



## Experimental Teaching Centre Platform "New Engineering" Practice Teaching Mode

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### ABSTRACT

Experimental teaching is an important part of engineering teaching. It is an important way to consolidate the content of theoretical teaching, cultivate students' practical ability and develop students' innovative thinking. Especially with the deepening of China's higher education reform and the continuous expansion of enrollment scale, the original experimental teaching system, content, methods, equipment, etc. in many ways can not meet the new requirements of personnel training. Yantai University Engineering Mechanics Experimental Teaching Center, through the construction of student-centered, ability-based training as the core of the experimental teaching system and platform, improve the "virtual combination, virtual reality is complementary, can not be true, but also designed in the student" experiment teaching concept, in accordance with the students from cognitive to practice and then to the process of innovative design, developed with independent intellectual property rights of multi-functional materials such as mechanical testing machine equipment, make full use of virtual simulation and other technical innovation engineering practice teaching methods, the formation of students as the center of the 4-4-1 experimental teaching model, changed the experiment attached to the theory of teaching and can only verify the theory, the experimental device to determine the status of experimental content, to achieve the innovative design ideas and innovative experimental device development interaction, New engineering talent "creative-innovation-entrepreneurship" of the practice of education system, the results of radiation, to promote the application of more than 160 colleges and universities inside and outside the formation of a model, played a national experimental teaching center demonstration radiation.

**Keywords:** experimental teaching, experimental equipment, virtual simulation, resource sharing, engineering education

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### **State of the literature**

- This paper describes an attempt to teach mechanics virtual teaching
- The purpose of this study is to solve the problem of the distribution of efficient education resources
- Next research will focus on the lab's Internet +

### **Contribution of this paper to the literature**

- This article combines virtual simulation with national mechanical testing center
- Students can do more difficult experiments on the Internet or in short supply
- Effectively solve the problem of distribution of education resources in the country

## INTRODUCTION

Laboratory equipment is one of the important strategic science and technology resources in colleges and universities, which is the basis of virtual simulation experiment teaching demonstration Center construction. Education is a necessary requirement for education reform and development in the information age, which is the core of modern education characteristics. 《The national plan for medium and long-term education reform and development (2010-2020)》states that: "we must attach great importance to the revolutionary impact of information technologies on education development". Ministry of Education in March 2013 promulgated the 《Education Information Decade Development Plan (2011 ~ 2020)》from the top design(reform and development program, 2010), starting from the height of the macro strategy to establish a Chinese education with information system, We will have the information and learning environment for the quality education resources, the long-term goals, tasks and measures of the information-based support service system of the learning society, and the basic education, vocational education, higher education, continuing education and education Management information development level framework( Ministry of Education, 2013). The following development goals and basic indicators of the construction of higher education information in 2020 are as follows: (1) Based on campus network, digital classroom, virtual laboratory, digital education teaching resource library, teaching and scientific research management information system and the green, safe and civilized construction of digital campus; (2) the depth of information technology and teaching integration of teaching models, methods and content innovation applications, and information under the conditions of student self-learning, self-management and self-service ability training; (3) The information support research results are transformed into digital teaching resources and application in teaching; (4) scientific research information conditions and resource construction, sharing and network-based collaborative research capabilities; (5) teaching and research resources and learning platform in science, humanities, subject education as well as the role of radiation in the field of international cultural exchange.

Virtual simulation experiment teaching application of virtual reality, multimedia, human-computer interaction, database and network communication technology, through the construction of realistic experimental operating environment and experimental objects (Tao, & Lei, 2011; Weiguo, 2013; Dias et al, 2017; Galan et al,2017; Heradio et al, 2016; Banaszek, et.al. 2017), so that students in an open, autonomous, interactive virtual environment to carry out efficient, safe and economic experiments, and thus achieve the real experiment does not have or difficult to achieve the teaching effect, especially for those involved in high-risk or extreme environment, cannot be or irreversible operation, and the need for high cost, high consumption of experimental projects, virtual simulation experiment teaching has obvious advantages. And the traditional experimental teaching ideas, systems, models, content, methods and means have had a far-reaching impact (Ullah, Ali, & Rahman, 2016; Baig, & Madsen, 2017).

