PLM-based Solutions for Extended Enterprises

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WP3 - Maintaining and developing the industrial tissue

WP3 Academic partners:
- Centre for Innovative Product Development & Manufacturing - James GAO, Head of the CIPDM
- CESI – IRISE and LUSINE laboratories work lead by Mourad MESSAADIA, Lecturer and Researcher
Overview of PLM
PLM and Literature review

"product lifecycle management"

Environ 916 000 résultats (0,37 secondes)

Articles universitaires correspondant aux term: lifecycle management"
**PLM Definitions**

- PLM is an integrated approach including a consistent set of methods, models and IT tools for managing product information, engineering processes and applications along the different phases of the product lifecycle. PLM addresses not only one company but a globally distributed, interdisciplinary collaboration between producers, suppliers, partners and customers (Abramovici, 2005).

- For the analyst (CIMdata), PLM is defined as: “a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product definition information across the extended enterprise from concept to end of life – integrating people, processes, business systems, and information.”

- IBM defines PLM as “…a strategic approach to creating and managing a company's product-related intellectual capital, from its initial conception to retirement”

- For the PLM Interest Group (PLMIG), PLM includes research, management of customer requirements, product development CAD, CAM, simulation, rapid prototyping and virtual concurrent engineering, product / process design, sourcing of components, machining digital control, collaboration via the web with customers and suppliers. PDM is the IT Platform for PLM, the terms 'PLM System' and 'PDM System' mean the same thing, and are interchangeable
PLM Definitions: Synthesis

Terms related to PLM

<table>
<thead>
<tr>
<th>Terms related to PLM</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative Mode</td>
<td>CIMData (Miller, 2003)</td>
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<td>(PLM Interest Group)</td>
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<td>(Abramovici, 2005)</td>
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<td>Strategic approach</td>
<td>(Abramovici et al., 2004)</td>
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<td></td>
<td>(Saaksvuori, 2008)</td>
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<td>(CIMData), (IBM)</td>
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<td>(Amman, 2002)</td>
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<td>Requirement management</td>
<td>(PLM Interest Group)</td>
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<td>PLM Process</td>
<td>(CIMData)</td>
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<td>(Saaksvuori, 2008)</td>
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<td>(Feldhusen, 2008)</td>
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<td>(PLM Interest Group)</td>
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<td>PLM Architecture (IT tools)</td>
<td>(CIMData)</td>
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<td>Integrated management</td>
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<td>Product structure</td>
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<td>(PLM Interest Group)</td>
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<tr>
<td>Concurrent Engineering</td>
<td>(PLM Interest Group)</td>
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<tr>
<td>Engineering process management</td>
<td>(Abramovici, 2005)</td>
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</tbody>
</table>

Terms listed in different definitions ↔ multitude of acronyms and other topics associated to PLM.
Overview of PLM ➔ Need of Information management

1. (➔ 1980s) CAD evolution (Computer aided design and manufacturing)

2. (1990s) PDM: Managing technical data flow (CAD, technical data, Specification, Standardisation (STEP, ..), ..)

3. (Early 2000s) PLM (Product Lifecycle Management): DATA+Process+Human
   - Managing technical data through (Vaulting) allowing the access of different department
   - Process management (Engineering Change request, Engineering Change Order etc.)
   - Product structure management (BOM, etc.) and family product

PLM system (Tool) evolution:

- Workflow and change management
- Knowledge management
- Web-based solution
- Extended enterprise and distributed product development
Product Lifecycle Management (PLM)
Product Lifecycle Management (PLM)

R&D view and process

PLM: Data storage (Design database, Archival Design repository, ...) and exchange, management of development processes, knowledge management, ...

CAD, CAM: mechanical, electrical, ...
CAE, system engineering

0D and 3D Simulation software: thermal, vibration

Other IT tools

Enterprise Resource Planning (ERP), Manufacturing Execution System (MES), Customer Relationship Management (CRM), Supply chain management (SCM)
Defining general guidelines  
External/internal Evaluation STEEP, SWOT  
Business model supporting product/service  
Product portfolio

Strategy is the highest level, where important decisions are taking and in this level we define the kind of organization and processes. The organizational level describes the shape of structure based on processes. Tools level is the implementation of processes and the support for the organization.
Origin of the project and industrial issues
Industrial issues

- Booming of digital engineering for product development, industrialization, manufacturing and product services in many industrial sectors.

- Knowledge management, constraints links to subcontracting and concurrent engineering including the development of mechatronic products.

