

Ecole Polytechnique Federale de Lausanne (EPFL):

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1 Special Services of the Research Partner

Research on:

- Product Lifecycle Management,
- Closed-loop PLM using Product Embedded Information Devices,
- Process Planning Modeling for machining, assembly, disassembly using Petri nets
- Quality Embedded Manufacturing

2 Special Competencies of the Research Group

2.1 Previous Projects (of the last 5 years)

CTI 3416-1: DEVIPLAN, interactive method and software for bid preparation of mechanical parts

Abstract: DEVIPLAN is an interactive method and software tool, for the cost estimation and corresponding bid preparation for the machining of a mechanical part.

The DEVIPLAN main characteristics are as follows:

- its user interfaces are easy to use and designed to facilitate the dialogue between a supplier and his clients for the purpose of negotiating a price for a machining contract,
- it provides a detailed “feature based” product description that is accessible and can be modified at any time,
- it is based on an advanced modeling method that allows the optimization of the process plans and, therefore, the corresponding machining costs,
- it allows the consideration and evaluation of different machining alternatives with the corresponding costs.

Partners: CADCAMation, BOROTEC, RMV NECANIC, LEYAT, FGA, ELMEC.

Role in the project: Initiator, coordinator, principal investigator.

CTI 6574.1 EUS-ES: SwissPROMISE

Abstract: This project is a feasibility study of the conditions and requirements for an information flow management system that will allow designers to get feedback and use data, information and knowledge, gathered during the Lifecycle of a product system. Its objective is to investigate the state-of-the-art and applicability of information modelling techniques and Design for X for that purpose. The more specific issues to be investigated are:

- Information Modelling: How do data, information and knowledge gathered during the Lifecycle of a product system have to be modelled?
- DFX: How product Lifecycle information stored in a PLM system can be used in a way that it allows designers to improve product designs and thus achieve significant savings and improved competitiveness?

Partners: BOMBARDIER, ENOTRAC.

Role in the project: Initiator, coordinator, principal investigator.

CTI 6324.1 IMS: WIN-SwissMode

Abstract: This project is a feasibility study of the conditions and requirements for a complete renovation of the operational mechanisms of SMEs of the mold and die manufacturing sector in Switzerland. Its objective is to investigate the state-of-the-art and applicability of business and technical solutions that will allow SMEs of this sector to become efficient, agile components of the emerging digital economy. Some of the more specific issues to be investigated are:

- Partnerships: How do SMEs with different core competencies team with each other to speed up the design and manufacture of advanced mold/die systems?
- Mastering of complex software tools: How SMEs may use appropriate software tools, which are usually complex and expensive and SMEs often cannot afford them and/or do not have the expertise within the company to use them?
- Participating in the emerging e-economy: How SMEs may make a balanced use of Internet-based technologies and sound business practices, in a way that allows them to achieve significant savings and improved competitiveness of their businesses?

Partners: ZPA, CIMSI, Styner + Bienz, TELAST, AWM, LEGO, PRECICAST.

Role in the project: Initiator, coordinator, principal investigator.

2.2 EU projects

All of the above projects are a combination of public/industrial funding

2.2.1 FP5

2.2.1.1 G1RD-CT-2000-00257: AEOLOS - An End-Of-Life of Product System

Abstract: As we enter the new millennium, a new perspective is required with regards to production, consumption and disposal. Sustainable Development (SD) encompasses not only environmental but also economic and societal issues. An assessment of the sustainability of any strategy therefore necessitates an initial quantitative and qualitative analysis of the economic, environmental and social (EES) impact of any proposed action, followed by a comparative analysis of disparate elements. Optimisation for SD requires trade-offs between multiple criteria. AEOLOS addresses all aspects of sustainability, and presents the complementarity between different EOL treatment levels based on EES issues exemplified through EOL treatment of Electric and Electronic Equipment (EEE). The integrated methodology and toolset will enable policy makers to determine EOL policy based on EES criteria so as to ensure least environmental load whilst also taking account of the economic and social aspects.

