# Ingineria Automobilului

Romanian Automobile Register
SIAR
Society of Automotive Engineers of Romania

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## Renault Technologie Roumanie

## TITU TEHNICAL CENTER

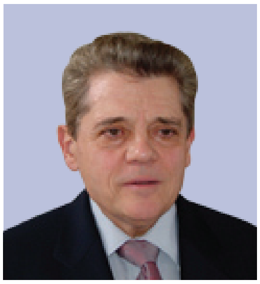
- Engine thermal management
- Interview with the General Director of RTR
- SIAR Anniversary
- Research Laboratory at the University of Craiova

SIAR IS AFFILIATED TO

FISITA — INTERNATIONAL FEDERATION OF AUTOMOTIVE ENGINEERING SOCIETIES

EAEC — EUROPEAN AUTOMOBILE ENGINEERS COOPERATION

# Society of Automotive Engineers of Romania (SIAR) is Celebrating Two Decades of Activity



Founded in 1990 as a professional NGO, SIAR is the frame of automotive engineers, together with other professionals carrying out activities in education, design, manufacture or operation of the car, with the main aim of stimulating and accelerating the exchange of information in this field, creating direct links between specialists and developing relationships with the related organizations from other countries. It is the materialization of an earlier automotive engineers desire, expressed repeatedly during their meeting in scientific sessions and congresses. A special role in organizing all of these events has had universities and research institutes in the field, such as: University Transilvania of Brasov - organizer of CONAT, University POLITEHNICA of Bucharest (before 1992: Bucharest Polytechnic Institute) - organizer of ESFA and University of Pitesti - organizer of CAR.

SIAR is the successor of the Association of Automotive Engineers in Romania - AIAR, professional organization that was founded in 1988 and affiliated to the National Council of Engineers and Technicians of Romania (CNIT). Society of Automotive Engineers of Romania was registered at a District Court in Bucharest, the civil decision no. 57 January 1990 and has been taking over the AIAR assets and members. The goal of the new society was to promote and develop collaboration with relevant international forum and related societies from abroad.

Shortly after this, SIAR has been affiliated to FISITA and then to the European Group EAEC, accomplishing, this way, an opening to the world elite of automotive engineering.

The bilateral collaboration with SAE International – USA an SIA – France allowed the SIAR members to become in the same time members of this societies, having particularly advantageous conditions.

With support from SAE International, new libraries were created in Bucharest and Brasov branches.

The editorial board was founded, and they published the first number of RIA – Magazine of Automotive Engineering. Nowadays, RIA appears on paper with support from Romanian Auto Registry and also in electronic format, in parallel with SIAR Info Bulletin.

Another side of SIAR's activity was the organization of scientific events. If in the first few years, it was difficult to organize a national conference every 2 or 3 years, in the present it is a custom that each year, by rotation, five of the university center braches from Bucharest, Brasov, Pitesti, Cluj-Napoca and Craiova to host a SIAR International Congress.

Something noteworthy is the organization during the congresses of some sessions dedicated to students and young engineers with prizes for the most valuable papers.

The development of the international relations in the field, raised the number of Romanian specialists participating at the scientific manifestations organized by FISITA, EAEC and national organizations.

New bonds and scientific collaborations were made between well-known companies from the automotive industry – Schaeffler Technologies GmbH, BOSCH, Renault Technologies Romania etc., as well as national mechanical engineering faculties.

Nowadays, when automobile's development is made on an international scale, by cooperating with important companies and attracting the scientific potential from universities, SIAR aims to stimulate and promote the Romanian research as integrated part of the international research.

To all the colleagues that participated with such passion and devotement to our organization activities, I address you many thanks and best wishes on this anniversary date.

Prof. Dr. Eng. Eugen Mihai Negrus
President of SIAR

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# RTR – a Center of Excellence in the Automotive Industry

## Interview with Sorin Buşe, RTR General Manager

*Sorin Buşe took over the management of Renault Technologie Roumanie, on October 1st 2010, replacing Philippe Prével. With 20 years of experience in the automotive industry, at an international level, Sorin Buşe joined the Renault Group in 2008 and set up to guide RTR on the path of professionalism and excellence in engineering.*

***Ingineria Automobilului: What did you discover in your first year at RTR and which are RTR's priorities for the next period?***

**Sorin Buşe:** From my first visits here, in 2008, I discovered a young organization, with incredible potential and an open and positive atmosphere. The RTR employees have a very good theoretical training and this is starting to have its confirmations on the practical side as it was proven with the Duster project. The RTR teams have a high level of energy and potential and my role is to create an environment for their development, to give them a practical finality.

Without a doubt, the conception of the vehicles that will replace the Logan range is the 1st degree priority for me and for every RTR employee. This is the moment when we are asked to perform at a high level as we proved we could with Duster.

On the long term, my responsibility as manager is to ensure that the organization is sustainable. This is why I have created a pole of research and innovation at RTR because every engineering center must have a creative function as well. Our engineers have to be able to break standards when they want to, not just follow them.

Last but not least, an immediate priority is the management of change at RTR: from a company oriented towards the interior and France, RTR is becoming a center of the Renault engineering network and must open itself towards the exterior and coordinate teams and activities in other countries. On the medium and long term, RTR will become a center of excellence in Romania and the nearby region automotive industry.

***I. A.: What is expected of the Titu Technical Center, launched in September last year, and how could the scientific and technical potential of the specialists and students from the Romanian technical universities be put to good use?***

Titu Technical Center is the missing link from the Renault automotive chain in Romania: now we have all the activities from design to after-sale. It is the key element for the complete development of automotive projects in Romania. This is a good thing for the development of abilities in RTR, for our young engineers who will have physical prototypes next to their 3D design.

Titu Technical Center will also allow us to collaborate with universities on other fields than the ones we have approached so far: primarily research and innovation because now we have more complex tools and top-level technologies in the automotive field.

***I.A.: What do you think of the professional training of the automotive engineers in Romania and of those in Renault in particular? What is lacking in their training and how could this be fixed by modernizing the educational programs in the Romanian technical universities?***

Romanian students have in general a good theoretical training. Along the recruitment process, we did identify a few points that could be improved and we have already made a few changes together with a few universities. An example is project management.

In 2007, together with the main technical universities (Bucharest, Iasi, Craiova) and the Technical University of Compiegne (France), we launched a post graduate training – Automotive Project Engineering, which focuses on project training and development of transverse abilities.

From 2009, the training became an official master program in the partner technical universities from Bucharest, Craiova, Iaşi, Piteşti.

***I. A.: As member of the SIAR Honor Comity and supporter of the SIAR International Congresses, what do you think of the collaboration between RTR and SIAR?***

SIAR, as professional association, has an important responsibility in the evolution of the automotive engineering in Romania, first thru its continuous contact with universities but also with the many automotive companies.

I believe that SIAR and RTR need to become vectors of an industry transformation, to help create a bigger closeness between the theoretical and practical fields, between education and employers.

The collaboration with SIAR started in 2007, in the first year of existence for RTR and we want it to continue as it is in the benefit of both parties. RTR will continue to support the SIAR and Romanian technical universities conferences. These conferences are an opportunity to connect the university life with big automotive companies, thus exchanging experience and know-how.

On the other hand, as we have already shown, one of our priorities for the future is linked to innovation and research. We want to become a center of excellence and our capacity to find solutions is tightly connected to our collaboration with universities and research institutes. We already have a team that deals with this subject and which will be interacting more and more with the specialists from universities. I am convinced that in time our partnership will evolve benefiting both parties and especially the Romanian automotive industry.

***Ingineria Automobilului*: *Think you very much, Mr. General Manager, for this interview.***

# Urban Traffic Control Systems


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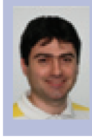

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## REZUMAT

*În lucrare se face un studiu al soluțiilor posibile pentru îmbunătățirea condițiilor de trafic, se analizează cei mai importanți factori care intervin în ecuațiile ce modelează fluxurile de vehicule. Sunt analizate modificările posibile ale geometriei intersecțiilor și impactul pe care acestea le pot avea și cu o trecere în revistă a tipurilor de sisteme de management al traficului. Este prezentat și un algoritm pentru gestionarea situațiilor de congestie, pentru care sistemele actuale nu oferă o rezolvare corespunzătoare. Acest algoritm a fost testat pe date reale de trafic, dovedindu-și eficiența.*

In the paper is presented a study of possible solutions for improving traffic conditions, and are assessed the most important factors involved in the equations modeling the flow of vehicles. Are analyzed the possible changes for the geometry of junctions and the impact they may have and is made an overview of the types of traffic management systems. Is also presented an algorithm for congestion management, situation for which current systems do not provide a proper solution. This algorithm was tested on real traffic data, proving its effectiveness.



**Keywords:** intelligent transportation systems, urban traffic systems, traffic lights, traffic management, the „green wave“ system


## INTRODUCTION

Since the road network capacity is often exceeded due to the exponential increase in the number of vehicles, traffic jams are a daily constant. Studies done by various companies in the field have led to the implementation of urban traffic management systems, but these prove their limits in certain situations. This paper is an overview of existing algorithms, presenting a solution for the management of special circumstances, namely traffic congestions.

**Modeling of urban traffic.**

**Traffic management solutions**

For a signalized junction where are no queues of vehicles, the relation is:

$$v_{oi} V_i = v_{ii} T \qquad (1)$$

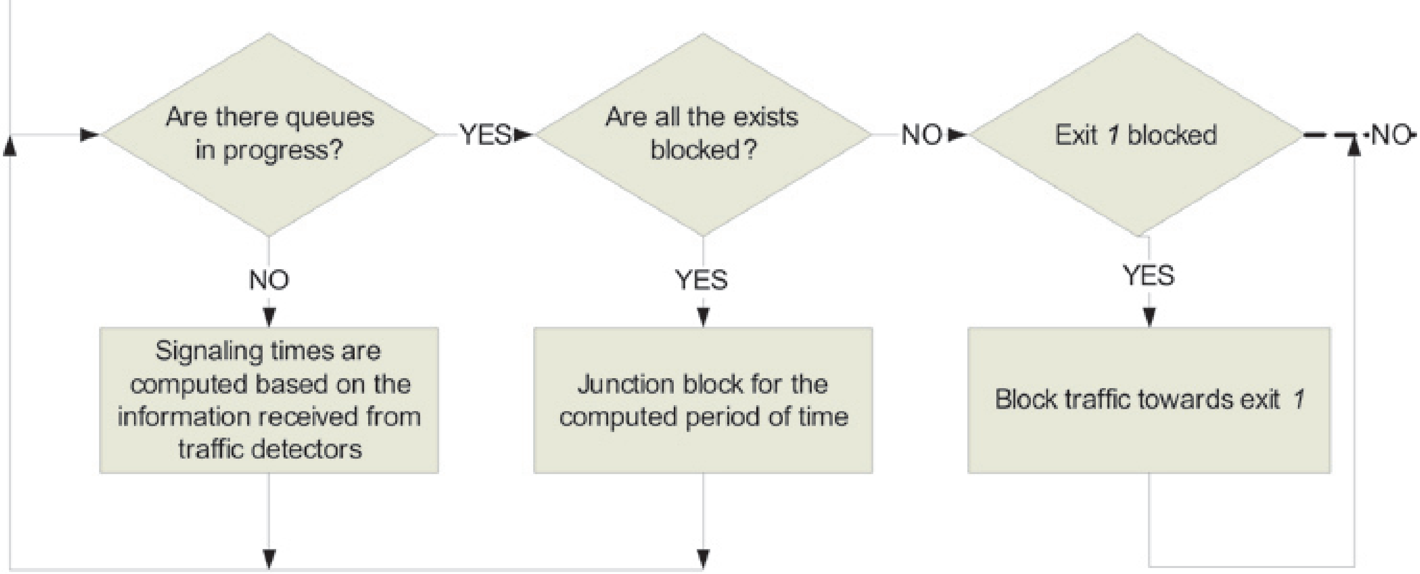
where:
$i$ = number of entries into the junction;
$v_{ii}$ = number of vehicles that arrives at the junction in one second from the direction $i$;
$v_{oi}$ = number of vehicles that leaves the junction in one second from the direction $i$;
$V_i$ = green time for the direction $i$;
T = total cycle time.

On the other hand, the number of vehicles leaving the junction is given by,

$$v_{oi/h} = v_{ot} \cdot N \cdot f_l \cdot f_{vg} \cdot f_g \cdot f_p \cdot \cdot f_p \cdot f_{ba} \cdot f_z \cdot f_{vdr} \cdot f_{vst} \qquad (2)$$

where:
$v_{oi/h}$ = number of vehicles leaving the junction in one hour;
$v_{ot}$ = theoretical number of vehicles exiting the junction on each lane, the default value is 1800 vehicles / hour, green time, lane;
$N$ = number of lanes in lane group considered;
$f_l$ = adjustment factor for lane width, standard width is 3.6 m;
$f_{vg}$ = adjustment factor for heavy vehicles in traffic;
$f_g$ = adjustment factor for the slope;
$f_p$ = adjustment factor for the existence of adjacent parking lanes and number of park-

Fig. 1. The decision diagram



ing maneuvers on that lane;

$f_{ba}$ = adjustment factor for blocking effect produced by local public transport stop in the station located before the junction;

$f_z$ = adjustment factor for area type (central, peripheral, etc.);

$f_{vdr}$ = adjustment factor for right turns in lane group;

$f_{vst}$ = adjustment factor for left turns in lane group.

In addition, the vehicles movement capacity is also influenced by other traffic regulations (road signs) and the behavior of drivers (those factors fall into other categories of analysis and are only partially studied in this paper).

