

Teaching Situation and Future Viewing of Introduction to Vacuum Tube Transportation

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Abstract--Vacuum Tube Transportation is a new coming hyper-speed transportation mode. The relating research and development is being progressed and its construction would be started in the near future. As a promising important industry, relating student education, subject building, specialty branch and course system would certainly come forth. The course Introduction to Vacuum Tube Transportation had been opened as the first time all over the world since spring term of 2005 and has been taught in 4 school terms. More than 500 students have studied the course. A set of course system, teaching outline and education plan has been constructed. Being ready to publish textbooks, finished making PPT teaching plan, and opened the internet course. With the coming construction and operation, as well as confirmation of relating specialty, the course Introduction to Vacuum Tube Transportation would be taught in more and more universities all over the world. It is a multi-subject course, so as to be convenient for students to study and understand the current science and technology frontier, comprehensive knowledge. Especially, it is right for being as a public course in some relating universities. Besides teaching knowledge and educating students, the course also could boost Vacuum Tube Transportation to come to reality as soon as possible and future development.

Keywords--vacuum tube transportation; introduction; teaching situation; course; multi-subject; high-speed

I. INTRODUCTION

Human beings never stop pursuing a faster travelling speed. Vacuum Tube Transportation (VTT) is a coming new transportation mode which would be faster than autos, high-speed trains and planes^{[1][2][3]}. The feasibility and the development foreground of VTT have been recognized. Some institutes and companies in China and America are engaged in VTT research and developing^[4]. The first man-loading VTT testing line is coming soon^[5]. Furthermore, a new industry on VTT would be brought out.

Accordingly, a new education subject on VTT would come out and some courses such as Introduction to Vacuum Tube Transportation would be certainly taught in some universities. In order to plan, design, operate and manage VTT, the new industry needs a large number of engineers, technicians and administrators. Anyway, a new specialty on VTT will certainly be created.

According to the university education system and course rule, generally an introduction course is scheduled for a relative specialty so as to introducing the character,

background and key technical point of it. However, VTT hasn't been built and the specialty subject on VTT hasn't been decided at present. In the case, it is reasonable to arrange VTT introduction course for students to introduce the basic concept, structure and technical principal of VTT. In a hand, the course could introduce and spread VTT knowledge and boost VTT to come to reality as early as possible; in another hand, it is useful for finding, training and storing persons with ability.

II. ORIGIN AND DEVELOPMENT OF VTT

VTT thoughts could be traced back to the America patent "Vacuum Railway" applied by Mr. Robert Ballard Davy (US1336732, May 23, 1919)^[6]. At the same time, Robert Hutchings Goddard (1882.10.5-1945.8.10), the father of modern rocket, also put up VTT idea. After Robert Goddard went over, his wife Mrs. Esther Christine Kisk applied the patent "Vacuum Tube Transportation System" (US2511979, May 21, 1945)^[7] and another patent "Apparatus for Vacuum Tube Transportation" (US2488287, Oct. 6, 1945) on behalf of Mr. Robert Goddard^[8].

In 1965, Edwards. LK. published paper "High-speed Tube Transportation" on the journal Scientific American. In 1975, Forgacs. RL. published paper "Evacuated Tube Transportation, Energy and The Environment" on the journal High Speed Ground Transportation. These two papers primarily stated the basic principal of VTT^{[9][10]}.

In 1999, American engineer Mr. Daryl Oster, applied the patent Evacuated Tube Transport^[11] and was engaged in ETT work since then.

Swissmetro is also a kind of VTT and its team ever finished the early plan and tentative project scheme in 1990s.

With the invitation from Dr. Zhang Yaoping and Prof. Wang Jiasu, Daryl Oster and his wife tripped to China and Southwest Jiaotong University in Dec. 2002, working there for 3 months. Since that time, VTT research work was started in China. In Sep. 2004, the book A New Industrial Era Coming---Initial Dialogue on Evacuated Tube Transportation written by Zhang Yaoping and Daryl Oster was published by Tsinghua University Press. The book primarily discussed about the concept and basic principal of VTT^[12].