Courtesy O2M project
Generic V-cycle used during system development

Requirements Analysis

System Analysis and Design

Module analysis and Design

HW/SW components Design

HW / SW Implementation and Unit Test + prototype

Components validation

Module Integration and Test

System Integration and Test

System Acceptance

CAD Tools (mechanical, electrical, multi-physics)
Simulation multi-physiques

System engineering (Ex: SysML language)
Simulation. (Ex: Simulink, Modelica)

CAD’15 – London
V-cycle for the global system and for the equipments (OEM and suppliers)

OEM: global system architecture and design

Requirements Analysis
System Analysis and Design
Module analysis and Design
HW/SW components Design
HW / SW Implementation and Unit Test + prototype
System Acceptance
System Integration and Test
Module Integration and Test
Components validation

How to manage the communication issues, design sharing, project management, ... ?

Product development in collaboration with suppliers

Suppliers: equipments architecture and design

Equipment 1
Equipment 2

CAD'15 - London
Problems to be addressed:

- **Product development/manufacturing in collaboration with suppliers** (communication issues, design sharing, project management, ...)
- **Management** of various versions and configurations of **products** (including **supplier parts**)
- **Knowledge management** (requirements, manufacturing capabilities, testing knowledge, suppliers knowledge, ...)
- **Evolution of the Information System (IS) and processes** to take into account of the entire **Product Lifecycle Management**

→ Structured databases, process based information management (PDM, PLM), web services, social media
OEM Industrial Needs
The investigation covered the three specific areas of:

- Employee Collaboration and Knowledge Sharing
- Product Lifecycle Management and ICT Tools
- Maintenance, Servicing and Testing

Methodology employed:

- Informal individual audio-recorded face to face interviews: 60 - 90 minutes
- 17 employees, inc. Plant Manager, Manufacturing Engineers and Production Line Team
- Interview panel of 3
- Standardised 7-part questionnaire with a mix of open and closed questions
- Audio transcriptions of interviews for analysis purposes

Aim: To identify organisational practices and challenges in relation to the 3 subject areas

Investigation results

- Results relating to PLM include…
  - Product information traceability and Integration issues ➔ CAD ➔ PDM ➔ PLM
  - Cross functional Data Sharing between different business units
  - Common standards issues
  - Change management
  - Supplier integration
  - Part numbers not consistent between legacy and current systems – prone to error
Results relating to Maintenance include…

- No current methods to capture the degradation of the equipment
- Decisions made dependent on engineers’ experience – not by decision support system
- Limited knowledge sharing between manufacturing and assembly line

Results relating to KM include…

- E-mail used as preferred communication method – relied on too much
- Face to face collaboration is encouraged to speed-up communication
  - Provides opportunity to listen and ask questions
  - Difficult to get everybody involved in a project together at the same time
- Face to face and telephone communication relied upon for supplier collaboration
  - Builds trust – get to know suppliers on a personal level
- Project Teams can create and manage their own intranet sites – ‘Team Rooms’
Knowledge Management and Evolution of the Information System
Work on Knowledge management framework

What is Knowledge Management?

- The systematic approach to capturing, organising and sharing both the tacit and explicit knowledge of employees, so that others may utilise it in order to be more effective and productive in their work outputs.

- Knowledge can relate to any aspect of a company’s business including its customers, its products, its processes, its competitors and its partners.

- One of the most valuable resources owned by organisations is employee knowledge.

- Opportunities to establish competitive advantage lie in the ability to enhance ideas and intellectual know-how, often making use of the knowledge held by partner organisations within supply chains.
Classification of Knowledge

Knowledge has two forms:

- ‘Explicit’ or ‘codified’, which may be found in tangible forms such as books, drawings, tapes etc.,
- ‘Tacit’, which may be considered as personal know-how, practical knowledge and skills, including the intellectual property of the product designer.

Product knowledge refers to the evolution of a product through its lifecycle.

