Opening keynote of PLM’12

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Global Product Development for the whole lifecycle: news and trends

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Outline

1. News about IFIP WG 5.1
2. Trends about PLM evolution
3. Conclusions
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Aims of IFIP TC5 WG5.1:
The aims of the WG are to understand the whole life-cycle impact of products in product development. One of the major issues is also to analyze and take into account the interaction of products with the environment, which is recognized as of enormous importance for the sustainability of future economic development while understanding of the life-cycle costs of products (the total costs of ownership) and their interaction with users is vital as company portfolios move toward product-service systems (PSS) and services assume greater importance in economic life. The objective is to propose new approaches to product development that take account of the increased importance of life-cycle issues, and for support systems that allow the information and data associated with products to be developed and sustained through the product life-cycle.
IFIP TC5 WG5.1

Scope of the WG5.1:
The scope of the WG will concern all aspects of Product Development for the whole life-cycle, including rapid product development and concept validation, CAD tools for early design, collaborative product development, capture and reuse of design information, feedbacks from supply chain, usage and product recycle management, etc.

- **Global product development** (global products, global teams, global processes)
- **Product Life-cycle Management** (PLM) (Product life-cycle phases, PLM systems architecture, Distributed PLM systems)
- **Product Life-cycle Engineering concepts and methods** (Design for the life cycle, Life-cycle analysis, Through-life aspects – feedback from users and service, Knowledge Lifecycle Management and long-term knowledge sustainment, Product-Service Systems)
- **Generic issues** (Value, Risk and cost management, Emerging standards and best practices, Metrics and benchmarking, performance evaluation, Educational and training approaches).
Board of the WG5.1

- Co-Chairs:
  Prof. Alain BERNARD, Ecole Centrale de Nantes (France),
  and Prof. Chris McMAHON, University of Bath (UK)

- Vice-Chair (Europe-Africa):
  Prof. Abdelaziz BOURAS, University of Lyon 2 (France)

- Vice-Chair (Americas):
  Prof. Deba DUTTA, University of Illinois at Urbana-Champaign (USA),

- Vice-Chair (Asia-Pacific):
  Prof. Balan GURUMOORTHY (IISc Bangalore),

- Secretary:
  Henk Jan PELS (Eindhoven University of Technology)
- The official journal of the WG is the IJPLM: www.inderscience.org/ijplm
- All of you are very welcome to submit your best papers to the journal in order to let it being a well-known and high scientific level journal
- You may also contribute to the scientific success of the journal in becoming reviewers and members of the editorial committee
- You may also disseminate information to people in the field of PLM.
IFIP TC5 WG5.1

The Web site:

www.ifip-wg51.org (connected to IFIP-TC5 website)

Different links from the WG5.1 home page to:
- IJPLM website (www.inderscience.org/ijplm)
- PLM conferences (www.plm-conference.org, which contains history, past conferences and proceedings, conference management, conference guidelines, current conference)

To be developed and provided:
- Activities with other WGs in TC5 (SIG-PLM with WG5.7, ...)
- Additional events/Special sessions/tracks in conferences (like APMS)

http://www.apms-conference.org/

Convenor, communication and outreach: Sergio TERZI
The first Doctoral workshop of WG5.1

- About one day long.

- 9 PhD students have presented their work.

- Each PhD has peer reviewed the text from another PhD student and one senior member of the group has completed.

- There has been interesting discussions based on these initial comments and feedback.

- One of the PhD students will be Awarded.

- Thank you to Yacine and Sergio
Outline

1. News about IFIP WG 5.1
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PLM definition

1. **Product**: Beyond mechanical engineering field
2. **Lifecycle**: Beyond design stage
3. **Management**: Beyond Data Management
PLM: Product Dimension

Multi-technology, universal environments, collaborative design

Mass Customization
Diversity
Innovation
Knowledge management
Re-use in context

Rebuilt from DASSAULT SYSTEMES material, April 2008
PLM: Lifecycle dimension

Product Lifecycle Management

Product Information is... all product related intellectual capital used to create and simulate a product, through its lifecycle, from initial conception to retirement.
PLM: Management dimension

Capture/Manage/Re-use all Product Information to enable collaboration, throughout the product lifecycle, within the organization with partners, suppliers and customers.
Product Lifecycle Management

PLM: a **business strategy** that aims to **collaboratively manage the product centred activities** during the **whole product life cycle** and through **the extended enterprise**.