Yantai University, engineering mechanics virtual simulation experimental teaching center, follow the "virtual combination, virtual reality is complementary, can be true, but also designed to students" principle (Ministry of Education,2014), to establish high-quality resource sharing mechanism as the core, information technology experimental teaching resources construction as the focus, based on the "industry-leading, scientific and practical, integrated optimization, powerful" concept, with the national engineering mechanics virtual simulation experimental teaching center platform to ensure that the advanced equipment, applicability, economic , under the premise of the experimental equipment of the standard, standardized, digital as the goal, developed with independent intellectual property rights of engineering mechanics multi-functional series of experimental equipment, research and development of equipment combined with virtual simulation resources to complete the display from the perception to the process of innovation. Innovative thinking to lead innovative equipment, innovative equipment to support innovative experiments, and pay attention to virtual technology, network technology, professional software applications, to meet the laboratory open, students self-learning and teacher-student interaction requirements, greatly enhance the experimental teaching of the information, intelligent management level (Zhu, Yu, & Riezebos, 2016).

## MULTI-FUNCTIONAL MATERIAL MECHANICS EXPERIMENTAL MACHINE

### The Main Innovations

All the experimental projects required for the material mechanics outline are completed on one equipment. Each laboratory can save millions of equipment and a large number of experimental rooms, including metal materials tensile test; metal material compression test; metal material forward and backward repeated torsion experiment; pull and pressure alternating load elastic modulus  $E$  and Poisson's ratio  $\mu$  test; positive and reverse torsional measurement  $G$  experiment; different bearing forms of alternating beam bending test; alternating load In-band bending and twisting tube bending and torsion combined electrical test; with lateral interference pressure bar stability test; alternating load strength beam electric



Figure 1. Material mechanics testing machine



Figure 2. Material mechanics testing machine virtual demonstration



Figure 3. Yantai university material mechanics open laboratory



Figure 4. Materials mechanics laboratory of Qingdao university of science and technology

test; pressure vessel electrical test; sheet bending strain and strain gauge working principle experiment; Compression and compression analysis of the second, third, fourth strength theory experiments.

Test machine can be replaced: 100kN tensile press machine; 500N\*m torsion test machine; shear test device; beam bending test device; elastic modulus and poisson ratio electrical test device; with section of the internal bending and bending experimental device; equal strength beam experimental device; with lateral support of the bar stability test device; fuel tank pressure vessel stress state test device; 8-channel data logger; experimental teaching courseware production system, more than 10 sets of experimental teaching equipment.

Chuck connection form is simple, is conducive to the rapid installation of the test and the second development of the experiment, innovation. Supporting the teaching video, animation, virtual simulation software, is conducive to the student's remote experiment, the



**Figure 5.** YJ- III A experimental device



**Figure 6.** YJ- III D experimental device



**Figure 7.** Dalian University of Technology Open Laboratory



**Figure 8.** Shandong University of Architecture Open Laboratory

teacher's remote guidance, to achieve the experimental equipment of the standard, standardized, digital (Trna, 2014; Kędzierska, & Wnęk-Gozdek, 2015; Grooms, 2017).

### The Main Technical Parameter

Maximum tensile load: 100kN; maximum compression load: 150kN; maximum torque: 500N.m; maximum clamping diameter:  $\Phi 20\text{mm}$ ; stroke: 200mm; indication accuracy: level 1; other experimental device system error:  $\leq 5\%$ ; weight: about 1200Kg; measuring the number of channels: 8; sampling frequency: 1 to 200Hz adjustable; data display type: real-time curve. The development of the material mechanics multi-function testing machine has been applied to more than 70 domestic colleges and universities. **Figure 3**, **Figure 4** is the development of the material mechanics multi-function testing machine in the Yantai University of materials mechanics open laboratory and Qingdao University of Science and Technology laboratory application of materials.

## COMBINATION of STRUCTURAL MECHANICS EXPERIMENTAL DEVICE

The structural mechanics combined with the experimental test device, the end of the structural mechanics because there is no suitable model cannot carry out the experimental history, can be combined with structural mechanics truss, rigid frame, composite structure and other structural forms, complete structural mechanics, steel structure, steel Concrete and other courses 24 experimental projects, the effective realization of the relevant disciplines, professional exchange convergence for the follow-up 4-4-1 virtual simulation experimental teaching system construction, providing a reliable guarantee, the practice of the "industry-leading, scientific and practical" idea.

Developed six series of structural mechanics multi-functional combination test device (**Figure 5**, **Figure 6** is one of the two series), has applied to more than 100 colleges and universities. **Figure 7**, **Figure 8** is the development of structural mechanics multi-functional combination test device, open laboratory in Dalian University of Technology and Shandong University of Architecture and Technology to open the application of the situation.