Process knowledge can be classified into:

- Design Process Knowledge (mechanisms for realising design details at various stages of the product lifecycle);
- Manufacturing Process Knowledge (activities associated with the manufacturing floor);
- Business Process Knowledge (processes associated with marketing, strategic planning, supply chain management, financial and other associated functions).
Current challenges in Knowledge Management

- Knowledge is not always directly and easily accessible;

- Organisations often suffer from a culture of “knowledge silos”;

- The sharing of knowledge and skills in supply chains is often seen as challenging;

- The failure to capture employee knowledge means that expertise is no longer available;

- The usability of knowledge capture tools and how they may be made more interoperable with current PLM tools.
Study the benefits of using Web 2.0-based groupware to improve employee collaboration and knowledge sharing between dispersed PD teams:

- Blogs, Wikis, Forums, Internet Surveys, Micro-blogging, Social Network, RSS feed, Slide Hosting, Video calling, …

- Facilitate informal communication and collaboration within defined groups and teams;
- Create an open interactive working culture with reduced management barriers;
- Recognise and reward good work by adding “likes” and “personal comments” on individuals’ profiles, which are visible to colleagues and peers;
- Share information and content easily with colleagues; and
- Mentor individual groups and teams through the posting of constructive advice.

A Framework for Improving the Sharing of Manufacturing Knowledge through Micro-Blogging

Knowledge Management

Co-located Environment (same-site colleagues)

- User acquires explicit manufacturing knowledge by searching micro-blog public news feed using specific keywords and phrases
- User targets specific individuals and project groups to receive explicit knowledge using @specific-user and #name-of-project-Group
- User re-posts explicit knowledge to his/her own public news feed for ALL personal connections to view, read and re-share
- Message is read by individuals or project group members and then re-circulated to external environment colleagues using @user or #Group
- Tacit knowledge is provided to recipient in response to question or feedback

External Environment (overseas and national colleagues)

- External colleague receives notification of explicit knowledge; recipient reads knowledge and re-circulates with his/her personal work colleagues
- Questions and feedback are sought from knowledge provider to solve work related manufacturing issues
- Tacit knowledge from knowledge provider is re-used to inform solution to manufacturing issue

The Process

1. Knowledge Capture
   - Search
     - Keywords and Phrases
   - Locate
   - Re-Post
   - Target Colleagues

2. Knowledge Management
   - Share
     - Targeted Hashtags
     - @User

3. Knowledge Sharing
   - Read, Decipher and Re-Share
   - Consider Use and Ask Questions
   - Contribute further Knowledge

3.5 Knowledge re-Sharing

4. Knowledge Application

5. Knowledge Re-use
## Business Process for Improving the Sharing of Explicit Manufacturing Knowledge

<table>
<thead>
<tr>
<th>Level</th>
<th>User...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Capture</td>
<td>Searches and locates explicit manufacturing knowledge employing targeted keywords and phrases.</td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>Targets internal colleagues who would benefit from receipt of explicit manufacturing knowledge. Re-posts knowledge to his/her own personal news feed so that others can search and locate knowledge.</td>
</tr>
<tr>
<td>Knowledge Sharing</td>
<td>Shares manufacturing knowledge with targeted colleagues and project groups using specified #Hashtag or @user functionality.</td>
</tr>
<tr>
<td>Knowledge re-Sharing</td>
<td>Reads and deciphers knowledge and shares with targeted colleagues and project groups using specified #Hashtag or @user functionality.</td>
</tr>
<tr>
<td>Knowledge Application</td>
<td>Considers supplied knowledge and applies to business needs, where appropriate. Posts questions and gives feedback to knowledge provider.</td>
</tr>
<tr>
<td>Knowledge Re-Use</td>
<td>Provides tacit or further explicit knowledge in response to knowledge recipients’ questions or feedback. Re-uses knowledge received to improve business processes and re-distributes to project group members.</td>
</tr>
</tbody>
</table>

Product development/manufacturing in collaboration with suppliers

⇒ Extended entreprises and collaborations types
Vertical collaboration: this type of collaboration involves companies having or may have an OEM / supplier direct contract (transaction).

Horizontal collaboration: this type of collaboration brings together competitors, engaged in a joint project.

Diagonal collaboration: between companies that have no direct transactions or competitive relationships, and whose products are complementary.

Inter-sectorial collaboration: this type of collaboration is between companies from different sectors fully met the time of a project.

## OEM-Supplier Relationship

### Vertical cooperation levels

<table>
<thead>
<tr>
<th>Input data</th>
<th>Activity/Supplier</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users Requirements</td>
<td>Participate to elaborate requirements, ..., manufacturing</td>
<td>5</td>
</tr>
<tr>
<td>Functional Requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function module</td>
<td>Design, industrialization and manufacturing</td>
<td>4</td>
</tr>
<tr>
<td>Function component</td>
<td>Design, industrialization and manufacturing</td>
<td>3</td>
</tr>
<tr>
<td>Specification</td>
<td>Participate to the design, Patent registration (2a), Give up the IP (2b)</td>
<td>2</td>
</tr>
<tr>
<td>Product Technical Specification</td>
<td>Industrialization and manufacturing</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Manufacturing</td>
<td>0</td>
</tr>
</tbody>
</table>
3 collaboration types

- Collaboration modes based on trust levels
  - (a) Free mode: open relationship between supplier and OEM
  - (b) Coordinator mode: virtual organization (GSN: Global Supplier Network)
  - (c) Project mode: important trust level, sharing of knowledge, resources, …

- Example from the Aeronautic sector.