Courtesy: PhD LE DUIGOU
PLM within the Extended enterprise

- SMEs belong to many extended enterprises at the same time.
- SMEs want their own repository environment

Courtesy: PhD LE DUIGOU
Typology

Assembling

Product with a large number of components

Production

Product with a few number of components

- Equipment
- Component

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Component</th>
<th>Craft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural machine</td>
<td>Compressor</td>
<td>Stamping</td>
</tr>
<tr>
<td>Special machine</td>
<td>Bearing</td>
<td>Forge</td>
</tr>
<tr>
<td>Hoisting equipment</td>
<td>Main transmission</td>
<td>Welding</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Courtesy: PhD LE DUIGOU
PLM for SMEs: Methodological framework

Generic models

Specialisation

Specific model

Implementation

Modelling

Data

Processus

Need

Specific models

Enterprise type equipment

Enterprise type component

Enterprise type craft

Enterprise X

Courtesy: PhD LE DUIGOU
PLM for SMEs: Modelling method

Two types of knowledge are extracted: explicit and implicit knowledge. Two methods are used:
- Observation and interview of the expert doing his job.
- Do the job of the expert (immersion).

1. Identification of the needs (mind map)
2. Modelling the processes (IDEF0)
3. Extract the objects (UML class diagram)
4. Automation (VB.Net & MS Access)

Confrontation with the expert

Implementation

No

Yes

Courtesy: PhD LE DUIGOU
needs, processes and data models useful to:

• The exchange of information between the design department and the production department.
• The exchange of information between the design department and the suppliers.
• The coherency between the different views.

Identification of needs, processes and data models useful to:

• Exchange of information between the design department and the production department.
• The exchange of information between the design department and the suppliers.
• The coherency between the different views.
Equipment company

The automation of activities validated:

- The extraction, restructuration and import of BoM.
- The update of information from CAD and ERP.

Courtesy: PhD LE DUIGOU
Subsystem company

Identification of needs, processes and models necessary to:

- The structuration of product information during design
- The link between functions and design parameters
- The information exchanges between the customers and the design office
- The classification of products (parametrized product families).

Courtesy: PhD LE DUIGOU
Subsystem company

Activities automation has validated:
- The Structuration of design product information
- The links between functionnal parameters and design parameters.

Courtesy: PhD LE DUIGOU
Identification of needs, processes and models necessary for:

- The information exchanges between the customers and the Manufacturing engineering office.
- The link between product geometry and manufacturing process definition
- The creation of process plan
Component company

The automation of activities has validated:

- The extraction of product information for the creation of process plan.
- The extraction of the other information needed for the creation of process plan (machines, cutting tools, tooling...).
Modelling framework

Adapted from GERAM
PLM software user interface

- Multiview
- Associated files
- Enterprise referential
- Viewer
- Data card

[Image of a PLM software user interface showing various functionalities such as associated files, functions, BoM, use cases, routings, and enterprise referential.]

Courtesy: Philippe DUIGOU
How to reach the goal of a whole lifecycle management for all products

- Some products have a quite long lifecycle (planes, energy plants, etc...), they need significant information retention and re-use depending on the context (time has to be taken into consideration).
- The stored fragments have to evolve both on content and on structure.
- The users of these fragments should use mechanisms to consult/add/modify/delete these fragments.
How to reach the goal of a whole lifecycle management for all products

- Systems are more and more complex, in fact systems of systems that interact.
- These systems are defined and designed through different view points.
- The representation of these systems has to be achieved with multiscale structuration.
How to reach the goal of a whole lifecycle management for all products

- Three major needs:
  - needs for models and structuration
  - needs for a better knowledge integration
  - needs for multi-temporalities and multi-dimensions
Plan

1. News about IFIP WG 5.1
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   - Some major needs
     - needs for models and structuration
     - needs for a better knowledge integration
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3. Conclusions
Needs for models and structuration

- **STEP**: STandard for Echange of P roduct model data - Norme ISO 10303.

