Tools for Improving Vehicle Availability, Reliability and Safety (SAFECAR)

Expression of Interest proposal
Annex

Monet2 (IST-33540) Automtive Task Group
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Premise
This Expression of Interest is supported by the Monet2 Network of Excellence (Model Based Systems and Qualitative Reasoning- EU Project Number IST-33540.) and has been produced by the Automotive Task Group of the Network.
The proposal is the result of a discussion involving expert representatives from several automotive manufactures and suppliers (e.g.: Actia, Audi, BMW, Centro Ricerche Fiat, Siemens, Magneti Marelli, Bosch) as well as small companies (such as Adersa, FirstEarth, Occ'm and Rose) and research institutions and Universities active in the field.
After an open discussion (kicked off with a meeting of the task group co-oordination committee), which raised a wide list of topics, the present proposal is the result of a ranking performed by the experts.

Background
Model-based reasoning proved to be a very powerful technology for automotive applications, for tasks such as diagnosis, design, simulation, etc. This has been demonstrated in some recent projects, including successful EU funded projects (such as VMBD and IDD) and by the recent deployment of tools supporting this task (e.g., Autosteve by First Earth, Raz'r by Occ'm, Rodon, IDEA by Fiat, MDS by Daimler Chrysler, …).
In particular, the general idea is that models, and specifically, qualitative models can support several activities which are critical in the life cycle of vehicles: from analysis of the orginal design through on-board monitoring, diagnosis and recovery, to diagnosis and repair in the workshop. These previous experiences and projects addressed with success some problems, showing that they can provide interesting advantages but in some sense addressed only some isolated problems and parts of the process.
The main goal of the integrated project we are proposing (which may be viewed also as a cluster of projects with a common theme and co-ordination) is to enlarge the view, addressing in a more thorough way a number of tasks and processes that are critical to the development of more available, reliable and safer vehicles and that are critical in the competitiveness of European car manufactures and suppliers of automotive technologies.

Goals of the Integrated Projects

The goal of the project(s) is the development of a set of tools, centered around models, that can support various phases of the life cycle of a vehicle (from its initial conception to the market and the customers). Moreover, the projects aim at creating a framework for the integration (and standardization) of these tools.

The tools should provide designers, engineers and technicians with a set of facilities which can support the improvement of the vehicle safety, reliability and availability. Moving from the experience of previous projects (tools for diagnosis and for integrating diagnosis in the design process – FMEA generation, diagnosability analysis), the projects aim at filling in gaps in the current life cycle, providing support for activities that are currently not fully or completely supported (or even not supported at all).

The need for these tools stems from the increasing complexity of vehicles (especially as regards electronically controlled systems). In parallel with this increasing complexity also the expectations of customers have increased, forcing manufacturers and suppliers to develop new products frequently (the life of car models has reduced significantly in the last decades), and each new product must be more technological and complex, but also more reliable and safer than the previous product.

These needs require the availability of tools for speeding up the design and development of a new vehicle, guaranteeing at the same time that the quality of the vehicle is very high from the very beginning (the very first car which is sold must already be "perfect", without teething problems).

The adoption of models and the possibility of studying and simulating the new components or subsystems of a new vehicle in a virtual environment are thus very critical. Previous experience showed that different types of models are needed at different points in this process, from mathematical models (commonly used by engineers) to qualitative models.

However, currently only a few phases are supported by model-based tools. Thus, new tools need to be developed for supporting critical tasks (currently unsupported) and for creating a framework that supports the life-cycle as a whole.

In the project(s) we propose to concentrate on some tasks that are considered the most critical and urgent ones by experts in automotive and supplier companies; in particular:

1) Tools for Knowledge management of technical knowledge via models. Managing the know-how of companies is a critical problem, especially as regards know-how on technology. Models can provide an interesting opportunity, especially qualitative ones that can provide a very clear and understandable knowledge content and that could allow for the design of tools for knowledge maintenance and retrieval (at a semantic level). The tools should support the construction of a model warehouse and Model maintenance, selection and use across the work process (models as interfaces between processes and tools), the re-use of models across multiple projects; integrated environments for modeling. This can lead to the definition of international standards for model representation and interchange between companies.

   Moreover, the standards and the model warehouse should support the use of models for training and tutoring engineers and technical people.
2) On-board systems; integration of control and diagnosis; software solutions for the deployment of model-based diagnosis on-board. Model-based approaches

to meet on-board diagnostic requirements and to meet requirements for improving safety and for controlling conditions that can lead to abnormal emissions. The possibility of having model-based tools for these tasks would allow the rapid development of these software systems, cutting the time and cost currently spent on these activities.

3) Model-based testing. Testing a new component or sub-system (or even vehicle) is a critical and time consuming activity. Models can provide a means to support and speed this activity in several ways. First of all testing can be done on the models. Secondly, tools based on models can provide suggestions on how to test a system, analyzing critical aspects for on-board systems. This is particularly important for on-board software, for which the tools should provide support for formal specification and verification and testing.
4) Preventive diagnosis. Preventing faults is a major goal of car manufacturers. This problem may arise in several contexts. During the design, support should be provided for analyzing the reliability and fault tolerance of a system and to generate guidelines for the maintenance of each subsystem (given models of the components' characteristics as regards their behavior in time, wearing, etc.). Moreover, the tools should support the introduction of indicators for preventative maintenance.
   After market, the tools could be used in workshops (possibly with a remote connection to the vehicle) to analyse the vehicles state. Again, the use of models, in conjunction with statsitical analysis should provide support for preventive maintenance and anticipation of faulty and possibly dangerous situations

These tools could be the topic of integrated projects with a common co-ordination, which imposes common standards, languages and also common software platforms for the integration of the tools.