Collaboration level 0-2

- **OEM**
- **Tools workshop**
- **Purchasing department**
- **Logistics**
- **Rank 1 supplier**
- **SMEs**
- **Rank 2 supplier**

**Flux informationnel**

**Flux physique**

**Reception**

**DO: Donneur D’ordre**

**Rank 1 supplier**

**Rank 2 supplier**

**PME: Réalisation**

**PME: Etude**

**PME: Vérification**

**Expedition**

**Expedition**

**Expedition**

**Physical flow**

**Information flow**
Coordinator Mode

Collaboration level 3-4

- Tools workshop
- Achats
- Réception
- OEM
- Cluster Coordinator
- BD Filière
- MAJ
- Réception
- SME - design
- SME - manufacturing
- SME - quality
- Shipment

Information flow
Physical flow

Supplier: SME
Collaboration level 5

- Project Database
- Atelier Outillage
- Achats
- OEM
- CP: Chef de Projet
- Réception
- SME - design
- SME - manufacturing
- SME - quality
- Shipment
- Supplier: SME

Physical flow

Information flow
Proposition of a conceptual collaborative framework based on Trust levels

Importance of the trust to have a high level of collaboration (sharing data, common and define process, tools access, ...)

Product development/manufacturing in collaboration with suppliers

An example of collaboration process
Collaboration process between OEM and suppliers

- Process planning is an important step to convert a design concept to a manufactured product.
- Efficient collaborative product design and manufacturing is necessary for extended enterprises willing to develop complex products during a short time to market.
- Workflow model for representing all tasks that must be carried out for the collaborative process planning between extended enterprises (OEM) and suppliers (SMEs)
- Model the business processes (for each collaborator) and provide advice on improvement:
  - Study of different tools used to model Business Processes: BPMN, IDEF0, UML, SYSML, etc
  - On the basis of the literature review and Industrial investigation working on BPMN (Business Process Model and Notation) models of collaborative process
Methodology of proposed BPMN

Methodology of proposing a BPMN model for designing process between OEM/SMEs with their suppliers by means of existing researches:

- Investigating application, limitation, main advantages, class diagrams and packages of information models for implementing design and manufacturing process in PLM system

- Investigating all tasks related to design process between extended enterprises and their suppliers

- Comparing data models with all existing tasks

- Development of a BPMN for illustrating design process between OEM with their suppliers

BPM of the collaboration process between OEM and suppliers

**Design**

- Pre-testing prototyping
- Design validation
- Shared data vault
- Design report

**Planning**

- Project management
- Manager of R&D
- Director of R&D
- Receive conceptual solution
- Validation concept
- Validate conceptual idea
- Prepare meta plan
- Technical report

**Manufacturing Proposal**

- Receive request
- Prepare macro plan
- Send quotation
- Negotiation

**Quotation**

- Receive quotation
- Review feasibility report
- Feasibility ok?
- Prepare process plan
- Demand for start executive

**Supplier (SME)**

- OEM
- Manufacturing
- Production planning
- Manufacturing
Benefits of BPM

- All tasks and steps have been developed according to existing research in the domain of design process.
- Graphical representation of role-based views and interoperability between OEM and SME.
- Process is designed by connecting “Flow object" with “Connecting objects“ through an organized way.

CAD’15 – London
Product development/manufacturing in collaboration with suppliers

⇒ The SMEs point of view – Maturity levels
Maturity Levels (Level of collaboration through PLM)

Inputs: Types of collaboration and BPMN analysis
Necessity to study the maturity levels of SMEs
• What is the actual level of collaboration?
• What are the activities of each level of the maturity model?
• What are the requirements elements to improve the level of collaboration?

