MOTOR VEHICLES – EDUCATION AND RESEARCH IN SERBIA

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INTRODUCTION

Motor vehicle, in the aspect of science and research, and also of profession, is a multidisciplinary object. It represents ideal training ground for implementation of the new scientific discoveries and technical achievements of the material field (first of all composites for auto body parts and even vital elements of the machinery group), of electronics and automatics (which find the widest application through automatisation of the control process and control), and of human disciplines such as ergonomy and professional occupational medicine.

In terms of the scope of production it can be the object of mass production, retail or individual production of the various types of vehicles and vehicles for various purposes, passenger vehicles (sport vehicles, family vehicles, public transportation vehicles), goods vehicles (light, heavy, and goods vehicles for special purposes).Each of these products demands specific knowledge.

- Education in developing and achieving global competitiveness, as well as positioning in the world's leading teams,or,
- Education in licensing the production of passenger/ goods vehicles programme or
- Education in producing and maintaining agricultural vehicles and working machinery, trailer vehicles?

Specialized, or General Mechanical Engineering?

Mechanical or Industrial or Traffic Engineering?

Strategic issue! In order not to turn into rhetorical question, it is necessary to wisely adjust the development of the whole society with education, considering surroundings and scientific, political and economic trends. Which with what? Should technical intelligence be directed so that education adjusts the needs and possibilities of economy or should economy be directed towards educational trends? Which came first, the chicken or the egg? The answer is neither, but the dynamic interaction of education, development and production should be provided.

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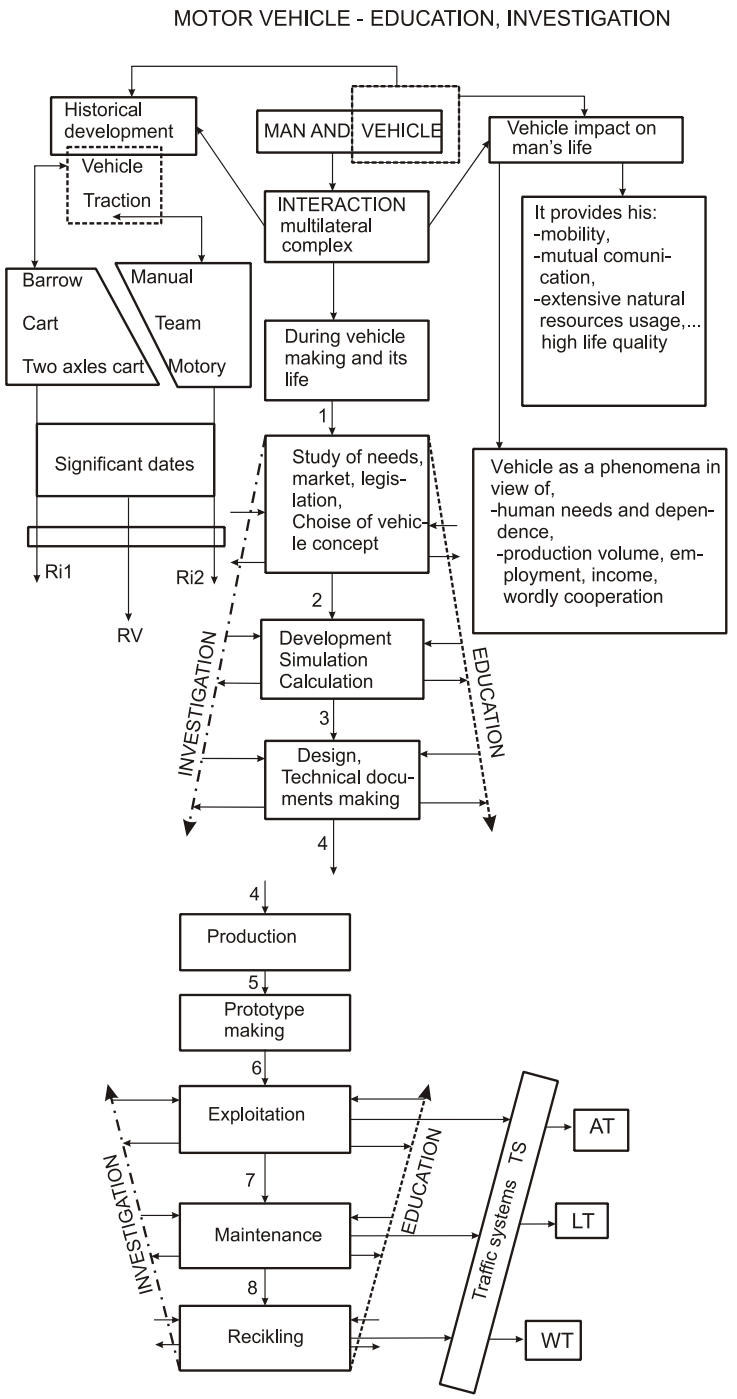


