Advanced Methods and Tools for the Production of Next-Generation Industrial Software

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Abstract

Effectiveness and the productivity in the current development of software needs innovative methods, techniques and tools to allow the applicability of theoretical solutions to industrial context. The results obtained in the last years evidence the wide distance between the state of the art and the real practice in the development of next generation software systems. With this project we intend to face these challenges by producing methodologies and tools to make possible the integration of the critical activities in the development of industrial software. Within this project, we are defining models, languages and tools for the design and development of application software in open systems, characterizing their applicability, defining the appropriate methodologies for each case, and building tools to support and allow the easy application of such methodologies. As a concrete of the contributions of this project we are building tools of great practical interest in two different application domains: Web Engineering and Data Warehouses.

Keywords: Conceptual Modelling, Web Engineering, Model-Driven Development, Data Warehouses, Document Modelling.

1 Project Aims

The METASIGN Project is a non-coordinated project leaded by Dr. Jaime Gómez, from University of Alicante. According to its initial plan the objectives of the project were categorized in the following three main tracks:

- Executable Web Conceptual Models
- Models and Tools for the Design of Datawarehouses
- Digital Document Modelling

The general objective is to produce methodologies and tools to make possible the integration of critical activities in the development of industrial software. With this purpose, we aim at a precise objective: to facilitate the construction of next generation software developed under industrialization...
levels similar to those that have been reached in the production environment of other engineering disciplines.

Following the commented structure, we are going to introduce the particular, concrete objectives associated to the three sections of the project. In all cases, the required activities are scheduled to be accomplished in the three years of project duration. As the initial schedule has been basically respected, more details can be obtained in the original project description [52].

Executable Web Conceptual Models

The objective of this project part is to define a software production environment to generate web applications from conceptual models. In concrete, the project focus on the following aspects:

- To improve web conceptual modelling methods to support the specification of new relevant properties (i.e. personalization).
- To define an action language (with a precise semantics) to improve the automatization of the software production process.
- To identify new execution models for web applications.
- To understand how to design and develop web applications for the most relevant software architectures (possibly applying the MDA standard).

Models and Tools to Manage Information from Datawarehouses

In this context, the Project objective is to improve the conceptual design phase in the development of Datawarehouses. This type of systems are specially relevant for decision support in big-size companies. The concrete objectives can be structured according to the following items:

- To improve the conceptual design in Datawarehouses (DW) in order to get more expressiveness.
- To define a guideline for DW based on the Rational Unified Process.
- To improve the techniques used to automate ETL processes starting from heterogeneous data sources.
- To develop some relevant case studies with an industrial focus in mind as a previous step to apply the techniques in the EPOs of this project.

Digital Document Modelling

The Project objective in this context is to develop a methodological proposal to design the structure of complex documents like those used in Digital Libraries, Help-Desks and so on. To achieve this central objective, the Project focus on the following specific aspects:

- To study relation between semistructure data models and the UML.
- To integrate UML and XML standards in an interactive and dynamic environment that allows the definition of different types of semistructured documents.
- To define an automatization process to elaborate those digital documents.
- To study the integration of those documents with DW.
2 Project accomplishments

The success level achieved in the Project is high. It is being really very productive, and it is mainly being developed according to the initial schedule. There are not remarkable problems, beyond the fact of being out of money for travelling too soon, due to the big success in the acceptance rate of papers in relevant national and international conferences. The level of cooperation with industry is even higher than expected, which is again a strong reason for satisfaction.

Next, we highlight the main achieved scientific and technological results, following the same Project structure used in the previous section. In the next section, we will introduce the concrete production indicators to justify and measure the success we are talking about.

Executable Web Conceptual Models

We have been working on extensions to Object-Oriented, Model-Based Code Generation Techniques, starting from the OO-H approach developed in Alicante. As a result of that some extensions have been produced:

- Inclusion of personalization support in the method by means of a new Personalization Rule Modelling Language (PRML).
- An MDA approach to Generate Web Applications following the MDA approach (WebSA).

Both extensions have been extensively and successfully published, they have generated both a rich industrial relationships and a rich set of academic results. The most relevant publications are cited in [ref].

Models and Tools to Manage Information from Datawarehouses

Two main results in this area:

A process, a method and a prototype for DW modelling have been defined. Generically called DW4UML, its extends the GOLD model by guiding the process of generating a DW model. This model is converted into a DW conceptual schema following a precise set of steps to translate modelling primitives into their corresponding Conceptual Modeling counterpart. The process is partially automated. It has generated a rich set of academic results and a very promising industrial relation.