In 2006, the research project "Basic Study on Evacuated Tube Maglev High-speed Transportation" was funded by China National Natural Science Foundation and Zhang Yaoping was the sponsor (No. 50678152). In 2009, the

research project “Technology Study on Evacuated Tube Maglev High-speed Transportation” was funded by Shaanxi Science and Technology Department (No.2009K09-24) and Zhang Yaoping was responsible for it. In 2014, the research project “Study on the Reasonable Vacuum in Evacuated Tube Transportation Based on Rarefied Aerodynamics” sponsored by Zhang Yaoping was funded by Shaanxi Educational Department (No. 14JK2167).

III. COURSE TEACHING SITUATION OF INTRODUCTION TO VTT

In the spring term of 2005, as the first time all over the world, Southwest Jiaotong University started the course Introduction to VTT. More than 20 students from different specialties studied this course. Fig. 1 shows the classroom where Zhang Yaoping is having the lecture to students.



Fig. 1. 2005 spring term classroom on VTT in Southwest Jiaotong University

Since it was taught as the first time in Southwest Jitong University in 2005 spring term, the course Introduction to VTT had experienced a 10 years of dreariness. Luckily, with support from Xijing University, the public course Introduction to VTT was opened again in 2015 spring term. More than 200 students from different specialties selected this course. All these students were assigned into 3 classes in 3 different times weekly (Fig. 2), and they were involved in more than 20 specialties of Xijing University as shown in TABLE 1.



a. Students listening to the lecture



b. Zhang Yaoping having the lecture to students

Fig. 2. 2015 spring term classroom of Introduction to VTT

TABLE I. STUDENT SPECIALTY DISTRIBUTION WHO STUDIED THE PUBLIC COURSE INTRODUCTION TO VTT

No.	Specialty	2015 Spring Term		2016 Spring Term		2016 Fall Term	
		Number of Student	%	Number of Student	%	Number of Student	%
1	Financial Management	8	3.7	9	6.5	8	5.4
2	Control Technology and Instrument	1	0.5	0	0	2	1.3
3	Electronic Commerce	1	0.5	5	3.6	13	8.7
4	Electronic Information Engineering	1	0.5	0	0	1	0.7
5	Animation	1	0.5	5	3.6	2	1.3
6	Engineering Management	3	1.4	5	3.6	4	2.7
7	Engineering Cost	7	3.2	9	6.5	2	1.3
8	Industrial Design	0	0	1	0.7	3	2.0
9	International Economy and Trade	12	5.5	13	9.4	10	6.7
10	Chinese International Education	2	0.9	0	0	2	1.3
11	Environmental Design	7	3.2	10	7.2	14	9.4
12	Accounting	58	26.6	38	27.5	20	13.4
13	Machine Design	9	4.1	5	3.6	13	8.7
14	Tourism Management	2	0.9	4	2.9	3	2.0
15	Fine Arts	4	1.8	3	2.2	4	2.7
16	Automotive Services and Engineering	3	1.4	3	2.2	4	2.7
17	Visual Communication Design	7	3.2	3	2.2	7	4.7
18	Marketing Management	6	2.8	5	3.6	6	4.0
19	Civil Engineering	24	11.0	6	4.3	19	12.8
20	Logistics Management	14	6.4	4	2.9	7	4.7
21	Journalism	11	5.0	4	2.9	4	2.7
22	Art Design	10	4.6	0	0	0	0
23	English	27	12.4	1	0.7	0	0
24	Applied Chemistry	0	0	2	1.4	1	0.7
25	Applied Statistics	0	0	3	2.2	0	0
	Total	218	100	138	100	149	100