Figure 1 Connection between man and vehicles

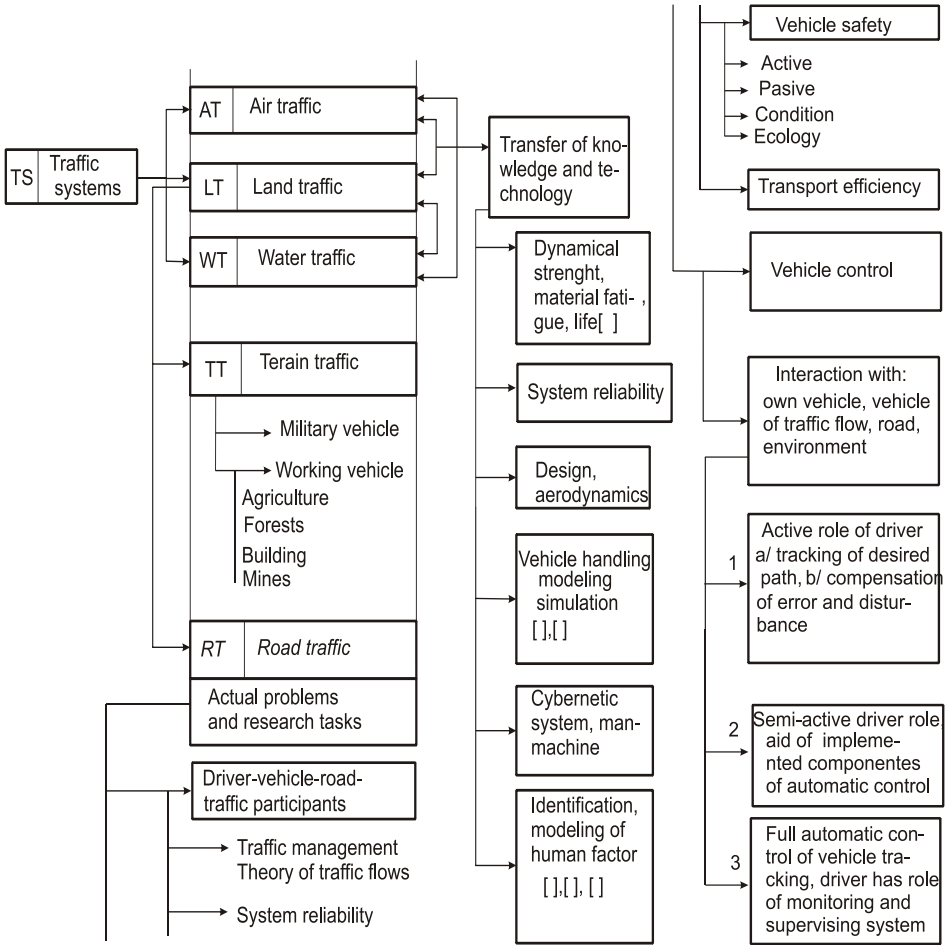


Figure 2 Connection between traffic, man and vehicles (left) and actual investigation (right)

