New Educational Demands for the Future: Automotive Technology – Master of Science

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Abstract— **This paper summarizes the educational programs of a number of prominent European universities and universities in the USA, and proposes a new TU/e program. In Europe there are only three universities/institutes, which offer a true Master's automotive educational program which is similar with respect to the total duration and work load of the program compared to the TU/e program. However, the main focus of the TU/e differs substantial. The MSc Automotive Technology is: (i) Strong applied academic education embedded within the framework of research innovation program High Tech Automotive Systems (HTAS), (ii) Broad interdepartmental or multidisciplinary educational program, and (iii) The system boundaries are at the integral vehicle system level including the interaction of the vehicle system with its surroundings. The character of the systems approach offered by the program is unique, in Europe there are no programs comparable to the M.Sc. Automotive Technology in Eindhoven.**

I. Introduction

The master program discussed in this paper is the new full Automotive Master as discussed in [1]. Aims and objectives of this master program called Automotive Technology are to contribute to the demand for more highly qualified academic professionals, and is built with a new systems approach to high tech automotive systems. The program consists of a set of coherent projects and courses related to the backbone required by automotive industry to meet market demands in a broad, integrative sense. The program was designed in close cooperation with the automotive sector itself, and is strongly supported by the (automotive) research done at TU/e. The tremendous increase of electronic and embedded systems in cars calls for engineers with in-depth knowledge in this field. The introduction of and research on hybrid vehicles and of vehicles that run on new fuels such as hydrogen, require engineers with a strong background in power electronics, physics, chemistry and control engineering. In short, the automotive engineer of today is not only the mechanical engineer from before, yet is more and more a multidisciplinary engineer with a clear automotive focus educated in several disciplines. In this paper information about different institutes and universities, which have educational programs in the field of automotive technology, is summarized. Not all study programs have a duration of 2 years and an equivalence of 120 ECTS. In the last part of this paper various study programs are compared with the Automotive Technology program of the TU/e.

II. Universities with BA / M.Sc. / Specialization Tracks in Automotive Engineering in Europe and the USA

In this section an overview is given per country in Europe and in the USA of different universities/institutes (research department within a faculty) offering courses in the field of automotive engineering. The discussed countries in Europe are: Belgium, Germany, France, Italy, Austria, United Kingdom, Sweden, Swiss, and Czech Republic (see, also [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30], [31], [32]). Thereby, limited selected parts are taken several referred websites.

A. Belgium

1) Vrije Universiteit Brussel: as part of the M.Sc. Mechanical - and Electrical engineering, it is possible to graduate at the group ETEC (Electrical engineering and Energy technology) [2]. ETEC's primary field is electrical engineering; this includes all applications of electric energy in our society. For 30 years the group ETEC has been involved into research related to alternative drive trains for the road transport, more specifically related to electrical vehicles. The research at ETEC is focussed on the power electronics, which is an essential element of the electric drive train. In accordance with the underlying technological evolution the research interests of ETEC have expanded from battery-electric vehicles to electric vehicles; including hybrid vehicles and fuel cell vehicles. The activities of ETEC in this field have an international focus; the establishment of the international associations AVERE and CITELEC allows reinforcement of the synergies between the different associations. Electrical vehicles are part of the ETEC-education; for the students of the second bachelor year by means of the seminar "Build of an electric go-cart".

2) Katholieke Universiteit Leuven: within the Department of Mechanical Engineering - M.Sc. education [3], [4] exists the possibility of following the specialization track "Vehicle

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Technology". The Vehicle Technology program focuses on the design, the analysis and the production of vehicles and systems for the transport industry. In addition, the focus is on the different components of drive train and the chassis, and the resulting performances of the integrated system.

B. Germany

1) Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen: offers the M.Sc. Curriculum "Automotive Systems Engineering" [5], as part of the Department of Mechanical Engineering. The program will be taught either completely in English or completely in German. Both courses take place each year. The duration of the program is two years. The program provides in-depth knowledge and understanding of Automotive Engineering. Its particular focus is on industrial R&D practices and on modern manufacturing processes of vehicles and their subsystems. A candidate should have a first degree (Bachelor of Science or Engineering) in an engineering discipline, such as Mechanical, Automotive or Combustion Engine Engineering, awarded by an internationally recognized university-level institution. Candidates should have also performed above average in their undergraduate studies. This program is appropriate for both engineers coming from industry as well as those coming directly from university.

