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THE CHALLENGE TO RESEARCH FROM MATURE BUSINESS: THE CASE OF THE AUTOMOTIVE INDUSTRY

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1) INTRODUCTION

The automotive industry, in general, has not a record of being in the foreground as a source of motivation and inspiration for basic and applied research. The situation is now changing and one can forecast that more and more research agendas of university scientists will be oriented to problems derived from the automotive sector in parallel to an increased effort of applied research and development programs performed directly by industrial R & D laboratories.

Six major European automotive industries have recently set up a Joint Research Committee (JRC) with the task to explore potential fields of long term research to be performed jointly. In USA the Government and the industries are developing the base for a joint support of basic research; the so-called CARP program (Cooperative Automotive Research Program). Twelve research areas have been identified (see Fig. 1) for inclusion in CARP.

Several working groups have been set up by the European JRC to develop program proposals in different areas and cooperation with UK universities has already started in the combustion field. In USA, for CARP, a team of approximately 100 scientists from university, industry and government laboratories has been preparing advisory reports which will lead to a technical framework for the Program. This framework will describe a range of research topics for each of these areas and will serve as a guide for the Program's participants (see for more details Annex A).

In Italy FIAT Research Center, which is an active part of JRC, is since several years stimulating universities to converge research on areas of interest for the development of the automobile field and is directly supporting, through contracts, researches in fields like: combustion, plastic and composite material properties, engine noise analysis, new techniques for quality controls, understanding material behaviour during rapid deformation for metalforming, aerodynamics computation techniques, etc.

The increasing need for research to reach the very ambitious objectives of vehicle energy conservation, together with the specific actions at international and national level indicated above, are the base for forecasting more and more involvement of university research in the automotive field.

Because of the resisting to change in research directions due to internal inertia of any research body, including university institutes, it might be interesting to discuss how quick and effective will be the acceptance of the opportunities to work motivated and oriented by the automotive research needs.

Someone might reject the appeal from the automotive sector, fearing an attempt to the "freedom" of university research. One could counterargue on a general ground, that such freedom of choice is purely nominal in the to-day "dense" and very specialized scientific world. In several basic research fields the dimension of research facilities and the need of team work make necessary to "plan" basic research for long period, plan in which, because of specialization, the "free" scientist will find himself trapped.

It seem to me therefore proper for an industrial sector, in urgent need of research, to try to present its own case to the research community trying to "orient" basic research on fields more closely related to such needs. The effort will be successful if more and more scientist will "freely" decide to pick up, in planning their future work, long lasting research agendas related to such fields.

My task today is to contribute in that direction by unveiling some potential research agendas coming from my direct experience. No completeness or detailed analysis have been attempted, the purpose being to provoke interest and discussion.

2) THE CASE OF HEAT TRANSFER IN ENGINE

Although engineers have been successful in designing car engines for a long time, only recently the actual nature of the processes going on inside and outside the engine cylinders have been subjected to careful study. This new trend has been promoted by the general recognition of inadequacy of the current design procedure to tackle and solve the large variety of complex problems posed by future engines that will be expected to operate under quite unusual conditions requiring challenging optimization among many conflicting features.

Instead of current design approach - namely, try a new solution based on intuitive learning, see what the results are and decide what to try next - a "numerical experimentation", as in other engineering fields, has appeared a far more adequate and time and money saving methodological design approach. Thus considerable impetus is being placed for the development of analytical and numerical capabilities.

For the heat transfer science a turning point happened around the year 50 in conjunction with the evolution of nuclear power. During these years research in two-phase heat transfer and fluid flow, for istance, has grown at an astonishing rate primarily due to the problems associated with water cooled nuclear power plants.

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The research topics to underpin the desired extension applications are:

1) Physical Metallurgy (work hardening limit state, recovery and recrystallization phenomena, superplasticity, etc.).
2) Process Metallurgy (influence of alloying, at micro and trace level, in order to design strictly defined alloys).
3) Science of Constructions (design of preforms suitable for giving, through Thermomechanical Treatment operations, the required characteristics and shapes).
4) Machines Design (extrusion and forging machines, of suitable power, designed for giving higher production rates through high-speed deformation and in site heating and cooling systems).
5) Tribology (tool-material interaction; lubricants for warm working operations, lubrication systems for complex geometries, etc.).

7. CONCLUDING REMARKS

The cases presented I hope could show that challenging and long lasting research problems can be found also in a "mature" business.

Because of the well perceived need of research the business sector is organizing to make the research demand become explicite. In the Introduction three cases were indicated: that of a single company which is pushing cooperation with universities, the case of a group of companies joining together to better define the research problems and to cooperate in solving them, and the case of a large government-industries cooperative problem definition program.

How the research communities, and specifically the universities, will react trying to match the demand with the research offer? The risk is that the coupling between two so complex systems, demand and offer, will be very "dissipative".

The trick to induce efficient "organized" response from the complex university research system is "good communication", as we know from the theory of complex non-linear systems and their capability to show "cooperative" "self-organizing" behaviors.

Communicating among complex systems is an iterative process. I will try to summarize here the first steps of such process for the case of matching research demand with research offer:

- from the industry side
  1 - make the problem areas look familiar: from the stated innovation objectives go up stream to development, applied research and basic research needs identifying relevant disciplines.
  2 - put the problems within well established research paths: show how in research development in different areas are to be found the roots for further progressing the state of science according to the new research needs. It will be as implanting a branch in an existing tree, taking advantage of the organized lymph system.
- from the university side:
  3 - look for existing solutions for the perceived familiar aspects of the problems: at this stage the problem will only partially be understood. This notwithstanding, looking at what is available in the state of the art of the different scientific disciplines, will permit to start interacting with the demand sides by proposing solutions that could be transferred. This will have the important effect to gain insights in the real complex problems.
  4 - make a generalized definition of the perceived problems: the research offer side should not be passive pretending to have only the role of problem solving. On the contrary if it will make an effort in assuming also the role of problem definition, at this stage of the game the results will be a first generalization of the problems, which will help in better understanding it, on both sides demand and offer, and more over in facilitating the spreading of efficient understanding in the research communities.

The process should continue iteratively. I tried in this paper, for the shown cases, to follow, even if in a very approximate way, the first two steps. For the business sector here considered, as for other business case, the innovative tasks to be reached are very ambitious, both in target and time, and require such a research effort that it is not possible to rely on casual interactions among industrial and research communities. It is needed to "plan" the research. And to do it efficiently, the only hope is, regarding the university communities, to "excite" their internal self-organization capabilities (seminars, conferences, informal scientists communications, academic recognitions, etc.) that, after having well understood the problems area, will succeed in developing a "cooperative", "coherent", "resonant" response to the research needs.

Fig. 1 - USA Cooperative Automotive Research Program (CARP)- List of identified research areas (March 1980)

- Combustion, Thermal and Fluid Sciences
- Structural Mechanics
- Electrochemistry
- Aerodynamics
- Materials Science and Processing
- Control Systems
- Tribology
- Acoustics and Vibration
- Surface Science and Catalysis
- Environmental Science
- Biomedical Science
- Behavioral Science