Partners: SINTEF, CIMRU, BIBA, BIRD, Q-Free, MULTIS, INTRACOM, PWC.

Role in the project: Responsible and principal investigator for LICP.

2.2.1.2 IMS-IST-2001-32059: GEM - Global Education in Manufacturing

Abstract: The industry has over the last decade undergone a significant change. It is no longer home-based; it operates in a global market. Digital business has become a strategy to survive. The extended enterprise is being implemented. Parts are made where conditions are most favourable.

Non-core activities are out-sourced. These service companies then become part of the supply chain that also spans suppliers and distributors. They all comprise an integrated international co-operative network to provide manufactured goods and support services for a world market just in time, at low prices and with quality surpassing customers' expectations.

This calls for a new type of education that is internationally oriented. GEM will provide such a new training scheme for engineers by developing a new curriculum covering both manufacturing technology and manufacturing business – a Master degree in *Manufacturing Strategy*.

The main objectives of GEM are to:

- Define and understand the needs of the manufacturing industry for training and education in manufacturing strategy on a global basis to comply with the concept of digital business and extended products
- Develop detailed specifications for a manufacturing strategy curriculum focusing both manufacturing and business administration topics. This curriculum will provide a basis for a world standard. Selected modules will be tested in all IMS regions applying a modern IT-based delivery of training and education (web-based multimedia solutions).

Partners: SINTEF, CIMRU, BIBA, POLIMI, ALFAMICRO, SIEMENS, ALCAN, Metropolitan Tokyo University, Lehigh University, KAIST, University of Melbourne.

Role in the project: and principal investigator for LICP, responsible for the Knowledge Area “PLM and EOL planning and management”, development of one e-Learning demonstrator.

2.2.1.3 G1RT-CT2001-05032: MANTYS - Thematic Network on Manufacturing Technologies

Abstract: The MANTYS Thematic Network will promote innovation in the field of manufacturing technology, focusing on machinery technology and its interfaces with the manufacturing process.

The current MANTYS Network set-up connects around 70 research projects, among which more than half are EC-funded. About 80 industrial companies and research organisations will actively contribute to the Network. The structure of the Network guarantees an industry-driven approach, with a clear involvement of small and medium size enterprises (SMEs).

The network is organised in different entities that contribute to the objectives of the MANTYS Network as a whole, but focus on a specific mission within the Network.

Participants of the connected research projects will act as interface between the projects and the Network. They will provide non-confidential information about the objectives and activities of their projects. On the other hand, they will use the information generated by the Network in order to achieve the set research objectives and exploit the research results while taking into account the socio-economic aspects of the exploitation.

Partners: CECIMO, Swissmem, UCIMO, University of Bremen, CATERPILLAR, AMTRI, CRF, FIDIA, University of Stuttgart, ...

Role in the project: Responsible for LICP and co-coordinator of the Research Area “Process (ECO-) Efficiency” together with Dr. Jochen Echebrecht of the University of Bremen, Germany.

2.2.1.4 IMS-IST-2001-65001: IMS-NoE - Network of Excellence on IMS

Abstract: IMS Network of Excellence is proposed as a follow-on to the successful initiative of the IMS-Working Group (Esprit 21955). The IMS-WG has demonstrated, throughout its 46 months of activity, to be an effective sensor observing the emergence and development of the next-generation manufacturing systems within the IMS initiative. The IMS-NoE aims at further developing the IMS-WG's activities by providing a well-coordinated and effective support infrastructure throughout Europe, and through collaborations with other non-EU Networks also at IMS inter-

regional level, in order to share and exchange the latest researches and developments in the key areas of design, engineering and control of manufacturing systems.

Partners: POLIMI, BIBA, SINTEF, ALFAMICRO, PROFACOR,

Role in the project: Responsible for LICP and co-coordinator of the Scientific Interest Group “Sustainable Products and Processes” together with Dr. Odd Myklebust of SINTEF, Norway.