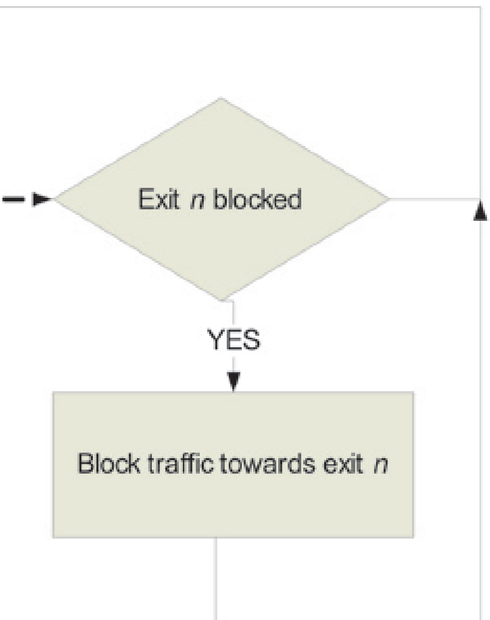
In relation (1) is known the value of $v_{ii}$, resulting from the information obtained from traffic detectors. From the relation may result, depending on how the problem is formulated:

• $v_{oi}$ - as parameter that depends on the traffic light;

• $V_i$ - in case $v_{oi}$ is determined by equation (2) and total cycle time is set - only for the junction analyzed or for an entire artery (in case there is an implementation of „green-wave" system, for which the traffic light cycle length must be equal for all junctions, or can be written as a multiple of the standard value);

• $T$ - when all the other values are known.

When the values of the parameters previously mentioned no longer respect the relation (1), queues of vehicles are formed in the junction. A special situation arises when the length of vehicle queues exceeds the storage space existing between road network nodes and adjacent junctions are blocked.




To solve the problem there are several approaches. A solution will involve maximizing the value of $v_{oi}$, meaning an increase in the number of vehicles leaving the junction (which involves changes in the geometry of the junction, the maneuvers permitted or the signaling).

Another solution, which is the best, is to build bridges or tunnels, through which traffic crossing paths disappear. Most times this cannot be done due to the lack of space in cities and high costs.

By adjusting the geometry of the intersection the values can be modified for:

• N (number of lanes): involves widening the road, where there is sufficient space or implementing any method of sharing available lanes between directions - which can be done statically or dynamically (for situations where traffic flow changes significantly depending on time of day or day of week).

• $f_l$ (bandwidth factor) can be improved by widening the lanes - which is possible only if there is enough space; this factor will increase also by prohibiting parking in certain areas, leading to partial or complete release of the first lane. The full release of the first lane also increases the value of N.

• $f_{vg}$ (factor for heavy vehicles in traffic) can be improved by banning the access of heavy vehicles in certain areas. Freight traffic may be restricted in certain areas or for certain periods of time.

• $f_p$ (adjacent parking factor) can be corrected only if there is are parking areas nearby, for crowded cities $f_p$ cannot change, the need for parking facilities leading to the marking of all available spaces as parking.

• $f_{ba}$ (adjustment factor for blocking effect produced by public transport vehicles stopping at the junction): this can be corrected by placing public transportation stations after the junction, so they do not obstruct transit of vehicles during the green time. In addition, where there is space, the stations can have pockets in which case is eliminated the blocking of a lane during the stop of the bus.

• $f_{vdr}$ (right-turn adjustment factor) can be corrected by the existence of blinking yellow (green) color at the traffic lights for this turn, which allows the reduction of vehicle queues. In addition, one can adjust (where there is sufficient space) the curvature radius so that the turn can be performed with higher speed.

• $f_{vst}$ (left-turn adjustment factor) can be improved by introducing a separate phase at the traffic light for left turns and by creating a separate lane for this.

The value $v_{oi}$ can also be increased by the signaling design, meaning by increasing the percentage $V_i$ of the total cycle time. This is the solution offered by the current traffic management systems, which modify the signaling design depending on the traffic demands for crossing the junction. These systems may have different implementations, from the fixed-time systems (that assume a constant number of vehicles reaching the junction) to the adaptive systems (which collect real time data from traffic detectors and continuously adjusts the signaling times based on current traffic conditions). Below is a brief overview of the types of traffic management systems.

*Fixed time systems*

These systems rely on the existence of only small variations in traffic flows and thus the traffic lights may have the values throughout the day. The most important aspect is that these systems do not respond to traffic pattern changes over time.

*Systems with selection of traffic light plans*

Such systems use multiple fixed-time plans and select the most appropriate one depending on time of day or information received from traffic detectors (depending on the implementation's approach). When necessary, the system can run a specific plan for special events.

*Systems generating traffic light plans*

These systems receive data from traffic detectors and generate traffic lights plans with fixed time. Thus, the system is able to respond to unexpected incidents, but does not allow major changes to the existing plan and therefore it is possible that in certain situations it may not provide an adequate response.

*Centralized dynamic systems*

These systems collect all traffic information in a central computer which then manages traffic controllers. Such a system can provide a prompt response to traffic requests, having the advantage of storing in one place all the relevant information obtained from detectors and other sources.

*Dynamic systems with distributed processing*

A major difference between centralized dynamic systems is given by the communication system used. Traffic controllers from a centralized dynamic system are directly related to the central station, while within the dynamic distributed system each traffic controller is connected to its neighbors. Thus, the message can be transferred between any two traffic controllers, being guided to reach the destination needed. In addition, a local adaptation can be performed to change the traffic light plans imposed by the central office. Local adaptation can increase the green time in some cycles, leading to an optimization of traffic.

Most commonly used algorithms for traffic management (such as SPOT / UTOPIA, SCATS, SCOOT) aim to maximize the number of vehicles leaving the junction, considering that if the next traffic controller knows this number it can achieve an adaptation of traffic light plan to manage the traffic flows. This situation is valid only if the network isn't already congested, in which case the redistribution of traffic flows through traffic lights is no longer effective.

A second direction to seek for the solution of eliminating the queues of vehicles is to minimize the value of $v_{ii}$, meaning reduce of the number of vehicles reaching the junction.

Is assumed that in case of congestion, traffic lights cannot dissipate the flows of vehicles from a road network node, and thus queues of vehicles are created. If the vehicle queues' length exceeds the distance between two nodes of the road network, the problem cannot longer be solved by traffic lights, but only by the intervention of police or after the rush hour has passed and the number of vehicles has reduced.

A study was made for the controlled blocking of vehicle access into the junction, which intended to block the access through traffic lights in order to prevent the creation of vehicle queues that block the adjacent junctions. Thus, the signaling system operates similar to a police agent, allowing vehicles to pass in the directions that are not congested (if any) or completely blocking access to the junction until the one or more outputs get free. From the analysis carried out was concluded that for most situations, total block time do not exceed 3 seconds, which is considered to be an acceptable situation. If the total blocking time set has a bigger value (determined based on the need for long queues of vehicles not increase too much), it is considered necessary to inform the drivers in order to avoid the dangerous situation in which they may conclude that traffic lights do not work.

The decision diagram for the algorithm is shown in figure 1:

The solution was considered useful in terms of the following criteria:

- an blocked junction can hardly unblock and in addition can induce the drivers an attitude of ignoring the indication of traffic lights;
- a driver information panel prevents the false assumption that traffic lights do not work, conclusion that could be reached by drivers if they see that all the traffic lights in the junction display the red color;
- by preventing junctions' blocking is reduced the travel time and thus are reduced the emissions of substances, namely pollution; as a consequence there may be a reduction of noise pollution caused by horns.

The algorithm was tested on the route Piața Iancului -> Universitate, in two variants of implementation. The first one pursued individual analysis of junctions with the objective of maintaining the queues' length below the maximum allowable value. In the second case was tested a possible implementation of the „green wave“ system in case of congestion, meaning the creation of an area where is applied this principle by shifting the waiting time on the artery to the entrance into the area, maintaining the restriction for the maximum allowable length for queues of vehicles.

After conducting the simulations was concluded that the implementation of such algorithms is effective as the total travel time decreased significantly: for the morning rush hour the reduction is 64% and for the afternoon peak the travel time decreased by 49%.

## CONCLUSIONS

To solve the traffic problems have been tested and are constantly improving and testing new methods of managing the increasing number of vehicles that request access to the urban road network. So far, the solutions address partially the problem and only for specific situations. When the number of vehicles exceeds the capacity of the road traffic queues and congestion of vehicles that tend to block traffic are inevitable. Due to limited space in cities, the ideal solution would be to eliminate road crossings by bridges or tunnels, but this cannot be applied many times. In these circumstances, the only solutions are to increase the transport capacity (and not the number of vehicles), which involves limiting the access of private vehicles, promotion of the public transport or development of new transportation systems that ensure the move of a significantly higher number of travelers in the public space.

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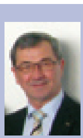
# Modren Thermal Management for Internal Combustion Engines

## How much water does an engine need?



Eduard GOLOVATAI-SCHMIDT

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### REZUMAT

*Articolul prezintă o pompă controlată de răcire pentru controlul temperaturii motorului în concordanță cu cerințele specifice. Obiectivele semnificative ale dezvoltării administrării temperaturii sunt reducerea consumului de combustibil, durata de viață a motorului mai mare şi creşterea confortului. Datorită pompei de apă controlate, volumul lichidului de răcire poate fi controlat în funcție de condițiile de funcționare a motorului iar eficiența poate fi mărită prin ajustarea deschiderii rotorului. Obiectivele dezvoltării în acest caz au fost atinse prin modificări inteligente în combinație cu componentele existente. Integrarea acestei pompe controlabile de răcire şi a altor componente variabile în sistemul de management termic este o provocare promițătoare în viitorul apropiat. Managementul termic, este un factor important în reducerea emisiilor de $CO_2$. Acest articol prezintă motivele pentru utilizarea unui sistem de management termic, o analiză a cerințelor şi o abordare a implementării unui astfel de sistem.*

### ABSTRACT

Thermal management is an important factor for reducing CO2 emissions. The term „thermal management“ describes the efficient control of thermal energy flows in vehicle in accordance with the specific requirements and the prevailing operating and load conditions. As a result, vehicle emissions can be reduced, and the thermodynamic and mechanical engine efficiency can be improved. This leads to lower fuel consumption, a longer engine life and improved thermal comfort. The coolant temperature should ideally be adjusted depending on the operating condition of the engine. During cold start, the combustion engine should heat up rapidly in order to achieve a significant reduction in engine friction. Rapid heating of the engine oil and the resulting decrease in oil viscosity are the decisive factors. The heat generated by the engine must therefore not be dissipated by the coolant but used for heating the engine oil. At low and medium loads, high coolant temperatures of approx. 110°C are desirable for further reducing engine friction. To prevent knocking of the gasoline engine and reduce the enrichment of the mixture, the coolant temperature should preferably be reduced to approx. 80°C at high loads and high speeds. This article presents the reasons for the use of a modern thermal management system, an analysis of the requirements and an approach for implementing such a system. **Main Section** - Thermal management is an important factor for reducing $CO_2$ emissions at internal combustion engines of conventional type. This article presents the reasons for the use of a thermal management system, an analysis of the requirements and an approach for implementing such a system. **Keywords** - Thermal Management, Variable Water Pump, Engine Heating, Engine Cooling

### THERMAL MANAGEMENT

The term "thermal management" describes the efficient control of thermal energy flows in the vehicle in accordance with the specific requirements and the prevailing operating and load conditions. As a result, vehicle emissions can be reduced, and the thermodynamic and mechanical engine efficiency can be improved. This leads to lower fuel consumption, a longer engine life and improved thermal comfort. The coolant temperature should ideally be adjusted depending on the operating condition of the engine (Figure 1).

During cold start, the combustion engine should heat up rapidly in order to achieve a significant reduction in engine friction. Rapid heating of the engine oil and the resulting decrease in oil viscosity are the decisive factors. The heat generated by the engine must therefore not be dissipated by the coolant but used for heating the engine oil.

At low and medium loads, high coolant temperatures (approx. 110°C) are desirable for further reducing the engine friction. In addition to the above advantages, the acoustics of diesel engines can be improved by reducing the ignition delay time. Intelligent thermal management can influence the evaporation rate and thus the ignition delay. To prevent knocking of the gasoline engine and reduce the enrichment of the mixture, the coolant temperature should preferably be reduced (to approx. 80°C) at high loads and high speeds. Intermediate stages must be defined between the two limit values for the coolant temperature. These vary depending on the combustion engine and can serve diverse goals (reduced friction, optimized combustion, lower raw emissions, increased comfort etc.).

The ideal thermal management system should be able to adjust the relevant coolant temperature in accordance with the above requirements.

Thermal management measures can achieve fuel savings of up to 4% in the NEDC (Figure 2).