- **Goals**:
  - To become a multi-application standard applicable to all manufactured products, all skills and all lifecycle stages.
  - To enable long term retention of data, information and knowledge, exchange with neutral format, integration of applications with a unique centralised database.
Needs for models and structuration

**STEP AP 214: Core Data for Automotive Mechanical Design Processes**

- **Geometry**
  - Solid geometry
  - Surface models
  - Wireframe data
  - Measured data

- **Analysis**
  - Kinematic simulation

- **Specification/Configuration**
  - Diversity management
  - Product structure

- **Presentation**
  - Technical drawings
  - Visualisation Data

- **Fabrication**
  - Fabrication process plan
  - Fabrication resources

- **Technological data**
  - Materials
  - Form Features
  - Tolerances
  - Surface quality

Courtesy: PhD Chambolle
Vehicule diversity

The concept of family (MacKay96).

- **product_class**: platform, family and version of vehicule.
- **product_classHierarchy**: hierarchical link between vehicules.

Courtesy: PhD Chambolle
Decomposition

- Concepts of organ and function (Mony92).
- product_component : organ.
- product_function : function.
- class_structure_relationship : association link between an organ, a function and a vehicle.
- product_structure_relationship : composition link between organs and functions.

**Organ**
- Front
- Rear
- Parking

**Function**
- Braquing
- Road
- Parking

**Concepts of organ and function**
(Mony92).

**product_component** : organ.

**product_function** : function.

**class_structure_relationship** : association link between an organ, a function and a vehicle.

**product_structure_relationship** : composition link between organs and functions.

Courtesy: PhD Chambolle
Part management

- Concepts of parts (Männistö98) and views (Harani98).
- item : part.
- item_version : part version.
- design_discipline_item_definition : view.

Lever

Version A

Version B

Version C

Computational view

CAD view

Courtesy: PhD Chambolle
**Instances**

- **quantified_instance**: quantified instance of a part.
- **single_instance**: single instance of a part.
- **instance_placement**: position of a given instance of a part with respect to an organ.

Courtesy: PhD Chambolle
Solutions

- Concept of alternative solution (Saucier97, Vargas95).
- technical_solution : technical solution.
- supplier_solution : supplier solution.
- final_solution : final solution.

Courtesy: PhD Chambolle
Product configuration

- Concept of configuration (Bourdichon92).
- Configuration: Use of elements for a given vehicle.
- Effectivity: Effectivity of a component along time periods.

Courtesy: PhD Chambolle
Administrative data

- approval: Approval of an element.
- security_classification: Level of confidentiality.
- property: Property of an element.
- organization: Enterprise or service.
- date_and_time: Temporal data.

Courtesy: PhD Chambolle
Needs for models and structuration

- One given person does not need to have access to all the data.
- One view consists of a filter on data.
  > Design office view
  > Industrialisation office view
  > Fabrication view
Needs for models and structuration

Lifecycle management of technologies and organisations

Two main needs:
- To provide digital environments (virtual engineering)
- To enable a coherent coordination of information lifecycle

Data integration – Interoperable models and applications
Needs for models and structuration

Evolution of PLM context: From individual knowledge to the management of collective knowledge along product lifecycle

Courtesy: DUTTA, Workshop PLM, Noida, 2005
Needs for models and structuration

Fragmented organisation: People-Processes-Information…

OEM, suppliers, consumers, distributors,…

Fragmentation (multi-representation of information related to products)

Fragmentation (design, production, usage, service, recycling,…)

Courtesy: DUTTA, Workshop PLM, Noida, 2005
 Needs for models and structuration

**Toward « product-service systems »**

Basic pillars: product/process/service engineering, information and knowledge technology, management and control of organisations

- **Product/process/service engineering**
- **Management and control of organisations**
- **Information and knowledge technology**
- **Sustainable development**
- **Complexity and diversity management**
- **Management of social aspects**
- **Innovation Management**
- **Resource Management**
- **Requirement Management**
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Needs for a better knowledge integration

Integration of knowledge in a design and manufacturing process of mechanical parts

Methods

Tools

KADS
MOKA
MKSM
CYGMA

SGBD
SGED
UML

Ontologies

Specification for

Informal knowledge within the company

Formal Knowledge inside the system

Courtesy: PhD AMMAR-KHODJA
Needs for a better knowledge integration

Results:

• Extraction method of knowledge for the creation of a knowledge-based tool

Courtesy: PhD AMMAR-KHODJA
Needs for a better knowledge integration

Part patterns
Machining
Models
Machining
Plates
Machining
Tools patterns

Courtesy: PhD DELPLACE
Needs for a better knowledge integration

Courtesy: PhD DELPLACE
Needs for a better knowledge integration

Main concepts of the information model

- **Working team**
- **Usage tasks**
- **Safety solutions**
- **Critical event**
- **Risk**
- **System**
  - **Technical Solutions**
  - **Functions**
    - **Tools**
    - **Consummables**
- **Potentially Dangerous phenomena**

Courtesy: PhD HOUSSIN
Development within DELMIA

PPR structuration

Risks and Barriers

Courtesy: PhD SHAHROKHI
Needs for a better knowledge integration

A screen shot of the application

Elements of risk evaluation for each part of the body

Distances between the parts of the body and the dangerous zone

Courtesy: PhD SHAHROKHI
Needs for a better knowledge integration

Results

Dynamic model of hand and interaction modes within the working situation in virtual reality environment for a realistic immersion

Courtesy: PhD POULQUEN
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Objectives

- Real object
- Virtual object

Objectives

- Capitalize old know-how and popularize it.

Finalities

- Museologic valorisation for any kind of public
- Virtual thesaurus (digital archives)
- Safeguards in industrial archaeology
- Reconstruction at scale 1:1
- Springboard for generate innovation
- Didactic use for experts or students

Courtesy: PhD LAROCHE
Hypothesis: Heritage lifecycle
Objects transformation - intermediary states
Scientific problematic: how to integrate the time concept?

**Hypothesis**

Reverse the design time axis and use virtual engineering tools

Need an Information System for supporting:
- past information of a specific object;
- contemporary information of the same object;
- relations between those two information in past and present.

Courtesy: PhD LAROCHE
An object transformation into different intermediary states

- Every **finality represents 5-10 %** of the knowledge collected.
- More possibilities of final representations we want (**Artefact**), more the amount of elements owned must be bigger and diversified.
- However, when ruling on the **objectum**, the **finality is not determine**: we must capitalise so much knowledge as we can (**Object+Sources**).
- **An new intermediary state is required**

**Technical Heritage File / Container model**

- **DMU taken as reference** *(static & dynamic scale mode of the virtual object)*
- **Associated to a multi-format knowledge data base**

Courtesy: PhD LAROCHE
General methodology

Knowledge's evolution...

<table>
<thead>
<tr>
<th>Digitizing Knowledge Management</th>
<th>Modeling</th>
<th>Dynamic used situations Virtual Reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Object</td>
<td>Digital heritage Reference model (object contextualized)</td>
<td>Immersive system</td>
</tr>
<tr>
<td>Technico-industrial</td>
<td>Standalone use at home</td>
<td></td>
</tr>
<tr>
<td>Socio-economical</td>
<td>Museum</td>
<td></td>
</tr>
</tbody>
</table>

Courtesy: PhD LAROCHE
Synthesis of the model

Digital Heritage Reference Model

Intermediary representation modes

Produit numérique final
Dossier d'oeuvre patrimonial technique
Traces
Objectum

Etats

D H R M
- atemporel
- adimensionnel

Schèmes

Objet technique ancien

Usage

Homme

Description of multi-temporal and multi-dimensional

Courtesy: PhD LAROCHE

Global Product Development for the Whole Lifecycle – Prof. Alain BERNARD - PLM’12 Montréal – 9th July 2012
Object in context: multilevel representation

An Objet and its context

Out of its context, an object loses all its signification. Human and Machine evolve in an unvariant real natural environment. They modify this world to adapt it to their needs: This is Reality. [Aristote]

Real VS Reality

Courtesy: PhD LAROCHE
DHRM, Digital Heritage Reference Model
**UML conceptual model description**

**Internal aspect**
- ✓ Characteristics
- ✓ Structure
- ✓ Function
- ✓ Dynamic

**External aspect**
- ✓ Organisational and economical context
- ✓ Human, Enterprise and Society

Courtesy: PhD LAROCHE
Multi-dimensionalities and multi-temporalities

Salt: Legislation

Salt: Current usage

Extraction methods of gemme and sea salt

Salt fields community

SCA

Modern washing methods

Batz washing machine

Components

Batz washing

Courtesy: LAROCHE
Knowledge modeling: simple relations for complex systems
Knowledge modeling: simple relations for complex systems
Database: knowledge modeling and exploring
Knowledge base: Towards a meta-model for « intelligent » updates
Perspectives: Create interaction between real object and virtual artefact