2.2.1.5 IMS-IST-2001-00007: STEP-NC: STEP-Compliant Data Interface for Numerical Controllers.

Abstract: The IMS STEP-NC project will develop and implement a comprehensive STEP-compliant data model for the CNC manufacturing process. It will provide a new quality of IT-based manufacturing by integrating the shop floor into the company-wide information and logistics network. By that way machine operators will be provided with full process information. Manufacturing know-how can be captured and re-used. New cross-departmental IT solutions based on the data model will be demonstrated. The project will take the results of ESPRIT 29708 STEP-NC and ISO 14649 DIS beyond their milling-oriented focus into consideration and extend the modelling to all major manufacturing technologies and systems involved.

For the implementation of the developed models into the industry use a global teamwork is very helpful for taking into consideration the different applications.

Partners: SIEMENS, WZL, EiG, AGIE-Charmilles, DaimlerChrysler, University of Stuttgart, STEP Tools, OpenMind, OSAI, ...

Role in the project: Proposal development and responsible for LICP.

2.2.1.6 GRD1-2000-25302: LITHOPRO: Advanced Manufacturing Systems for Customer Oriented Production of Technical Ceramics and Natural Stone

Abstract: There is an upcoming renaissance of technical ceramics and natural stone in industrial and construction applications due to excellent material properties and evident ecological benefits. The technical ceramics serve for big industrial end users like automotive companies, the natural stone business is mainly a domain of SME companies. However, both material areas include many similarities in general manufacturing features. The main problem area encountered with the production of complex precision parts of ceramics and natural stone are their huge material variety combined with individual machining properties, which are completely different to these in the metal manufacturing sector. Also the production cycles are traditionally based on handicraft features and the herewith combined factory organisation. Prototype or single-part and small-batch manufacturing of ceramics and natural stone is rather difficult. The manufacturing strategies for natural stone and ceramic products require selected machining parameters and tooling technologies, if the end-products require individual 3-D shapes. Thus the LITHO-PRO project enables on a European level a close connection of customers' demands and end-user expertise, designer/supplier features and production requirements. This strategy provides a clear sustainability of the achieved results. The project is divided in two main application areas of different manufacturing scale, according to the targeted industrial sectors. The intended RTD results project will provide a significant benefit for companies involved with natural stone and ceramics manufacturing and machining equipment.

Partners: FH-NON, SIEMENS, IBAG, SMR, Lund University, JAMBO Tools, ...

Role in the project: Proposal development and responsible for LICP.

2.2.2 FP6

2.2.2.1 FP6-IP 507100 and IMS-01008: PROMISE

Abstract: PROMISE will develop appropriate technology and associated information models for decision making as well as business processes (standardisation). This is done to enable and exploit the seamless flow, tracing and updating of information about a product, after its delivery to the customer and up to its final destiny (decommissioning, deregistration, EOL) and back to the designer and producer.

PROMISE offers the following business proposition to the Product Lifecycle stakeholders: **to create value by transforming information to knowledge at all phases of the product lifecycle and thus improve product and service quality, efficiency and sustainability.**

The main objectives are to develop new

1. **Closed-loop lifecycle information flow models** for MOL (Middle of life) and EOL (End of Life)
2. **PLM (Product Lifecycle management) system and IT infrastructure** exploiting the capabilities of **smart product embedded information devices**
3. **Standards**
4. **Working and business models** appropriate for the use and exploitation of the new technologies and tools in a product lifecycle.

Partners: SINTEF, Cambridge, HUT, BIBA, CIMRU, POLIMI, ITIA, CRF, CATERPILLAR, BOMBARDIER, INTRACOM, MTS, WRAP, FIDIA, SAP, INFINEON, Indyon, Stockway, ENOTRAC, COGNIDATA, InMediasP.

Role in the project: Initiator and Scientific responsible, Quality and Integration Manager.

