, making it more difficult for students today to visualize the motion of mechanisms. On the other hand, students today are comfortable and familiar with interactive software. So using modern software for motion visualization both fills a need for the students and generally suits their background and learning styles.

Most textbooks and classroom teaching are intuitive, verbal, deductive, and sequential, and this environment cannot meet the needs of some students who are sensing, visual, inductive, active, and global learners. This CD presents a learning environment to reach this group of students based on an easy to use, powerful, and robust software WM2D [1] which allows a user to play "what-if" scenarios -- important for active learners.

Few of the software packages currently available for mechanism animation and analysis promote an active learning environment [2]. Most animation packages for PC's have limited graphics capability and so use sticks (line segments) to model links, a representation that is too abstract for some mechanisms. For example, each part of the compound snips in Fig. 1 is difficult to visualize as a stick.

2. Reference CD

A collection of over two hundred WM2D simulation files of mechanical device forms the kernel of a reference CD. These simulation files cover a wide range of mechanical devices including linkages, gears, cams, tools, machinery, construction equipment, farm machines, and furniture. Sources of these devices are from textbooks, reference books, catalogues, service manuals, U.S. patent documents and technical papers.

Motion of multi-loop mechanisms is difficult to visualize. Figures 1 to 6 show two different positions of each multi-loop mechanism. For every mechanism in this CD, it has a WM2D file, video file, and picture file. In many cases, it also has a photo file to show the real mechanism, and a text file for the introduction of the mechanism, suggestion for "what-if" scenarios in WM2D files, and other relevant information.

To organize these files in an easy-to-use manner, Microsoft Internet Explorer, an internet browser, is used to navigate hyper-linked HTML files containing text, picture, video, and WM2D files. With the clicking on a button, the browser can move back and forward between linked documents. It can also search document, ideal for reference.

Video files are generated from WM2D in the format of Microsoft's Video for Windows, and these files can be played independent of WM2D. Video files can be played with a click on the "play" button, or played one frame at a time for detail observation with another button. Alternatively, they can be played by dragging the scroll bar for slow motion. Picture files are generated from screen copies of WM2D files to provide a quick snapshot of the mechanism. Text files are used for introduction of the mechanism, suggestion for possible "what-if" scenarios in WM2D files, and other relevant information.

A typical HTML file is illustrated in Figure 7 showing the mechanism of a Watt's engine. A video file is hyper-linked with picture file. With the click on the picture, the associated video file is activated to play. Clicking on WM2D button will activate the WM2D file

3. Utilization of the CD

Multimedia courseware is important to today's college students who grew up with MTV and video games. The reference CD can supplement textbooks in kinematics, machine design, and introduction to engineering to animate mechanisms referred in these books.

First, this CD can supplement kinematics textbooks [3,4]. This CD, which provides hundreds of animated mechanisms, should help students understand better benefit users of all textbooks, which can only accommodate limited number of mechanisms.

Secondly, this CD can supplement machine design textbooks. As the engineering curriculum is revised to accommodate new technology and development, the kinematics course is coming to be viewed as a supplement to, rather than an essential component of, the mechanical engineering's undergraduate education. Consequently in some schools, kinematics, once a required course, is now elective. Since mechanism design is still an important component in mechanical design, this CD serves as a useful supplement to fill this knowledge gap for machine design textbooks when kinematics is an elective.

Lastly, this CD can supplement introduction to engineering textbook. Many introductory courses now have a component of design projects. This CD is an ideal resource to stimulate design ideas.

Many evolving design oriented courses, including capstone designs, lack good textbooks. Since each course in a different curriculum has different emphasis, it is difficult to have one book meeting all needs. This CD can be a good resource for design projects to review existing designs and stimulate new design ideas. In this capacity, this CD can help practicing engineers. Moreover, it can assist the general public (including students in K-12) with a curious mind as an animated "how things work" reference.