Virtual world

Real world

Museum

Tactil screen and pointing system

City

Mixed reality for mobile

web access

Knowledge database

Augmented immersive digital simulation

Courtesy: LAROCHE
Conclusion

✓ Create an Information System dedicated to heritage objects based on PPR
✓ Take into account new variability:
  Knowledge = f (Data; Time(s); Geographical position(s); Context(s))
✓ Imagine a new language for enriching engineering models and industrial PLM
✓ Integrate Human/user factors
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# Recommandations

**Fr-USA workshop, NIST, Nov. 2006**

<table>
<thead>
<tr>
<th>Breakout Team ID</th>
<th>Green engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify: Problem or Issue</td>
<td>Introduction of new regulations</td>
</tr>
<tr>
<td>Analyze: Root Cause</td>
<td>Environmental and social issues</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Green engineering</td>
</tr>
<tr>
<td>Benefit</td>
<td>…</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plan: Action(s) to implement</th>
<th>Owner/Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of existing standards and labels</td>
<td>Bernard+Venkat</td>
</tr>
<tr>
<td>Analysis of social issues of green engineering</td>
<td>Sub</td>
</tr>
<tr>
<td>How to embed environmental ontologies into PLM ontologies</td>
<td>Bernard+Bernard</td>
</tr>
</tbody>
</table>
Green Product Lifecycle Management Initiative

WORK PROGRAMME 2010
PEOPLE
MARIE CURIE INITIAL TRAINING NETWORKS 2011 (ITN)
• Call identifier: FP7-PEOPLE-2011-ITN

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## Sustainability background

### Green Product Lifecycle Main Stages

<table>
<thead>
<tr>
<th>(Eco) Design</th>
<th>An approach to <strong>green product design</strong> considering product life cycle environmental impacts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Eco) Development</td>
<td>An approach to the development of manufacturing process plans (Meta, Macro and Micro) with special consideration for the <em>environmental impacts of the manufacturing technology</em>.</td>
</tr>
<tr>
<td>(Green) Manufacturing</td>
<td>Manufacturing of products that use materials and processes that minimize negative environmental impacts, conserve energy and natural resources, safe for employees and society and are economical. <strong>Sustainable manufacturing</strong>.</td>
</tr>
<tr>
<td>(Green) Logistics</td>
<td><strong>Sustainable production and logistics</strong> that considers how mass production and outsourcing contribute to Green PLM</td>
</tr>
<tr>
<td>(Green) Maintenance</td>
<td>Design considering the recycling of parts and disassembly and sometimes the reuse for third world.</td>
</tr>
<tr>
<td>(Green) Recycling</td>
<td>In order to close de cycle products should be rescued and reused or disassembled and recycled.</td>
</tr>
</tbody>
</table>

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Network Scientific & Technical Objectives

Summarized Vision

Green PLM

✓ The company of the future has imperatively to have a broad vision of the product design and development with a sustainability commitment.

✓ Companies will have to define eco-processes for the product design and development of green products.

✓ The factory of the future has to be now and has to be the evolution of today’s small and medium enterprises set of regional competent SMEs (either consumer products or service to industry) that can compete but are available to collaborate when needed sharing knowledge and resources and assuring the survival for this Green Generation Manufacturing.

✓ Therefore there is a need of a New Generation SME is that one that maximizes today’s resources / facilities getting ready for the future.

Copyright: Green PLM consortium
Conclusions

- PLM has a great influence on the whole product lifecycle.
- Needs for generic concepts in order to enable genericity of modeling and interoperability.
- Needs for new ways of interaction with knowledge fragments, with simulation tools, with CAX (semantic enrichment).
- Needs for coupling numerical product models with their justification (simulation, CA decision making processes) and with their usage context definition in order to define the conditions for use and re-use.
- Needs for an efficient Knowledge Management approach in close relation with PLM.
- Needs for proofs of concepts in different application fields.
- Needs for multidimension PLM: From objects to plants.
- Needs for multitemporal PLM: From the past to the future
- Sustainability can be supported by PLM.
Thank you for your kind attention!

Questions?

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