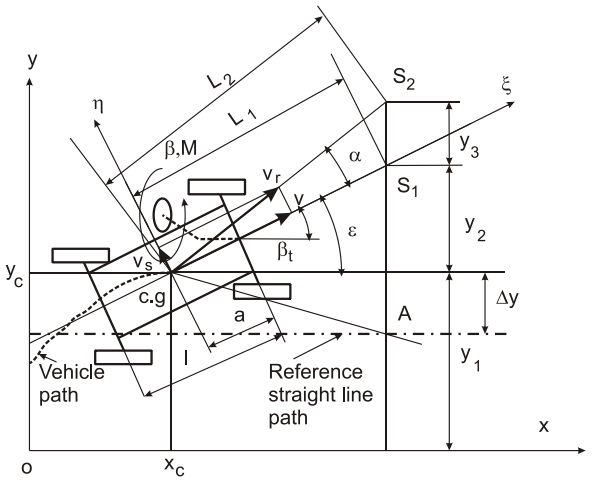
THE SITUATION IN SERBIA

Strategic plan to industrialize SFRY initialized the development of the motor industry in Serbia and in the region of Yugoslavia. Thereby they particularly insisted that the mainstream, development and subcontractors expand throughout all the country and this mainly had political, rarely economic background. Production machineries were built and education of engineers was needed. Industry demanded technically educated personnel, starting from the production workers, through machinery administrators – technicians and engineers, and all the way to the creative workers -constructors, technologists, analysts and experimental engineers. Thus technical schools of various levels of education arose, secondary schools, academies and faculties.

Faculty of Mechanical Engineering in Kragujevac was founded out of need to educate mechanical engineers that would become part of the former giant Factory „Crvena zastava“. It was based on two directions, Production engineering and Motor vehicles. Educational platform of the motor vehicles, as multidisciplinary and interdisciplinary

objects of research and production, expanded and changed. Development and education intertwined seeking support one from another. By this extracting of the motor vehicle's fundament from the rest of the production machinery, including automobile production, the development of the motor vehicles was stressed in our country. Disciplines fundamental in the vehicle's development were studied, first of all contemporary measurement methods and examination methodologies, computational mechanics and mechatronics, dynamics and thermodynamics.

For fifty years was done much. Some of the results are shown in the following figures.



$$\Delta Y = \Delta y + y_2 + y_3 \cong \Delta y + L_1\varepsilon + L_2\alpha$$

Figure 3 Geometric presentation of vehicle-visual field interaction on straight line path

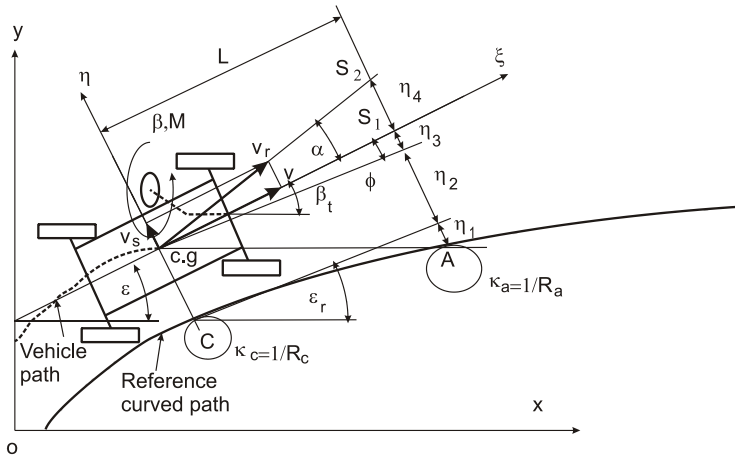


Figure 4 Geometric presentation of vehicle-visual field interaction on curved path

Geometric diagrams of a vehicle model following a reference straight line path and a reference curved path, to investigation in this paper, are given in Figure 3, 4, respectively.

Geometric diagram of vehicle model following a reference curved path, in Figure 4, is a generalization of previous model given in Figure 3.

Advanced lateral deviation of vehicle as sum $\eta_1 + \eta_2 + \eta_3 + \eta_4$, is oriented perpendicular on tangent of curved reference path in point C, near of vehicle centre gravity c.g, with adequate segments, $\eta_2 \rightarrow \Delta y$, $\eta_3 \rightarrow y_2$, $\eta_4 \rightarrow y_3$, and unique sight point distance L.

Segment η_1, is part of perceived deviation as coordinate of aim point A, from tangent on curved path in point C.

In the compensatory control mode, based on the previewed lateral deviation, command input from curved path is only one cue, the aim point A. On the other hand, in the anticipatory control mode, command input from reference curved path is curve segment finite length which driver estimates and uses as visual information.

