precise
a guide to current research
PReCISE

PReCISE is a research center of the Faculty of Computer Science of the University of Namur (FUNDP) devoted to advanced Information System Engineering, that is, the analysis, design, implementation, deployment, maintenance and evolution of wide-scope, large-scale and multi-paradigm applications considered in their organizational context. PReCISE develops and studies models, methods and tools in most aspects of information system engineering, including software and database engineering. Its current competences are organized in six complementary axes, namely (1) Modelling and Methods, (2) Database Engineering, (3) Requirements Engineering, (4) Interoperability, Reengineering and Evolution, (5) Quality and Measures and (6) CASE and MetaCASE tools.

Vision

Information system engineering is viewed as a global, multi-dimensional, complex process involving interrelated activities, methods, practices and tools and aiming at the production and evolution of high quality information systems, with concerns ranging from organizational requirements to data and code quality and evolution. Mastering such a wide-spectrum process necessitates not only high-level expertise in the contributing disciplines but also to weave interactions between these disciplines.

Mission

The mission of PReCISE is to conduct basic and applied research in information system engineering, investigating problems of interest to society in general, and companies in particular. This research addresses specific challenges that can have a significant impact on the success and quality of software and data intensive systems. PReCISE develops strong collaborations with other national and international research entities and networks. PReCISE is concerned with knowledge exchange with Belgian and European, private and public companies. With this respect, its mission also includes the elaboration of material and activities intended to help these partners to develop competence and awareness in information system engineering.
Modelling and Methods

Modelling and Methods are unifying themes of PReCISE’s research. Since the early 70’s, our Faculty promoted the idea that conceptual modelling was the weapon of choice to tame the ever-growing complexity of information systems. This idea has then been acknowledged by a much larger community, now most often called the Model-driven Engineering (MDE) community. We firmly believe that precisely defined modelling languages featuring high-level abstraction mechanisms can drastically improve the engineer’s mastery over the Information System, as well as help them by allowing to automate such tasks as model verification, transformation, code generation, reverse engineering, etc. The many activities involved in information system engineering require different modelling languages and paradigms, and we have studied quite a variety of them: data, behavioural, functional, architectural, object-oriented, agent-oriented, goal, feature modelling, etc. Moreover, languages often need to be specialized according to specific concerns (e.g., security or performance) or application domains (e.g., banking). The need for such flexibility is supported by our CASE tools, and most prominently our MetaCASE tool.

Unfortunately, adopting MDE is not sufficient to guarantee quality information systems. This also necessitates to follow methodological guidelines. These can take many forms and can vary in rigour (or “agility”), depending on project context. At a coarse-grained level, we have studied various development life cycles. At a fine-grained level, we try to provide very detailed engineering guidelines, and automate as much process support as possible.

Database Engineering

Databases are at the core of information systems, so that their engineering fully belongs to Information System Engineering. The objective of the Laboratory of Database Applications Engineering (LIBD), PReCISE’s member in charge of the database dimension, including data-centered application programs, is to develop models, techniques, methods and tools to support the whole process of database engineering.

The LIBD has developed transversal resources such as (1) GER, a generic, wide-spectrum multi-paradigm and multi-level data specification formalism, (2) a comprehensive schema/program transformational framework supporting refinement, abstraction and co-evolution processes and (3) DB-Main, a generic, programmable, transformational, CASE platform that supports database engineering processes. Comprehensive methods have been developed for such problems and processes as standard, temporal and active database design and implementation, database reverse engineering, database migration and reengineering, database evolution, database integration, program analysis and transformation, code generation, XML engineering, web reverse engineering and reengineering. All of them are supported by specific components of DB-Main. ReveR, a spin-off of the LIBD created in 2003, is in charge of the evolution and the marketing of DB-Main and of the database engineering methods developed by the LIBD.
Requirements Engineering

Requirements Engineering (RE) is a set of activities concerned with identifying and communicating the purpose of a software-intensive system, and the contexts in which it will be used. RE acts as the bridge between the real world needs of users, customers and other stakeholders, and the capabilities of software technology.

The main RE activities are requirements elicitation, specification, documentation, verification, validation, prioritisation, negotiation, evolution and traceability. The main outcome of RE is the requirements document which serves as a basis for the subsequent development activities.

We are particularly interested in modelling notations that, through abstraction, help mastering problem complexity when specifying requirements. Transparent formalisation of these notations allows for powerful automation, removing some burden off the analyst. We have studied, applied, evaluated and improved notations like Albert, Live Sequence Charts, Statecharts, UML, Goal Models, and investigated automation of their related activities. Our current activities focus on RE for Software Product Lines with Feature Diagrams, Problem Frames and Orthogonal Variability Modelling.

Interoperability, Reengineering and Evolution

Interoperability is "the ability of different types of computers, networks, operating systems, databases and applications to work together effectively, without prior communication, in order to exchange information in a useful and meaningful manner". Interoperability can be considered at different levels, ranging from physical (communication media), to software (making software systems understand each other), to business (compatibility of business models and strategies of several enterprises). Federated databases form a specific architecture dedicated to data interoperability.

Information System Reengineering consists in analysing and modifying an existing system through a systematic approach in order to improve it. The subject of a reengineering effort can be a specific software or information system, but may also be a set of enterprise processes (Business Process Reengineering) or an enterprise as a whole (enterprise reengineering). It generally consists a reverse-forward engineering global process: (1) creating conceptual models of the existing system (generally through reverse engineering techniques), (2) modifying these models to obtain models of the target system and (3) developing a new system based on an engineering approach and migrating the components that must be preserved.

