Application of simulation in theory of machines and mechanisms for excellent engineering training

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ABSTRACT: The engineering training plan proposed by the Ministry of Education is a major movement in the reform of engineering education in China. To cultivate high quality engineering professionals in mechanics, teaching of mechanical foundation courses must be reformed. In particular, the reform of the theory of machines and mechanisms is imperative. According to the abstract characteristics of the theory of machines and mechanisms, closely centring on the main policy of improving students' comprehensive abilities, the assembly of mechanisms and simulation of motions can be established through computer software. In this way, structures of mechanisms can be expressed visually, movements of mechanisms can be displayed intuitively, and analysis of results shown by animations, graphics, tables and other forms. At the same time, the contents of practice teaching are increased to cultivate students' practical abilities. What is more, engineering examples are expounded during the process of teaching to improve the teaching level of theory of machines and mechanisms, so that the excellent engineers training plan can be implemented better.

INTRODUCTION

Excellent engineers geared to the future needs of industry are facing the world of engineering education on the basis of knowledge with a focus on the ability provided by training. Engineering technology is the main focus, and it aims to allow students to develop a solid theoretical foundation, practical ability, high comprehensive quality, and for them to grasp mechanical electronic engineering applications. The characteristics of Heze University emphasise four areas for strengthening.

- Strengthening the training of students' comprehensive quality and engineering ability. Through training mode reform, optimising the training plan, strengthening the humanities education and students' cultural accomplishment to cultivate moral, able, and all-round developed and highly talented engineers will be possible. Focusing on improving the students' employability, their engineering practice ability and their innovative consciousness can be achieved in this way [1].

- Strengthening the control and the application of student of interdisciplinary knowledge and high technology [2]. Through construction of the Heze University Engineering Centre, high level modern mechanical and electrical engineering innovation and practice base, optimising the training plan and course system, reforming teaching content and teaching method, promoting the interactive disciplines, teaching and scientific research, will strengthen the students' high and new technology, and interdisciplinary knowledge.

- Strengthening the construction of a high quality engineering teaching staff. This can be achieved by bringing in staff with business experience and senior engineering and technical personnel into the classroom as full- or part-time teachers [3]. There are plans to send teachers and young teachers to acquire in-depth business credentials or part-time training, building a high quality engineering teaching staff, so they can provide better engineering education.

- To strengthen the internal and external interaction, promoting the exchanges and cooperation. Taking part in domestic colleges and universities to implement an excellent engineers' training plan to exchange ideas and discussion activities, to sum up experiences, improve the quality of school management and expanding industry influence. Links can be improved by regularly inviting famous university teachers from home and abroad and enterprise senior management personnel and technical staff to college to give lectures; by constructing and implementing bilingual courses, raising the standard of students' English by establishing an overseas practice base, and encouraging students to participate in college student exchange programmes overseas.

EMBODIMENT OF SIMULATION IN THE TECHING OF THEORY OF MACHINES AND MECHANISMS FOR EXCELLENT ENGINEERS

In basic engineering courses, the teaching process is important as projects will be used as a carrier to pull teaching along, as shown in Figure 1. Students' interest in learning, researching and practicing in the field by increasing gradually and systematically their engineering practice ability, innovation ability and scientific research ability, also shown in Figure 1.