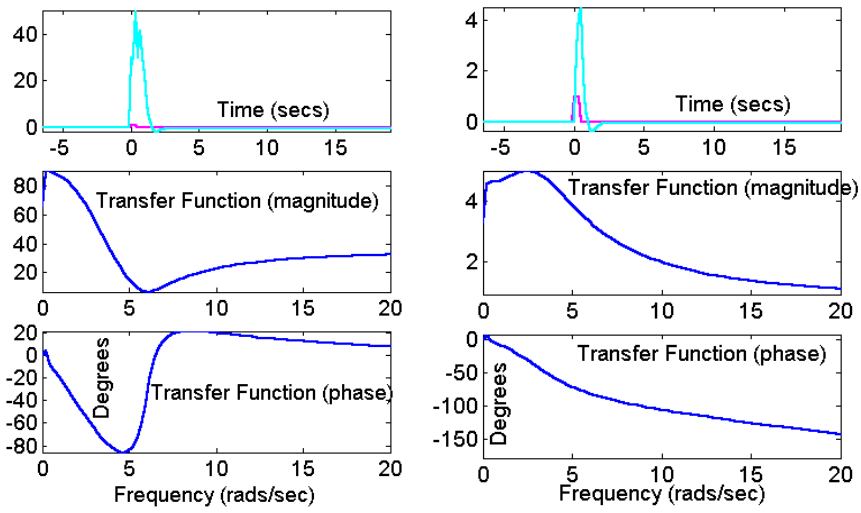


Figure 5 Vehicle transfer function, input – steering wheel angle, output: a/ lateral acceleration,b/ yaw velocity. Longitudinal velocity, 20m/s

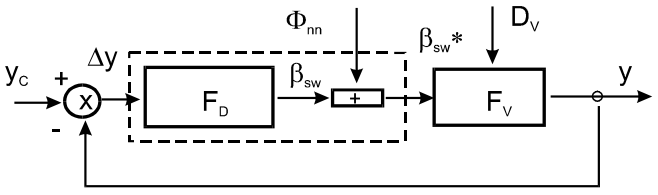


Figure 6 Block diagram of single-loop driver/vehicle system.

The rational of driver equalization can be approximated by ″ crossover model ″, according to Figure 6:

$$F_D F_V = \omega_c \frac{e^{-j\omega\tau_e}}{j\omega} \qquad (1)$$

where, τ_e– includes the neuromuscular time constant, T_N, as well as,τ.

Generally, drivers use multiple information as input for controlling the vehicle. Good multi-loop system structures are those which no require the driver equalization, for example, only gain plus time delay in each of the loops. But driver dynamics as a multi-input system is often approximated by equivalent a single loop system. In the study [12], driver dynamics is described by equivalent closed – loop system which comprising vehicle lateral position and yaw angle feedback loops from corresponding multiple loop. This model is useful to examine the vehicle with 2WS steering system which shows a close correlation between its yaw angle and lateral position response, Figure 7.