System evolution is a more general process through which the current information system is transformed in order to make it meet new functional (new business objectives) or non-functional (new software architecture, platform substitution) requirements. The main challenge in system evolution is co-evolution, that is, the consistent and synchronized modification of all the system components when one of them is changed.
**Quality and Measures**

Like any engineering discipline, information system engineering should rely on quantifiable approaches to the specification, development, operation, and maintenance of information systems. This implies a systematic control of the quality of all the products and processes being involved.

The information system quality discipline involves three levels of study: (1) precise definition of product and process qualities, (2) quality evaluation through rigorous and reproducible approaches, and (3) quality improvement.

At the level of process quality, we are interested by the adaptation of classical quality models (CMMI-like) to different particular contexts of use: small businesses, agile development and free software development.

At the level of product quality, we are particularly interested by the validity of measurement methods. Many of the measurement methods intensively used by industry appear to be questionable theoretically (ill-defined, inconsistent...) and/or practically (improper use, unjustified thresholds, improvised prediction...).

Methods and measurement models for assessing the quality of data intensive systems and the quality of software design models are currently investigated.

**CASE and MetaCASE Tools**

CASE tools aim at facilitating software engineering activities by supporting both mundane and knowledge-based tasks such as capturing, editing, verifying and transforming models, generating code, reverse engineering and maintaining traceability, to mention a few. PReCISE has a long experience (since 1984) in the development of CASE tools (ORGA, TRAMIS, Phenix, DB-Main, Albert, RetroWeb...). These are used by many universities and companies in Belgium, Europe and beyond.

The holistic view of information systems defined in the other five axes leads us to constantly define new models and languages for specific purposes. We are thus developing a MetaCASE that can generate ad hoc CASE tools for specific modelling domains and support for information system engineering processes for which no tools are available so far. The MetaCASE allows method engineers to easily specify custom meta-models, methods, notations and processes. Its flexibility provides support for their evolution.

The following catalogue briefly describes the current projects of PReCISE along with some closed projects which researchers are still members of the research center.
Projects
Research and Theses
Artist 2
Embedded Systems Design
FP6 Network of Excellence (2004 – 2007)

STAFF
Prof. P. Wolper (ULg), Belgian coordinator
Prof. P.-Y. Schobbens, FUNDP coordinator
Prof. P. Heymans

KEYWORDS
Embedded Systems – Verification – Hybrid Systems

SUMMARY
The strategic objective of the ARTIST2 Network of Excellence is to strengthen European research in Embedded Systems Design, and promote the emergence of this new multi-disciplinary area. Operationally, this is achieved by integrating the teams, and building excellence. We gather together the best European teams from the composing disciplines, and will work to forge a scientific community. Integration will be achieved around a Joint Programme of Activities, aiming to create critical mass from the selected European teams. The Belgian team is participating in the “Testing and Verification” cluster.

WEB
www.artist-embedded.org

SELECTED PUBLICATIONS
Creation of Frameworks for Enterprise Modelling

STAFF
Prof. M. Petit
S. Sandron (PhD student)

KEYWORDS

SUMMARY
Nowadays, an enterprise must be able to rapidly modify its strategy, its business model, its organization, its business processes and its supporting ICT systems in order to adapt to its changing environment. All these changes must be kept as coherent as possible with each other. We envisage the use of a model-based approach as a solution to this problem in which mechanisms are used to ensure alignment among various models of the enterprise, and in particular between business models, business process models and IT models. This requires concepts and tools to allow the definition of alignment requirements among different modelling languages.

Problems related to alignment include: (1) the use of different languages for similar models; (2) the existence of not explicitly related models expressed in different languages rendering propagation of change in one model to another model difficult; (3) enterprise design models containing redundant information; (4) the absence of certainty that all the information required has been represented in models; etc.

The main goal of the thesis is to create a method that could help the creation of a customized enterprise architecture. This architecture will be composed of modelling languages selected in specific categories. The main goals of the framework are to help to ensure that the required information is present in models and to facilitate the alignment between the chosen modelling languages. The big steps to succeed are to formalize a method to classify modelling languages, to effectively classify some modelling languages, to study the links between these modelling languages, and to validate the approach on case studies.

WEB
www.info.fundp.ac.be/~ssn

SELECTED PUBLICATIONS
Formal Modelling and Verification of Access Control Policies

STAFF
Prof. P.-Y. Schobbens
H. Toussaint (PhD student)

KEYWORDS

SUMMARY
At a time where software resources are more and more inter-connected, and where security has become a primary concern, there is a pressing need for simple and precise ways to determine and enforce access rights on software-based resources.
To this end, various access control schemes have been proposed in the literature, each with its advantages and drawbacks. In this thesis, we focus on role-based access control (RBAC) and propose our own scheme which formalises and generalises its predecessors. We take advantage of the formalisation to allow for the verification of some crucial security properties. Validation of our control scheme against the XACML standard (Extensible Access-Control Markup Language) has been carried out. We are now investigating its integration within a large object-oriented groupware application.

WEB
www.info.fundp.ac.be/~hto

PARTNERS
www.contactoffice.com

SELECTED PUBLICATIONS
IRIS
Integration of Research in Information Systems
Internal project (2007-2011)

STAFF
Prof. V. Englebert, Prof. N. Habra, Prof. J.-L. Hainaut, Prof. P. Heymans, Prof. M. Petit, Prof. P.-Y. Schobbens

KEYWORDS
Computerised Organisational Information Systems (COIS) – Model-driven Development (MDE) – Situational Method Engineering – MetaCASE

SUMMARY
The overall objective of this project is to develop, apply and validate a tool-supported framework to integrate method fragments – consisting of notations, tools and process guidance – that proved useful in engineering software for Computerised Organisational Information Systems (COIS). Examples of COIS are enterprise resource planning, medical, e-Business, e-Government, logistic, customer relationship management, food traceability systems, etc.