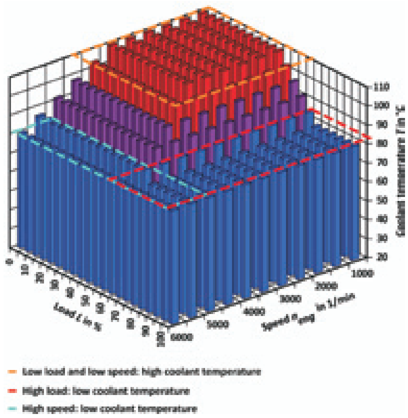


Fig. 1. Required coolant temperature depending on load and speed from [1]

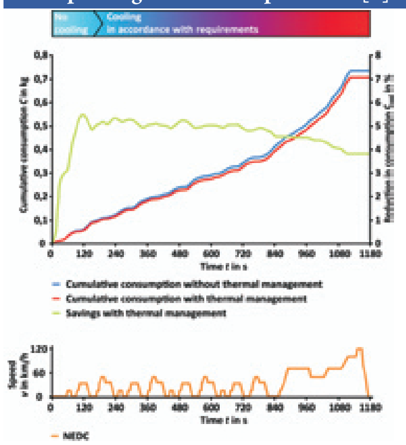


Fig. 2. Savings due to thermal management from [2]

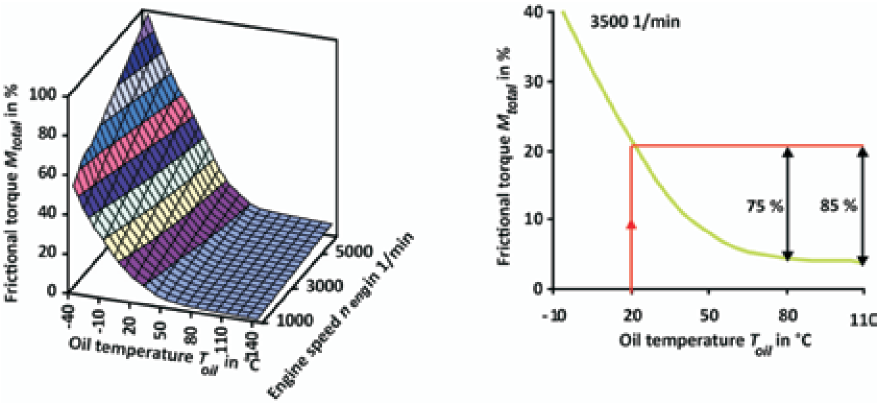


**Fig. 3. Reduction in engine friction from [3]**

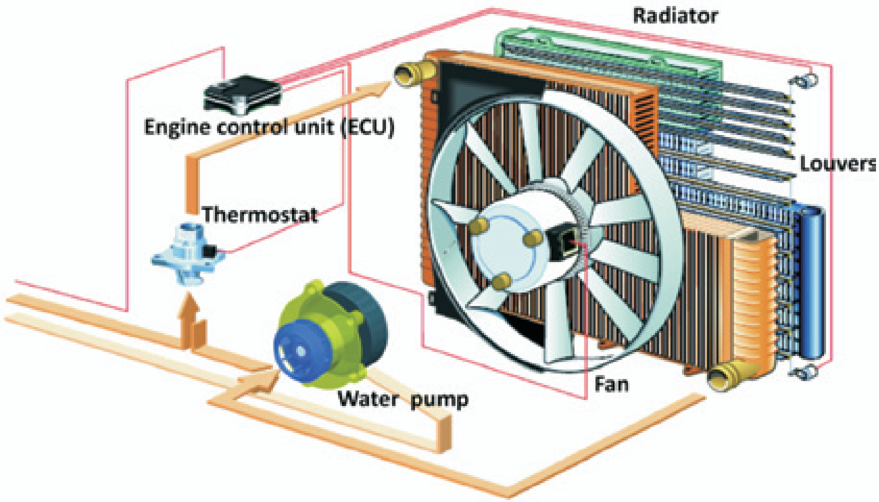


**Fig. 4. Components of thermal management from [1]**

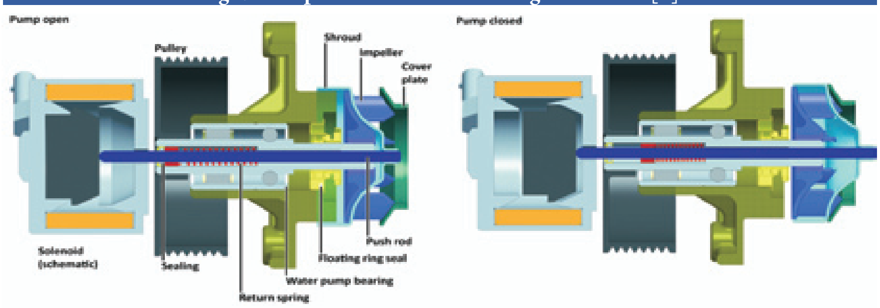


**Fig. 5. Design of a controllable water pump**

The blue curve shows the accumulated consumption of a reference engine, the red curve that of an engine with a thermal management system. The green curve indicates the savings in percentage terms that can be achieved in the NEDC with the thermal management system. Significant savings potentials of more than 4% can be expected particularly in short-distance driving operation. This is mainly due to a more rapid heat-up of the engine and the corresponding reduction in friction.

Figure 3 gives an impression of the possible reduction in engine friction. If the oil temperature increases from 20°C to 80°C, the total frictional torque of the engine decreases by 75%. At an oil temperature of 110°C, it decreases by as much as 85%. This shows that rapid heating of the engine oil and operating the engine at the highest possible temperature make a significant contribution to reducing friction and therefore fuel consumption.

## COMPONENTS FOR THERMAL MANAGEMENT

All components in the cooling circuit as shown in Figure 4 – radiator, fan, louvers, thermostat, engine control unit, and water pump – must in principle be included in the thermal management system. These components are currently characterized by a limited variability.

For example, there are thermostats that are controlled by means of wax elements. Switchable or electrically-driven water pumps are also being used. The cooling air flow can be limited by splitting the radiator into several parts or covering it with louvers. Solutions have been developed for the fan that are similar to those for the water pump (electrically-driven fan, viscous coupling etc.).However, almost all vehicles today still use uncontrolled, mechanically-driven water pumps. These are permanently linked with the engine speed via the belt drive and therefore allow no variability. Presented below is a controllable water pump that possesses the required variability. The variably adjustable flow rate enables an additional degree of freedom for the cooling system.

## CONTROLLABLE COOLANT PUMP

The controllable coolant pump is a centrifugal pump with a shroud that is integrated in the impeller as shown in Figure 5. A defined width of the impeller vane is exposed when the shroud is moved axially. This enables adjustment of the flow rate.

If the shroud is in the left position (Figure 5, top diagram), the active width of the impeller is completely exposed and the generated flow rate achieves a maximum. The solenoid, which is located on the left side and serves as an actuator, is de-energized. If the flow rate is to be reduced, the solenoid is energized with a defined amount of current. The armature presses against the push rod and thus moves the shroud to the right correspondingly. This reduces the effective width of the impeller and cuts the flow rate continuously (Figure 5, bottom diagram).

To ensure the fail-safe function in case of a failure of the solenoid, a compression spring retains the shroud in the completely opened pump position. The compression spring is designed so as to ensure that the water pump is completely opened even when the flow forces reach maximum values. Figure 6 shows the flow behavior of the pump at different closing ratios and speeds. A closing ratio of 0% corresponds to a completely opened pump. The pump is closed at a closing ratio of 100%. The diagram indicates that the flow rate decreases significantly with increasing closing ratios. The flow rate can therefore be adjusted by the position of the shroud. Figure 7 shows the pump efficiency in relation to the flow rate at a speed of 2500 rpm. The diagram indicates that the maximum efficiency at this speed is achieved when the pump

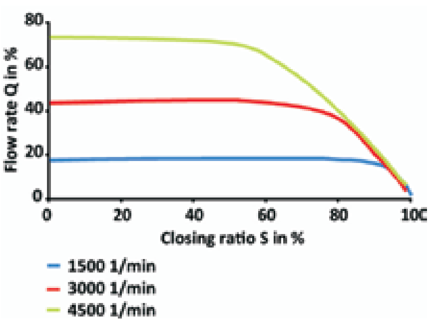


Fig. 6. Flow rate in relation to pump closing ratio and speeds

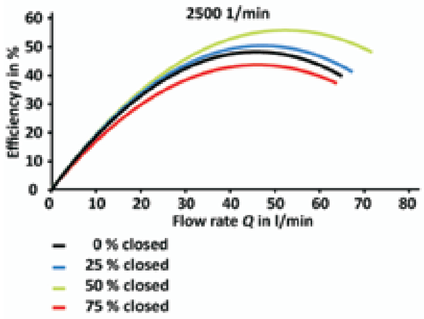


Fig. 7. Pump efficiency in relation to flow rate and closing ratio

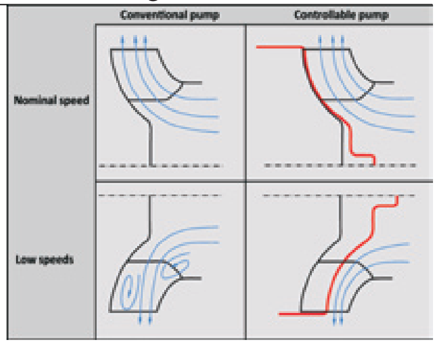


Fig. 8. Comparison of conventional and variable water pumps

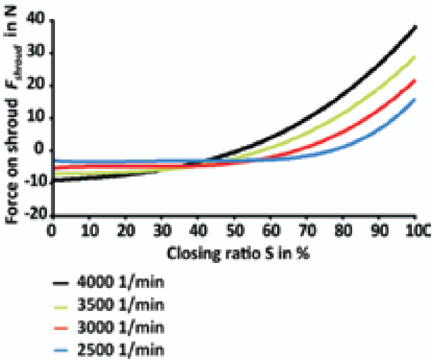


Fig. 9. Forces on the shroud in relation to closing ratio and speeds

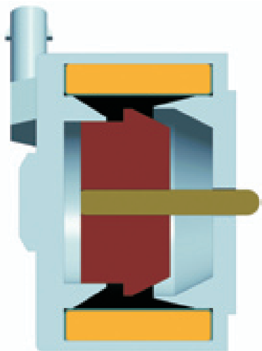

Fig. 10. Solenoid layout

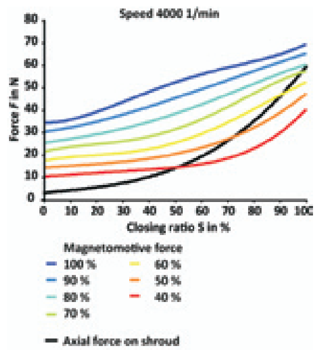


Fig. 11. Magnetic forces in relation to current and closing ratio of the shroud

is approx. 50% open. This can be attributed to backflows and turbulences that occur outside the design point (Figure 8). At nominal speed, the complete impeller width is used for pumping the medium. At low speeds, backflows occur in the conventional pump (Figure 8, left column) and reduce the efficiency. When using a shroud, the impeller width can always be adjusted to the required flow rate (Figure 8, right column). This prevents energy loss caused by backflows and therefore increases the pump efficiency.

## ACTUATOR

Figure 9 shows the axial forces acting on the shroud in relation to the pump closing ratio at different speeds. The negative axial forces resulting from the flow move the shroud towards "closed", whereas the positive axial forces move it towards "open" (Figure 5).

The diagram in Figure 9 indicates that the force on the shroud changes its direction at different closing ratios for different speeds. This point represents the optimum impeller width at a specific speed. The flow rate can be regulated at impeller widths lower than the optimum width.

Due to its physical functional principle, the forces of the electromagnetic actuator act only in one direction (push solenoid). A compression spring is used for compensation to ensure a constantly positive force level on the shroud. This way, the shroud is retained in the "open" position under all operating conditions and moved towards "closed" by the actuator. Adjusting the impeller width and thus the flow rate depending on the speed requires an actuator that allows continuously variable forces. The simplest solution for this is a push solenoid with a pulse width modulated signal (PWM) for defining the force characteristic of the actuator. Figure 10 shows the solenoid of the variable water pump in full section view.

Figure 11 shows the forces exerted by the solenoid depending on the current and the stroke of the solenoid, as well as the axial forces on the shroud. The diagram indicates that the force on the armature changes for different currents and the force equilibrium is achieved in different positions of the shroud. Thus, the position of the shroud can be set in a targeted manner and the flow rate can be continuously reduced towards zero. As the forces on the shroud change with both speed and position, each operating condition requires a specific current that can be set by means of PWM.

## SUMMARY AND OUTLOOK

This article presented a variable coolant pump for controlling the engine temperature in accordance with the specific requirements. Significant development objectives of thermal management are reductions in fuel consumption, longer engine life and increased comfort. Due to the presented variable water pump, the coolant flow rate can be controlled depending on the operating condition of the engine, and efficiency can be increased depending on the driving situation by adjusting the impeller width. The development objective in this case was achieved by intelligently modifying and combining existing components.

The integration of such a water pump with other variable components in a thermal management system is another very promising approach for the future.

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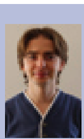
# The Investigation of the Road Vibration in the Car Using the Principal Component Analysis



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## REZUMAT

*Excitațiile generate de transmisia motoare și de calea de rulare au contribuția majoră în problemele de zgomot și vibrații ale automobilului. Acest articol se ocupă cu identificarea componentelor principale ale vibrațiilor induse de calea de rulare, componente utilizate ulterior în simulările efectuate pentru a reduce nivelul acestora. În primul pas sunt determinate experimental funcțiile de răspuns în frecvența corespunzătoare excitațiilor generate de deplasarea automobilului. Acestea sunt folosite pentru determinarea răspunsurilor în zgomot și vibrații ale automobilului utilizând încărcările reale măsurate. Sunt calculate puterile spectrale ale fiecărui răspuns cât și puterile spectrale încrucișate între răspunsuri, evaluându-se nivelul de corelare între aceste mărimi. Folosind metoda descompunerii matriciale în valori singulare, sunt identificate componentele principale decuplate ale excitațiilor generate de calea de rulare. Sursele virtuale de excitație sunt independente și sunt asimilate cu sursele coerente, ceea ce îmbunătățește semnificativ procesul de analiză și simulare în problematica NVH. Sunt prezentate două aplicații practice folosind acest concept.*



**Cuvinte cheie**: analiza componentelor principale, zgomot vibratii si discomfort, descompunerea in valori singulare, analiza cailor de transfer



## ABSTRACT

The powertrain and the road inputs are the major contributors to the noise and vibration of the cars. This paper is focused to find out the road principal components (virtual references) that contribute to the complex noise and vibration problems in order to reduce them. In the first step it defines the road frequency response functions set, that is coming from a test database. These FRFs are later used for calculating the response of the car body, subjected to the measured road loads. It follows the creation of the crosspower set. Crosspowers describe the spectral contents of the part of a response signal that is correlated to a reference signal. In the next step the road principal components are calculated. The PCA breaks down the non-coherent vibrations into coherent sets of vibrations and assigns the latter to so-called virtual sources that can be treated in a similar way to coherent sources. The referenced virtual spectra will be applied to the model and the response is calculated. Two applications are described to demonstrate the usefulness of this concept.