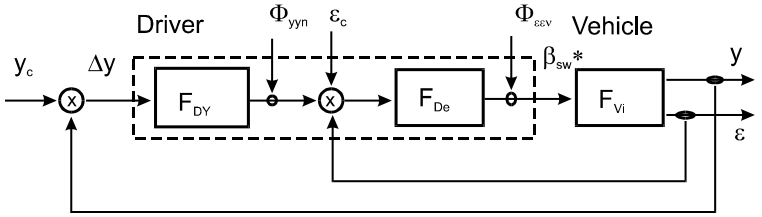


Figure 7 Block diagram a comprising multi-loop driver/vehicle system

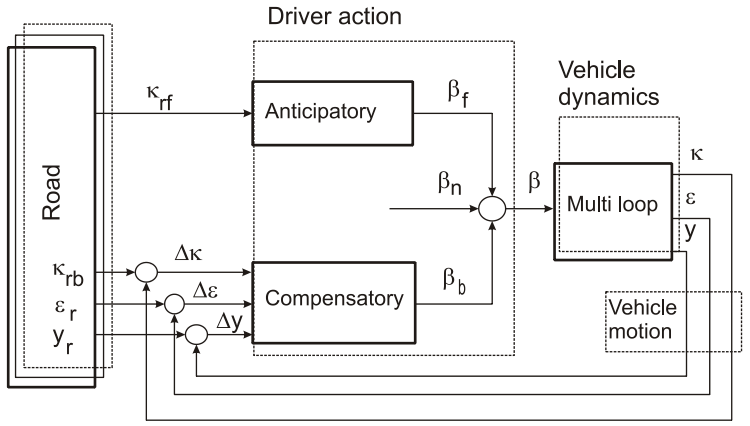


Figure 8 Block diagram of road-driver-vehicle control system

Driver can improve the system control performance by using derived path command information in visual field and operating in anticipatory mode. That is, driver can perform the steering task hierarchically into two levels, guidance and stabilization, [15], [16]. In the case of driving into a curve, driver perceives desired path curvature and responds to it an anticipatory open – loop control mode with a part of total necessary steering wheel angle. Based on the perceived path error in closed – loop compensatory mode the driver generates a correcting steering wheel angle, Fig. 4, 8, 9.

By forming driver model based on the concept – vehicle lateral deviation advanced in time, it assumes that driver operates on an estimated or projected lateral deviation error of vehicle centre gravity, Δy, Figure 3, 4. The perceptual preview time, as relation driver look – ahead distance and vehicle forward velocity results in a pure lead equalization term in effective vehicle dynamics.

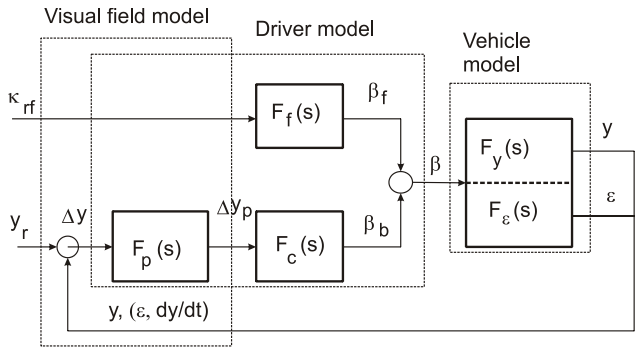


Figure 9 Model of visual field-driver-vehicle control system

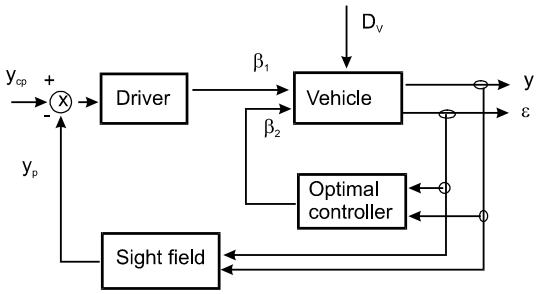


Figure 10 Block diagram of the driver/optimal controller/vehicle system

The vehicle do not possesses own stability of the lateral displacement in relation to desired path. To study the vehicle lateral stability the driver or other controller, which perform his function, must be included. In this paper, the behaviour driver/ (controller) /vehicle system and its components is considered according to block diagram in Figure 10. The following combination are examined: a) vehicle in the open loop with defined steering wheel position, b) vehicle in the closed loop steered by driver, c) vehicle in the closed loop steered by optimal controller, d) vehicle in the closed loop steered by driver and optimal controller.

2-axis Optical
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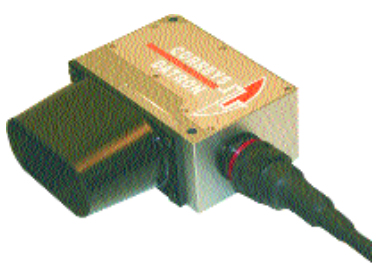
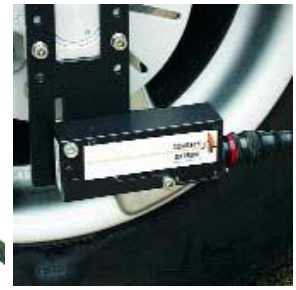




a)

b)

Figure 11 MSW/S - Measurement Steering Wheel for non-contact measurement of steering speed and angle

a) 2 – axis Optical CORREVIT Sensors (Speed, Distance, Slip Angle Measurement)

b) Sensors for non-contact measurement of steering wheel speed and angle

a) *b)*

c)