2.2.2.2 FP6-STREP 016542: PRIME - Providing Real Integration in Multi-disciplinary Environments

Abstract: The main objective of the PRIME project is to give business professionals in manufacturing a dynamic work environment where they can experiment with new ideas and learn how to handle the entire lifecycle of products and processes for all stakeholders within an organization and innovation networks. PRIME proposes to achieve this by enhancing current work environments with a new paradigm based on the creation of Virtual Business Environment (VBE), which will combine together virtual environments with serious gaming in a strategic manufacturing context. This will provide the means for learning by experience within a virtual environment that is safe and foments risk-taking without detrimental impact on the business. The experience garnered is based on strategic manufacturing in a multi-disciplinary global business environment, including multi-stakeholder negotiation and business connectivity.

Partners: SINTEF, ALFAMICRO, INTRAPPOINT, BIBA, Sofia University, KESZ, SIEMENS, INRACOM, IAI, LEGO.

Role in the project: Quality and Risk Manager, responsible for LICP.

2.2.2.3 FP6-IP for SMEs 505339: KoBaS - Knowledge Based Customized Services for Traditional Manufacturing Sectors Provided by a Network of High Tech SMEs

Abstract: The KoBaS project aims to provide a breakthrough in the current practices in the use of manufacturing machines, by developing a set of tools of new conception meant to enable the quick customization of solutions in order to provide, on one hand, an advanced task and process planning and, on the other hand, machine configuration, maintenance, training and management support. This set of tools are founded on techniques such as Virtual Reality, 3D & Discrete Events

Simulation, Knowledge Based Systems and Finite Element Analysis, evolved, combined and optimized in their interaction thanks to a new brand of innovative technologies that are the main object of KoBaS. The approach is meant to be flexible, adaptable, and scalable, to cope with the needs of a wide range of manufacturing centres for a number of traditional but strategic industrial sectors in Europe.

These novel tools, for task and process planning, will be provided as services (customized for every manufacturing machine) for less intensive R&D traditional industrial sectors, by a Network of High-Tech SMEs that will be built during the project. Thanks to this new core of innovative tools, the manufacturing machine itself becomes intelligent, being aware of its state and being able to provide the desired goods, starting from the virtual model of the goods to be produced and naturally interacting with the user.

Partners: ITIA, TTS, RPK, ETHZ, CADCAMation, INTELLIACT, INESC. TEKNIKER, URPEMAK, MCM, SCM GROUP, Wittmann & Partner, IICS, AZEVEDOS INDUSTRIA, ZENON, UNITY, QUINSON.

Role in the project: Proposal preparations, negotiations and management, responsible for LICP.

2.2.2.4 FP6-IP 011815: NEXT - Next Generation Production Systems

Abstract: The Integrated Project NEXT aims at committing the European production machinery industry to new frontiers in diverse fields. The main objectives of the project are the following:

1. **THE GREEN MACHINES:** Environmentally friendly machines. The aim is to get machines that consider environmental aspects through their entire lifecycle: use of recycled materials for machine elements (>50%), reduction of energy consumption (25% at least) at machine use, zero waste produced, dismantling and recycling of 100% machines.
2. **THE USER CENTRIC AUTONOMOUS MACHINE.** The objective is to get machines that help the operator in all his/her tasks by a complete set of features (added applications, ergonomic aspects, improved maintenance aspects) heading users support and satisfaction as well as automatically recognise machining tasks and process conditions.
3. **THE MANUFACTURING FRONTIERS:** Process oriented high performance production equipment. The aim is to get 5x improvement in machine productivity, as well as an order of magnitude improvement in machine accuracy, compared to current available machines
4. **NEW BUSINESS PARADIGM FOR MACHINERY:** New paths to create value for the machinery business. The exploitation objectives of the project target the commercialisation of the developments, by the industrial companies involved, by the generation of take-up companies and by the definition of new ways of doing business in the machinery sector (e.g. selling production hours instead of machines)
5. **NEW CONTENTS FOR TRAINING AND DISSEMINATION AROUND PRODUCTION EQUIPMENT.** The dissemination task will target both academic and professional training, by the generation of new contents arising from the research and establishing the means to reach the target audiences, focusing specially in machine using and building SMEs all over Europe. Gender issues will be given a specific treatment by specialists.