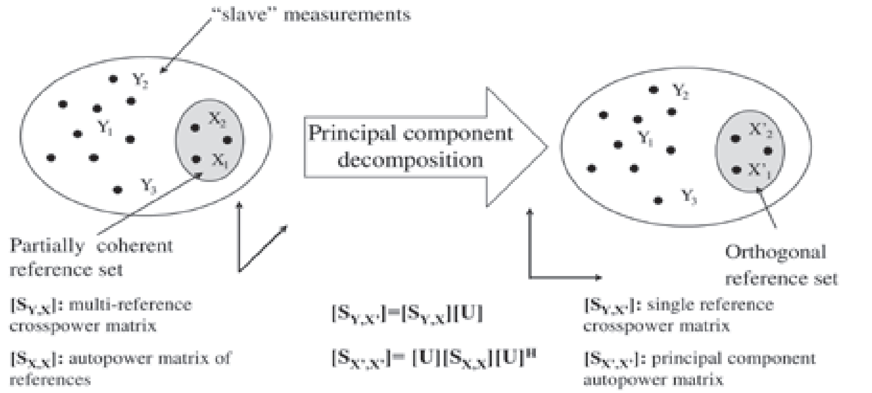


**Fig. 1. Principal component decomposition process**

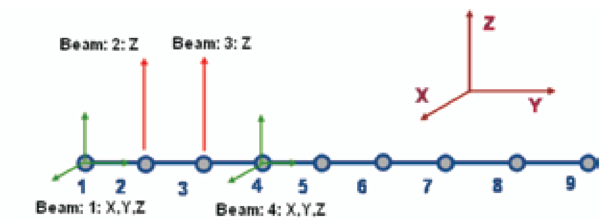


**Fig. 2. PCA beam structure geometrical model**


**Key words**: Principal Component Analysis (PCA), Noise Vibration and Harshness (NVH), Singular Value Decomposition (SVD), Tranfer Path Analysis (TPA)


## THEORETICAL VIEW

In order to solve road noise and vibration problems it is important to understand how the road inputs from the four wheels are transmitted through the suspension components, and

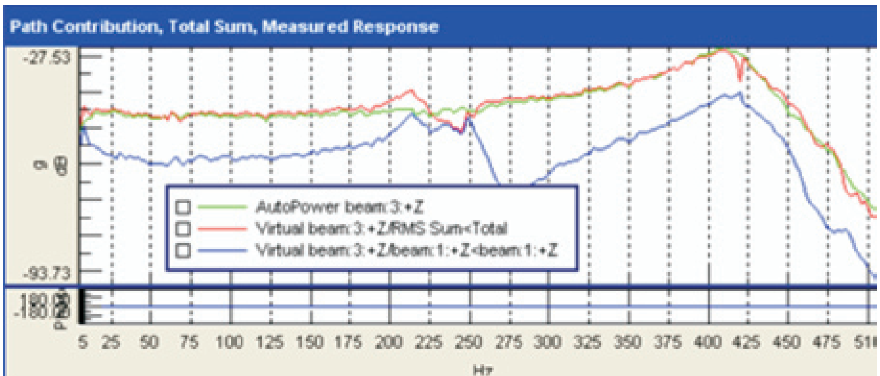


**Fig. 3. TPA results using uncorrelated virtual loads**

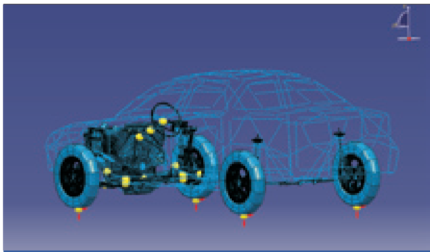

**Fig. 4. FE car model and the interested points in TPA**

through the mounting elements into the car.

The wheel inputs are always partially correlated, with a degree of correlation depending on the road surface characteristics. Therefore multiple reference crosspower measurements are necessary to describe properly the road noise and vibration problems.

Virtual coherence analysis is a technique based on „singular value decomposition", used to decompose the chosen set of partially-correlated reference signals into their orthogonal constitutive components (the „principal components"), Figure 1. The crosspower signals at all other measurement locations can then be processed into single reference crosspowers with respect to each of these principal components. These single reference crosspower spectra are called „virtual crosspowers". When scaling each of the crosspowers with the corresponding principal component autopower, this results in referenced spectra, the so called „virtual referenced spectra".

## PCA BEAM STRUCTURE STUDY

Using a simple beam structure, the concept of Principal Component Analysis for multi-reference Transfer Path Analysis can be verified and validated, Figure 2. The beam structure consists of eight element defined by nine points, along the length of the beam. The excitation sources are applied to the beam through points 1 and 4, in X, Y and Z directions, these points and directions being the origins of the transfer paths. Points 2 and 3 are treated as mechanical targets in the Z direction.

In order to see the influence of the PCA concept, two transfer path analyses were made. In the first one the load sources were partially correlated and in the second TPA, by using the PCA concept, the applied sources were virtually independent.

The results of the first TPA analysis show a difference between the measured acceleration on Z direction in point number 3 and the total contribution calculated using TPA method.

Using PCA method, a set of uncorrelated virtual loads was calculated. Figure 3 presents the results, using the same paths and the same target locations as in the previous TPA analysis. It can observe that the TPA sum contributions (red colour) and the measured acceleration (green colour) are very closely.

## WHEEL COLUMN VIBRATION PCA STUDY

The objectives of this study are:

- to find out the principal components (virtual references) that contributes to the complex noise and vibration problems in order to reduce them;
- to compute the non-coherent steering wheel vibrations and the forces at the subframe and steering system caused by the road load inputs in the time domain, which are applied at four tire patch excitation points.

The load application points are the tire patches, where the large masses are attached. The interface points are the subframe and steering system points and the response points are the steering wheel points.

The FE model of the car and the interested points in TPA are presented in Figure 4.

The time load data needed to be process into crosspower spectra to provide crosspower set of force signals (now in frequency domain) from the input time domain data.

The FRF-based forced response case allows to compute the response of the system for the given transfer functions (FRFs between the input points and the output points) and load functions (referenced virtual spectra). In this study, the output points are the Z displacements of the three points on the wheel column.

The virtual loads were computed by the PCA case. As these virtual loads are uncorrelated, they are deterministic loads (as opposed to random loads). The road loads (referenced virtual spectra) was applied to the model and the response was calculated.

Figure 5 shows the total displacement (response) in Z direction (cyan colour) for all virtual references (Virtual Reference.1 ... Virtual Reference.4) in the point number 27, on the wheel column. Also, the displacements (responses) for each virtual reference separately over the complete frequency range at the steering wheel in the Z-direction are presented.

The principal conclusion signalizes that the main contribution in the response is represented by the Virtual.Reference.1 (red colour).

## CONCLUSION

The referenced virtual spectra are used as the operational data for the transfer path analysis model. The different virtual spectra related to the different independent sources are considered as individual load cases, which can be processed in sequence. The acoustical frequency response functions, the structural frequency response functions and the complex dynamic stiffness of the mounting elements remain to be defined, as with the single reference transfer path analysis.

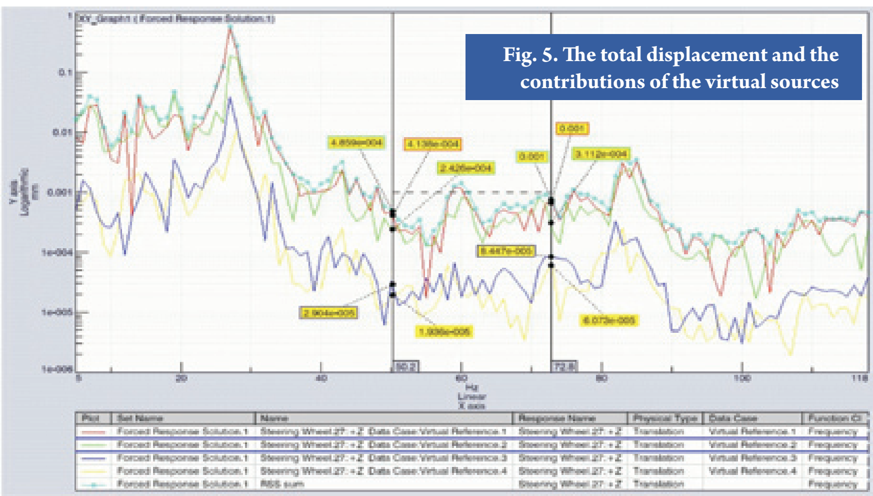

**Fig. 5. The total displacement and the contributions of the virtual sources**


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# Titu Technical Center, part of Renault Technologie Roumanie


On September 15th 2010, Renault Technologie Roumanie inaugurated Titu Technical Center, the only automotive testing center in Romania.

As part of Renault Technologie Roumanie (RTR), the Titu Technical Center's mission is to test the vehicles and powertrain parts designed in Renault's offices in Romania or worldwide.

Titu Technical Center is the only center of this kind in Eastern Europe and complements the Aubevoye and Lardy test facilities in France.

With an over 350-hectare surface and over 300 employees by the end of 2010, Titu Technical Center offers RTR's engineers from vehicle and mechanical engineering departments the means to test vehicles and parts, in various stages of their development.

The tests on tracks alternate with virtual simulations and tests on benches, in order to guarantee a high level of performance for Renault and Dacia's future models. From performances in terms of consumption and emissions to acoustics and comfort, everything is tested in order to meet the customers' demands in terms of quality and reliability.

## TRACKS

A 32-kilometer tracks network, located on the Titu Technical Center site permits a detailed analysis of vehicle behavior in various use conditions. Ten types of tracks such as the fast track, the deformed tracks, the water or gravel tunnels and the city circuit simulate the difficulties a driver could come across on country roads, congested city streets and even highways. In just a few months, the new models are submitted to extreme conditions, meant to accelerate their wear down in order for the necessary improvements to be made.

Thus, clients will benefit from cars that reach the highest standards in terms of performance, comfort, security and endurance.

## TESTING BENCHES

The technical center's buildings host dozens of testing benches for complete vehicles, vehicle components or mechanical components (engines, gearboxes or various sub-systems). Same as on the tracks, the benches simulate the conditions to which a vehicle might be submitted during many years of use: very high or very low temperatures, wind etc. The car or only certain components are exposed for hours to sunlight or cold simulators, studied in rain cabins of different intensity or run for months on auto-piloted benches which operate the connecting gear, the clutch or the acceleration similar to a pilot driving on different routes.

All this is necessary in order to meet the vehicles specifications, but, most important, in order to meet the clients' expectations.

## TITU TECHNICAL CENTER AND THE ENVIRONMENT

During the construction, the site strictly respected the European regulations regarding environment protection. Like all other Renault industrial locations, Titu Technical Center will apply for the ISO 14001 certification in its first year of full operation. A strict environment protection policy has been implemented to ensure less water and energy consumption, waste management and emissions control. Special sorting and stocking areas have been set up for waste. Also, in the following years, hundreds of trees will be planted near the tracks to reduce the atmospheric and noise pollution generated by testing vehicles.

## PEOPLE

300 engineers and specialized technicians work already at Titu Technical Center, preparing and carrying out tests on tracks or benches and ensuring the maintenance of all testing means. The top technologies and instruments which they use are the newest in the field, and the rapid evolution of the automotive industry contributes to their continuous improvement.

Their work takes place in close relation with the technical centers in Aubevoye and Lardy from France, but also with the engineering offices in Bucharest, where the new vehicles and mechanical components are designed.

# Innovation and Research at RTR

*Innovation is for most companies, no matter their field of activity, a vital tool in order to ensure their sustainable development. Innovation represents the launch or renewal of products, creation of new functionalities, implementation of new procedures, methods or ways of organization. Thus, it can be applied to a product, process or organization level.*

Recent international evolutions, but also the economic and financial crisis generated a radical change in the way the car is perceived. At this time, the whole industry faces three major challenges:

• *growth*, which will be sustained by developing markets in the next period (mainly Brazil, India, China and Russia)

• *energy and environment* (legal evolutions of states, but also more and more obvious concerns on environment issues)

• growing *competition*

This is why all major automotive producers are concerned to maintain their competitiveness and must find new methods to progress and answer the market demand and the new context.

Renault makes no exception and puts *innovation* in the center of its strategy.

In 2010, along with a growth in ambition for innovation, Renault decided to involve the regional engineering centers in the research and advanced studies activities. The main reason is that they can use local opportunities and a better vision on the region where they operate.

Renault Technologie Roumanie (RTR) is the first engineering center outside France that started this pilot-activity in July 2010. Procedures and rules will be created and implemented here and they can later be a model of research development for other Renault engineering centers worldwide.

In this sense, a research-development pole was created at RTR with the mission to innovate, especially for low-cost products and procedures.

“The research and innovation pole from Romania has a double direction: from local to central and return. On one side, the RTR team will function as a Renault antenna in order to identify ideas and innovations in Romania and the nearby countries. These ideas will be submitted for validation and then they could be developed by RTR or within the Group.

On the other side, the team located in France, in collaboration with local teams, will participate in international projects, like the ones that have already started on consumption and emission reduction”, declared Nicolae Boicea, in charge of innovation and research at RTR.

In the future, the RTR research pole will develop research and innovation activities for the Logan range and will contribute to the implementation of low-cost innovative solutions, adapted to the needs of the local markets.

Nicolae Boicea also stated that in this context RTR began collaborating with a series of universities and research institutes from Romania in order to find and evaluate ideas that can be developed together. The main fields which are emphasized are tied to the RTR strategic axes, more precisely:

• cars accessible to all

• design of innovative architectures for the new models

• development of ecological and economical cars, with an emphasis on consumption and emissions reduction but also on extending the car life cycle

• reduction of the total costs for car developing

• comfort while driving and new services, especially connectivity and multimedia services

“Romania has universities where the theoretical training is a good one and where there is potential for innovation and research. Our goal is to find it and use it. I want to take the opportunity of our collaboration with the SIAR magazine to inform professors, post-graduates and students about this new dimension RTR wishes to develop with universities”, declared Nicolae Boicea.