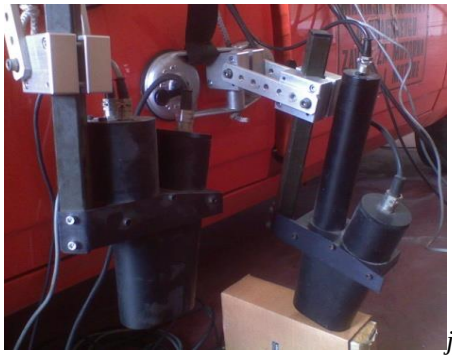
Figure 12 a)dynamic camber mesurement, b) wheel force transducer and dynamic camber measurement, c) Contidrom Proving Ground [21]

a)  *b)* 

c)  *d)* 

e)  *f)* 

g)  h) 

i)  j) 

k)  l) 

Figure 13 Sensors for Motor Vehicle Measurement: a), c) steering wheel speed, angle and torque, b) brake pressure HBM, d), e), f), h), i), j), k), l), vehicle lateral and longitudinal velocity Leitz – Correvit,L - , Q- Sensors, d), g) wheel angular velocity, own design.

(Motor Vehicle Laboratory, Faculty of Mechanical Engineering Kragujevac, MVL/FMEK)

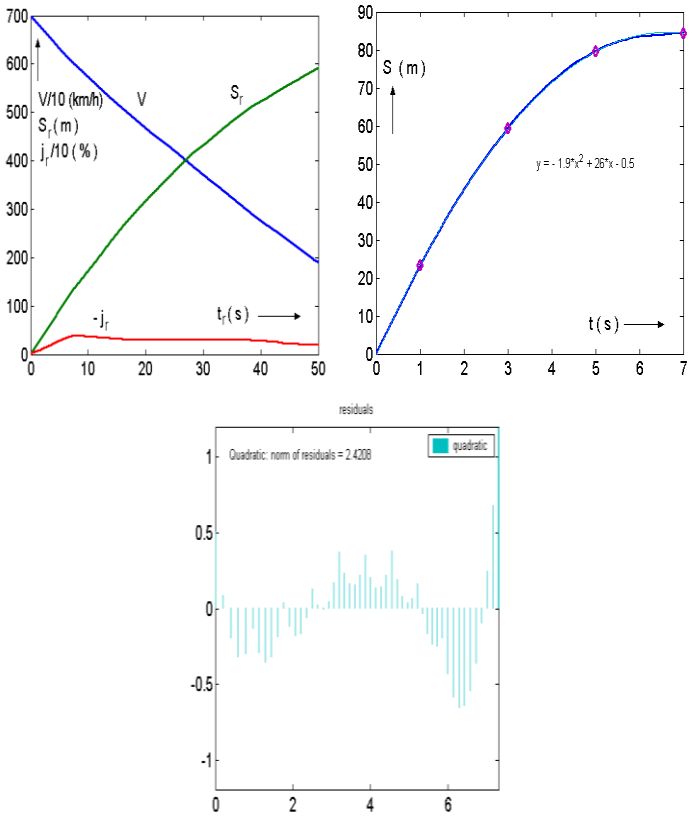


Figure 14 Experimental results of the vehicle traction and braking performance of MVL/FMEK

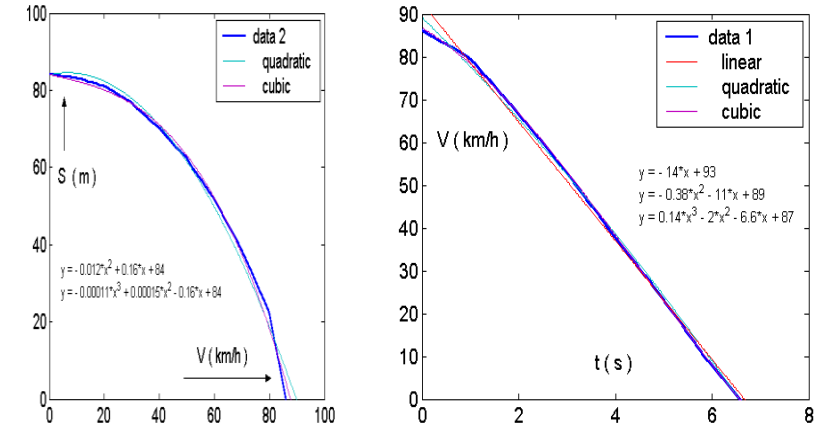


Figure 15 Experimental results of the vehicle traction and braking performance of MVL/FMEK

a)  b) 

Figure 16 Different condition to vehicle testing, [22]

The first personnel that were supposed to carry out the production burden were the mechanical engineers of the Department of the Faculty of Mechanical Engineering of Belgrade University, the 1960. generation. That generation could choose between the production engineering or motor vehicles in accordance with the needs of the industry in Kragujevac in those days. Besides Belgrade University, Universities of Novi Sad and Niš also existed but motor vehicles as an individual discipline were not recognizable. Capital cities of the Republics of the former Yugoslavia and Belgrade were leading in the development of the field of engines and motor vehicles, and Kragujevac was the first city from the inland that started the strong development of the integrated industry and education.