A process and a method to model ETL processes in DW. In this case, we provide the necessary mechanisms for an easy and quick specification of the common operations defined in ETL processes such as, the integration of different data sources, the transformation between source and target attributes and the generation of surrogate keys. As an advantage of this proposal we provide a seamless integration of the design of the ETL processes with the DW conceptual schema. This process is partially automated, and it has generated a rich set of academic results.
Digital Document Modelling

This Project section has generated a proposal to adapt modeling methods originally meant for business applications, on the design of the complex markup vocabularies used for XML Web-content production. We have been working on integrating these technologies to create a dynamic and interactive environment for the design of document markup schemes. The task focuses on the analysis, design and maintenance of XML vocabularies based on UML. It considers the automatic generation of Schemas and DTDs from a visual UML model of the markup vocabulary, as well as pieces of software, like input forms. Additionally, we are integrating these UML design capabilities with other handy tools like automatic Schema simplification and multilingual markup.

The proposal has been applied successfully to develop real applications in the context of the Miguel de Cervantes Digital Library. The next step will be to try to generate a tool that implements this environment for document modelling. This part is generating an interesting set of academic results, and an incipient industrial relationships with the industrial partners of the Project.

3 Project-accomplishment metrics

The Project results indicators are going to be structures following the same items that are used along this report. Its presentation is strongly connected to the previous section information. The most relevant results will be introduced (researchers in formation, publications in journals and LNCS based conferences, technological transfer, international initiatives and collaborations with other research groups). The full set of publications including other conferences publications can be seen in the final results summary report [52].

PhD Thesis


Two more PhD thesis are about to be defended:
Publications (2005-2007)

The following is a summary of the 51 publications (international workshops and national conferences not included) obtained during the years of the project.

Books (edited)  7
Book chapters   4   (published by Springer, Addison Wesley, etc.)
Articles in International Journals   17 (11 of them included in the JCR)
Paper in International Conferences 23 (published in LNCS, IEEE CS Press, etc.)

Technology transfer and Collaboration with other research groups

This project has greatly helped establishing strong links with other research groups. We want to remark specially the interaction with the groups of Nora Koch (LMU, Munich), Piero Fraternali (Politecnico de Milano, Italy), Olga De Troyer/Geer Jan Houben (VUB, Brussels) and Gerti Kappel (TU Wien, Austria). The participation in the Program Committee of some of the most relevant international conferences on Web Engineering and DW is another consequence of all the work done (including WWW, ICWE, EDOC, ER, DOLAP, DAWAK among others).

The industrial liaison has been very important with Diputación de Alicante, Caja de Ahorros del Mediterráneo, COFTI and COGAA. These R&D contract prove the interest of the involved companies, and are for us a clear indicator of success.

4 References


Industrial and production engineering (IPE) is an interdisciplinary engineering discipline that includes manufacturing technology, engineering sciences, management science, and optimization of complex processes, systems, or organizations. It is concerned with the understanding and application of engineering procedures in manufacturing processes and production methods. Industrial engineering dates back all the way to the industrial revolution, initiated in 1700s by Sir Adam Smith, Henry Ford, Eli known. to industrial engineers, albeit as largely separate tools for use in specific, limited environments. IT is used in industrial engineering as an analysis and modelling tool, and IE’s have often taken the lead in applying IT to manufacturing environments. Well-known examples of IT use in manufacturing include process modelling, production scheduling and control, materials management information systems, and logistics. The importance of multiple customer supply processes; the generation of special bids was perceived as being of highest priority, and was the first process to be redesigned. Some of the business areas. Next, we address the issue of the current standing of PSE both in academia and in industry, and for which we present results of a survey conducted by the authors. Finally, we close with a discussion on future challenges in PSE from both the industrial and academic perspectives. Keywords: Process systems engineering, process simulation, process synthesis, process control, scheduling and planning, mathematical programming. 1. Introduction. The field of process systems engineering (PSE) has been around in various forms for over 50 years mostly under the labels of process design and process control. Next generation biomaterials. Wearable soft robotics. Functional lattices for automotive components. Development of new mechanical and dissolution methods of support structure removal necessary for the creation of complex geometries in 3D printing. Robust strategies for pinning and depositing jetted functional and structural materials on arbitrary substrates through surface modification and formulation adaptations. Understanding of new curing modalities for structural 3D printing materials (particularly based on UV and IR) and understanding their effect on the final material properties. Developed and demonstrated a new, low temperature approach to the production of metallic items via nano-printing.