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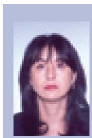
# Micro Heat Exchangers for Motor Vehicle Applications

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## ABSTRACT

*The development of the automotive technologies is crucial for the current challenges in terms of energy conservation and environmental impact reduction. Among the key technologies, as vectors of development there may be included also the microheatexchangers. The current paper is addressing an engineering approach for modeling the heat and mass transfer processes in micro heat exchangers. The approach is based on the dimensional analysis and principles of theory of similitude that allow the modeling of micro scale systems using a physical system at miniscale. There are identified constant relationships between dimensions permitting the analysis of the fluid flow through micro channels, taking into account the differences between fluid flow through micro and mini channels. The velocity scale ratio is in inverse ratio to length scale and similar, it is modified the accelerations scale. The pressure drop is higher with smaller channel dimensions. In this study the interfacial effects are neglected.*


## INTRODUCTION

More than 70 million of vehicles were manufactured worldwide in 2008. These vehicles have been equipped with sophisticated control and safety systems. Due to the fact that in automotive industry, as well as, in defense and aerospace industry are very important the reducing in size of sensors, actuators and electronic devices, the micro sensors for pressure, accelerometers, air - bags, "smart" envelopes, navigation and air conditioning systems there are frequently used. In the same time, the micro technologies are applied in production control, in military application as: micro devices for precision guided munitions, for surveillance, arming systems, data storage sensors, the air traffic control systems, consumer electronics and office technology, being used in equipments such as tape head driver, inkjet printer heads, earthquake sensors, pressure sensors, data storage systems, optical fiber network components, relays, displays of portables, switches and filters [4].

A recently study [7] estimates that the micro-electro mechanical systems (MEMS) market for 2010 is 8 billion and will double in 2015, having as main vectors automotive, defense, aerospace, medical, electronics and consumer goods industry. A significant component of MEMS is represented by microfluidic systems, covering a wide range of applications, from medical systems of „lab-on-chip" to electronic cooling systems for microprocessors and compact applications for defense and aerospace industry. The micro heat exchangers are very important, having as main application field in microprocessor industry. Now, there are extended in many applications in process and energy industries.

Studies on heat transfer at the micro level began about 30 years [8] by producing and testing a high performance heat sink with cool water. In the device, the heat generated by microelectronic components is removed by a coolant, flowing through channels, located closer to the heat source. Microchannels have been set at a depth of 300 μm, channel width and fins of 50 μm in a silicon plate with thickness of 400 μm. The geometries of the micro heat exchanger have been developed by alternant stacking silicon plates that were tested with water as the working fluid. A heat flux of 790W/cm$^2$ was

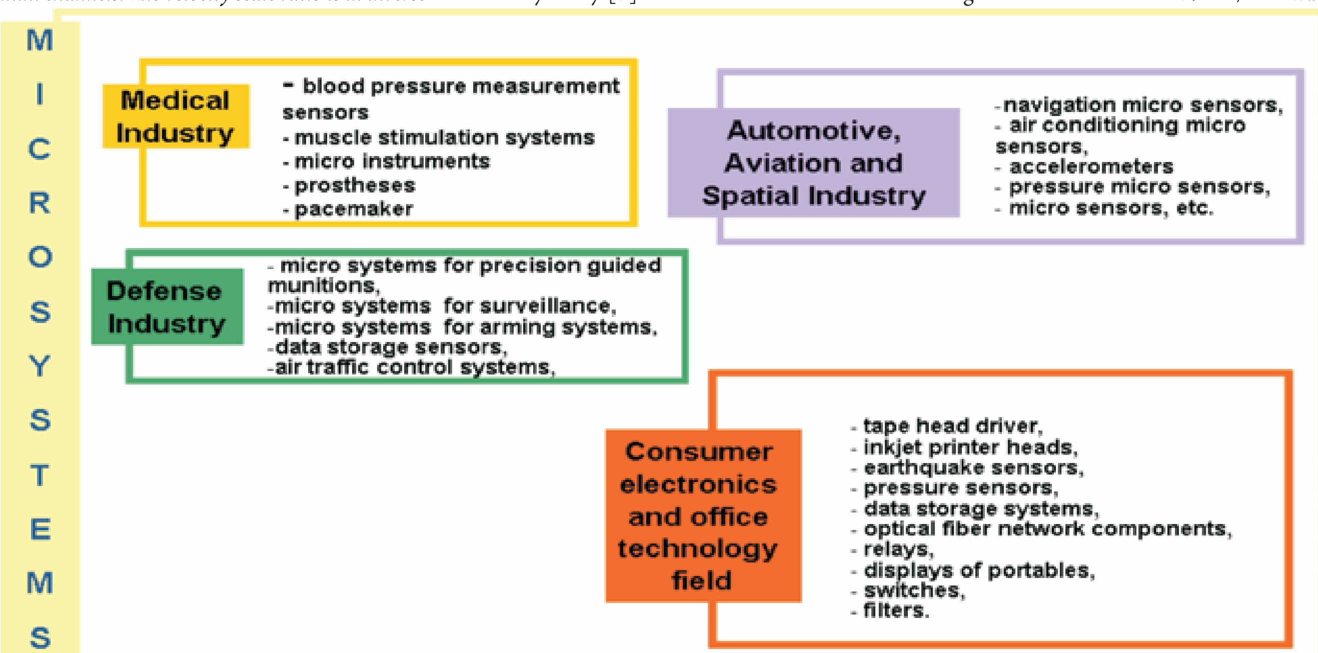



Fig.1. Applications of Micro Technologies

measured for an area of 1 $cm^2$. The temperature difference between thermal agents was of 71 °C and the thermal resistance of 0,09 °C/W. The heat flux means the amount of heat that passes through an isothermal surface in unit time.

## CURRENT STATUS

The performances of the micro cross-flow heat exchanger have been studied in 1986 [3]. The channel size is 300 μm depth and 400 μm. The channels were fabricated using photo etched corrugated titanium plates technology. The obtained volumetric heat transfer coefficient was higher than 7 $MW/m^3K$ and the overall heat transfer coefficients higher than and 4 $kW/m^2K$.

In 1988, researchers from the Karlsruhe Nuclear Research Center (CCNK) have been developed in cooperation with the company Messerschmitt-Blohm (MBB), a mechanical method for manufacture of micro separation nozzle used in the separation nozzle process for isotopes of uranium - 235 enrichment. An important role in this method is playing by the aluminum parts machining that are cutting with high precision micro shaped diamonds [1]. Based on these results, within their activities in the field of micro-technologies, they have developed a new technique for mechanical manufacture of other microstructures.

Thus, in 1990 a mechanical method for manufacturing microchannels of micro heat exchangers was developed, being generated a model by high precision cutting with profiled micro diamonds, followed by bonding of the foils where these microchannels were made [2], obtaining in this way the micro heat exchanger body. In order to obtain the micro current-flow heat exchanger made by aluminum alloy, copper, stainless steel and titanium have been used different welding methods such as electron beam welding, diffusion bonding and laser beam welding. These geometries have been tested with water as the working fluid, and the results were presented for a copper heat exchanger. The results confirm that it is possible to transfer a heat flux of about 20 kW in a volume of 1 $cm^3$, for a log mean temperature difference of 60 °C.

Channels of 1 cm length and a hydraulic diameter of 88 μm have developed a very high volumetric heat transfer coefficient of 234 $MW/m^3K$ and an overall heat transfer coefficient of 22,8 $kW/m^2K$, with a pressure drop of 4,7 bar of both water flows [2].

In 1994, Friedrich and Kang have been studied the processing of thin metal foil by cutting with a profiled diamond and their vacuum diffusion bonding for assembling them into a micro counter flow heat exchanger [6]. They have developed a micro counter flow heat exchanger made by copper with a channel having the hydraulic diameter of 100μm. Hydraulic diameter was calculated using the formula:

$$d_h = \frac{4S}{P}$$

(1)

where S is the flow section of channel in $m^2$ and P is the wetted perimeter of the fluid channel, expressed in m.

The volumetric heat transfer coefficient obtained with this micro heat exchanger was of 45 $MW/m^3K$ and overall heat transfer coefficient was of 6 $kW/m^2K$ [6].

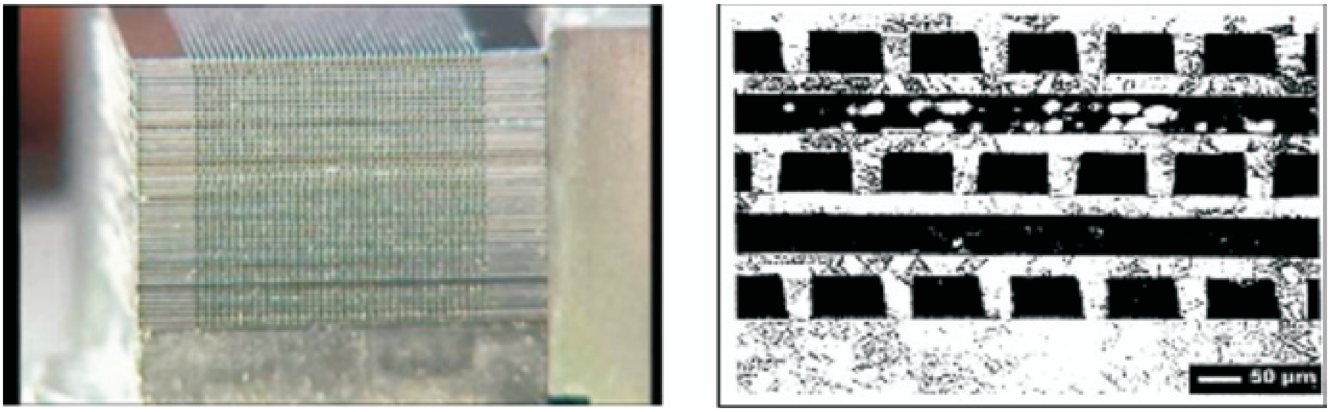
Later, in 2001, a group of Chinese researchers have been studied fluid flow in microchannels and porous media [6] by forced convection proving that the micro heat exchanger performance using porous media are better than using microchannels, while the pressure drop in the first case is higher. The volumetric heat transfer coefficient for the micro heat exchanger using porous media was of 86,3 MW/m3K, while for the micro heat exchanger using microchannels was of 38,5 MW/m3K. The pressure drops were 4, 66 bar for porous medium and 0,7 bar for microchannels.

## DIMENSIONAL ANALYSIS APPLIED TO MICRO HEAT EXCHANGERS

To simplify the experimental study there are using the similitude theory and dimensional analysis. In the investigation of single-phase forced convection of a fluid flowing with velocity $u$ [m/s], through a pipe with diameter $d$ [m], taking into account that the properties of fluid influence the convective heat transfer, and the main physical quantities that influence single-phase forced convection are those appearing in differential equations of convection: $\lambda$, thermal conductivity [W/mK], $c_p$, specific heat capacity at constant pressure [J/kgK], $\eta$, dynamic viscosity [Pa•s], $\rho$, density [$kg/m^3$] [5]. All of these are dependent on temperature.

The geometries and dimensions of the heat exchange surface: planar, cylindrical, internal (through channels), and external have a crucial influence on the hydrodynamics of flow and related to this, on the heat transfer.

As base quantities for the dimensional system is selected the length $L$, mass $M$, time $T$ and temperature $\theta$. For both scale model and prototype, the values of the dimensionless param-




a) b)

**Fig. 2. a) Packing of foils with machined micro channels in order to obtain a cross flow construction; b) image obtained by electron microscopy on the cross flow micro channels [4], [5]**

eters have to be the same because they have to ensure the similitude.

$$\sigma_L = \frac{l_m}{l} \qquad (2)$$

where, $\sigma_L$ – length scale, $l_m$ – length of model, $l$ – length of prototype.

For example, if the model and prototype are using the same fluid, then, density $[\rho]$ expressed in dimensional system as $ML^{-3}$, dynamic viscosity $[\eta]= ML^{-1}T^{-1}$ and thermal conductivity $[\lambda]= MLT^{-3}\theta^{-1}$ are constants, the following relationship could be written:

$$\sigma_\rho = \sigma_M \cdot \sigma_L^{-3} = 1 \Rightarrow \sigma_M = \sigma_L^3 \qquad (3)$$

where: $\sigma_\rho$ – densities scale, $\sigma_M$ – masses scale.

$$\sigma_\eta = \sigma_M \cdot \sigma_L^{-1} \cdot \sigma_T^{-1} = 1 \Rightarrow \sigma_L^3 \cdot \sigma_L^{-1} \cdot$$
$$\cdot \sigma_T^{-1} = 1 \Rightarrow \sigma_T = \sigma_L^2 \cdot \qquad (4)$$

where: $\sigma_\eta$ – dynamic viscosities scale, $\sigma_T$ – times scale.

$$\sigma_\lambda = \sigma_M \cdot \sigma_L \cdot \sigma_T^{-3} \cdot \sigma_\theta^{-1} = 1 \Rightarrow \sigma_L^3 \cdot$$
$$\cdot \sigma_L \cdot \sigma_L^{-6} \sigma_\theta^{-1} = 1 \Rightarrow \sigma_\theta = \frac{1}{\sigma_L^2} \cdot$$
(5)

where: $\sigma_\lambda$ –thermal conductivities scale, $\sigma_\theta$– temperatures scale.

It is not always possible to realize the strict similitude during a model test, and in several cases some aspects of similitude may be neglected, focusing on only the most important parameters. In this case, the length scale is kept independent. It should be established the determinative regime of process.