SME without collaboration
Un structured
Repeatable but intuitive
Defined
Managed & measurable
Optimal
SME with collaboration

Study of the maturity levels

- Based on a literature review
- 5 levels maturity model divided into 4 axes: strategy, process, organisation and tools

<table>
<thead>
<tr>
<th>Level</th>
<th>Working Practice</th>
<th>Strategy</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unstructured collaboration</td>
<td>Have started to recognize PLM topic in terms of collaboration and its importance have been agreed</td>
<td>Have begun to Select supplier after zooming potential ones</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Work must be done to define the PLM concept</td>
<td>There is no defined organization concerning lifecycle management; all lifecycle and product management issues are resolved by individuals on a case-by-case basis.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Have begun to identify potential supplier</td>
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</table>

| 4     | Managed and measurable collaboration | The state of uniformity of PLM concept is formed | Numerous workshops have been organized to understand the main criticalities of actual processes, to choose how to evolve the adopted system to meet the extended enterprises needs and to define the technical specifications of the new PLM platform | It is possible to monitor and measure the compliance between processes and to take action where processes are not functioning well | IT systems support PLM processes well |
|       |                                      | The state of uniformity of organization and processes are clear          | Processes and concepts have been refined to the level of best practice, based on continuous improvement and benchmarking with other organizations | Processes are developed through clear vision throughout the corporation |                                                                              |
|       |                                      | Concepts of PLM are developed through clear vision throughout the corporation | There is best practice of synchronisation with other organisations | No PLM platform |                                                                              |
| 5     | Optimal collaboration               | Use Execution plan PLM configuration and continual improvement           | New system functionalities have been defined in cooperation with industrial partners | The implemented system can be considered a good trade-off between some commercial PDMs tools and the most advanced CSCW applications | Evolution of the existing PDM tools toward a PLM approach |
|       |                                      |                                                                          | New system processes (PLM) have been defined process automation exists on an end-to-end basis | IT is used in an integrated manner | There is a PLM platform |
Maturity model gives to SMEs an analysis of their situation in terms of PLM collaboration according to:

- Levels of collaboration from basic one until the optimized one
- Different activities in each level.

It gives a description of activities to be done for evolving

Nevertheless, the maturity level only gives the actual level of SMEs ➔ what are the barriers and key success for PLM adoption?
Product development/manufacturing in collaboration with suppliers

⇒ The SMEs point of view – indicators of PLM adoption
Software solutions, PLM, accounted for very high costs and long and costly internal resources deployments.

SMEs are struggling to adopt PLM technologies

- Understand the barriers that discourage SMEs from taking advantage of PLM
- Review indicators that impact, positively or negatively, the SME’s adoption of such technologies.

Our current study aims to offer SMEs a quantified analysis of their situation and a vision of steps required to determine the "GO" or "NO GO" to PLM
The deployment of a PLM system for SME’s organization requires:

- More than one tool, impact processes and habits related to the organization, and the ability to change, the involvement of stakeholders.

- Functional/Business processes
- Data migration
- Global integration with other ICTs (such ERP)
- Driving change
- Training and support.
- …

PLM was initially **adopted by large company** in the field of automotive and aerospace industries.

SMEs differ from large enterprises, they are characterized by:

- Small size, lower hierarchical distance, promoting direct contacts and working relationships rather informal;
- Centralization/customization, management around the owner (Leader);
- Low specialization, both in the direction or resources (employees and equipment);
- An intuitive and little formalized strategy;
- Less complex and poorly organized internal and external information systems cede place for dialogue and direct contact (while large companies are forced to establish a formal mechanism for all transfer of information).

**Why SMEs are struggling to adopt PLM?**
SMEs with greater financial capacity will be more likely to adopt ICTs technologies [Lal, 1999].

Enterprises that have a capacity of self-financing will easier adopt new technology [Stoneman, 2001].

Enterprise which has a large R&D budget and implements a strategy of acquisitions and fusion promotes the adoption of new technologies [Bocquet, 2008].

The role of leader is crucial in the development of a strategy for the use of information technology. The introduction of information technology depends on the knowledge that had managers and their ability to understand the potential of these technologies [Brown, 1992]. The introduction of information technologies requires the development of new forms of organization and only leaders can effectively carry out these organizational changes over time [Mansell, 1998].

Enterprises that operate in highly competitive markets are likely to adopt an innovation may be necessary to maintain their market position and can enable for maintaining of “barriers to entry” [Robertson, 1986].
[Hollenstein, 2004] argues that the size of SME is positively correlated with rapid adoption and intensive use of ICT; he suggested an **optimum size** (from 50 to 200 employees). [Lal, 1999; Ciarli, 2007]

SMEs have an advantage, according to large company, considering the small number of services and people involved, the implementation of PLM will not face to hard resistance to change [Hollenstein, 2004].

