Knowledge Management Requirements within Machinery Engineering Domain

Ali AZARIAN[1] - Rikardo BUENO[2] and Aitor ALZAGA[3]
[1]*Institut Ligeron S.A., Parc Les Algorithmes, 91194 Saint-Aubin, France*
Tel : 33-01-69355884 ; Fax : 33-01-69355870 ; Ali.Azarian@ligeron.com
[2]*Fatronik System, Ibaitarte 1, 20870 Elgoibar Spain*
Tel: 34-943-748020 ; Fax: 34-943-743492 ; rbueno@fatronik.com
[3]*Tekniker, Avda. Otaola 20, 20600 Eibar Spain*
Tel: 34-943-206744 ; Fax: 34-943-202757 ; aalzaga@tekniker.es

Abstract : The requirements of European industry in the field of machinery, in terms of knowledge management, have been investigated in the context of the E.C. funded project IST-XPERTS (N° 11961) and reported in this paper. The issue of this investigation is mainly focused on the state of the art and industrial requirements for knowledge management in this domain. A number of general user requirements and industrial needs and expectations are also highlighted.

1. Introduction

Knowledge Management (KM) is an increasingly important new business opportunity. The machinery industries generally deal with long, complex research and development cycles comprising design, requiring access to large amounts of scientific and technical or product data from experts, which is constantly changing and must be meticulously tracked. In the machinery engineering domain, it is essential to ensure that up to date, correct design rules are applied and furthermore, adequate standards are taken into account.

The KM technologies are not commonly used in the machinery engineering domain in Europe even though for design, it pays off in fewer design errors, less redundancy, minimising loss of expertise, quicker problem solving, better decision making and reducing design costs and delays. For companies already using KM strategies, access to information and expertise is speeding up problem solving and response time to customers.

The requirements of European industry in the field of machinery, in terms of knowledge management, have been investigated in the context of the E.C. funded project IST-XPERTS (N° 11961) and reported in this paper.

The investigation carried out was specifically focused on the following aspects :

- collection of general information about the responders and their activities, e.g. company's size. It should be noticed that the XPERTS questionnaire set up for inquiry and forwarded for getting feedback, was anonymous ;
- the European state of the art in the machinery engineering domain and in particular for design activities, e.g. methods and tools presently used ;
- general user requirements gathering in order to provide a better visibility on the future trends, e.g. computer tools needed :
- the specific user requirements of knowledge management in the machinery engineering domain.

2. Profile of responders

Most of the companies having provided input, data and information to the XPERTS inquiry were the designers and manufacturers in the machine tool industry. These responding companies are mostly SMEs (Small and Medium Sized Enterprises) having a staff number of less than 250 which is the limit size for a SME as mentioned in the E.C. procedures. Research centres and universities are not represented as they should have been.

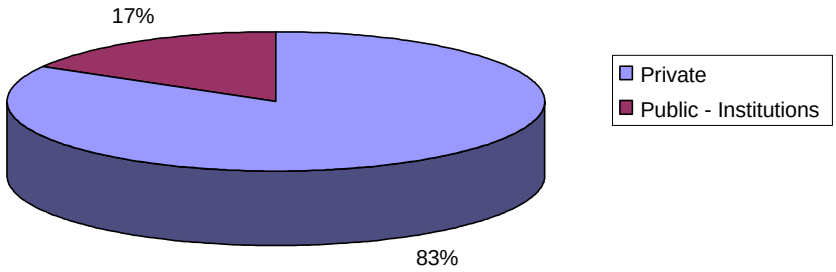

Figure N° 1 - Rate of answers from private and public companies

As depicted by the above figure (N° 1), 83% of the responders are private companies and only 17% are public. These figures are understandable as most of the SMEs working in the machinery sector in Europe are usually private companies.

The following figure (N° 2) which is related to machine types concerned by the responding companies, shows that :

- the milling machines and machining centres are frequently listed. Both machine types represent a high implication of the corresponding companies in the machine tool industrial sector ;
- the Prototypes, Lathes, Test–beds, Electrical Discharge Machines (EDM), Filtering systems, Grinding machines, Punching and Transfer lines are specific products of a number of responding companies and represent indeed a minority of responses.