For the hydrodynamic processes the viscosity is determinative and the modelling is made based on the similitude condition between model and prototype that involve the equality: $Re = Re_m$, that should be written

$$\frac{\rho \bar{u} d}{\eta} = \frac{\rho_m \bar{u}_m d_m}{\eta_m}$$
(6)

where $d$, $d_m$ – inner diameter of the pipe for prototype and model, respective in [m], $\bar{u}$, $\bar{u}_m$ – average velocity of the fluid flow for prototype and model, respective in [m/s], $\rho$, $\rho_m$ - fluid density for prototype and model, respective in [kg/m$^3$]; $\eta$, $\eta_m$ – dynamic viscosity for prototype and model, respective in [Pa s].

There are noted the scaling ratio with:

$$\sigma_L = \frac{d_m}{d} = \frac{l_m}{l} \qquad (7)$$

$$\sigma_\rho = \frac{\rho_m}{\rho},\ \sigma_\eta = \frac{\eta_m}{\eta},\ \sigma_u = \frac{\bar{u}_m}{\bar{u}} \qquad (8)$$

There are obtained the following modeling

$$\sigma_u = \frac{\bar{u}_m}{\bar{u}} = \frac{d}{d_m} \cdot \frac{\eta_m}{\eta} \cdot \frac{\rho}{\rho_m} = \frac{\sigma_\eta}{\sigma_L \sigma_\rho} \qquad (9)$$

$$\sigma_{Vf} = \frac{\bar{u}_m A_m}{\bar{u} A} = \frac{\sigma_\eta}{\sigma_L \sigma_\rho} \frac{4\pi d^2{}_m}{4\pi d^2} = \frac{\sigma_\eta \sigma_L}{\sigma_\rho} = \sigma_v \sigma_L \qquad (10)$$

where $\upsilon=\eta/\rho$ is kinematics viscosity, $A$ and $A_m$ is the surface in [m$^2$], and $V_f$ denotes volumetric flow (flux rate) in [m$^3$/s].

The quantity $\sigma_u$ will allow computing the prototype velocity $\bar{u}$ knowing the model velocity $\bar{u}_m$. Based on this value the mass flux and pressure drop could be calculated.

$$\sigma_{\Delta p} = \frac{\Delta p_m}{\Delta p} = \frac{d}{d_m} \frac{l_m}{l} \frac{\rho_m}{\rho} \left( \frac{\sigma_\eta}{\sigma_L \sigma_\rho} \right)^2 = \frac{\sigma_\eta^2}{\sigma_L^2 \sigma_\rho} \qquad (11)$$

If the model and prototype are using the same fluid, then $\sigma_\rho = 1$ and $\sigma_\eta = 1$. The modelling equations become:

$$\sigma_u = \frac{\bar{u}_m}{\bar{u}} = \frac{1}{\sigma_L} \qquad (12)$$

$$\sigma_{Vf} = \frac{\dot{V}_{fm}}{\dot{V}_f} = \sigma_L \text{ și } \sigma_{\Delta p} = \frac{\Delta p_m}{\Delta p} = \frac{1}{\sigma_L^2} \qquad (13)$$

It is marking out that the velocity scale ratio $\sigma_u$, is in inverse proportion to the length scale ratio $\sigma_L$. The effect is pronounced by maintaining the same volumetric flux rate while scaling down. Particularly, the pressure drop scale becomes huge in microchannels cross section, for the same fluid this enhanced as $\sigma_L^2$.

The electrokinetic effects that should occur at the interface between liquids and solids are ignored.

## CONCLUSIONS

The method of dimensional analysis using similitude theory for flow in micro channels is presented in detail.

Based on the results it is demonstrated that the method of dimensional analysis and principles of similitude theory allow the modeling of system at micro scale using a similar physical system at mini scale, making possible the analysis of flow characteristics through micro channels, but take into consideration the differences between the flows in micro scale and macro scale devices.

Thus, it shows that the ratio of velocities scale $\sigma_u$ is inverse proportional to the lengths scale $\sigma_L$. The acceleration scale is analogous modified. The effect is enhanced by maintaining the same flow rate as the scale decreases. In particular, become very large pressure gradients in channels with very small sections. For the same fluid pressure gradient increases $\sigma^2_L$ order. Interfacial effects are neglected.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# An Application of the 6 Sigma Approach

## for the Continuous Improvement of a Production Process from the Automotive Sector


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### ABSTRACT

The article presents an innovative approach for the implementation of a robust design optimization solution in an automobiles assembly process. The approach of the entire project is specific to the 6 Sigma optimization process, by applying the DMAIC cycle. The core of the paper targets the proposal that regards the innovative robust solution by which the process is optimized, by rendering it leaner. Therefore, for the already painted door's assembly on the already assembled cars it is proposed their final reassembly with a special work-holding (with errors proofing features), easy to handle by the human operator.


**Keywords:** optimization, 6 Sigma, robustness, quality, management.

### INTRODUCTION

The organizational processes optimization is realized, generally, by the implementation in various versions of approaches of the continuous improvement cycles, specific to 6 Sigma method (see Table 1). The 6 Sigma method [3] may be used for accomplishing several mandatory requirements for the Quality Management Systems of the automotive suppliers. These requirements addresses directly (for example, by the requirements from chapters: 8.5.2.: 8.5.2.1., 8.5.2.2., 8.5.2.3., 8.5.3.), and, indirectly, (by the chapters 6.2.2.2., 6.2.2.3., 6.2.2.4., 7.3.3.1., 7.3.3.2., etc.) [1] the implementation at of a defined process for problem solving leading to root cause identification and elimination. According to these ideas, it will be presented the results obtained by applying the 6 Sigma method for lowering the level of defects registered on an assembly line, for the off-road vehicles. The original technical solutions that followed the analysis were implemented on the assembly lines, in the new process plants that belong to an automotive OEM.

**Table 1: continuous improvement cycles**

| Abbreviation | English language description | Romanian language description |
|---|---|---|
| PDCA | Plan – Do – Check – Act | Planifică – Realizează – Verifică – Acţionează |
| PDSA | Plan – Do – Study – Act | Planifică – Realizează – Studiază – Acţionează |
| DMAIC | Define – Measure – Analyze – Improve – Control | Defineşte – Măsoară – Analizează – Îmbunătăţeşte – Controlează |
| DMAICR | Define – Measure – Analyze – Improve – Control – Replicate | Defineşte – Măsoară – Analizează – Îmbunătăţeşte – Controlează – Repetă |
| DMADV | Define – Measure – Analyze – Design – Verify | Defineşte – Măsoară – Analizează – Proiectează – Verifică |
| DCOV | Define – Characterize – Optimize – Validate | Defineşte – Caracterizează – Optimizează – Validează |
| IDDOV | Identify – Define – Develop – Optimize – Verify and launch | Identifică – Defineşte – Dezvoltă – Optimizează – Verifică şi lansează |

### THE IMPLEMENTATION OF THE 6 SIGMA METHOD IN A FINAL ASSEMBLY PROCESS, FOR A NEW VEHICLE MODEL

The approach of the entire project is specific to the 6 Sigma optimization process, by applying the DMAIC cycle within a robust engineering approach achieved through several innovatively designed solutions, for the process approach and for the equipment used in the process, as it will be described in the next paragraphs [2].

***"Define" phase***

There are defined a series of specific indicators, for the process optimization, by the team members, selected according with the certification criteria needed for this type of improvement project. The certification is referring to the body of knowledge needed for all the tools used during the various phases of the 6 Sigma projects. The indicators focus the encountered problem: during the assembly process, that was initially realized with opened doors (assembled on the car body), a series of non-conformities occur at product level because of the failures that need rework or scrap of the manufactured products. In consequence, the scope of the improvement project is to reduce the "in site" door damages (the product internal non-conformities).

***"Measure" phase***

By implementing the critical data regarding the controlling of the process productivity it was registered an ascendant trend (see Figure 1 a) of this kind of scraps, that are distributed for all the 4 doors, approximately equally (see Figure 1, b and c), for the two versions of a same vehicle model. Table 2 specifies the 6 Sigma metrics for continuously improvement of the quality characteristics that are monitored, for determining the perfor-

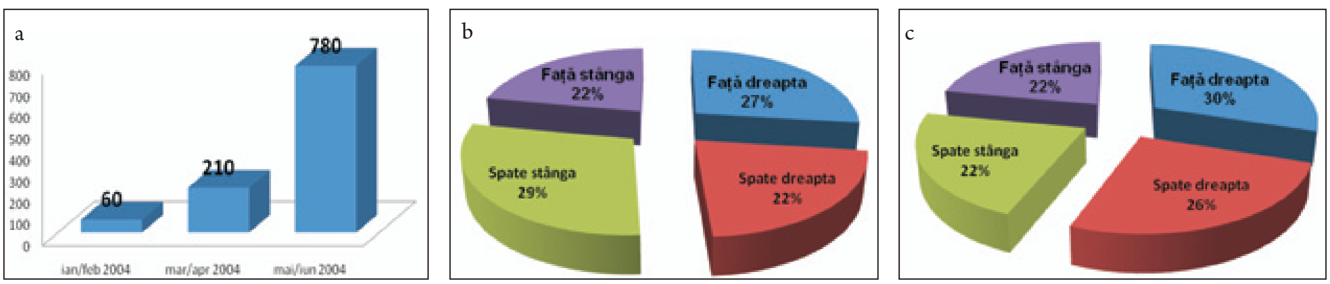


**Fig. 1. The ascendant trend of the new encountered problem, for a time interval of 6 months (a), with the spread of the defects on all the 4 doors, for 2 types of car body (b and c)**

| Characteristic | Defects | Units | Opportunities | Total opportunities | DPU | DPO | PPM | Zshift | Zbench |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 53 | 2000 | 1 | 2000 | 0,027 | 0,026500 | 26500 | 1,500 | 3,435 |
| 2 | 209 | 8000 | 1 | 8000 | 0,026 | 0,026125 | 26125 | 1,500 | 3,441 |
| 3 | 775 | 20000 | 1 | 20000 | 0,039 | 0,038750 | 38750 | 1,500 | 3,265 |
| Total | 1037 | - | - | 30000 | - | 0,091375 | 34567 | 1,500 | 3,318 |

**Table 2: quality characteristics values for the product performance and the 6 Sigma indicators registered before the implementation of the corrective solutions**

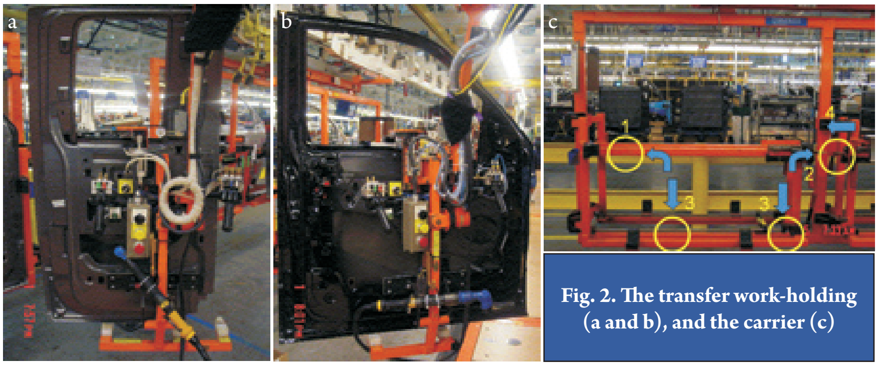


**Fig. 2. The transfer work-holding (a and b), and the carrier (c)**

| Characteristic | Defects | Units | Opportunities | Total opportunities | DPU | DPO | PPM | Zshift | Zbench |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 282 | 56000 | 1 | 56000 | 0,005 | 0,005036 | 5036 | 1,500 | 4,073 |
| 2 | 23 | 80000 | 1 | 80000 | 0,000 | 0,000288 | 288 | 1,500 | 4,943 |
| 3 | 20 | 160000 | 1 | 160000 | 0,000 | 0,000125 | 125 | 1,500 | 5,162 |
| Total | 325 | - | - | 296000 | - | 0,001098 | 1098 | 1,500 | 4,562 |

**Table 3: quality characteristics values for the product performance and the 6 Sigma indicators registered after the implementation of the corrective solutions**

mance level of the process, taking in consideration three quality characteristics, for the studied case. Therefore, it is observed at global level that for the non optimized process, in 6 months there were registered 34567 defective parts per one million of failure opportunities (DPMO = 34567), for a Zbench value of 3,318. This reflects the specific statistics for the Six Sigma approach for a 1037 defective units relatively to the 30000 units produced.

***"Analyze" phase***

The first and the most frequent used tool for analyzing the problem is the cause and effect diagram, which takes into consideration 6 possible sources of the failure / failures (the environment, the measurements, the material, the man-power, the methods and the machines). The conclusion we draw here is that the main elements which produces non-conformities in the production flow are the defective assembly and the inappropriate use of the equipment (as causes that are attributed to the man-power) and, also, the door transportation devices (the carriers) and the work-holdings used to hold the doors. So, these are the main causes at the level of which corrections need to be implemented even from their root causes.

***"Improvement" phase***

A fixture (Figure 5) is introduced that is very flexible because it can be used for the transportation and disassembling / assembling of all the 4 car doors. In this manner, the integrity of the painted door can be assured. Moreover, the failures encountered during the production with the previous type of process management will no longer be present. With this solution, failures such as scratches or chipping during the assembly of the car interior parts may be avoided. The fixture allows not only a door locating surface, but also an appropriate clamping system and clamping force. With these fixtures, we realize assembling operations of all the subsystem / components situated on the door interior. The work-holding used for the operational transport, for doors disassembling and their transfer in the transport carriers, is characterized first of all by universality (see Figure 2, a and b). For the doors inter-operational transport, it is used the work-holding presented in the Figure 2 c the designed solution having error proofing features, also. The error proofing details are the optical sensors, the electronic circuits that operate the production equipments and the designed mechanical solutions.