## STRUCTURE MODEL of VIBRATION PLATFORM

### The Main Innovations

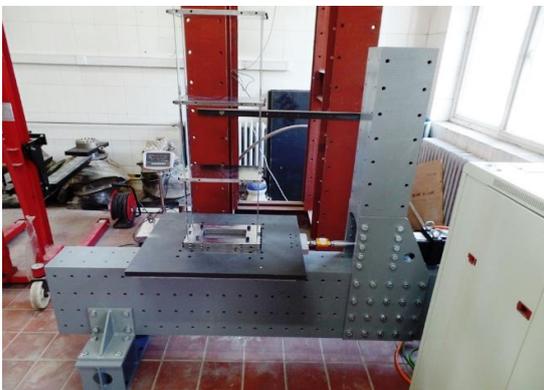
Based on the concept of "integrated optimization, scientific and practical", a new type of excitation system and multi-channel excitation test scheme are designed. The whole electric servo control system of servo motor driven ball screw is compatible with electromagnetic excitation and hydraulic excitation advantages(Zeng,Shan&Zhang,2015; Qiang&Li,2016), the structural base excitation, single-point excitation and other exciting means and test methods into one, can be displacement, load, acceleration closed-loop control, the lower limit of operating frequency is not limited, the upper limit can be up to 40Hz(Galan, Heradio, de la Torre, Dormido, & Esquembre, 2017), low energy consumption, low noise. At the same time equipped with data acquisition and processing and modal analysis system, structural model vibration process image processing system, can make structural dynamic experimental phenomenon vivid and intuitive to show, both relevant theoretical analysis can also be used for practical engineering structure State test. So that students complete perception, understanding, master, apply theoretical knowledge.

### The Main Technical Parameter

Work schedule: 150mm; Static/dynamic driving force: 5kN; Work frequency: 0-40 Hz; Rated acceleration: 100kg/1.5 g; Rated line speed: 500mm/s; Control mode: position, load, acceleration three closed loop; Sinusoidal signal, triangular signal, sweep wave seismic wave and user-defined waveform; modal test excitation mode: base excitation, electromagnetic excitation, hammer excitation; vibration platform size: 700 × 600mm (length × width). The experimental data and the experimental process are synchronized to capture the change of the feature points accurately. The development of structural model vibration platform, has applied to the domestic more than 40 colleges and universities. Figure 10, Figure 11 is the



**Figure 9.** Structure model of vibration platform



**Figure10.** Open Laboratory of North China Electric Power University



**Figure 11.** LiaoCheng University Open Laboratory

development of the structural model vibration platform in the North China Electric Power University open laboratory and LiaoCheng University open laboratory applications.

#### CONCLUSION

Yantai University Engineering Mechanics Experimental Teaching Center developed engineering mechanics multi-function experimental equipment to overcome the original domestic engineering mechanics experimental teaching equipment large and bulky, expensive, single performance, backward means of performance limitations, research and development of experimental equipment with advanced (strong function, high performance, good reliability, easy maintenance), applicability (in line with the purpose of use, training object, experimental content system design, test project development), economy (cost-effective, high utilization) characteristics, and make full use of the computer Technology and intelligent technology, so that the experimental equipment to the regular level, industrial level, commodity level of the standard level, to achieve the sharing of experimental equipment, open, to meet the students learning and interaction between teachers and students of the exchange requirements, greatly enhance the experiment teaching information、 intelligent management level.

Results (variety equipment accumulated) applied to, including the Hong Kong institute of advanced science and technology, more than 160 colleges and universities, the application level from 985 colleges and universities, 211 colleges and universities, the local colleges and private colleges to higher vocational colleges, scope of radiation throughout Hong Kong, Xinjiang and Tibet, and the domestic independent research and development of colleges and universities mechanics kind of instruments and equipment promotion, results of application to teaching experiment has realized the hierarchical, systematization, standardization and modernization, the latest development of industry and technology, industry new requirements for personnel training into the teaching process, updating experiment teaching content and course system, open up the "last learning kilometer". To promote teachers to research results into timely teaching content, improve the degree of interest, academic challenge degree. Promote the comprehensive development of students, and strengthen the core of the new engineering talent, enhance the innovation and entrepreneurship, cross-disciplinary cross integration, the ability of independent lifelong learning. The results of the previous period by the national college homemade experimental teaching equipment exhibition first prize two, the third prize of science and technology progress in Shandong province , two prizes for the first and second prize in teaching in Shandong province, one of the first prizes for science and technology advancement in Shandong province.

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