2) Darmstadt University of Technology: offers within the M.Sc. Mechanical Engineering, the track study "Automotive Engineering" [6]. The university has a student exchange program with Virgin Tech, USA. The specialization subjects are: (i) Advanced driver assistance systems, (ii) Mechatronic chassis systems, and (iii) Motorcycle safety.

3) Hochschule Esslingen, Stuttgart: this university has an international M.Sc. "Automotive Engineering" (AE). The program has 90 ECTS with a duration of 1.5 year [7]. There are two modules within AE: (i) Track Design and Manufacturing and (ii) Track Mechatronics. The AE Master's Program is structured to respond to multidisciplinary needs, because it is run jointly by two departments: Department of Mechanical Engineering, and the Department of Vehicle Technology. In addition to this, the learning approach itself is both international and interdisciplinary.

4) Technical University of München: offers as part of the Department of Mechanical Engineering, the track "Vehicle Technology" [8]. The specialization subjects are: (i) Processes and Tools in the Automotive Development Process; (ii) Driver Assistance and Control Systems; (iii) Vehicle Dynamics and Design; (iv) Mobile Off-road-Machinery; and, (v) Interaction between driver and car.

5) Karlsruhe Institute of Technology (KIT): the Instituts für Fahrzeugtechnik und Mobile Arbeitsmaschinen (IFFMA) [30] exists since January 1th 2007. This institute consists of two sections, i.e., Lehrsthle für Mobile Arbeitsmaschinen (MOBIMA) [31] and Fahrzeugtechnik (LFF) [32]. The IFFMA works in the field of vehicle system technology. The focus is on analysis, and optimization of complex interactions between mechanical, hydraulic, electric and electrical components in vehicles, its environment, the vehicle and its driver, vehicle efficiency & emissions, safety, usability and comfort. The Karlsruhe Institute of Technology (KIT) [29] is the merger of Universität Karlsruhe (TH) and Forschungszentrum Karlsruhe. At the KIT a Center of Automotive Research and Technology (CART) is located. IFFMA is a partner of CART.

C. France

In France there are three universities of which one, i.e., Ecole du Pétrole et des Monteurs, Institute Franais du Pétrole (IFP) School offers a M.Sc. in Automotive Engineering. The other universities, i.e., Laboratoire d'Automatique de Grenoble and Laboratoire d'Automatique, de Mcanique et d'Informatique industrielles et Humaines (LAMIH) performs (research) projects related to automotive technologies.

1) Ecole du Pétrole et des Monteurs, Institute Franais du Pétrole (IFP) School: the school [11] offers three M.Sc. studies in the field of "Internal Combustion Engines", "Power train engineering" and "Petroleum Products and Internal Combustion Engines". The studies are taught in French, English, and bilingual French-English respectively, and the duration is 10-22 months depending on the student's curriculum.

2) Laboratoire d'Automatique de Grenoble: in the past Laboratoire d'Automatique de Grenoble has investigated several problems related to automotive control [9] in heavy duty vehicles as well as in commercial vehicles. Research focus is mainly on modeling, control and observer design related to vehicle dynamics, but also clutch control design.

3) Laboratoire d'Automatique, de Mcanique et d'Informatique industrielles et Humaines (LAMIH): the system modeling and control theme has two main axis [10]. The first one is theoretical and its goal is to derive observers and control laws for nonlinear models using the so-called Takagi-Sugeno fuzzy models. New interesting results were obtained and are included in an international context. In particular LAMIH is involved in the TC 3.2 of IFAC "cognition and control". The second one is centered on the control of power trains, mainly for automotive applications. LAMIH is involved in a research group of the GDR MACS from CNRS named "Automatic control and Automotive", and also involved in the international IEEE VPPC committee "Vehicle Power and Propulsion" (S. Delprat, T.M. Guerra).

D. Italy

1) Politecnico di Torino: the Department of Mechanical Engineering [12], [13], offers a specialization track in Ground vehicle design with topics: reliability, comfort, vehicle dynamics, power train, functional design, structural design, safety, stability, structures and body shells, servo systems. In the automotive sector, the Department's major research initiatives are carried out with a number of FIAT Group companies, as well as with other leading companies in the sector. Several faculty members of Mechanical Engineering are also involved in the master's program in Mechanical Engineering offered together with the University of Illinois at Chicago (UIC). There is also an Automotive Engineering University Centre at the Politecnico di Torino, which organizes automotive

track courses. The Automotive Engineering course is held on the decentralized Lingotto campus, thereby taking advantage of the financial contribution made available by Fiat S.p.A. through a specific agreement. The Centre is primarily concerned with providing organizational support for all didactic activities connected with carrying out the degree course and the specialized degree course in Automotive Engineering, plus Master's courses and long-term training in the automotive sector.