COIS have been the focus of the research performed at our faculty since its creation, and many method fragments have been proposed and applied by us and others in support of various development activities (database engineering, requirements engineering, architectural design, etc.). This project aims at capitalizing this engineering knowledge so as to provide COIS engineers with an evolutive situational method base giving them context-sensitive guidance, smooth notation/tool/process integration and improved experience capitalization.

The integration framework is centered around a metaCASE tool (see MetaDone project) to describe, store and apply existing and new method fragments.

WEB
www.info.fundp.ac.be/precise/iris

SELECTED PUBLICATIONS
MetaDone
A Flexible MetaCASE Environment to support Domain-specific Visual Languages
Internal project (since 2003)

STAFF
Prof. V. Englebert, Prof. P. Heymans
N. Genon, F. Vermaut

KEYWORDS
Meta-Modelling – MetaCASE – Model Transformation – Visual Languages – Domain Specific Languages (DSL)

SUMMARY
Many CASE tools exist in support of a wide range of software engineering notations and methods, most prominently the UML. Most of the time, these tools are closed, bound to one notation, and offer very limited customization and extension possibilities. However, the ubiquitous need for software engineering notations and methods requires to interact with a variety of specific businesses, domains (e.g., automotive, medical) and concerns (e.g., security, performance, human-computer interaction) for which general purpose notations and methods need to be specialized and integrated, and new ones need to be defined.
The MetaDone project develops an open metaCASE environment supporting abstract syntax definition (metamodel), concrete syntax definition (textual as well as graphical), multiple modelling viewpoints, collaborative work, model transformation and method engineering. The resulting CASE tool then provides assistance to software engineers in defining and exploiting models in the most appropriate languages. Customisation and concrete syntax definition abilities beyond the current state of the art in metaCASE environments are the main strengths of this tool.

PARTNERS
Centre de Recherche PUBLIQUE Henri Tudor (Luxembourg)

WEB
www.info.fundp.ac.be/precise/metadone

SELECTED PUBLICATIONS
- Englebert, V. The Synchronization of Independent and Specific Models, In proc. of Workshop in Software Model Engineering, Dresden, Germany, 2002.
Towards a Generic Framework for Grid-based Agents
PhD thesis (since 2005)

STAFF
Prof. V. Englebert, Prof. J.-P. Vigneron
B. Jabari (PhD student)

KEYWORDS

SUMMARY
Within the context of the third generation of grid technology, namely the intelligent grids, this work proposes an integration of grid and the agent technologies. Our project aims to define new kinds of negotiations between agents to enact a meta-grid, with the opportunity to better distribute the tasks. Market-based metaphors are investigated to enforce qualities such as stability, fault tolerance, weak dependencies, etc. So far, we have specified a generic grid interface that can interoperate with any industrial grid implementation. This layer will make our agent layer independent from the industrial implementations.

PARTNERS
- LPS: Solid State Physics Laboratory (FUNDP, Belgium)
- Laboratoire d’Optique Appliquée et de Transfert d’Energie (Université Hassan 1er, Morocco)

SELECTED PUBLICATIONS
Vigile

Integrated Visualisation of Large Medical Images and Extensible Creation of Links
WIST2, PhD thesis (2007-2010)

STAFF
Prof. P.-Y. Schobbens
C. Peeters (PhD student)

KEYWORDS
Medical Image Analysis – Semantic Annotation – Web Ontology Language (OWL)

SUMMARY
The overall goal of this applied project is to provide medical imaging specialists with knowledge management support. The prototype platform will support both the individual specialist (detecting anomalies, computing their characteristics, retrieving similar cases, protocol writing) and staff meetings (collaborative work, minutes). To this end, we will develop (1) modules for image processing based on the JPEG-2000 standard using its multi-resolution facilities, (2) a methodology to ensure the global consistency of both the evolving modules and the OWL knowledge base.

The prototype will first address breast and lung cancers, and will consist of the following steps: (1) analysis of the requirements and user tasks; (2) state of the art (medical image annotations, medical ontologies, similarity evaluation and retrieval, component and ontology evolution); (3) specification of the new modules; (4) their development, (5) tests in hospital.

PARTNERS
The project is developed in collaboration with the following laboratories:
- UCL / TELE (Prof. B Macq, coordinator)
- ULB / Institut Jules Bordet
- UCL / Cliniques Universitaires St Luc
- UCL / Cliniques Universitaires de Mont-Godinne
DB-Main
Database Applications Maintenance and Evolution
Internal project (since 1993)

STAFF
Prof. J.-L. Hainaut, Prof. V. Englebert
Dr J. Hennard, Dr J.-M. Hick, Dr D. Roland

KEYWORDS

SUMMARY
DB-MAIN (DataBase MAIntenance and evolution) is a research, development and technology transfer program undertaken by the Database Application Engineering Laboratory since 1993. It addresses the domain of database applications engineering, and more specifically the development, reverse engineering, reengineering, migration, integration, maintenance and evolution of such systems.

The main results of the project are the following:
- a wide spectrum data structure model encompassing the main abstraction levels and paradigms (the GER model);
- a transformational framework to model and drive most database engineering processes;
- DB-MAIN, a programmable, transformational, database-oriented CASE environment;
- a tool-supported, database reverse engineering methodology;
- a tool-supported, database evolution methodology;
- engineering process model and language; a method engine integrated to DB-MAIN;
- ReveR, a spin-off devoted to database reengineering evolution and migration.

