INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN
ICED 05 MELBOURNE, AUGUST 15–18, 2005

A13 – CANADIAN RESEARCH IN THE GLOBAL AUTOMOTIVE INDUSTRY

Peter R. Frise, Ph.D., P.Eng., FCAE
Professor, Scientific Director and CEO
AUTO21 Network of Centres of Excellence
University of Windsor, Windsor, ON CANADA

As in all traditional automaking countries, Canada faces challenges in the global automotive sector. The major issues relate to demands for enhanced product quality, on-road and environmental performance coupled with pressures caused by production over-capacity, the need for flexible manufacturing and the emergence of low-cost countries. To meet these challenges, there has been a marked increase in the scope and scale of both public and private sector automotive research and development conducted in the country since 1996. The topics addressed in these initiatives all meet the needs of Canadian companies and the domestic subsidiaries of multinationals, each of which have a specific mandate within their organizations.

Canadian Automotive Research Partnership

A unique example of public-private research partnership will be described. Known as the AUTO21 Network of Centres of Excellence (NCE), the program is relatively new having been founded in late 2001. It consists of over 40 different applied research projects organized into six broad topic areas or "themes" which are: Health, Safety and Injury Prevention, Societal Issues and the Future Automobile, Materials and Manufacturing, Powertrains Fuels and Emissions, Design Processes and Intelligent System and Sensors.

This theme structure was developed in consultation with experts from the auto sector which laid out goals for the future car and its effect on society. The research projects within the themes are conducted by academic research teams (and their graduate students) at 38 universities located across the country. Each project lasts for two to four years and is supported by a grant from the AUTO21 NCE program along with one or more industrial or public sector partners who supply financial and in-kind support (equipment, access to specialized facilities and personnel, etc.) as well as guidance for the research path and goals and milestones for the work. The total AUTO21 research program grant is CAD $5.8 M/year with the external industry partners presently providing a further CAD $7.24 M/year for a total portfolio valued at over CAD $13 M annually.

The goals of the effort are to enhance the competitiveness of Canada's auto industry through the development of highly qualified personnel (i.e. the graduates of the program many of whom will go on to careers in the sector), improve the quality of life of auto workers, occupants and the public as it relates to the automobile, and advance the state of the art in key topics of vehicle technology. It is premature at present to provide detailed data on how the research will impact the future car, but it is clear from our industry partners that significant improvements are expected from the work in several key areas.

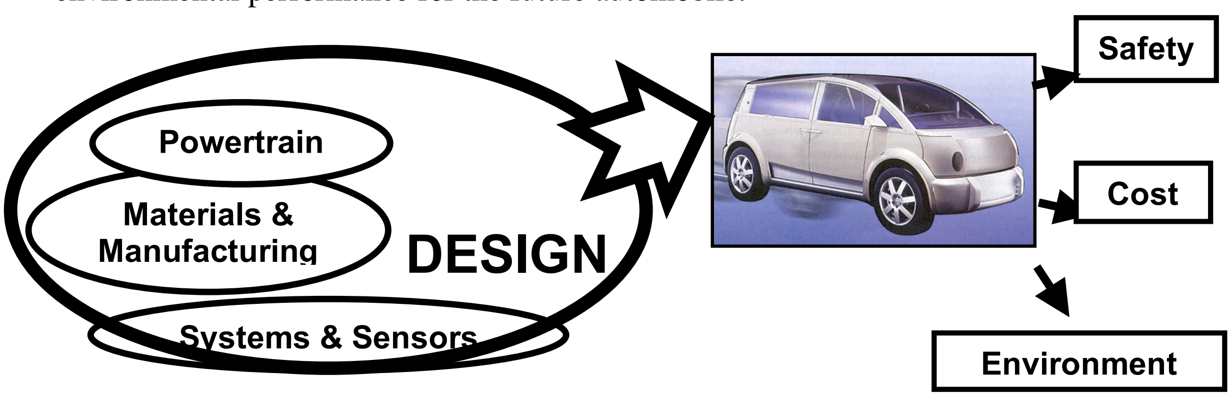
The Key Goals for the Future Automobile

The car is both a technological product and a facilitator of social change. The attainment of positive social change and the retention of an auto manufacturing industry as well as the responsible operation of a large fleet of consumer-owned vehicles require that a number of goals be realized. The board of directors of AUTO21 developed a set of research goals at the founding of the Network in 2001 and later it was found that another excellent articulation of a similar set of goals can be found in the report on future mobility prepared by the World Business Council on Sustainable Development (WBSCD).