In the other hand, SMEs with younger employees is able to have less resistance to changes [Giunta, 2007]. Also, **Age of SME** can have a negative influence on the PLM adoption.

The presence of **skills** and **accumulated knowledge** within the enterprise is important for the adoption of information technology [Ciarli, 2007].

**Enterprises exporting** are more likely to adopt new technologies to improve their internal organization and their production processes in order to remain competitive in **international markets** [Hollenstein, 2002].
The new technologies adoption, such PLM, requires a **standardization of procedures and information**, which penalizes SMEs for which the exchange, either internally or externally, stood mostly **informally** [Giunta, 2007].

Companies are **forced to redesign their products** more frequently to meet the rapidly changing demands.

**R&D department** is responsible, not only to develop new products, but also to change the information technologies that support the production process to make it more effective, and to develop effective and user-friendly applications to operate the assembly.

The presence of an **R&D department** facilitates the adoption of new technologies [Lal, 1999] which can be seen as an existing R&D process and an **ability to develop new products**.
The adoption of a new ICT depends on its characteristics, but also on the context, especially **technology already present in the company** (such ERP, CAD, etc.).

They determine the **compatibility of the new technology**, but also the **level of technological experience** acquired through the use of older versions.

[Tornatzky, 1982] shows that the adoption of new technology depends on its **advantage**, **compatibility** and **complexity**.

The introduction of CAD/CAM, for example, requires suitably **qualified employees** to use it effectively [Lal, 1999] knowing that PLM integrates such tools.

An enterprise may adopt a new technology only because **other enterprises**, **having relationship with it**, have **already adopted** [Rogers, 1991].
Few SMEs have adopted PLM

Strategy
- Indirect costs (S1)
- Expected profitability (S2)
- M&A Strategy (Merger-acquisition) (S3)
- R&D activity (S4)
- Manager profile:
  - Focus on short-term (S5)
  - Emphasis on new markets (S6)
  - Want to grow (S7)
  - Focuses on innovation (S8)
  - Risk aversion (S9)
  - Emphasis on quality (S10)

Organization
- Average size of effective of SME between 50 and 200 (O1)
- Age of SMEs (O2)
- Level of skill and knowledge (O3)
  - With similar technology
- Resistance to change (O4)
- Ability to assess technological opportunities (O5)
- Number of adopters (O6)
- Competitive environment (O7)
- Geographical proximity (O8)
- Rank of SME: 1st and 2nd, 3rd

Process
- Informal communication mode (P1)
- Knowledge Management (P2)
- Process synchronization (P3)
- Existing R&D process (P4)
- Existing Innovation process (P5)
- Interdependencies Collaboration (P6)
- Existing certified (QM) system (P7)

Tools
- Complexity (T1)
  - Ergonomic
  - Interoperability
- Compatibility (T3)
- Relative advantage (T4)
- Existing software
  - PDM (T5)
  - CAD/CAM (T6)
  - ERP (T7)

References:
- Goode et al. [2000]; Hollenstein, 2004; Giunta et Trivieri, 2007; Bocquet et al., 2008; I. Coello, 2009
PLM adoption

- 33 indicators of adoption (S1-S10, O1-O9, P1-P7, T1-T7)
- Development of a survey and associated tool ➔ PLM-Eval-Tool
- Survey deployed on 17 SMEs of the automotive sector

Trust level of the interviewed

Adoption results for the 4 axes
Results (1/3): SMEs from Automotive Sector

S9 - Reluctance to take risks

Evaluation

0 0,5 1 1,5 2 2,5 3 3,5 4

Enterprise ID

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Evaluation

0 0,5 1 1,5 2 2,5 3 3,5 4

Enterprise ID

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

O4 - Resistance to change

Evaluation

0 0,5 1 1,5 2 2,5 3 3,5 4

Enterprise ID

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Results (2/3): SMEs from Automotive Sector

P1 - Informal communication

T1 - Ergonomic complexity of the tools

Evaluation: 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4

Entreprises: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

CAD’15 – London
Utilization of the tools to extract recommendation for SMEs

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Interaction Matrix (adoption indicators / recommendation according to enterprise department)
Summary

Necessary to extend the SMEs investigation to other sectors as Aeronautic and countries.
Main publications linked to the project


CAD’15 – London
Thank you

BENEFITS WP3 team