WEB
www.info.fundp.ac.be/libd

SELECTED PUBLICATIONS
- Hainaut, J.-L., Research in Database Engineering at the University of Namur, SIGMOD Record, 32(4), Dec. 2003, 124-128
Gisele
Model-driven development and monitoring of complex medical workflow
WIST 2 (2007-2010)

STAFF
Prof. J.-L. Hainaut
A.-F. Bragneaux

KEYWORDS
Model-driven Design – Workflow Design – Model Synthesis – Model Checking – Medical workflow

SUMMARY
The goal of the project is the development of a software environment for the design, the checking, the validation and the control of complex and critical medical care workflow involving many agents and processes. The software must be interoperable with existing components, adaptable to various contexts and cope with the evolution of medical knowledge.
The mission of the LBD partner is to address the information and data dimensions of the system. In particular, it will tackle the problem of semantic and representation heterogeneity in transient and persistent data.

PARTNERS
The project is developed in collaboration with the following laboratories:
- UCL / INGI (coordinator)
- UCL / RBNT
- ULB / Bordet
- Industry: IBA, MOPSYS, MIMS, POLYMEDIS
ReQuest
Software for the rapid development of quality e-commerce applications

STAFF
Prof. J.-L. Hainaut, Prof. V. Englebert
Anne-France Brogneaux, Ravi Ramdoyal (PhD student), Julien Véz

KEYWORDS

SUMMARY
The ReQuest project aims to build intelligent tools intended to produce more quickly, and at lower cost, quality e-business web applications responding in a more satisfactory way to customer requirements. The tools, which are components of DBMAIN, provide the user with a great freedom to express his needs (e.g., he draws draft user interfaces to describe his information and behavioural needs), and assist the specialist in the analysis of these requirements and the partially automatic implementation of the programs. ReQuest also makes it possible to interface the new applications to the back-office and to legacy data and services. The software is dedicated intended for SME willing to develop applications of electronic commerce, either for third parties or for themselves.

ONGOING THESIS
The focus is on specifications acquisition through the analysis of human-computer interfaces. More particularly, we study how reverse engineering techniques can be used in a forward engineering approach by asking end-users to produce virtual artifacts and to keep being involved in most design processes.

PARTNERS
The project is developed in collaboration with the following laboratories of the University of Louvain-la-Neuve (UCL):
- FSA/INGI (behavioral aspects): Prof. A. van Lamsweerde, C. Damas & B. Lambeau.
- IAG/ISYS (HCI aspects): Prof. J. Vanderdonckt, A. Coyette & B. Michotte.

WEB
www.info.fundp.ac.be/precise/request

SELECTED PUBLICATIONS
TimeStamp
Modeling and development of temporal databases
RW project (1997-2001)

STAFF
Prof. J.-L. Hainaut
V. Defienne, D. Roland

KEYWORDS
Temporal Databases, CASE Tools, Database Design

SUMMARY
The goal of the project was to extend standard database design methodologies
to the development of temporal databases (TDB). The methodology supports all
the time dimensions (monotonous, transaction, valid, bi-temporal, hybrid) at the
conceptual, logical and physical levels. The main results of the project are the
following:
- temporal models for DTB;
- comprehensive database design methodology for DTB;
- mapping techniques for Oracle RDBMS based on active databases;
- a tool (components of DB-MAIN) that completely support the methodology,
  including the generation of Oracle schemas;
- an ODBC-like API to TDB based on a subset of TSQL and providing the main
  algebraic temporal operators for all the time dimensions.

WEB
www.info.fundp.ac.be/precise/timestamp

SELECTED PUBLICATIONS
Defienne, V., Hainaut, J.-L., CASE Tool Support for Temporal Database Design, In
proc. of 20th Int. Conf. on Conceptual modeling (ER 2001), Springer Verlag LNCS
2224, 2001
Architecting Software Systems using Model Transformations and Architectural Frameworks

STAFF
Prof. N. Guelfi (University of Luxembourg), Prof. P. Heymans
G. Perrouin (PhD student)

KEYWORDS
Software Product Lines – Model Driven Engineering – Model Transformation – Software Architecture

SUMMARY
On the one hand, Model Driven Engineering (MDE), by allowing the description of software systems through abstractions and deriving useful system artefacts, harnesses the inherent complexity of software systems and reduces time-to-market via model transformations. On the other hand, software product lines (SPL) foster software reuse by proposing to develop applications based on a set of common assets belonging to a particular domain. Thus, when SPL assets are carefully designed, both quality and time-to-market requirements can be achieved. Development methods that have emerged out of the SPL paradigm are generally putting the emphasis on the definition of common and variable assets to be reused by SPL members. However, they hardly address the development of applications from the SPL assets in a systematic way. Furthermore, the methods that do consider it propose automated but rather rigid approaches that unnecessarily exclude products which, although realisable by SPL assets, have not been explicitly envisioned during SPL definition. This thesis strives to propose a trade-off between automated and unsupported product derivation. It provides a model driven SPL development method that lets developers define SPL members by transforming a coherent and layered set of SPL models. Constraints on the possible transformations can be defined to indicate which products cannot be derived for both functional and technical reasons.

SELECTED PUBLICATIONS
CIGMoL
Comparison and Integration of Goal Modelling Languages
Internal project (2006 - 2008)

STAFF
Prof. P. Heymans
Dr R. Matulevicius

KEYWORDS

SUMMARY
Requirements Engineering (RE) is known to be the most crucial and challenging activity in information systems development. The growing complexity of today’s systems can only be tamed by powerful abstraction mechanisms such as goal-modelling techniques (e.g. *+, KAOS, Tropos, GRL). Unfortunately, the fragmentation of goal modelling research is a major impediment to a wide adoption by practitioners.