***"Control" phase***

After implementing the constructive solutions, were monitored the results regarding quality, being noticed continuously descending trends of the non-quality level and registering sensibly lower values for the 6 Sigma metrics (see Table 3).

The initially presented process indices, for the not yet optimized process, are finally evaluated, after the implementation of the innovative solution for a comparative study of the initial monitoring results and after the implementation of the corrective proposed solution thus underlining the critical conclusions. The economic indices that were monitored for the evaluation of the efficiency of the improvement project are also presented. Therefore, the economic report underlines the financial savings registered because of the implementation of the constructive designed solution for the optimization of the assembly process. As can be observed, the savings are a relatively important, of about 800.000 US dollars.

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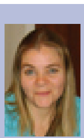
# Researches Regarding Impact Energy Dissipation
## by Breakaing for Front-Rear Collision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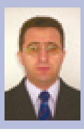
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### ABSTRACT

The paper presents theoretical and experimental researches concerning the reduction of negative effects of front – rear collisions at low speeds using partial dissipation of impact energy into friction between vehicle wheels and running path. The theoretical appreciations made on the presented mathematical model basis are confirmed by the experimental results, obtained in a simply and efficient experimental framework.


### INTRODUCTION

In the front – rear collisions the vehicle that strikes has, before the impact, a higher speed than the hit vehicle, for example, the situation in which the first accelerates and/or the second vehicle decelerates. These circumstances frequently appear in column traffic circulation and suppose assuming risks as traffic blocking, passengers exposure to impact specific high deceleration, the remanent deformation of vehicle bodies, after the elasticity limits are exceeded.

The impact energy dissipation solves, partially, these mentioned problems, specially at reasonable speed regimes, typical for city column movement. This purpose was realized by connecting to vehicles braking systems some devices characterized by constructive simplicity and functional efficacy. These devices are not affecting the performances of experimental vehicles, and realize the impact energy dissipation by braking, also meeting the requirements for industrial application.

The theoretical and experimental researches regarding the impact energy partial dissipation by braking the front – rear collisions implicated vehicle axes are the object of this paper and confirm the idea viability.

### THE PHYSICO – MATHEMATICAL MODEL OF FRONT – REAR COLLISION WITH EXTERIOR ENERGY DISSIPATION

The physico – mathematical model [1], [2] of front – rear collision, based on previous knowledge of implicated vehicles stiffness allows the determination of the main cinematic parameters for the vehicles. The braking force with the running path, used for the balance equations, is considering the number of braked axes for each collision implicated vehicle, and also the braking conditions, by adhesion coefficients.

The main cinematic parameters determined were:

$$W_1^* = W_{10} + \frac{j}{M_1}; \quad (1)$$

$$W_2^* = W_{20} - \frac{j}{M_2} \quad (2);$$

$$j = \frac{C\Delta W}{\omega^2}\cdot\left(1-\cos\omega\cdot t_f\right)+F_0\cdot t_f \quad (3)$$

where $C = \frac{C_1\cdot C_2}{C_1+C_2}$ (4)

$$\Delta W = W_{20} - W_{10} \quad (5)$$

$$\omega = \sqrt{\frac{(M_1+M_2)\cdot C}{M_1\cdot M_2}} \quad (6)$$

$t_f$ being the solution for the transcendental equation:

$$\frac{\Delta W}{\omega}\cdot\sin\omega\cdot t_f = \frac{F_0}{2}\cdot\frac{M_1+M_2}{M_1\cdot M_2}\cdot t_f^2 \quad (7)$$

and $F_0 = g\cdot(M_1\cdot\varphi_1\cdot\upsilon_1 + M_2\cdot\varphi_2\cdot\upsilon_2)$ (8)

The partial restitution coefficient $\lambda_p$ is a more refined notion for the global restitution coefficient $\lambda$, being a quantification for the exterior impact energy dissipation efficacy. At the model level, the exterior dissipated kinetic energy for the implicated vehicles (by friction with the running path, in this case) was separated by the rest of kinetic energy (consumed for remanent deformations) by the partial restitution coefficient, for which the following equation was developed:

$$\lambda_p = -\cos\omega\cdot t_f + \frac{F_0\cdot t_f}{\Delta W}\cdot\frac{M_1+M_2}{M_1\cdot M_2} \quad (9),$$

This expression was determined in the hypothesis that the kinetic changes after the impact are exclusively due to external energetic factors. The energy dissipated by braking is determined with the expression:

$$\Delta E = \frac{1}{2}\cdot j\cdot\left(2\Delta W - j\cdot\frac{M_1+M_2}{M_1\cdot M_2}\right) \quad (10),$$

where the used notations are:

W – speed [m/s]. Indices: 1 – for the vehicle that hits; 2 – for the hit vehicle; 0 – before the impact; * - after the impact; $M_1$ , $M_2$ – the vehicles masses [kg]; $C_1$, $C_2$, C – stiffness coefficients for the vehicles 1, 2 and global, [N/m]; $t_f$ – impact duration [s];

$F_0$ – the total braking force [N]; g – gravitational acceleration = 9,81 [m/s$^2$]; $\varphi_1$ and $\varphi_2$ – adhesion coefficients between vehicles 1, 2 wheels and the running path, [-]; $\upsilon_{1,2}$ – coefficients that take into consideration the number of braked axes for the vehicles 1 and 2; $\upsilon_{1,2}$ = 0 without braking; $\upsilon_{1,2}$ = 0,5 for braking with an axis, and $\upsilon_{1,2}$ = 1 for braking with both axes.

The model numerical application analysis allowed to formulate theoretical appreciation [2]:

- the impact energy dissipation by braking determines the increase of impact duration, with the consequence of deceleration regimes decrease for the passengers; the impact duration is increasing when the braking axes number is increasing, and when the adhesion with the running path is improved;
- energy dissipation by braking leads to partial restitution coefficient decreasing, and also to decrease of $\Delta W^*$ difference between the 2 vehicles speed after the impact.
- the impact energy is dissipated partially by friction with the running path, so the energetical reserve which would potentially produce remanent deformation is decreasing. The consequence – the deformations will be decreased, or eliminated, even at speed differences ΔW, before the impact, over the traditional value of 11 km/h;
- overall, the influence of wheels adherence with the running path is increasing in importance as the number of braking axes increases.

### RESEARCHES AND EXPERIMENTAL RESULTS

The impact energy dissipation method and the experimental installation ([3], [4]) are based on

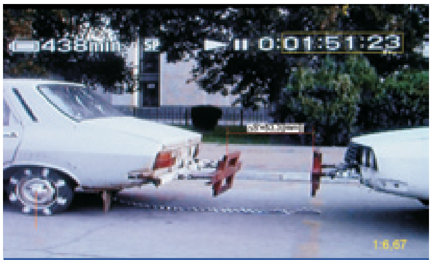


Fig. 1

a system that triggers the vehicles braking, being useful on the aspect of progressive and differentiate braking, without the driver's intervention. For the target vehicle the braking was with a single axis, and for the vehicle that strikes – both axes braking. This scheme takes into consideration the energetical transfer at the collision moment, from a vehicle to another, and also to the braking systems execution mechanisms. The braking is realized by longitudinal movement of protection bars in the collision moment [3].

The impact energy dissipation installation was realized on simplified schemes, according to the exposed functional principle ([3], [4]). The research, acquisition and data processing methods [5] allowed to obtain the desired data with a

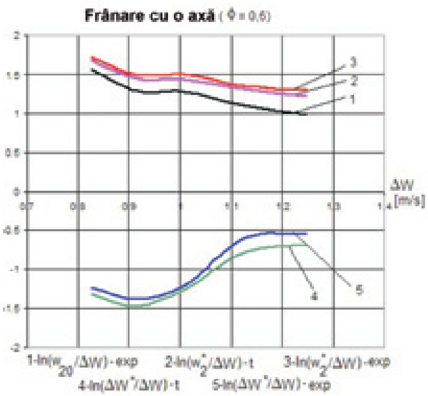


Fig. 2.

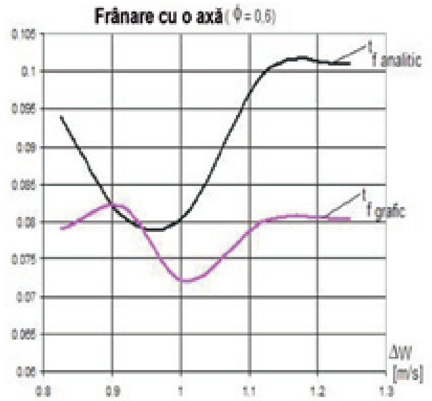


Fig. 3.

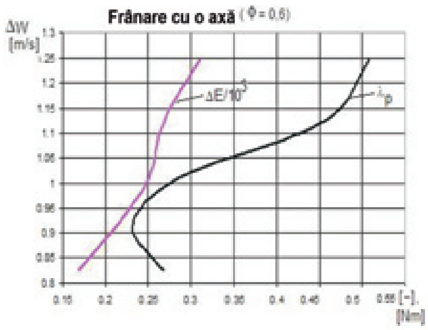


Fig. 4.

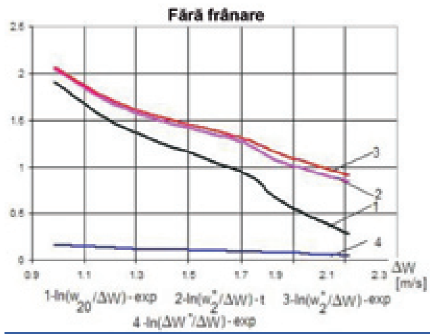


Fig. 5.

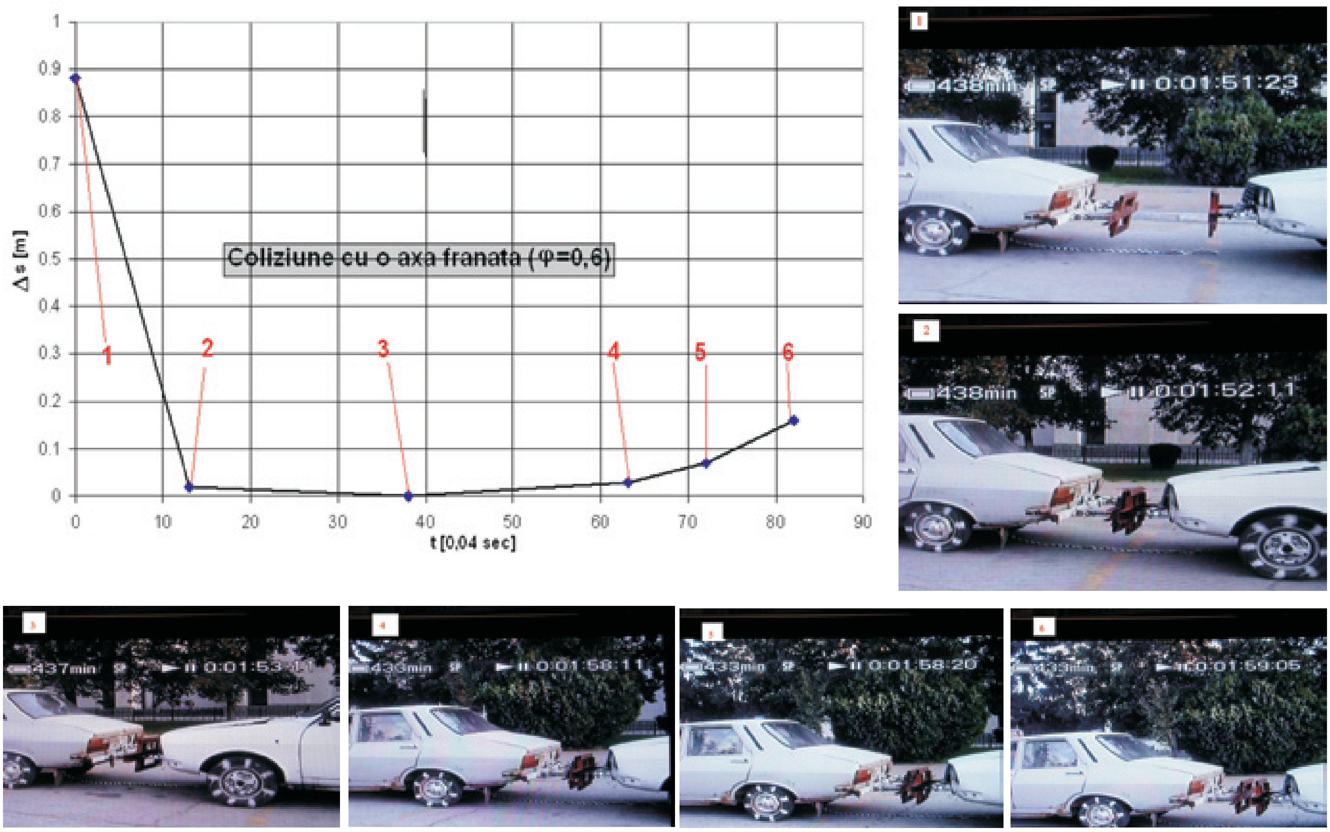
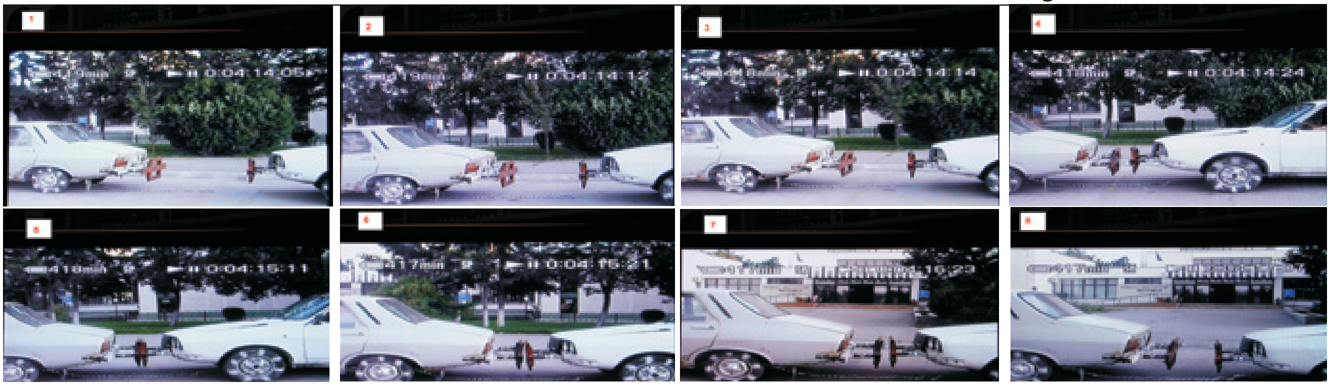


Fig. 6.