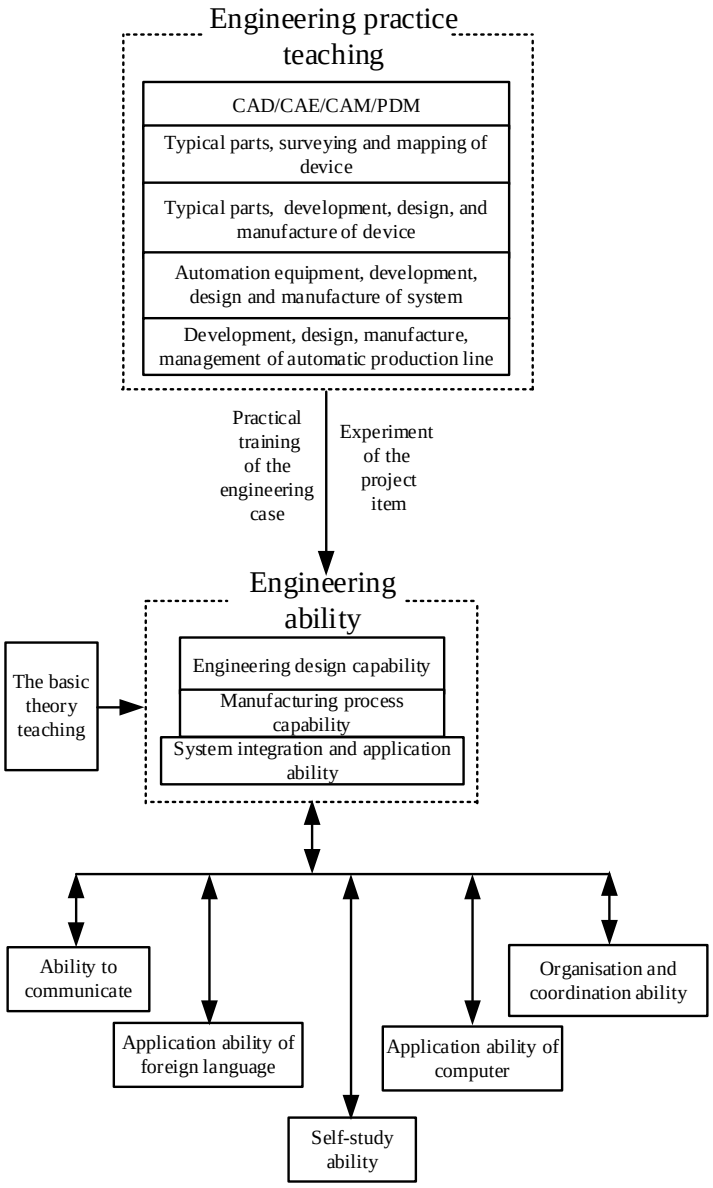


Figure 1: The process of driving teaching taking a project as a career task.

THE SYSTEM OF TEACHING THEORY OF MACHINES AND MECHANISMS BASED ON THE EXCELLENT ENGINEERS TRAINING PLAN

To cultivate the innovation ability and practical ability of science and technology in students is the core of education. This will cultivate an outstanding engineers' plan goal, combining with theory of machines and mechanisms. Heze University mechanical and electrical college of construction projects focus on innovation education, to cultivate and develop the students' comprehensive quality and practical ability as the goal is to stimulate students' interest in independent innovation and guide them to independent innovation practice, careful and meticulous planning and theory of machines and mechanisms teaching reform of the curriculum construction system.

As shown in Figure 2, the theory of machines and mechanisms course teaching system is divided into two modules, according to the need of theory teaching and practice teaching module. The theory teaching module includes organisation design as the main line of classroom teaching theory and basic theory of two parts, in the process, mainly focused on the transmission of knowledge and, at the same time, cultivating students' innovative consciousness and innovative way of thinking. While the practice teaching link module mainly includes experiment teaching, course

design and extracurricular technological innovation activities module, this part mainly focuses on the training and improving the students' innovation ability and engineering practice ability.

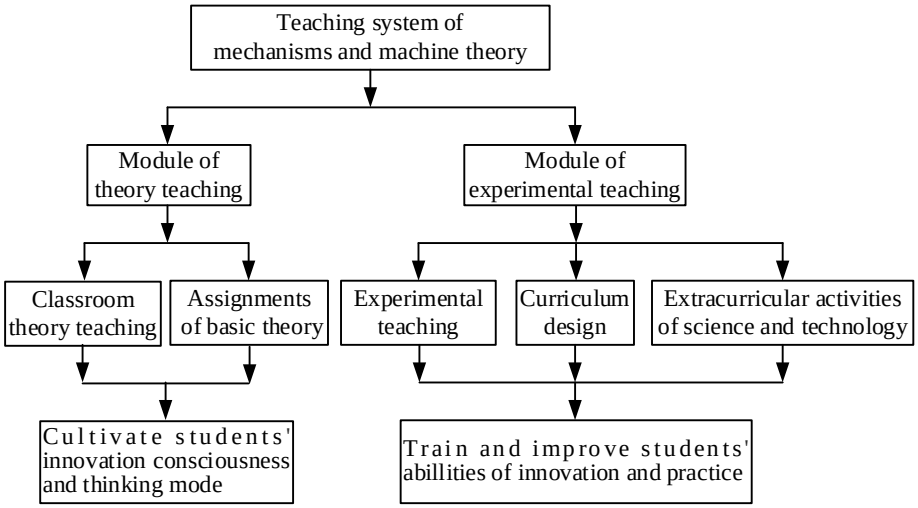
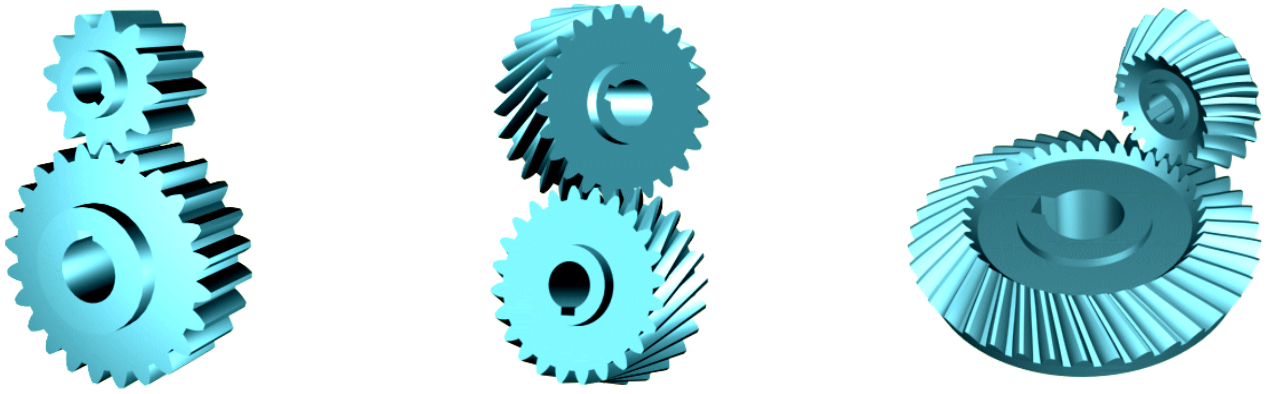