This project addresses this problem by adopting a rigorous and novel approach to evaluating, comparing and integrating goal modelling languages. We thereby hope to contribute to the emergence of a standard, comprehensive, sound, efficient and tool-supported goal modelling language.

WEB
www.info.fundp.ac.be/precise/cigmol/

SELECTED PUBLICATIONS
Formal Evaluation and Comparison of Feature Diagram Languages

STAFF
Prof. P. Heymans, Prof. P.-Y. Schobbens
J.-C. Trigaux (PhD student)

KEYWORDS

SUMMARY
Software reuse has been a popular topic since 1968. Nowadays, software product lines (SPL) engineering promotes systematic reuse throughout the whole software development process. In this context, variability modelling and management is a crucial concern that crosses all development stages. The most popular variability modelling technique is probably Feature Diagrams (FDs). Since the seminal FD language, FODA, many extensions have been proposed to improve it. The pros and cons of these languages are difficult to evaluate for two main reasons: (1) most are but informally defined, (2) no well defined criteria were used to justify the extensions made to FODA. As a consequence, variability modelling and management techniques proposed in the literature or used by practitioners are often suboptimal. In this thesis, we address the above issues by:
- Using a quality framework to serve as a roadmap to improve FD languages;
- Formally evaluating and comparing FD languages against well-defined quality criteria (expressiveness, embeddability, succinctness, computational complexity) following a clear research method;
- Formally defining and motivating a new FD language obtaining the highest scoring according to the criteria;
- Developing tools that automate reasoning on, and manipulation of, FDs.

SELECTED PUBLICATIONS
Managing Security Risks during Requirements Engineering

STAFF
Prof. E. Dubois (CRP Henri Tudor, Luxemburg), Prof. P. Heymans
N. Mayer (PhD student)

KEYWORDS
Security – Requirements Engineering – Risk Modelling

SUMMARY
Security is currently a major concern of IS developers and users. On the one hand, it is generally recommended to take care of security since the early stages of IS development, that is requirements engineering. On the other hand, IS security within organizations is more and more focused around risk management, which has demonstrated to considerably reduce losses originating from weak IS security. This tendency is also perceptible in the job of security officer, which is increasingly extending to the one of risk manager. In this project, we propose to confront and reconcile security-oriented requirements engineering approaches (e.g. Misuse Cases, Secure-Tropos, KAOS anti-models, Abuse Frames, etc.) with risk management approaches. This work aims to deliver integrated notations, tools and methods to support IS security risk management starting from the first stages of development.

WEB
www.nmayer.eu

SELECTED PUBLICATIONS
Model-based Selection of Off-the-Shelf Software Components

Internal project, PhD thesis (2006 - 2010)

STAFF
Prof. P. Heymans, Prof. P.-Y. Schobbens
G. Saval (PhD student)

KEYWORDS
Requirements Engineering – COTS Selection – Reference Models – Model Evolution – Model Configuration

SUMMARY
Acquiring off-the-shelf software components (aka COTS) is often an affordable alternative to custom development. However, compliance of the acquired software with the requirements remains paramount. Several methods for this have been proposed in the literature, but they tend to underexploit model-based abstraction, automated reasoning techniques and model reuse. Our work consists in devising, and experimenting with, a COTS selection method that does not have these drawbacks. The method relies on domain-specific reference models that are customized each time they are used for a specific COTS evaluation endeavour. Special emphasis is set on providing automated assistance for model configuration, model co-evolution and COTS selection. We are currently experimenting with a case study dealing with conference management systems to better understand the modelling needs.

PARTNERS
- Prof. X. Franch (Technical University of Catalunya)
- Prof. J.-M. Favre (University of Grenoble)

WEB
www.info.fundp.ac.be/~gsa

SELECTED PUBLICATIONS
PLENTY
Product Line ENgineering of food TraceabilityY software
First Europe Objectif 3 project (2003 - 2007)

STAFF
Prof. P. Heymans, Prof. P.-Y. Schobbens
J.-C. Trigaux

KEYWORDS
Requirements Engineering – Software Product Lines – Variability Modelling –
Feature Diagrams – Food Traceability Software – Safety Critical

SUMMARY
The project developed, applied and disseminated a Software Product Line (SPL)
method that emphasized: (1) suitability for small companies, (2) certification of
safety-critical products, (3) automation of software variability management.
The method was elaborated in cooperation with the SSE at the University of
Duisburg-Essen and applied to food traceability software within BIVTrace, an SME
developing a food traceability software product line.