Automobile factory that developed as expansion of the already existing military technical industry, was based in Kragujevac but it had subcontractors all over Serbia and in other republics of Yugoslavia. As a huge novelty and support to the construction, calculations were made as well as experimental researches. These two areas were precisely the germ of the development of motor vehicles that sustained in Serbia mostly through modelling and aggregate examination.

Our faculty had foreign support during the 1970s through Humboldt, Fulbright and other scholarships for our PhD students who worked their dissertation mostly in Germany and America, but also in other European countries. After that they would come back to Serbia and bring their knowledge, educational spirit, and organizations of the most developed countries here to this very ground. Besides this personnel support, and creating of the human resources, we also received help in terms of the research equipment, thus unique contemporary measurement equipment from the West Germany (analogue computer and numerous analogue measurement instruments), as a development and cooperation support in the area of the motor vehicles, came to this very faculty.

After the year of 2000. a lot of donation were made for contemporary, digital research equipment, this was the support of the developed countries in order to surpass the abyss after the breakup of Yugoslavia and our perennial isolation, but the supplied equipment was utilized and oriented in a different way, because of the significantly different social circumstances. Very modest mobility donations were intended for the researches and teachers of the motor vehicles area, the area where great progress was made in the world, which further degraded higher education of this field after the motor and vehicle industry breakup.

This symposium is one of the branches out of the trunk of the synthesised scientific discipline "motor vehicles and engines". How long will it be thematically sustainable considering the fact that the economy support is getting weaker and weaker? Will it become

overview of the world situation or will it succumb to the trend of the industrial and traffic engineering development?

Universities, higher education and secondary schools in the motor vehicle area suffered great stagnation or even extinction as a result of social changes and economy situation. Transformation was needed, but it was implemented without any strategy, and when a strategy was adopted, it was not consistently applied, it was warped according to the personality strength or according to the inertia to sustain the existing with surface changes, the result was quite a chaos in higher education.

The reason for the transformation of the development of engineering into production engineering lies in basic need to withstand competition on the market of the higher education. After the isolation period, destruction and closeout of our economy we did not have a training ground for our students nor did they have a future in terms of the employment. We welcomed FIAT with open arms, a company that came to our country for its own profit and that requires production organisation, logistics and automatics, with English language knowledge by default. This is the reason why many our experienced engineers did not manage to find their place in this completely new surroundings. They have not been adequately prepared for this kind of technology and production organization, and it was too late to make efforts to master the new knowledge and skills. They forgot that intellectuals have to be perpetual students, in order to remain a competitor in the global market match. Besides, for the new process and volume of the production fewer people are needed, so the number of students and curriculum should have been adjusted to the innovated motor vehicle industry. How?

Present model of study, which continuously promotes the so called mobile students, allows that students go to higher levels of study in the developed countries, thanks to the adjusted and accredited programmes of study or to the research projects. This departure is mostly in one way, for the time being, that is from the parent country to the foreign countries. Are the causes of the one way traffic found only in the conditions for the research or in the living standard or in our misgiving that we will have to necessarily change ourselves by creating environment that will bring the new rules and new standards and habits. Isn't our inertia and a dose of self-love the reason for our slow integration in the developed world that frightens us a bit. If inertia and the fear from the ones that are better settle into higher education institutions, then the higher education and the whole society go downhill. If the ambition is heating up vanity and becomes so powerful that it conquers the space that should be conquered by the breadth of spirit, then the research turns into plagiarism or the personal success is shared as an apparent team success and the academic community is rushing to become "emperor in his new suit". What we never succeeded to valorise through the last reform of the higher education, and which is estimated worldwide, is the contribution of the intellectuals to the society. Did the insisting on the quantity of the printed papers and the number of students, rather than their spontaneous and natural expansion, give positive or negative effects the time will show.