The CD is self-guided and self-paced for students to visualize and explore– good for visual and active learners, and an ideal medium for self-directed learning. The CD can also supplement courseware for distance learning in an asynchronous environment. This mode of education can benefit students in remote or inaccessible places and is gaining importance in higher education which students are freed from the constraints of place and time.

4. Discussion

WM2D animation is different from those made by CAD software like ProEngineer, I-DEAS, or AutoCAD, for the former is physics-based simulation. WM2D animation files are sometimes more challenging to produce, but are physically correct and are more meaningful to users.

The simulation files developed so far are restricted to planar mechanisms. Working Model 3D, now a part of visualNastran 4D [5], will be used later to develop additional files of spatial mechanisms incorporating helical, bevel, and worm gears.

5. References

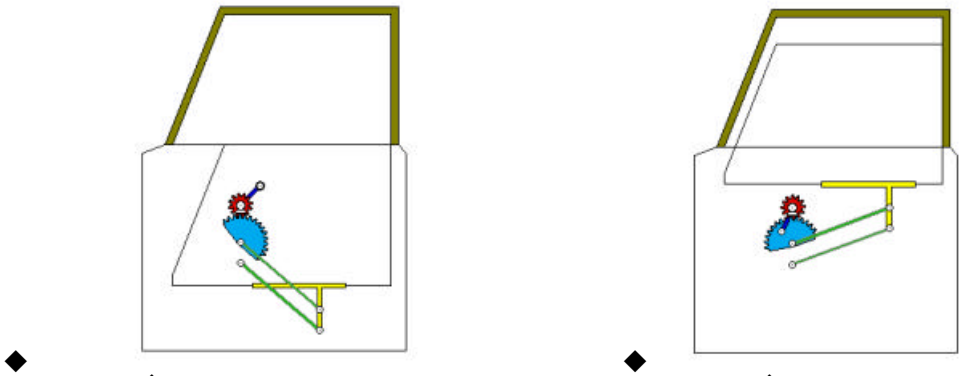
[1]. Working Model User's Manual, Knowledge Revolution, San Mateo, CA, 1996.

[2]. Felder and Silverman "How Students Learn: Adapting Teaching Styles to Learning Styles," Proceedings of ASEE/IEEE Frontiers in Education Conference, Santa Barbara, CA., p. 489, 1988.

[3]. Norton, R., Design of Machinery, 2nd ed., New Media Version, McGraw-Hill, 2001.

[4]. Wang, S-L., Mechanism Simulation in a Multimedia Environment, as a supplement to Design of Machinery, 2nd ed., New Media Version, by Norton, R., McGraw-Hill, 2001.

[5]. MSC Software, http://www.krev.com, 2000.

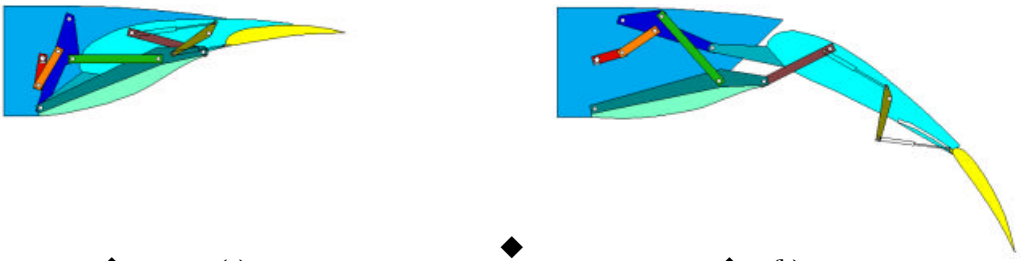


(a) (b)