Figure 2: The system of theory of machines and mechanisms.

APPLICATION OF SIMULATION TEACHING OF THE THEORY OF MACHINES AND MECHANISMS IN CULTIVATING EXCELLENT ENGINEERS

The three dimensional drawing software must be mastered by the students [4]. Among three dimensional drawing software packages now popular are Solidworks, UG and Catia, and the basic function and usage of them is similar. Learning to use one of these software packages will be enough if there is a need to use the other packages. Students can be introduced early to 3D drawing software when the teacher talks about gear mechanisms in the course. Due to the limited number of classes, the teacher could introduce one kind of 3D drawing software, and the Catia software package is powerful and widely used.

Catia can be used for several gear modelling processes including straight gears, helical gears and bevel gears, and students can deepen their understanding of gear structures, but also become familiar with the operation of the three dimensional drawing software. The gear model established by Catia is shown in Figure 3.



a) b) c)

Figure 3: The application of the three dimensional software in gear machines: a) gear transmission of parallel axis; b) gear transmission of crossed axis; and c) gear transmission of intersected axis.

FLASH APPLICATION IN TEACHING ABOUT THE FOUR-ROD MECHANISM

The basic form of the connecting rod mechanism is a hinge four-bar linkage and three kinds of basic forms of crank rocker mechanism. Respectively, these are the double crank mechanism and double rocker mechanism, when it is a hinge four-bar linkage of crank rocker mechanism, through the agency of inversion, it can get double crank mechanism and double rocker mechanism. In the teaching process, using the digital simulation software to establish the digital model of the crank rocker organisation, according to the practical application of design, one gets a radar antenna pitching mechanism as shown in Figure 4, the agency application of the crank rocker mechanism; the doors open and close institutions as shown in Figure 5, the application of the double rocker mechanism; mixing mechanism as shown in Figure 6; and the inertia screen, as shown in Figure 7. This is the application of theory with practice.

Figure 4: Radar antenna pitching mechanism.

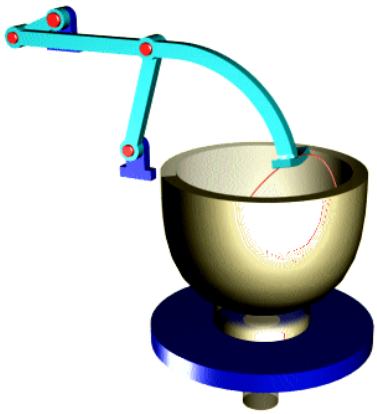


Figure 5: Mixing mechanism.

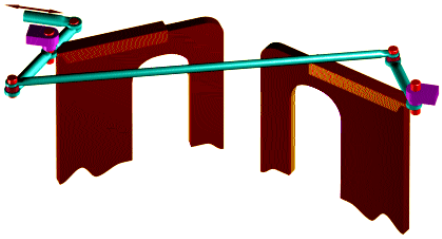


Figure 6: The car door mechanism of open and close.