E. Austria

1) Graz University of Technology: the Institute of Automotive Engineering Graz (FTG) [14] was founded in February 2003 as a department of the Institute for Internal Combustion Engines and Thermodynamics at Graz University of Technology. Since January 2004 it has changed to an independent institute. Since 2005 FTG is a Member of Frank Stronach Institute (FSI). The Institute of Automotive Engineering Graz is engaged in education and research in the field of ground vehicles, whereas the focus lies on cars and commercial vehicles. Related research projects in cooperation with the industry and testing in the laboratory are also part of the institutes' duties.

F. United Kingdom

1) Cranfield University: the Department of Automotive Engineering [15] is contained within the School of Engineering. It is concerned with all aspects of the design of road vehicles including: teaching at M.Sc., M. Phil., Ph.D., Eng.D. and industrial short course levels, as well as conducting research to evaluate new technologies and to improve automotive product engineering processes. The department provides services to industry in the form of measurements, computations, design assessments and advice. Research: Hybrid Electric Vehicle Design, Integration and Testing. The Department of Automotive Engineering views the modeling, control, systems integration and testing of hybrid electric vehicles as one of its primary core-competencies. The department has always placed a strong emphasis on the importance of designing practical engineering solutions for real hybrid electric and fuel cell vehicles. This is evident in the fact that almost all of the department's different research and development projects in this area have industrial partners and are geared towards the production of an actual vehicle. The Department of Automotive Engineering offers two M.Sc. educational programs: Automotive Product Engineering (full-time, duration 1 year, limited places 30) and Automotive Technology Management (part-time).

2) Imperial College London: has automotive research and education activities within the Hybrid Power Research Group [16] as part of the Department of Mechanical Engineering. Hybrid power research is an expanding area of research within the CASE section of the Mechanical Engineering Department of Imperial College of Science, Technology and Medicine. Based on the expertise of high-speed electrical machine design, the group focus is now on specialized electric machines for hybrid power application and system simulation and optimization. The research interests of the Hybrid Power Research Group: (i) Hybrid Power trains: Research into power train components and integration; including combustion engines, modular controllers; (ii) permanent magnet electric machines, notably high power density axial flux topology, in generator application.

3) University of Hertfordshire, Hatfield: the university (see, [17]) offers a Bachelor and a Master's degree (4 years) in Automotive Engineering (with Motorsport, or with Management), and Motorsport Technology separately.

4) University of Birmingham: this university offers a MEng/BEng program (4 years) in Mechanical and Automotive Engineering [18], [19].

G. Swiss

1) ETH Zürich, Institut fr Mess- und Regeltechnik (IMRT): the Measurement and Control Laboratory [20] is part of the Department of Mechanical and Process Engineering at ETH Zürich. Together with the Automatic Control Laboratory, the IMRT offers an education program in dynamic systems and controls. In research the IMRT is active in the following fields: automotive systems; energy systems; unmanned aerial vehicles; financial engineering; theory and methodology of systems modeling and controller design. The impact of individual transport systems on the environment as well as the usage of energy motivates the research in the improvement of the propulsion systems in terms of efficiency and the reduction of emissions. Regarding the real impact on the environment, the internal combustion (IC) engines powered by liquid hydrocarbons will continue to dominate the market. Alternative propulsion systems will achieve a not negligible market-share and contribute to the security of the energy supply. Future IC engines will have to fulfil strict regulations for emission as well as for greenhouse gas emissions and in particular CO2. PAC-Car II has been a joint project of ETH Zürich with partners from academia and industry. The goal was to build a vehicle powered by a fuel cell system that uses as little fuel as possible. PAC-Car II set a new world record in fuel-efficient driving during the Shell Eco-marathon in Ladoux (France) on June 26, 2005.

H. Sweden

In Sweden there are three universities of which two, i.e., Chalmers University of Technology [21] and KTH [22], respectively, offer a M.Sc. in Automotive Engineering. The other university, i.e., the Lund University (electric drives) [23] performs (research) projects related to automotive technologies.