As shown in TABLE 1, 218 students selected this course in the 2015 spring term. By the attendance and assessment, finally 199 students got qualified results and other 19 students got unqualified results or 0 score. These students from 22 specialties and the specialty distribution covered 80% of the total specialty number in Xijing University. Thereinto, 1 student belongs to the class of 2011 (graduating class), 74 students belong to the class of 2012, 132 students belong to the class of 2013, 11 students belong to the class of 2014 (freshmen). The specialty with the most student number who selected this course is accounting, occupying for 26.6% of the total student number. The probable reason is that the student number in the accounting specialty is accounting for the most proportion in the total student number of Xijing University. Another probable reason is that the teaching administration department of Xijing University requests that all students in economic and management subjects must get some public course scores in science and technology area, and the Introduction to VTT could cover the most comprehensive knowledge in science and technology.

In the 2016 spring term, the public course Introduction to VTT was opened as the second time in Xijing University. 138 students selected it (as shown in Fig. 3) and the specialty distribution on students is shown in TABLE 1. By the attendance and assessment, finally 104 students got qualified results and other 34 students got unqualified results or 0 score. These students from 21 specialties and the specialty distribution covered 80% of the total specialty number in Xijing University. Thereinto, 1 student belongs to the class of 2012 (graduating class), 14 students belong to the class of 2013, 122 students belong to the class of 2014, 1 student belongs to the class of 2015 (freshmen). The specialty with the most student number who selected this course is also accounting, occupying for 27.5% of the total student number who selected this course.



a. Students listening to the lecture



b. Zhang Yaoping having lecture to students

Fig. 3. 2016 spring term classroom of Introduction to VTT

In the 2016 fall term, the public course Introduction to VTT was opened to students as the third time in Xijing University. 149 students selected it and the specialty distribution on students is shown in TABLE 1. All 149 students were arranged in a classroom so that the teacher couldn't guide students efficiently.

IV. COURSE CONTENTS OF INTRODUCTION TO VTT

VTT belongs to the new advanced technology scopes, and is a comprehensive system engineering which refers to the

broad specialties and needs to be highly integrated. As an introduction course, its goal is to have students recognize the thoughts origin, research background and recent progressing of VTT, leading students to love science, yearn for science, encouraging science spirit, cultivating science thinking. In addition, this course could offer the direction guidance and specific topics for students who want to innovate and explore science and new technology.

Currently, this course is scheduled in 32 teaching hour

units, namely 16 times of lecture or in 16 teaching weeks. The main content includes the thoughts origin, research history, current technical groups, human beings high-speed dream and stage aim speed of VTT, tube cross-section and structure choice, maglev technology select, risk factor and safety measure, VTT vehicles, station designing, route planning and layout, vacuum, airlock, insulation door and exhausting system, VTT aerodynamics and thermodynamics problems, VTT economics, etc. The course system is shown in TABLE 2.