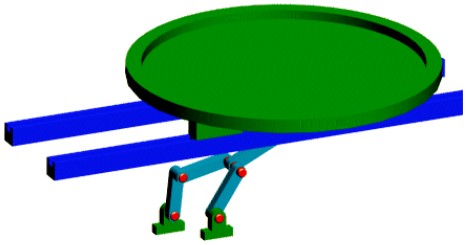


Figure 7: The mechanism of vibration sieve.

SIMULATION OF MOTIONS OF CAM MECHANISM USING PRO-E

Fitter completion of the cam assembly motion simulation can be carried within academic institutions as follows. First, add a drive to the model. Click [driver] button to open the [define] dialog servo motor, a new drive for the cam mechanism, rotary cam centreline selects the drive shaft as the connection. And, select the norms group box speed, the initial position to select the current input drive speed of 50°/s in the [outline] tab in the A. After adding the drive one can perform motion analysis after the click [analysis] is defined, analyse the Customise dialog box open, select the Type box set position to determine the start time of the cam movement is 0, suspended for 10, select the initial position of the current, the other options the default system settings, click the Run button, one can observe the movement of the cam mechanism, click and drag the tool point, organisations will be able to take a position at the time of the snapshot. For the simulation exercise, it can also be played back, and made into a multimedia animation files; for example, as shown in Figure 8.

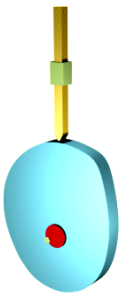


Figure 8: A cam mechanism.

Select the type of kinematic analysis, click the Run button, at this point one can observe the movement of the cam mechanism. Perform analysis [define], click [analysis] measurement results generated, the system pops up a dialog [measurements], motion analysis (if AnalysisDefinitionl3) results in the selection set group box has just choose to create a new measure in the measurement. Type group box types can be selected for analysis, such as speed and acceleration. Here, select the end point displacement measurement putter, each time step to accept the system of assessment methods, in accordance with the requirements after completion of all the parameters are defined analysis results can be obtained, the displacement -time curve is shown in Figure 9. From the figure one can see the end point of the cam followers only change, such as the one from 2.2 s to 3.6 s putter displacement 148 mm. Putting in the last paragraph break, from 5.8 ~ 9.4 s putter displacement of 208 mm, putter in the far off segment. In the same way one can get the speed - time and acceleration - time measurement curve. Similarly, the plunger speed can be analysed and the acceleration-time curve is shown in Figure 10, when t = 3.8 s, the maximum acceleration of the push rod end -point, a = 62.54 mm/s2.

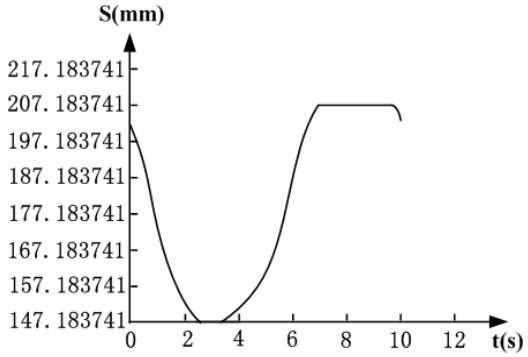


Figure 9: The displacement-time curve.

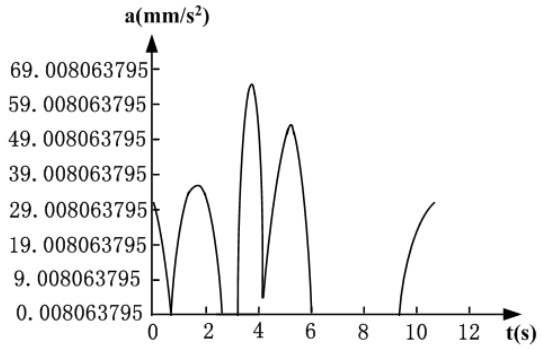


Figure10: The acceleration-time curve.

APPLICATION OF SOLIDWORKS IN GEAR TRAIN TEACHING

Due to the solid model in SolidWorks generating a variety of different methods, a more reasonable approach needs to be taken based on experience [5]. In general, a generative mode is chosen according to the shape of the graph. Sketching as simple as possible, it is best not to draw fillet, chamfer and other non-critical information. First is the use of SolidWorks in the stretch, rotate, basic operation scans, such as the establishment of an array of three-dimensional solid model of the device to work. The entity model in SolidWorks can have many different ways to generate, but to establish what method is more reasonable and effective, it is necessary to have a process of experience. First SolidWorks was mainly used in the stretching, rotating, scanning, array device, such as a basic operation to establish working three-dimensional entity model.