Figure 1 Car Window

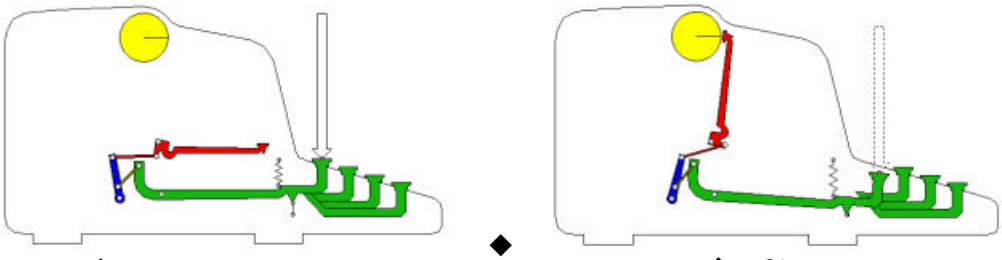
(a) (b)

Figure 2 Wing Flaps



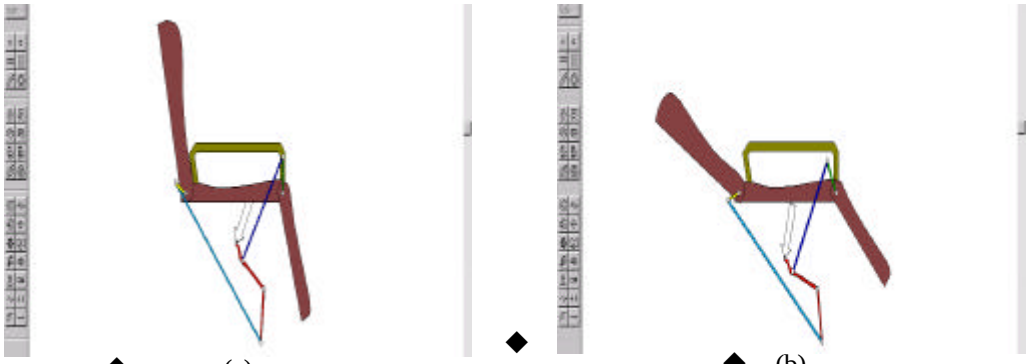
(a) (b)

Figure 6 Airfoil3



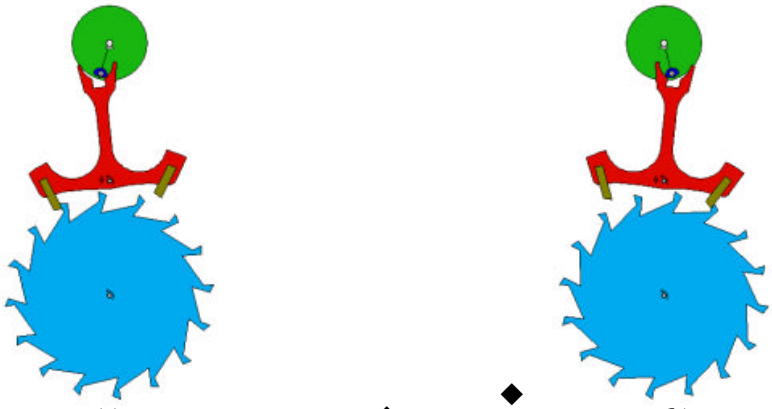
(a) (b)

Figure 4 Typewriter



(a) (b)

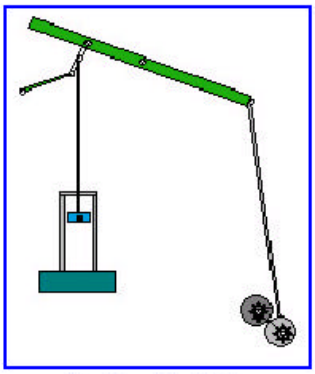
Figure 5 Reclining Chair



(a) (b)

Figure 6 Escapement

Watt's Engine



Working Model file

Watt's linkage—a straight line mechanism.

Click here for Watt's linkage.

In 1784, James Watt designed this engine to produce power directly on a shaft. The double acting cylinder has a bore diameter of 19 inches with a 4 ft stroke.

Figure 7 A Typical HTML file of Animated Mechanisms