Otherwise, the broader platform was created over time in mechanical engineering through interaction of classic, original engineering and electrical engineering with electronics, first of all, but also organizational sciences, human and bio-technical sciences, standardisation and technical law, so the mechanical engineers always had an open network of trails through their professional career. That network had knots and narrow paths, precipitous paths and wide, flat paths in its structure, so everybody could choose and change the road according to their abilities and affinities, there is a saying that "mechanical engineers know everything".

HOW TO CONTINUE?

How should the education and training for motor vehicles research be conceived? Did the development of the new disciplines significantly influence on divergence in mechanical engineering education, from the 30 year ago training, or the community orientation to its own production and import industry had the greater influence on educational changes. The answer is both. The development of the new scientific disciplines associated with IT "dragged" one part of the engineers to those new domains, which is a positive thing, while the destruction of the production resources and illegal trade caused to develop a great number of unaccredited business academies, that had a bad influence on the whole higher education system. It may not seem to be like that right away but rapid graduation and possibility to continue education caused the average level of the faculty students to descend. Economy destruction definitely caused the decline of the criteria on technical colleges because of the lack of the rapid employment motif, and getting the mechanical engineer for motor vehicles diploma was not easy a task so the number and the quality of the interested graduates for this kind of study decreased.

Therefore the solution for quality technical education lies in interaction with industry, which is now achieved through clusters, where colleges are increasingly included. This is not a new idea but promotion of region development and technical progress of IT networks creates favourable climate for this kind of cooperation. Economy-research-higher education is a triangle which is stable in every social system and this bracing gives results, whether it is achieved in region or through international institutional cooperation.

Significant participation of scientific research in higher education and a high level of permeating of these two domains raise university education above all the other heigher education. However, complete equalization of higher education and scientific research, degrades the very education because this imposes a match in which education loses tradition component. The educational and innovative component should undoubtedly be in strong correlation concerning the university education. What is the good measurement between these two components? It changes depending on the level of development and the gradients of scientific development in a society. Sometimes or more precisely somewhere their own research is dominant and somewhere the researches are interpreted and taken from the developed countries and education is dominant. Our country was not lucky enough, the motor industry and vehicle industry did not develop as they started to develop during the 1970s and the 1980s, but the ascend was cut down during the 1990s, so the researches stagnated and apart from some exceptions we had to follow what happens in the area of the motor vehicles in foreign countries and reproduce this to our students. Our engineers lost their job and most of them never recovered professionally.

Globalisation that imposes high speed changes, emphasizes competition, cruel match between the most prestigious who take as their partners the most capable ones who are able to follow them and contribute to their success, causes vanishment of those who are not capable to be the part of this composition, which has its tracks through projects such as Horizont 2020, and its projection reflects through highly specialized clusters of the developed. Social circumstances, region development, circumstances and political climate imposes business economy that especially reflects on university education in techniques and economy. Motor vehicles completely depend on these two areas.

Europe accepted the new model of graded studies and huge diversifications in the curriculums, educating the new profiles including interdisciplinarity and also often multidisciplinarity. On the other hand, the narrow domain is created for the most talented, the so called excellent scientific research field, the excellent centres are created, research

and development centres and university centres that raised the relevant platform of knowledge in a unique synergy. This platform has clearly defined scientific areas that are priority to develop till the year of 2020 and traffic and vehicles are among them, but in a different dimension and with the aim of different knowledge outcome. The world of technique sharply polarized, high technologies and researches in the field of micro, nano and opto technologies are on one side, and on the other side are highly organized production systems which function as black boxes and for which good logistics, top organization and communication should be provided, the rest of it regulated someone who knows it. Where are Serbian higher technical schools and technical faculties in the whole story?

CONCLUSIONS

At this point it is certain that the broader space is being created for the mobility of the teachers and students, that international cooperation and compatibility of the curriculum are forced, which is a positive thing, however our own home is being neglected in terms of national economy development. Total acceptance of everything that grows on somebody else's field causes our becoming humble guests in our own house. Greater commitment to the national interest will not shut the door on the world. On the contrary, our recognizable identity in education and a level of usage of that knowledge to raise the living standard will be reflection of the higher education success. .

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