After the completion of 3D model of the working device parts, in order to create a virtual prototype of the need for individual parts for virtual assembly, the assembly drawing is shown in Figure 11. In the SolidWorks assembly module, one can add in front of the completed parts, gear section aligned with each other, according to the gear centre distance formula, set the distance between the sun gear and give mutual cooperation between the two gears to add a reference axis distance tie. The gear shaft, disposed coaxially with the gear between. By determining the position of constraint relations between the parts, one can put the device in the assembly work each 3D solid parts into working device and check whether there is interference between the parts. If a problem occurs, one can root it as it is necessary to generate the parts and features to modify the definition of the work until the device reaches the design requirements [6].

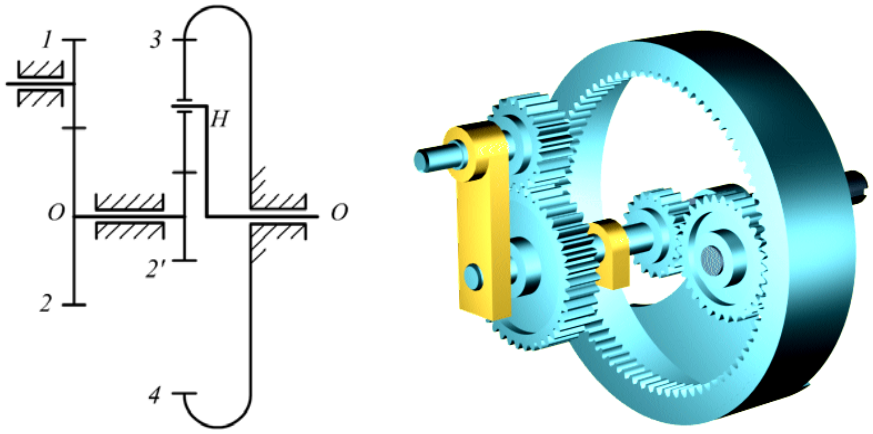


Figure 11: Plan and 3D assembly drawing of compound gear train.

CONCLUSIONS

Mechanical excellent engineer education reform of theory of machines and mechanisms course has achieved initial success. The computer software which is used in theory of machines and mechanisms classroom teaching is original, complementing the graphical method and analytical method; it embodies the teaching reform, mobilises the enthusiasm of students, improves student interest in learning, enhances the students' ability of analysing problems and solving problems.

The theory of machines and mechanisms course is one of the important basic courses for machinery engineering professionals. It has important significance to cultivate students' ability to work independently and meet the requirements of the follow-up teaching. In the process of practice, it is necessary not only to make the students participate in various design aspects, but also to let the students know how to check the design errors and correct them, rather than purely let them design continuously without the design effect. Therefore, using the general engineering software to assist practice teaching, not only can strengthen the students' understanding of each calculation step and the course's attractiveness to students, but it can also inspire students in the practice process of institutional innovation, so as to ensure the effectiveness of teaching practice.

In the process of implementing excellent engineering education reform, one may encounter some problems, such as most teachers lack of engineering experience, coupled with the requirement of cultivating talents, universities and enterprises lack of practice base, financial problems restricting engineering practice, inadequately qualified teachers in universities undertaking teaching tasks, difficulty in caring for each students who encounters difficulties in the process of professional learning.

In the cooperation between universities and enterprise system, how to realise part of the school curriculum is the teaching problem. Problem are likely to occur in excellence programmes, and the most effective solution is the establishment of a quality assurance system. A good quality system is a prerequisite to the implementation of the mechanical excellence programme. The good quality system cannot do without structure, system, teachers, funding, base and other aspects of quality; therefore, in institutional settings, it is necessary to set up a leading group comprising of a steering committee, the school enterprise cooperation working group, implementation and evaluation team.

In the quality system, the rules of the university and enterprise act in parallel, including training standards, training plan and teaching outline. In teacher support, the enterprise external treatment of teachers can be implemented. Training funds, practice outlay guarantee and school resources, enterprise training, network virtual resource base security, and any aspect of the work if not perfect, will lead to the difficulty in the continuation of the excellence programme. Also, the enterprise training plan implementation, requires the establishment of supervision, quality assessment and evaluation, and information feedback mechanisms.

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