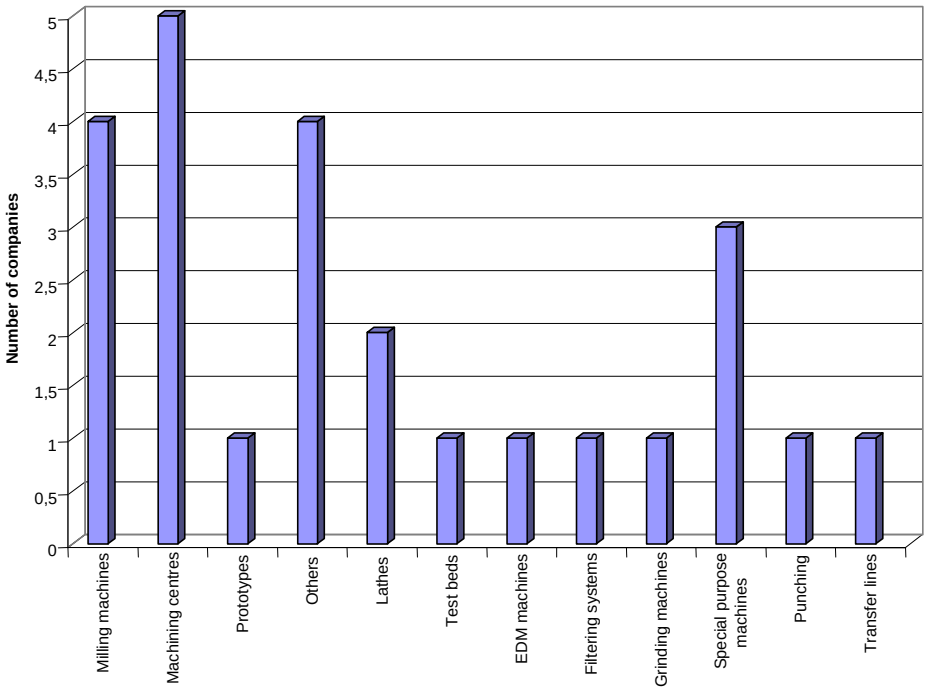

Figure N° 2 - Main products designed/manufactured by the companies

3. European state of the art in the machinery engineering domain

According to the issue of the XPERTS investigation, knowledge management tools are not currently used within the European machinery engineering domain. It should be noticed that in this sector, the industries are not really aware of benefits of using such a tool. Moreover, only a few commercial tools which can be considered as real solutions, are available on the market.

For new product or machine development and design, the most currently used tools as shown by the following figure (N° 3) are :

- calculation programmes ;
- Finite Element Analysis (FEA) ;
- 3D-CAD ;
- 2D-CAD.

This latter tool (2D-CAD) is also commonly used for the following design activities :

- product customisation ;
- generation of product variant.

The use of PDM and even drafting boards is not significant when compared to the other design employed tools.

It appears that for new machine tool design, all available tools are extensively used.

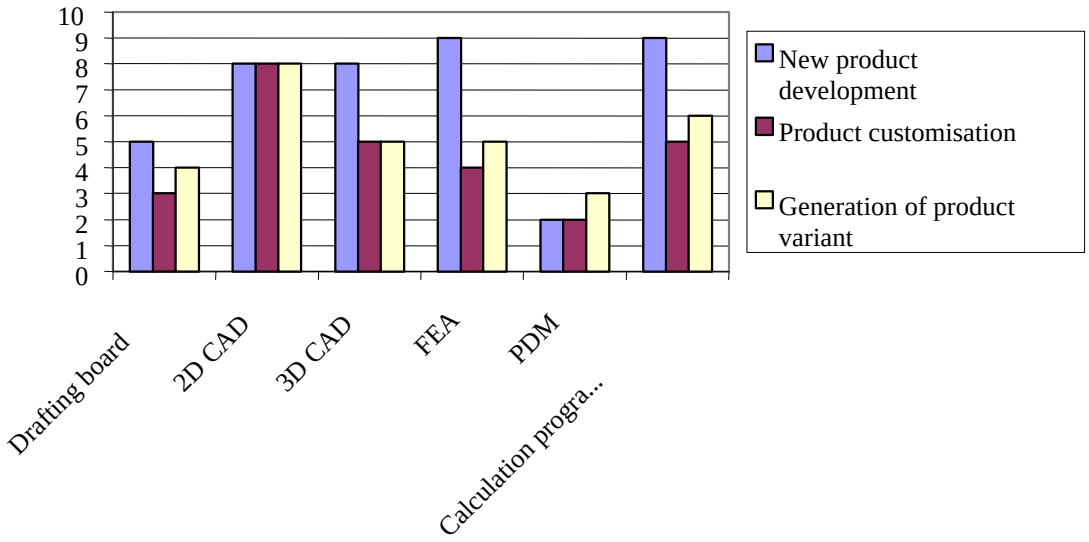

Figure N° 3 – Tool used

In the machinery engineering domain as well as for concurrent enterprises, it is crucial to ensure that up to date, correct design rules, procedures and standards are applied. The following figure (N° 4) shows the standards used for each category of product activity. The following conclusions with respect to standards can be drawn :

- the ISO standards are important in the machinery sector. Indeed, the ISO 9001 standards are taken into account for any design activity whatever the purpose of design is (e.g. new machine tool development or not) ;
- the IEEE-IEC, ASME, UNE NF DIN and AFNOR standards are also employed but less than the ISO 9000 standards ;
- the UNE NF DIN standards are specifically used in the machinery sector ;
- the use of CENELEC, ISO-STEP, AERO, MIL STD, DXF, IGES, European Directives is not yet significant when compared with other standards ;
- the European directives as well as the ISO-STEP are emerging. The level of familiarisation with these new emerging standards and regulations seems low ;

- there is no unique and agreed standards used in the machine tool sector except the general ISO 9001 guidelines.