1) Chalmers University of Technology: at Chalmers, two Master's programs are offered in the field of Automotive Engineering: (i) Automotive Engineering: the aim of the Automotive Engineering program (AE) is to prepare students for a professional career with a broad knowledge of automotive engineering while offering specializations central to the industry; and, (ii) Automotive Industrial Design Engineering (AIDE): the AIDE program was successfully launched in the autumn semester of 2004. It focuses on the automotive industry and the realities of this increasingly complex business. This

Master's Program, the first of its kind when it was launched, has been developed to provide students with a unique and comprehensive education in automotive industrial design engineering. The program is held in English and is open to global applicants. The AIDE program is part of collaboration with the Umea Institute of Design, at Umea University, under the name "The Sason School of Design". More information is available from the website: "www.sason.se".

2) KTH, Royal Institute of Technology, Aeronautical and Vehicle Engineering: KTH Department of Aeronautical and Vehicle Engineering [22], is the result of a merger between the department of Aeronautics and the department of Vehicle Engineering. The new department which became operational January 1^{th} 2003, is unique in its coverage of all vehicle engineering disciplines, i.e. air, ground, rail and sea transport vehicles. At the KTH, a M.Sc. programme in Vehicle Engineering is offered. The programme consists of two tracks, i.e. road vehicles and rail vehicles, followed by four different profiles: structural design, functional design, control design and transport systems. The basic curriculum is comprised of a short introductory course and one of the two tracks, and corresponds to approximately 45 ECTS. Three of the courses listed in the chosen profile have to be taken. Further courses from the chosen profile, from the other three profiles or from the second track also have to be taken. Together with the courses from the basic curriculum, the total sum of university credits has to be at least 75 ECTS. This leaves about 15 ECTS for optional (elective) courses.

3) Lund University: the Department of Industrial Electrical Engineering and Automation (IEA) [23] started its current graduate program and research in 1987. The IEA profile is quite unique for Sweden, since the main feature is the combination of automation, electric drive systems and electrical power systems.

I. Czech Republic/France/The Netherlands

1) Czech Technical University/ENSIETA/HAN University: an international M.Sc. automotive engineering program is offered by two universities, i.e., ENSIETA (Brest, France), Czech Technical University (CTU), and an institute with an educational level just below university (Hogere Technische School, HTS), i.e., Hogeschool van Arnhem - HAN (Arnhem, The Netherlands) [28]. The target group is technical bachelors or equivalent, and the master studies hold two years studies. The first year is taught in English on CTU with participation of lecturers from both partner universities. The study is structured as multidisciplinary and involves the following areas: design of motor vehicles and internal combustion engines (ca 410 hours); manufacturing processes and technology of automotive production (ca 150 hours); management, communication, and marketing (ca 70 hours); microelectronics, CFD, CAD (ca 140 hours). All subjects are specific to motor vehicles. The content of subjects were consulted and adapted according to need of European automotive industry. Important part of Master studies is languages. For Czech students and students willing to go to study on ENSIETA is prepared an intensive course of French taught by native lecturers on the French Institute in Prague. Foreign student will follow intensive course of Czech language. In the third semester a choice can be made between: (i) ENSIETA (Brest, France) studies in French with choice of two specializations: Design of vehicles; Modeling and simulation by means of FEM (specific for motor vehicles); (ii) HAN (Arnhem, The Netherlands) studies in English with specialization: Vehicle dynamics and Advanced transport systems. Last semester is devoted to the final thesis with condition that five months will be spent on work period at a vehicle or vehicle parts manufacturer or research center wherever in the world. Students will get their diploma from the Czech Republic and from France or The Netherlands (accordingly to the chosen second year).

J. USA

1) Massachusetts Institute of Technology (MIT): which is located in Cambridge, USA. Although the MIT School of Engineering [24] does not offer specific courses in automotive engineering, there are a few MIT laboratories conducting research in that field, for example, the Sloan Automotive Laboratory, which is a part of the School's Department of Mechanical Engineering. In addition, the International Motor Vehicle Program, the MIT Motorsports Club, and the Media Lab conducts also some car research. Some of these laboratories do offer research opportunities for undergraduates. Undergraduates interested in automotive engineering most likely do a major in an area of mechanical engineering. Five faculty and research staff members are involved in the Laboratory's programs, with about thirty graduate students and several undergraduates.

2) University of Texas A&M: within the Department of Electrical and Computer engineering [25], a research laboratory (Power Electronics and Motor Drives Laboratory and Advanced Vehicles Systems Research Program) is available, which conducts research in the field related to automotive technologies. The research center is located in the Wiesenbaker Engineering Research Center on the campus of Texas A&M University, in College Station, Texas. The research is focused on power electronics and motor drives with regard to vehicle systems as well as other applications such as wind power, space and military systems, power and energy storage systems, consumer products, and other industrial applications.