Relevance
The project(s) are relevant with respect to several of the themes of Framework VI. First of all, the Sustainable development, global change and ecosystems section contains priorities such as: Making surface transport safer, more effective and more competitive, which is exactly the target of the integrated project(s). Similarly, the IST section contains priorities such as improving mobility and environment impact, acquiring and modeling, navigating and retrieving, representing and visualizing, interpreting and sharing knowledge.
Previous projects showed that integrated project with consortia including several companies and institutions can provide interesting benefits for projects facing goals like those mentioned above. In fact, the combination of experiences, know-how and resources from different companies is beneficial. Moreover, the presence of several companies makes it possible to define steps towards standardization, which is an important outcome of these kinds of projects.

Scale of Ambition and Benefits
The project(s) can have important benefits for the competiveness of European Automotive Companies (car manufatures and suppliers), impacting at least the following aspects:

- More reliable and safer vehicles, thus more customer satisfaction thus better position in the global market.

- Reduced time and cost during the whole life-cycle, the tools developed in the project, supporting several activities in the life cycle can lead to shortest time for developing new products. This means the shortest time to market and better products.
- Improved reliability and safety can have a significant impact on environmental issues, with the ability to control emissions and prevent problems with emissions.
- Better management of technical knowledge and know-how; improved condition for sharing of knowledge and training/tutoring of young technical staff and engineers.
- Standardization of interfaces between tasks and of modeling primitives.

The recent projects and systems showed that the technology and the know-how in European Companies and Research Institutions is mature to achieve these goals. Actually, this is an area of Excellence for European companies and the aim of the projects is to maintain and improve this level of excellence, which can have a positive impact of the competitiveness of European companies.

Critical Mass and Integration

As noticed above the proposal has been coordinated by the Monet2 Network which includes about 60 Members (Companies, Universities, Research Centers). In particular experts from several major European companies contributed to the Monet2 proposal, and specifically the Automotive Task group, can act as a support for the co-ordination and integration of the participants to the project(s) and possibly of the projects(s).

The companies which participated in this exercise manifested a potential interest to participate in the projects (similarly, other companies, which we cannot list in this document, supported the proposal). Similarly, several research centers and Universities, with many years of experience in model-based reasoning and in automotive applications declared their interest to participate to the project(s) in this proposal.

Universities and research centers could provide methodological support as well as support in the design of the tools.

IT Companies and suppliers could provide know-how for the design and development of prototype tools.

Automotive manufactures could be the final users, providing requirements, specifications and concrete case studies to experiment and demonstrate the tools.

Clearly, the final two groups of partners are those that could have the most important advantages from the exploitation of the results of the project(s)

References

C. J. Price, AutoSteve: Automated Electrical Design Analysis, in Prestigious Applications of Artificial Intelligence (PAIS-2000), Berlin, August 2000, in Proceedings ECAI-2000, pp721-725.

C. J. Price and N. S, Taylor, Automated multiple failure FMEA, Reliability Engineering and System Safety, Vol 76/1 pp. 1-10, May 2002

F. Cascio, L. Console, M. Guagliumi, M. Osella, A. Panati, S. Sottano, and D. Theseider Duprè, 'Generating on-board diagnostics of dynamic automotive systems based on qualitative deviations', *AI Communications*, 12(1), 33–44, (1999).

L. Console and O. Dressler, 'Model-based diagnosis in the real world: lessons learned and challenges remaining', in*Proc. 16th IJCAI*, pp. 1393–1400, Stockholm, (1999).

Occ'm Software GmbH, 'Raz'r version 1.6, see http://www.occm.de, Technical report, (2001).

Readings in Model-Based Diagnosis, eds., W. Hamscher, L. Console, and J. de Kleer, Morgan Kaufmann, 1992.

M. Sachenbacher, P. Struss, and R. Weber, 'Advances in design and implementation of OBD functions for diesel injection systems based on a qualitative approach to diagnosis model-based diagnosis to real problems in real cars',i*n SAE 2000 World Congress*, (2000).

C. Picardi , R. Bray, F. Cascio, L. Console, P. Dague, O. Dressler, D. Millet, B. Rehfus, P. Struss, C. Vallee: IDD: Integrating Diagnosis in the Design of automotive systems, in Prestingious Applications of Artificial Intelligence, European Conference on artificial Intelligence (ECAI), Lyon, July 2002.

F. Cascio and M. Sanseverino}: IDEA (Integrated Diagnostic Expert Assistant): model-based diagnosis in the car repair centers, *IEEE Expert* 12 (6), 1997.

R. Brignolo, F. Cascio, L. Console, P. Dague, P. Dubois, O. Dressler, D. Millet, B. Rehfus, P. Struss: Integration of Design and Diagnosis as a Common Process, In Proc. VDI Conference (German Engineer Conference), 2001.