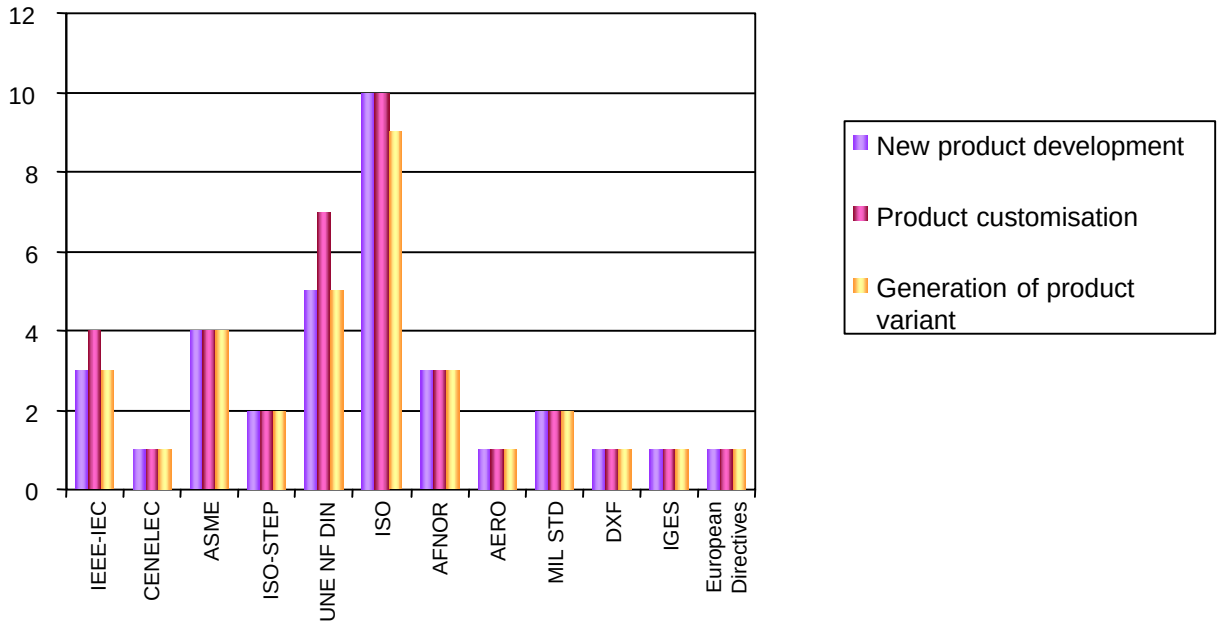

Figure N° 4 – Standard used

4. Industrial needs within the European machinery engineering sector

The machine tool industries need databases, workflow, document management facilities, product data management (PDM) and knowledge management (KM) implementations (figure N° 5), because they have crucial needs to address the economical challenge mainly imposed by evolution of regulations and the loss of skilled workers.

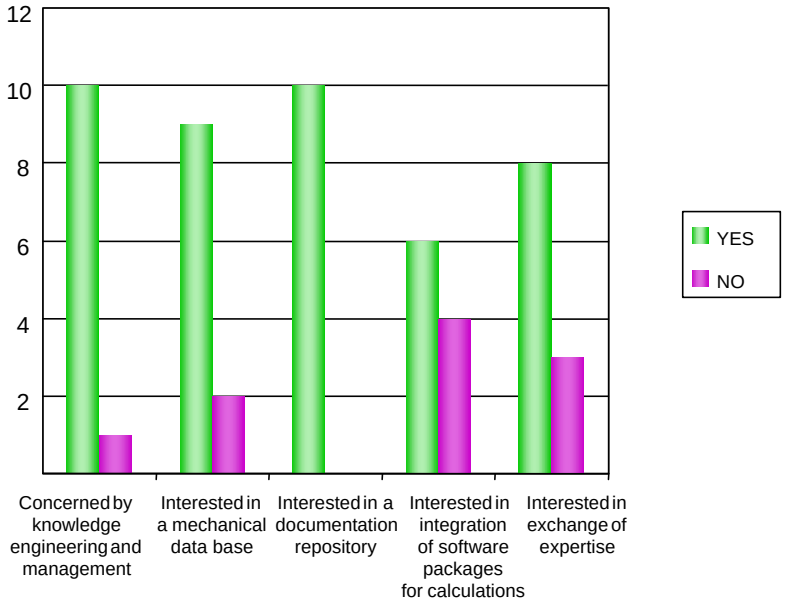

Figure N° 5 - Future intentions and needs

As an example, most of the companies consider that they need a database mostly comprising mechanical component data, but the purpose of using such a database is different from a company to another. Figure N° 6 shows the expressed intentions of using such a database. It seems that the most mentioned purpose of using such a database is for :

- lessons learnt - experience return and somehow for keeping the traceability in terms of different engineering activities ;
- design and pre-design activities. For pre-design tasks, databanks are already used in a lesser extent ;
- maintenance activities either preventive or corrective.