3) Illinois Institute of Technology (IIT), Chicago: the Department of Electrical and Computer Engineering, research laboratory Grainger Power Electronics and Motor Drives Laboratory [26], [27] performs research and education in the field of automotive. The Illinois Institute of Technology (IIT) has different education and research programs in electric power and energy systems. The mission of the Electric Power and Power Electronics Center (EPPEC) is to make significant educational, research, and practical contributions to the fields of electric power, power electronics, electric machines, motor drives, and vehicular power systems. The research institute organizes several short courses related to automotive technologies (vehicle power systems, power electronics, and electric

drives). Example of a student project in the field of automotive engineering from IIT: the Formula Hybrid Competition, challenges student teams from around the world to build hybrid race cars to compete in several events.

III. Comparison of different 120 ECTS-M.Sc. automotive educational programs

In this section, the automotive educational programs of some universities in Europe (Germany, Sweden, and Prague) are compared with the TU/e program. As discussed in Section 1, the universities or institutes, which offer a course program comparable (i.e., 2 years, 120 ECTS) with the TU/e program are selected for comparison. For example, Hochschule Esslingen, Stuttgart also offers a M.Sc. "Automotive Engineering" of 90 ECST (1.5 year program), yet is left out of consideration due to this constraint. This has been done by comparing the ECTS for each part of the study program. Summarized the following study program is offered by:

TU Eindhoven - M.Sc. "Automotive Technology"

- 8 compulsory courses (24 ECTS) + 1 project assignment/case study (6 ECTS) + Cars in context (3 ECTS);
- 9 elective courses (27 ECTS);
- Internship (10 ECTS);
- Graduation project (50 ECTS).

Chalmers University of Technology - M.Sc. "Automotive Engineering"

- 4 compulsory courses + 4 semi-compulsory courses (60 ECTS);
- 2 elective courses (15 ECTS);
- Automotive engineering project (15 ECTS);
- Master Thesis (30 ECTS).

RWTH Aachen - M.Sc. "Automotive Systems Engineering"

- 8 compulsory courses (52 ECTS);
- Approximately 4/5 elective courses (24 ECTS);
- German language course (6 ECTS);
- Industrial internship (9 weeks, 9 ECTS);
- Mini Thesis (260h, 9 ECTS);
- Master Thesis (4 months, 20 ECTS).

KTH - M.Sc. "Vehicle Engineering"

- 2 compulsory courses + (4+3+1) semi-compulsory (track+profile+other track/profile) (75 ECTS);
- 2 elective courses (15 ECTS);
- Master Thesis (30 ECTS).

CTU/ENSIETA/HAN - M.Sc. "Automotive Engineering"

- 12 compulsory courses (50 ECTS);
- 7 specialization courses (30 ECTS);
- French language course (5 ECTS);
- Marketing, economy (non-automotive) course (5 ECTS);
- Master Thesis (30 ECTS).

A. Study programs

In the Figure 1, a bar diagram is shown, which shows the ECTS for each part of the study program of the different universities. The generic core consists of compulsory, or also of semi-compulsory (e.g., depending on the track (and accordingly profile) chosen by the student at Chalmers (or, the KTH)). It can be observed that the average

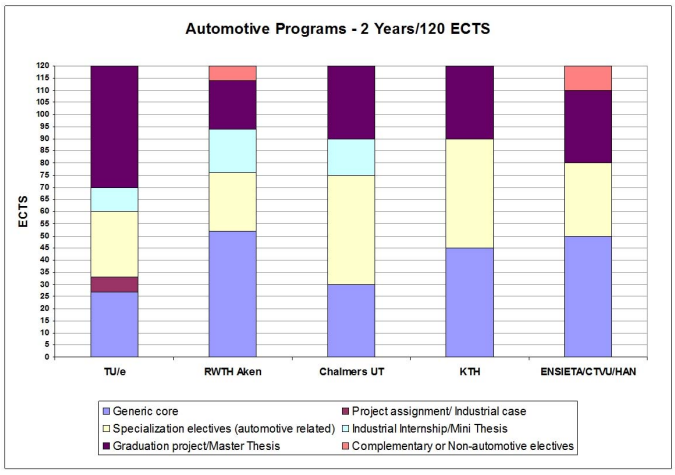

Fig. 1: Automotive Master study programs (120 ECTS) of different universities in Europe.