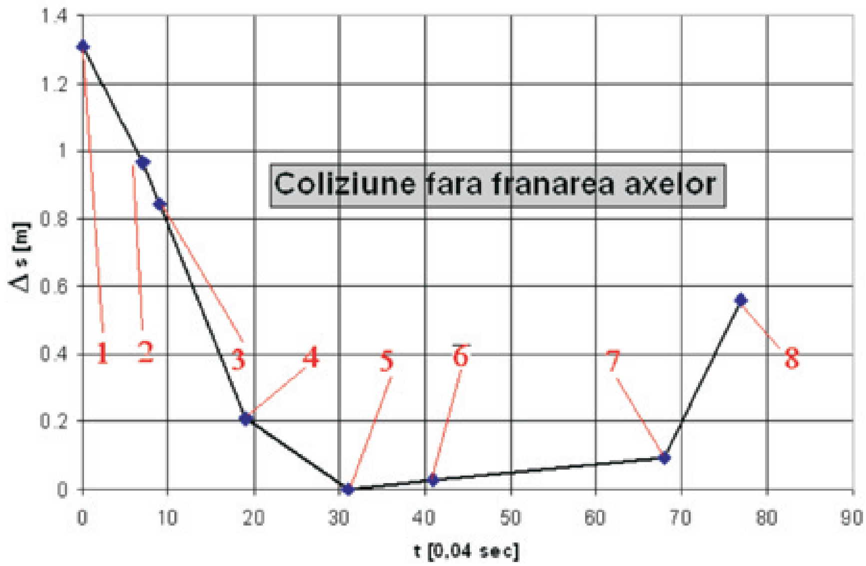



Fig. 7.

satisfying precision for the one axis braking and without braking cases.

The collision tests were recorded with high resolution video equipment (SONY DCR-TRV 285E). The successive photograms correspond to a real time interval of $4 \cdot 10^{-2}$ [sec]. The kinetic parameters determination (vehicles absolute movement, relative movement) was made by direct measuring technique and was verified with numerical photogrametry relations. The inscriptioned scale corresponds to 196 x 200 [mm x mm] photogram.

On this basis the variation $\Delta S = \Delta S(t)$ for figure 6 (one axis braking) and figure 7 (without braking) was drawn. It presents the vehicle relative distance variation, for the duration of the 3 collision phases, for the mentioned cases. The experimental results highlight the fact that for both cases, the tests were made for small differences ($\Delta W = 0{,}8 \div 1{,}25$ m/s – for a single axis braking and $\Delta W = 0{,}95 \div 2$ m/s – without braking).

The speed absolute values recorded, for the vehicle that strikes, at beginning of the impact, are typical for column movement in urban areas: 4,6 [m/s] (16,5 km/h) for single axis braking and 7,8 [m/s] (28,1km/h) without braking.

For the partial restitution coefficient, the experimental determined values were between 0,231 and 0,507, the dissipated energies being small, between între 169 ÷ 370 [Nm]. It is to be noticed that, for the same speed difference ΔW at impact beginning, the target vehicle speed at the end of collision is doubled, compared to one axis braking case. For both cases, the target vehicle speed variation at the end of collision, experimentally determined, reproduces the analytical determined evolution, the errors being under 6% (in the case of one axis braking) and under 8,1% (in the case without braking).

The differences in $\Delta W^*$ (the difference between vehicle speeds at the end of collision) are under 7,5% (in the case with one axis braking) and 4% (in the case without braking). The impact duration $t_f$ analytical determined is different with 14% by the one experimentally determined. The analyzed parameters evolutions, experimentally obtained, confirm the application of mathematical model. In the figures 2, 3 and 4 are represented the graphics for experimental variations of some parameters, for the case of one axis braking.

The kinetic parameters evolutions for the target vehicle and also the speed difference at the end of collision in the case without braking were represented in figure 5. For the speeds it was preferred their raportation to $|\Delta W|$ and the utilization of logarithmic scale (ln) for y axis. The calculated values for the parameters were obtained on the basis of experimental values ΔW and using the relations presented in the mathematical model.

## CONCLUSIONS

The exposed method of exterior impact energy dissipation has the advantage of reducing traffic blocking, increasing passengers protection and reducing or eliminating the remanent deformation for the vehicle bodies. The presented theoretical and experimental facts are justifying the application, in the future, of this procedure on a larger scale, the technical solution being simple, efficient and not expensive.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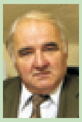
# The Laboratory of Calculation and Construction for Automotives University of Craiova Faculty of Mechanics



**Prof. PhD. eng.**
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Head of Automotives
Engineering Department

The Laboratory of Calculation and Construction for Automotives, from the Faculty of Mechanics, University of Craiova, is available since 1990, when it was founded the specialization of Automotive Engineering.

The laboratory is designed for undergraduate students, in order to achieve their practical skills necessary at the module of Calculation and Construction of Automotive, from Transport and Traffic Engineering, and also for graduate students from the field of Automotive Engineering and Transport Engineering. The laboratory is also involved in different researches done by PhD students from the field of Mechanical Engineering.

## AREAS OF EXPERTISE

Main area of expertise of the laboratory is know-how in the field of the transmission components and other systems of the vehicles.

Other areas of expertise are the key tests and measurements of functional characteristics of the transmission and the following systems: steering, suspension, brakes. Regarding the research activity, in the laboratory are possible the determinations of different mechanical solicitations, studies of vibrations and noise, tests of endurance and reliability. Also are possible, fatigue tests for major automotive systems (transmissions, axles, steering, and suspension) and for different components of these systems (pivots, bushings, stabilizer bars, spring suspension).

Fig. 1. Gearboxes test rig

## INFRASTRUCTURE

The laboratory is equipped with various test rigs to determine the performance of various systems mentioned, As follows:

- gearbox test rig allows the study of endurance, determination of operating temperature, noise and vibration measurement and verification gearbox seal (Fig. 1);
- rear axle roll durability test rig (Fig. 2);
- damping bush durability test rig (Fig. 3);
- ball joint wear study test rig (Fig. 4);
- front and rear stability test rig (Fig. 5);
- didactical platform “Mates” for measuring of steering system parameters, transmission, steering, braking and suspension system (Fig. 6);
- tand equipped with 0.8 MPI engine and transmission (DAEWOO), that can determine the functional parameters of the engine and transmission (Fig. 7).

All these stands are equipped with control panels and real-time monitoring of test parameters. Also, the laboratory is equipped with a data acquisition system with software for ADwin-GOLD, ADbasic for processing.

Fig. 2. Rear axle roll durability test rig

Fig. 3. Damping bush durability test rig

Fig. 4. Ball joint wear test rig

Fig. 5. Front / rear stability test rig

Fig. 6. Platforma didactică ”MATIZ”

Fig. 7. Stand motor – transmisie Daewoo

# University Research

## Complex robotic system for functional recovery of children with locomotion disabilities

*Program:* PN-II-RU-PD-2009-1. CNCSIS – Postdoctoral financing projects

*Description:* The proposed project's main objective is to design and achieve an autonomous rehabilitation robotic system used for children functional recovery of locomotion apparatus. This can be used in rehabilitation centers or hospitals, which have therapy programs for children locomotion recovery. The children locomotion disabilities can be caused by diseases or traumas resulted from car accidents and need recovery therapy in order to reestablish an independent life and to become at a physical normality.

In the last few years new recovery systems have been developed, but for mature persons with locomotion disabilities such as: arthritis, osteoporosis, or car/work accidents, and for this a new recovery therapy had been created and it was called stationary walking. With this therapy program, patients with locomotion disabilities will learn to walk again. By considering this therapy type and children special recovery program, a new system for children functional recovery will be designed. This system consists in an exoskeleton equipped with sensors and actuators which will be guided and controlled through a computer with special software. This system has on its structure a treadmill used for walking activities. The exoskeleton structure will be a modular one and adjusting dimensions mechanical systems will be used. This system will be designed for children with ages 4- 7 years.

*Project manager:* Junior Lecturer. PhD. Eng. Copiluşi Petre Cristian, Faculty of Mechanics. University of Craiova. Calea Bucuresti no.107. Dolj. Romania,
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## Research Activities in the Transports Field – the EU funded project "In Time"

The EC project In-Time (Intelligent and Efficient Travel management for European Cities) focuses on Multimodal Real Time Traffic and Travel Information (MRTTI) services with the goal to reduce drastically energy consumption in urban areas across the different modes of transport by changing the mobility behavior (modal shift) of the single traveler.

In-Time provides mainly 3 services:

- Business-to-business services (B2B) will enable European-wide Traffic Information Service Providers (TISPs) to get access to regional traffic and travel data and services of the single pilot cities via a harmonized standardized open interface.
- Interoperable and multimodal RTTI services (e-services) to end-users. E-services will influence the on-trip travel behavior by optimizing journeys taking the energy consumption into account. The community will be the users of mobile devices or navigational devices. Mobile applications include routing for several modes of transport (pedestrian, bicycle, public transport and personal car, including the fuel consumption estimation) and real-time information regarding traffic for the following pilot cities: Vienna (AT), Bucharest (RO), Munich (DE), Brno (SK), Florence(IT) and Oslo (NO);
- Web based interoperable and intermodal pre-trip information with the potential to influence the travel behavior in the trip planning stage by taking environmental aspects into account. The application is available at www6.softeco.it/mixerdemo3 ..

With an overall budget of around 2,6 MEUR, the project started in April 2009, with a three years development activity. There are over 20 EU partners, Romania being represented by UPB-CEPETET, the research centre in Politehnica University of Bucharest, Transports Faculty. The official launch of the applications has been performed in Vienna, on 25th of January, this year. All interested persons in using and testing the free mobile applications are invited to register themselves for download at www.in-time-project.eu.

## Detailed Chemical Kinetic Models for Cleaner Combustion CM 0901 CM 0901

*Coordinator:* Dr. Frederique Battin Leclerc, École Nationale Supérieure des Industries Chimiques, Nancy, France.

*Objective:* to promote the development of cleaner and more efficient combustion processes through the design and implementation of better defined and more accurate chemical kinetic models.

*Stage:* 2nd year of implementation, romanian partner: "Ovidius" University of Constanta

*Responsible person:* Prof. Dr. Ing. Eden MAMUT,
Email: emamut@univ-ovidius.ro

# Technical University of Cluj-Napoca
## Student's Involvement in International Competitions

**Cristian COLDEA**
Technical University
of Cluj - Napoca


The „Flying Conrods" Team of Technical University of Cluj-Napoca

**ABSTRACT**

*Article shows the participation of students from the Technical University of Cluj-Napoca in the international contest „Rexroth Pneumobil Race", contest dedicated to designing, building and trying of vehicles operated by pneumatic systems. This type of competition also succeed in attempts to raise issues that make the connection between theoretical concepts assimilated in the university courses and translate them into practice purposeful creations.*

Already a tradition, through the three editions already held annual international competition takes place „Pneumobil Rexroth" (in the town of Eger in Hungary), contest dedicated prototype vehicles that use as energy source pneumatic propulsion systems. Competition is open to students from high schools and technical faculties, and its complexity is proved by numerous tests (and therefore prizes) that takes place between the two days of racing (speed test circuit, acceleration, endurance, design, innovative technical solutions, etc.).

Initially, considered more as a bet to prove his capabilities, imagination and skill to produce such a vehicle, the team Technical University of Cluj-Napoca consisted of four students, has designed and produced a pneumobil, which main achievement was intended to obtain an 2000 m autonomy (powered by a single air compressed tube), in the detriment of high speed and acceleration. The expectations were exceeded by the total distance traveled was 2940 m. For the 2011 competition the Technical University of Cluj-Napoca will participate with two teams from the Faculty of Mechanic, with the stated aim to obtain more improved results both in terms of autonomy, as well as maximum speed that can be achieve with such a vehicle prototype.

In 2010 race contest, from a total of 35 teams, Romania were represented by a total of 7 teams (One team from Technical University of Cluj-Napoca, three teams from University of Oradea and also three teams from the Sapientia University of Tg. Mures 3). If teams of Oradea and Tg. Mures already had experience of previous participations and Cluj-Napoca team participated for the first time, overall results were good teams by placing it in the first half of the standings in the various tests that have participated. More than that, the great winner of this contest was offered to students in emulation of process development, design and construction of such kind of vehicles. Completion of such a project would not have been possible without a thorough knowledge of pneumatic fields, machine building, mechanical transmissions and steering systems, knowledge and skills obtained by attending courses in the existing educational curriculum.

The participants' unanimous opinion was that this kind of competition manages to make the necessary connection between theory and practice and also create challenges whose resolution can be achieved only through hard work the team. About friendships and atmosphere of a contest (which otherwise benefited from an excellent organization of the Bosch Rexroth Kft Hungary Team), and especially the future desire to be the best offer premises to participate successfully in the future such competitions.

The Romanian Teams – Rexroth Pneumobil Race 2010


Flying Conrods pneumobil

# REGISTRUL AUTO ROMÂN