The level of required databases in the machinery sector for the quality assurance aspect and operations does not seem significant.

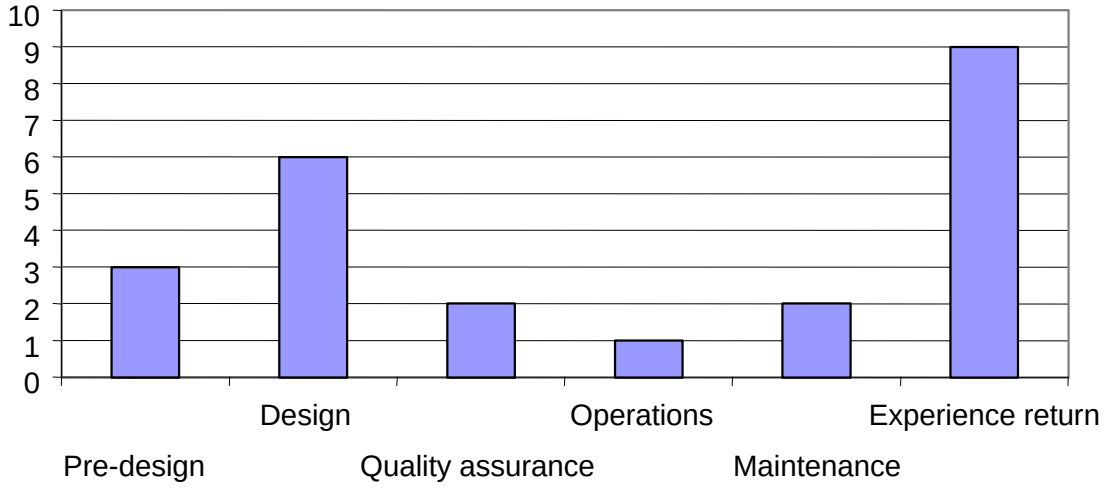

Figure 6 - Database use purpose

The analysis focused on Knowledge Engineering requirements in the machinery engineering sector shows an explicit requirement for an appropriate methodology with respect to knowledge acquisition and its encapsulation. The following type of knowledge are under consideration :

- knowledge about legal problems and and regulatory requirements (necessary certificates, allowances, security, safety regulations, etc…) ;
- knowledge about the mechanical design engineering ;
- knowledge about pin point key design issues and high level expertise ;
- knowledge about the design procedures and work flow ;
- knowledge about the organisation of design activities (who is responsible for what ?) ;
- knowledge about the available resources and means (what machine is needed and where is its location ?) ;
- knowledge about the customers - users and operators and lessons learnt or experience return.

The main focus of the KM requirements is to produce a knowledge based engineering system, which will be used by designers of machine tools in order to help them in their daily work.

5. Conclusions

The general requirements and industrial needs of the European machinery sector are identified in the context of the E.C. funded project IST-XPERTS (N° 11961). The requirements are mainly gathered from private SMEs working in the machine tool industry and in particular for design purposes oriented to :

- development of a new product and machine ;
- product customisation ;
- generation of variants.

There is a need for design process and design rules formalisation.

The software integration in order to produce a software toolkit for design activity with the goal of facilitating the design tasks, is welcomed by industrial companies. Such a software toolkit should normally contain a 2D and 3D CAD – FEA and a wide range of calculation modules having a pre-processor and preferably a graphical post-processor.

Although the ISO, IEEE-IEC, ASME, UNE DF DIN and AFNOR standards are presently used within the machinery industrial sector, special requirements exist for ISO 9000 and UNE DF DIN or ASME standards. The degree of familiarisation is low for ISO-STEP 10303 standards as well as for E.C. directives and regulations which are emerging.

There is a clear need for technical data exchange on an electronic format. The data should be textual and graphical. The data sources should be : the information provider, internet and the company itself. Data bank should be used : personal data banks and data banks of component providers and suppliers (e.g. INA and FANUK). The main purposes of data banks are for lessons learnt and experience return.

The hardware to be considered is mainly PC. The relevant languages are C++, C and Fortran.

Most of the companies are interested to develop :

- a mechanical data base ;
- a documentation repository ;
- knowledge engineering and management.

Acknowledgement

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