ECTS/course varies significantly between the different universities. Chalmers, KTH, and RWTH Aachen have relative high average values compared to the TU/e (3 ECTS/course), i.e., 7.5, 7.5, and 5.9 ECTS/course respectively. RWTH Aachen, and CTU/ENSIETA/HAN have also non-automotive elective courses. The non-automotive elective courses are devoted to language and/or marketing, economic courses.

The part of the program devoted to the Master Thesis of the TU/e is much larger compared to the other universities. The TU/e study program in contrary to the other universities offers also a multidisciplinary project assignment, or industrial case during the first year in close cooperation with the industry.

In comparison with the other universities, the study program of KTH and CTU/ENSIETA/HAN offers no (industrial) internship or mini thesis. Moreover, the study program of CTU/ENSIETA/HAN consists of relative large amount of 21 courses.

B. Generic core courses

In the Figure 2, an overview is given of the generic course program offered by the different universities. The overall course program of RWTH Aachen focusses also for a significant part on production, quality management, and manufacturing techniques (laser, welding technology). The course program offered by Chalmers has the most similarities with the program offered by the TU/e. Within the course program it is possible to choose between three different specialization tracks: vehicle dynamics, power train and safety. The generic core courses of TU/e study program are clustered in two main separate parts: driving guidance and efficient vehicle. These

TU/e - Automotive Technology	Chalmers - Automotive Engineering
Driving guidance	Track: Vehicle dynamics
Vehicle dynamics	Introduction to automotive engineering
Human factors	Vehicle dynamics
Real time architectures	Road vehicle aerodynamics
Software system engineering	Track: Powertrain
Efficient vehicle	Automotive prime movers
Powertrain components	Hybrid vehicles and control
Electric components	Internal combustion engines advanced
Energy management in automotive applications	Track: Safety
Secondary batteries and hydrogen storage	Passive safety
	Active safety
	The human aspect of traffic safety

RWTH Aachen - Automotive Systems Engineering	CTU/ENSIETA/HAN - Automotive Engineering
Automatic control	Internal combustion engines
Automotive engineering I & II	Mechanical and hydraulic transmissions
Automotive engineering III	Microelectronics in vehicles
Internal combustion engine fundamentals	Multibody modelling for vehicle systems
Production management A (or I)	Manufacturing processes design
Quality management	Project + 3D CAD
Systematic engineering design I	Vehicle dynamics
Tribology	Computation of fluid dynamics
	Vibration of vehicles
	Technology of automotive production
	Design of tools and plastic parts
	Vehicle concept, structure, aggregates and safety
	Marketing, economy and company finances
German language	French language

KTH - Vehicle Engineering
Compulsory courses for all students
Vehicle System Technology
Theory and Methodology of Science w. Applications
Track: Road Vehicles
Vehicle Components
Road Vehicle Dynamics
Internal Combustion Engineering
Hybrid Vehicle Drives
Track: Rail Vehicles
Rail Vehicle Technology
Rail Vehicle Dynamics
Electric Traction
Railway Traffic - Market and Planning

Fig. 2: Generic course program offered by the different universities.

divisions are the same as used by HTAS, a market driven innovation program set-up and steered by the Dutch automotive industry to focus automotive innovation on areas that match the strengths and ambitions of the Dutch automotive sector. Further, the program has a unique character due to its strong multidisciplinaire program, which is a joint initiative of the (6) departments of mechanical, electrical, chemical engineering, mathematic and computer science, industrial engineering and innovation sciences and industrial design. This in contrary to program offered by, e.g., Chalmers, RWTH Aachen, KTH and CTU/ENSIETA/HAN, which consists of only the involvement of maximum 2 different departments.

IV. Conclusion

The study described in this paper summarizes the educational programs of a number of prominent European universities and universities in the USA. In Europe there are only three universities, which offer a true Master's automotive educational program, which has strong similarities with respect to the total duration and work load of the program compared to the TU/e program. These universities are Chalmers University of Technology, RWTH Aachen, and KTH. However, the main focus of the TU/e differs substantial. The MSc Automotive Technology is: (i) strong applied academic education embedded within the framework of HTAS program; (ii) broad interdepartmental or multidisciplinary educational program; and, (iii) the system boundaries are at the integral vehicle system level including the interaction of the vehicle system with its surroundings.

In this way TU/e positioned the program within the European context, and assured international standards of both the university and of the professional community. The character of the systems approach offered by the program is unique, in Europe there are no programs comparable to the M.Sc. Automotive Technology in Eindhoven.

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