The goals state that the future automobile should be safer, more affordable for a larger proportion of society and that it should have a smaller environmental footprint than present-day vehicles. Due to the wide range of technologies and organizations involved in the global automotive sector (and thus the difficulty in reaching a meaningful consensus) and the long-term nature of the work needed to make progress toward these goals, they are not expressed in numerical terms but rather as a set of general aims.

Technology Challenges and Example Research Projects

The theme structure of AUTO21 responds to a number of specific technical challenges which will also be described to provide a context for the research activities presently underway. The figure below illustrates how these technology topics are interwoven and require progress on a broad front based on design engineering if the future vehicle is take advantage of them and produce the desired outcomes of enhanced safety and better environmental performance for the future automobile.



Design engineering activity will be required in all of the three major areas of technical innovation shown above to achieve meaningful improvements in the future automobile. A few example projects in the AUTO21 research program are described below.

Societal Issues: One project in the Societal Issues theme is developing metrics to assess improvements in input energy and materials consumption in each of the phases (manufacture, operation and end-of-life or recycling) of the life of a vehicle measured by a total life cycle assessment (LCA) approach. Some of the technologies being or planned for assessment are:

bio-based plastics which could replace petroleum based materials and make use of the earth's massive over-capacity in the production of bio-mass, new powertrain technologies such as bio-based or other forms of clean diesel ICE's, hybrid electric systems and eventually fuel cell power systems which may allow the use of large scale hydrogen generation using nuclear or solar power,

New technologies should only be introduced if a full life cycle analysis shows that both an environmental and a cost benefit would be realized through their use. Life cycle assessment of automotive components is complex because most vehicle components are designed and built by companies other than the automaker itself. Thus, the overall assessment of an innovation must cross company boundaries and this is important in jurisdictions such as the EU where vendor take-back legislation is about to come into force in the automotive market. This has caused automakers everywhere to consider the LCA aspects of their products much more carefully.

Powertrain and Fuels: includes research on clean diesel engines, hybrid-electric drives and fuel cell engines. Each of these alternatives requires solutions to some very difficult challenges before these technologies can be adopted in the future vehicle. The most recent trends indicate that there will not be a single operating mode for the future powertrain and that profound changes will only roll-out over a significant period of time due to the technical challenges still facing engineers and the very large costs involved in changing the fuelling infrastructure for the world's transportation system. It is clear that the future vehicle will have less on-board power than many present-day vehicles, if only because the cost of energy will make it prohibitive to install powertrains capable of generating 200 kW or more, as is common in North America and elsewhere.

Materials and Manufacturing: is focussed on decreasing the weight of future vehicles to allow the (lower-powered) future vehicle to attain a power-to-weight ratio similar to that of present-day vehicles so that on-road performance is comparable. The research effort in Canada involves developing stronger alloys of existing materials such as dual phase and transformation induced plasticity ("TRIP") steels and enhanced fabrication techniques such as hydroforming of these high strength alloys. Other work involves the development of more reliable casting alloys and processes for aluminium and magnesium as well as some more novel materials such as bio-fibre reinforced or filled thermoplastics.

The trends in this area point out that progress is being made in making future cars lighter and stronger but more work needs to be done to lower the cost of the new materials and processes to competitive levels – unless the price of energy rises beyond where it is today.

Systems and Sensors: are being developed to allow higher traffic density without compromising safety. Another benefit of these technologies is lower energy usage through more effective vehicle navigation and traffic management operations. Many of the key issues in sensors and systems are technical but others are regulatory and/or legal (related to product liability). Specific examples of the latter are related to having computers control the vehicle path on the road and the need for simplified user-interfaces to preserve safety. Progress is needed on all of these issues to speed the adoption of systems which are otherwise nearly ready to introduce into the market.

Design Processes: this theme is directed mainly at providing an enhanced educational experience for students in automotive design. One project has a multi-university team developing a hybrid powertrain with a super-capacitor regenerative braking system for a full-size vehicle. This project is just getting underway but is showing promise as an innovative and realistic form of senior level design engineering training for students.

Conclusion

Although it has only been operating for about 36 months, the AUTO21 Network has been successful at providing new knowledge for the future automobile, assisting the industry to be more competitive and providing an enhanced education and training environment for design engineers hoping to enter the auto industry.

Contact : pfrise@uwindsor.ca