PARTNERS
- BIVTrace
- SSE, University of Duisburg-Essen

WEB
www.info.fundp.ac.be/precise/plenty

SELECTED PUBLICATIONS
- Heymans, P., Schobbens, P.-Y., Trigaux, J.-C., Matulevicius, R., Classen, A.,
Bontemps, Y. Towards the Comparative Evaluation of Feature Diagram Languages,
- Schobbens, P.-Y., Heymans, P., Trigaux, J.-C., Bontemps, Y., Generic Semantics
of Feature Diagrams, In Computer Networks, special issue on Feature
- Schobbens, P.-Y., Heymans, P., Trigaux, J.-C., Bontemps, Y., Feature Diagrams: A
Survey and A Formal Semantics, In proc. of the 14th IEEE International
Requirements Engineering Conference (RE’06), pp. 139–148, Minneapolis, USA,
September 2006.
Problem-oriented Modelling and Verification of Software Product Lines
FNRS, PhD thesis (2007-2011)

STAFF
Prof. P. Heymans, Prof. P.-Y. Schobbens
A. Classen (PhD student)

KEYWORDS
Software Product Lines – Feature Diagrams – Problem Frames – Formal Verification – Feature Interaction

SUMMARY
A lot of today’s software is produced in different variants (e.g. software for mobile phones, cars, telecom services, enterprise management). The development of such Software Product Lines (SPL) allows for massive component reuse, leading to an important decrease in cost and time-to-market; but it also bears the risk of losing track of the software variants that evolve in parallel, causing “feature interaction”. The importance of this problem comes from (i) the great number of possible variants, which is exponential with respect to the number of “features”, (ii) the complexity of software itself, which brings a lot of hard-to-foresee interactions, (iii) the possible impact of defects.

Among the challenges in SPL engineering, we focus on the fundamental aspects: the elaboration of formal SPL-specific specification and verification techniques. To this end, we propose an approach based on two complementary techniques: Feature Diagrams and Problem Frames. The expected improvements over current approaches are improved model modularity, and more efficient and accurate verification.

PARTNERS
Prof. Bashar Nuseibeh (Open University, UK), co-supervisor

SELECTED PUBLICATIONS
Relating inter-agent and intra-agent specifications: 
The case of life sequence charts
FNRS, PhD thesis (2001-2005)

STAFF
Prof. P.-Y. Schobbens, Prof. P. Heymans
Y. Bontemps

KEYWORDS
Agent-based specification – Requirements Engineering – Sequence charts – Automaton synthesis

SUMMARY
The graphical, user-friendly and very simple inter-agent specification language of Live Sequence Charts (LSC) defined by Harel and Damm promises of increased productivity even by non-specialists. LSC is presented and its properties are investigated: it is highly succinct, but inexpensive. There are essentially two ways to relate inter-agent and intra-agent specifications: (i) by checking that an intra-agent specification is correct with respect to some LSC specification and (ii) by automatically constructing an intra-agent specification from an LSC specification. Several variants of these problems exist: closed/open systems and centralized/distributed systems. We give inefficient but optimal algorithms solving all problems, besides synthesis of open distributed systems, which we show is undecidable. All the problems considered are difficult, even for a very restricted subset of LSCs, without alternatives, interleaving, conditions nor loops. We investigate the cost of extending the language with control flow constructs, conditions, real-time and symbolic instances. A prototype implementation of the algorithms is proposed. The applicability of the language is illustrated on a real-world case study.

WEB
www.info.fundp.ac.be/~ybo

SELECTED PUBLICATIONS
- Bontemps, Y., Relating Inter-Agent and Intra-Agent Specifications (The Case of Live Sequence Charts), PhD Thesis, April 2005, University of Namur
Separation of Concerns in Variability Models
Belgian Scientific Policy project (PAI MoVES), PhD thesis (2007-2011)

STAFF
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A. Hubaux (PhD student)

KEYWORDS

SUMMARY
Many software engineering models quickly become big and entangled when applied on non-toy case studies. This lack of scalability is a major obstacle to their adoption by practitioners because the models can become less clear and manageable than code. Separation of concerns (SoC) and modularisation in source code has been studied since several decades. More recently, this research has been dominated by aspect-oriented programming (AOP). Ideas from AOP are now being taken over by the modelling community, delivering techniques that allow to make models more manageable, traceable and evolvable.

In this project, we will focus on models that are used to describe variability: mainly, feature models and goal models. The former are most commonly used in software product line development, whereas the latter are used both in product line and single product development, especially during requirements engineering. We will develop formal techniques and tools to improve SoC in such models and hence to make their usage more cost-effective.

WEB
prog.vub.ac.be/moves

SELECTED PUBLICATIONS
BIGRE
Bioinformatics Grid Resources and Environments
WIST project (2003 – 2007)

STAFF
Prof. V. Englebert
P. Buyle, Q. Dallons, F. Vermout

KEYWORDS
Middleware Broker – Bioinformatics – Wrappers – Ontologies – Integration – Scalability – Architecture

SUMMARY
This project aims to design a distributed architecture of brokers deployed on the internet in order to federate bioinformatics resources (databases for example) and to propose those services as a unique interface to several profiles of users (researchers, doctors ...).
The objectives of the project are:
- to produce an applicative middleware in order to federate distributed resources (bioinformatics data banks) into a large federation organized in a P2P style. This middleware will offer transparent homogeneous access to legacy and new brand services and it will hide the heterogeneity such as: technology, network, user interface, security, ...
- to answer a growing request for a larger access to the bioinformatics resources.
- to define a decision making procedure to help the users in using the services with an adequate GUI depending on his profile.
- to deploy an operational prototype on several European laboratories.

PARTNERS
- ULB / Institut de Biologie et de Médecine Moléculaires (IBMM)
- ULB / IRIDIA

WEB
www.info.fundp.ac.be/~bigre

SELECTED PUBLICATIONS
- Buyle P., Dugas O., Dallons Q., Englebert V., BIGRE : Bioinformatics Grid Resources and Environments, in Journée CNRS – Passage à l’échelle et médiation.
BioMaze
Storage, Visualization and Analysis of Biochemical Nets
WIST (2003-2007)

STAFF
Prof. J.-L. Hainaut
Dr J.-M. Hick

KEYWORDS
Biochemical Databases – Database Design – Database Evolution

SUMMARY
The objective of the project is to develop a web-based open knowledge base for the representation, extraction and processing of biochemical nets. The responsibility of the LIBD is focused on the design and evolution of the underlying database. In particular, the BioMaze system includes components to keep, in a semi-automated way, the schemas, the data, the documentation and the OO API of the database synchronized with the conceptual evolution of the application domain. The documentation relies on OWL, so that OWL engineering tools are being developed as well. All the tools are components of DB-MAIN.