TABLE II. COURSE SYSTEM OF INTRODUCTION TO VTT

Introduction To VTT	1. Prolegomena	Course background VTT thoughts origin VTT research and development
	2. Current Main Technology Groups	American ETT China VTT Swiss metro Hyperloop
	3. Human Beings High-speed Dream and VTT Aim Speed	Human beings high-speed dream Speed competition based on human physique Speed of animals Speed of modern transport tools Speed of aeronautics and missiles VTT speed
	4. VTT Tube Cross-section and Structure Selection	Tube cross-section and figure Tube section diameter selection Tube engineering Tube materials and tube wall structure
	5. VTT Maglev Technology Selection	Maglev development introduction EMS maglev Superconductivity maglev HTSM maglev Other types of maglev Comparing to performance of some maglev technologies
	6. VTT Risk Factor Analysis and Safety Measures	Vehicle risk factors and safety measures Tube safety issues Dangerous in running and controlling, and risk prevent Safety problems caused by natural disaster Safety problems from witting destroying
	7. VTT Vehicle Designing	Some possible car door layout Vehicle section and size Vehicle aerodynamics outline Vehicle inside structure and seat installing Maglev system layout Logistics carriage Vehicle inside environment and life support system
	8. VTT Station	Station sort Passenger station design Cargo station design Station running and organization
	9. VTT Route and Layout	VTT route: underground, ground or overhead? Route planning on continent Route planning when spanning river and lake Route planning when going through ocean Line network consistence forecast
	10. Vacuum, Airlock, Insulation Door and Exhausting System	Airlock Insulation door Gas pumping system Vacuum airproof check and maintain
	11. VTT Aerodynamics	Rarefied aerodynamics application and research situation Reasonable vacuum in VTT tube based on aerodynamics Rarefied aerodynamics simulation and calculation on VTT Consideration on using VTT tube into wind tunnel experiment
	12. VTT Thermodynamics Problems	Vehicle running pneumatic heat Vehicle inside heat source Heat increasing in tube Measure exhausting heat from VTT tube
	13. VTT Maglev Spaceflight Launch	Basic principle and significance Reasonable line length and route figure Elevation calculation and route layout Key technical issues Important technology for big countries game to control space
	14. VTT Economics	VTT basic establishment cost Cost of Vehicle and running equipment VTT operation cost Impact of tube section on VTT cost VTT transit ability
	15. VTT and Social Development	The decision factor for realizing China dream VTT will promote peace all over the world

V. FUTURE VIEWING FOR THE COURSE INTRODUCTION TO VTT

Introduction to VTT is a new course with innovation and exploring character. It is opened for students in Xijing University where this course was never offered before 2015, and Xijing University is the sole one which is offering the course Introduction to VTT all over the world at present. In the case without much reference materials and existing template, the course system has been created, and the lecture plan has been finished. In addition, the author made the electronic teaching plan in PowerPoint format. In teaching, Zhang Yaoping asks students to submit their VTT works onto internet, so that all global people could browse and appraise that. Such teaching method has inspired students to study on VTT actively and the excellent works could be saved on internet enduringly. Of course, the works on internet are also spreading abroad VTT concept to more people.

VTT possesses the distinct character spanning over multi specialties and multi subjects. For example, VTT route, road basement and bridges are relating to civil engineering; Tube, airlock, rail track and vehicles are relating to mechanics engineering; Maglev, running controlling, accelerating and braking are relating to automatization; Gas pumping, vacuum maintaining and airproof are relating to the vacuum physics; Atmosphere, vehicle life support system, oxygen supplying and emergence succor are relating to life medicine; Construction cost, running and operation are relating to economic and management.

Based on the characters of VTT that spans multi subjects, the purpose of this course is to have students from different specialties roundly recognize the advanced science progressing and technology innovation method by studying this course. It could have students in social science subject hold the advanced science and technical knowledge, as well as have students in science and technical subject recognize and hold the link, intercross and crisis phenomena of their subjects. Furthermore, this course would have students deeply comprehend the value and significance of “Systematism Know” and “Comprehensive Episteme”. The primary teaching practice has indicated that the course Introduction to VTT is right and feasible for being as common public course in universities, and the teaching value and sense is obvious.

VTT would be important industry in the future and the construction is being started. With building and running, VTT specialty and subject would certainly come out. In that time, the course Introduction to VTT would be opened in more and more universities in the world. Anyway, not only this course will have students understand the advanced science and

technology, study relative knowledge, but also would it boost VTT to be realized as soon as possible, and play an important role in training people with ability for VTT. The milestone sense of this course would be confirmed in the future.

VI. SUMMARY

VTT will be a new transportation mode and an important industry field. Its construction would be started in the near future. The course Introduction to VTT was ever taught in Southwest University in the spring term of 2005. After 10 years, this course is opened in Xijing University. The teaching plan and content of Introduction to VTT has been created. Although only one university has this course at present, it would certainly be opened for students in more and more universities all over the world in the future.

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