Partners: FATRONIC, CECIMO, WZL, FIDIA, ASCAMM, DANOBAT, SIEMENS, BOSCH, K.U. Leuven, ONA, ITIA, CNRS, CRF, HULLER-HILLE, IFW Hannover, FhG-ISI, KOVOSVIT, MEKOF, TEKNIKER.

2.3 List of publications (only the last 5 years)

2.3.1 Book chapters

1. D. Kiritsis and A. Rolstadås, Ubiquitous PLM using Product Embedded Information Devices, Advanced Manufacturing-An ICT and Systems perspective, Taylor & Francis publisher, pp. xx-yy, 2007
2. Hong-Bae Jun, Dimitris Kiritsis, and Paul Xirouchakis, "Closed-loop PLM," Advanced Manufacturing-An ICT and Systems perspective, Taylor & Francis publisher, pp. 90-101, 2007.
3. Myklebust, D. Kiritsis, T. Lamvik, Sustainable Products and Processes: Challenges for Future Research, Advanced Manufacturing-An ICT and Systems perspective, Taylor & Francis publisher, pp. xx-yy, 2007.
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8. Hong-Bae Jun, Dimitris Kiritsis, and Paul Xirouchakis, "Product lifecycle modeling with RDF," in Product Lifecycle Management: Emerging solutions and challenges for Global Networked Enterprise, Inderscience enterprise Ltd, 2005. pp. 44-54.
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11. A. Bufardi, D. Kiritsis, P. Xirouchakis, "Generation of design knowledge from product life cycle data", in Tools and Methods of KLCM, Edited by Alain Bernard, to appear in 2008.

2.3.2 Peer reviewed journal articles

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13. Kiritsis, D., Ahmed Bufardi, Paul Xirouchakis, 2003, Research issues on product lifecycle management and information tracking using smart embedded systems, Advanced Engineering Informatics, 17, pp. 189-202.
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15. Hong-Bae Jun, Dimitris Kiritsis, and Paul Xirouchakis, "Research issues in closed-loop PLM," Computers in Industry, vol 58, no. (8-9), pp. 855-868, 2007. (SCI)
16. Hong-Bae Jun, Dimitris Kiritsis, Mario Gambera, and Paul Xirouchakis, "Predictive Algorithm to Determine the Suitable Time to Change Automotive Engine Oil," Computers and Industrial Engineering, vol. 51, pp. 671-683, 2006. (SCIE)

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18. D. SAKARA, D.-H. LEE, D. KIRITSIS, and P. XIROUCHAKIS, An extended two-level coloured Petri net model for stochastic job shops, *International Journal of Computer Integrated Manufacturing*, (accepted).
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2.3.3 Conferences

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42. D. SAKARA, D. KIRITSIS AND P. XIROUCHAKIS, A New Petri-Net Based Tool For Systems Modelling and Analysis: A Remanufacturing Cases Study, 12th ASIM Conference - Simulation in Production and Logistics , Kassel, Germany, SEP 26 - 27, 2006
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49. Ali Saffarpour, Dimitris Kiritsis, Heiko Duin, Manuel Oliveira, Felix Hunecker, Paul Xirouchakis, Strategic Manufacturing Decision Making Simulation: An Approach for Serious Gaming, Learning with Games 2007, September 24th – 26th September 2007, Sophia Antipolis - France

3 Running and upcoming Projects

1. PROMISE (see Section 2.2.2.1)
2. NEXT (see Section 2.2.2.4)
3. VRL-KCiP

4 Contact

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