PARTNERS
The project is developed in collaboration with the following laboratories:
- UCL / INGI (coordinator)
- ULB / Service de conformation des macromolécules biologiques et de bioinformatique (SCMBB)
- ULB / Informatique et réseaux (CS)

WEB
www.info.fundp.ac.be/precise/biomaze

SELECTED PUBLICATIONS
InterDB
Interoperability of Independent, heterogeneous and autonomous databases

STAFF
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Dr J.-M. Hick

KEYWORDS
Database Interoperability – Database Integration – Database Wrapping – Code Generation

SUMMARY
The InterDB project is dedicated to the integration and the interoperability of heterogeneous and distributed information systems. It proposes methods and CASE tools to help integrate such systems.
The main results of this project are the following:
- a generic framework for the abstraction of legacy databases through semantics-based wrapping technologies;
- a methodology for the integration of heterogeneous legacy databases;
- a generator of semantic wrappers that allow client application to read and update legacy databases (components of DB-MAIN);

WEB
www.info.fundp.ac.be/precise/interdb

SELECTED PUBLICATIONS
INTEROP
Interoperability Research for Networked Enterprises
Applications and Software
FP6 Network of Excellence (2003-2007)

STAFF
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T. Dufrasne, Dr R. Matulevic, I. Pollet, S. Sandron, G. Saval, J.-M. Zeippen
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KEYWORDS
Interoperability – Ontologies – Modelling Languages – Model Mappings –
Software Architectures and Platforms – Knowledge Map

SUMMARY
INTEROP is a Network of Excellence which aims to create the conditions of an
innovative and competitive research in the domain of Interoperability for Enterprise
Applications and Software. INTEROP studies the gaps between the existing paradigms
and the comprehensive systems required to enable true Interoperability for Enterprises
Applications and Software. The project facilitates the emergence of an
interoperability research corpus through the fusion of three knowledge-components:
Software Architecture & Platforms, Enterprise Modelling and Ontology.
INTEROP’s spreading of excellence activities should ensure the fertilisation of the
largest research community as well as IT providers and users, to provide a durable
Virtual Lab on Interoperability beyond the EU-funded period.

PARTNERS
INTEROP brings together leading academics, research centres, industrial stakeholders
and standards communities from Europe, representing 47 organisations, 15 countries.
See the project website for a complete list.

WEB
www.interop-noe.org
www.info.fundp.ac.be/precise/interop

SELECTED PUBLICATIONS
- Velardi, P., Cucchiarelli, A., Petit, M., A Taxonomy Learning Method And Its
  Application To Characterize a Scientific Web Community, In IEEE Transaction on
- Matulevic, R., Heymans, P., Sandre, G., Comparing Goal-modelling Tools with the
  276-284, 2006.
Quetelet.net
Critical System for Integration, Digitisation and Retrieval of the Belgian Penal Statistics
Belgian Science Policy project (2003 - 2007)

STAFF
Prof. J.-L. Hainaut, Prof. Claire Lobet
V. Detienne, F. Vesentini

KEYWORDS

SUMMARY
Today, the use of penal statistics runs up against many difficulties: almost total absence of complete series, heavy integration and critical work and, above all published in poorly printed books. The mission of the project «Quetelet.net» is the development of a system allowing the integration and critical availability of these statistics, published by the Belgian system since its founding in 1830. The application takes the form of a dynamic Website. It includes a database, a data entry sub-system permitting the technological transfer of published information towards the database, and a critical retrieval sub-system. One of the most challenging aspects of the project is coping with the temporal evolution of taxonomies. This pilot project is generic and can be transferred to other areas of administrative statistics.

PARTNERS
- Centre d’Histoire du Droit et de la Justice (UCL - CHD.J)
- Cellule Interfacultaire de Technology Assessment (FUNDP - CITA)
- SPF Justice – Service of Criminal Politics
- Statistics Belgium
- Vakgroep Nieuwste Geschiedenis (UGent)
- General Archives of the Kingdom and State Archives in the Provinces
- National Institute of Criminalistics and Criminology – Criminology Dep.
- Infapôle Cluster TIC

WEB
www.quetelet.net

SELECTED PUBLICATIONS
RetroWeb
Web Sites Reverse-Engineering Methodologies and Tools
Objectif 1 Phasing Out (since 2001)

STAFF
Prof. J.-L. Hainaut
F. Estiévenart, J.-R. Meurisse

KEYWORDS

SUMMARY
The RetroWeb project aims to develop methods and tools dedicated to web sites reverse-engineering and re-engineering. Interactive tools have been developed to allow the data semantics to be elicited and wrappers to be automatically generated. Efficient and effective extraction of data and their underlying semantic structure makes provides an easy way towards web site evolution, heterogeneous web sites integration, smart querying and web monitoring.

PARTNERS
- Scientific partner: CETIC, Gosselies, Belgium
- Industrial partner: REVER s.a., Charleroi, Belgium

WEB
www.info.fundp.ac.be/precise/retroweb

SELECTED PUBLICATIONS
RIStart

Migration of Large Information Systems through Automated Data-Centered Program Conversion
First Europe Objectif 1 project, PhD thesis (2004 - 2008)

STAFF
Prof. J.-L. Hainaut
A. Cleve (PhD student)

KEYWORDS

SUMMARY
Database reengineering consists in deriving a new database from a legacy database and adapting the associated software components accordingly. This migration process typically involves three main steps, namely schema conversion, data conversion and program conversion. The RIStart project focus on the program conversion phase and aims to explore its automation. Several conversion strategies are considered and compared. The proposed approach combines transformational and generative techniques, which are used to automatically propagate the database conversion at the program level. Supporting tools rely on two complementary development environments, namely “DB-MAIN” and the ASF+SDF Meta-Environment.

PARTNERS
- Scientific partner: Centrum voor Wiskunde en Informatica (CWI), Amsterdam
- Industrial partner: REVER s.a., Charleroi, Belgium

WEB
www.info.fundp.ac.be/precise/ristart

SELECTED PUBLICATIONS
Empirical Studies in Software Engineering
Internal project (since 2004)

STAFF
Prof. N. Habra
M. A. Lopez Martin

KEYWORDS

SUMMARY
This project carries out well-disciplined empirical studies to analyze some basic Software Engineering (SE) principles, thereby deepening our understanding of these principles. The first achievement of this project consists in criticizing some usual measurement methods (e.g. complexity) and providing an alternative sound approach to examine elementary OO design principles. The next steps involve empirical analysis of other SE principles, especially those linked to software evolution.

PARTNERS
- ETS-University of Québec
- Cetic

SELECTED PUBLICATIONS
Measurement of Software Quality at the "Design" Level

STAFF
Prof. N. Habra
B. Vanderose (PhD student)

KEYWORDS
Software Design – Quality – Measurement – Model-driven Engineering

SUMMARY
The last decade has witnessed an increasing interest in applying measurement methods to software engineering. At the beginning, software measurement studies mainly focused on the final product: code. But with the growing importance of model-driven engineering, the idea of evaluating intermediate products gathered momentum.

The intuition is that abstract software design contains two kinds of measurable information: (1) the quality that a model has per se (e.g. the length of Use Cases), and (2) the quality that it will induce in subsequent development artifacts (e.g. runtime performance). The focus of this project is on predictive evaluation of final quality depending on choices made at earlier development stages. Hence, we will investigate the conservation and alteration of quality information through the development process and thus through different levels of abstraction. The factors influencing the reliability of the prediction will be studied.

SELECTED PUBLICATIONS
Qualoss
FP6 (2006-2009)

WHO
Prof. N. Habra
F. Kamseu, B. Vanderose

KEYWORDS

SUMMARY
In cases of failures in software project, the financial loss is huge. Although failures may not solely be due to technologies and often relate to lack of communication or misunderstanding between people, it is clear that better software would relieve software projects from solving time-consuming technological problems and instead, would let stakeholders spend more time communicating.

Two important characteristics of better software are robustness and evolvability. Without these two attributes, a software product cannot gain credibility and looses all chances to become a viable option.

Thanks to the QualOSS method it will be possible to measure the quality of open source projects objectively, quantitatively, and quickly. QualOSS will:
- Build the QualOSS method, an objective method to assess the robustness and evolvability of open source software.
- Develop The QualOSS platform, a tool to automate most activities when applying the QualOSS method.
- Validate the QualOSS method empirically on at least 50 open source projects.

The impact of the QualOSS methodology onto the software companies and their developers will consist in providing a reliable assessment means to integrate FLOSS components in their developments.

The second main expected impact is the contribution to standards that consists in the improvement and completion of a famous standard about software product quality, that is, ISO/IEC 9126.

PARTNERS
CETIC; URJC-Universidad Rey Juan Carlos; Fraunhofer IESE; Zea Partners; MERIT- University of Maastricht; PEPiTec; ADACORE

WEB
http://www.qualoss.org

SELECTED PUBLICATIONS
Skywin
A Competitiveness Pole for
the Aeronautic and Spatial Sectors

STAFF
Prof. N. Habra
J.-C. Trigaux

KEYWORDS
Aerospace – Embedded Software – Critical Software – Quality – Certification – Software Reuse – Components

SUMMARY
The Skywin project contributes to the concept of “smart air-plane”. Safety-critical micro-systems are necessary to control, maintain and guarantee reliability in civilian and military air-planes. The purpose of this project is to provide technological innovations to improve (1) aeronautic communication through satellite, (2) air traffic control communication, (3) digital circuits for high precision clocks and (4) smart graphical user interfaces for pilots.

The potential innovations in the aerospace domain should reach a high level of quality and reliability. Moreover, they should strictly follow security rules imposed by civilian and military aviation. Certification is therefore a crucial aspect which will be considered for both electronic and software components.

PARTNERS
- Thales, Alcatel, CISSOID S.A., CREACTION, GILLAM-FEI, Vitrociset-EPB
- MULTITEL, CETIC
- UCL, ULG, FPMS

WEB
www.skywin.be
SPIinPME
Software Process Improvement in Small and Medium Enterprises
WIST & Internal project (2000 – 2009)

STAFF
Prof. N. Habra
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KEYWORDS
Quality – Software Process Improvement (SPI) – Small and Medium Enterprise (SME)

SUMMARY
Since 2000, we elaborated a light SPI model, named OWPL, tailored for SMEs and taking into account their specificities. The project SPIinPME perpetuates the experience of SPI in SMEs with a twofold objective:
- to continuously improve and adapt the model, in particular to Agile contexts;
- to increase our knowledge of SMEs and their peculiarities with respect to software practices.

PARTNERS
- CETIC
- ETS-University of Québec
- CRPHI-Luxembourg

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The PReCISE guide to current research

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