RESEARCH IN COMPUTING SCIENCE

Advances in Computer Science and Artificial Intelligence

Alexander Gelbukh
Michel Adiba
(Eds.)

Vol. 39
RCS

This volume contains 18 carefully selected papers by 56 authors from 6 countries: Chile, France, Mexico, Peru, Spain, and USA. These papers present the most recent developments in a range of areas related to computer science and artificial intelligence. The papers are arranged into 7 thematic fields:

Computer Science

- Software Technology and Human-Computer Interfaces
- Workflow and Collaboration
- Networking

Artificial Intelligence

- Logic and Multi-Agent Systems
- Natural Language Processing and Information Retrieval
- Machine Learning and Data Mining
- Neural Networks, Image Processing, and Scheduling

The volume will be useful for researchers, students, and general public interested in the corresponding areas of computer science and artificial intelligence.

50th Anniversary of Computer Science in Mexico

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Research in Computing Science es una publicación trimestral, de circulación internacional, editada por el Centro de Investigación en Computación del IPN, para dar a conocer los avances de investigación científica y desarrollo tecnológico de la comunidad científica internacional. **Volumen 39** Octubre, 2008. Tiraje: 500 ejemplares. *Certificado de Reserva de Derechos al Uso Exclusivo del Título* No. 04-2004-062613250000-102, expedido por el Instituto Nacional de Derecho de Autor. *Certificado de Licitud de Título* No. 12897, *Certificado de licitud de Contenido* No. 10470, expedidos por la Comisión Calificadora de Publicaciones y Revistas Ilustradas. El contenido de los artículos es responsabilidad exclusiva de sus respectivos autores. Queda prohibida la reproducción total o parcial, por cualquier medio, sin el permiso expreso del editor, excepto para uso personal o de estudio haciendo cita explícita en la primera página de cada documento. Para la portada se usó la imagen cortesía del Prof. Akiyoshi Kitaoka, www.ritsumei.ac.jp/~akitaoka. Impreso en la Ciudad de México, en los Talleres Gráficos del IPN – Dirección de Publicaciones, Tres Guerras 27, Centro Histórico, México, D.F. Distribuida por el Centro de Investigación en Computación, Av. Juan de Dios Bátiz S/N, Esq. Av. Miguel Othón de Mendizábal, Col. Nueva Industrial Vallejo, C.P. 07738, México, D.F. Tel. 57 29 60 00, ext. 56571.

Editor Responsable: *Juan Humberto Sossa Azuela, RFC SOAJ560723*

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Volume 39
Volumen 39

ISSN: 1870-4069

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Indexed in LATINDEX and Periodica
Indexada en LATINDEX y Periodica

Printing: 500
Tiraje: 500

Printed in México
Impreso en México

Preface

With this special issue we celebrate the 50th anniversary of computer science in Mexico. The volume is structured into two parts and seven sections:

Computer Science

- Software Technology and Human-Computer Interfaces
- Workflow and Collaboration
- Networking

Artificial Intelligence

- Logic and Multi-Agent Systems
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This issue was prepared in collaboration with the Mexican Society for Computer Science (SMCC), Autonomous University of Baja California (UABC) and Regional Government of Baja California, Microsoft, Center for Computing Research (CIC) of the National Polytechnic Institute (IPN), French-Mexican Laboratory of Informatics and Automatic Control (LAFMIA-CNRS), National Council for Science and Technology (CONACyT, Mexico), National Council for Scientific Research (CNRS, France), Université Joseph Fourier (France), The Americas University (UDLA, Puebla, Mexico), National University (Colombia), Social Networks Research Center (SoNet RC) of the University of Central Europe (UCE) in Skalica (Slovakia), and Grenoble Informatics Laboratory (France).

We want to cordially thank all people involved in the preparation of this special issue. First of all our very special thanks go to the SMCC President Genoveva Vargas-Solar for her constant help and encouragement. We thank the SMCC Vice-President María Auxilio Osorio Lama, Marcela D. Rodríguez and Gabriel López Morteo of UABC, Antonio García Macías of CICESE, Alfredo Sánchez of UDLAP, and Oscar M. Rodríguez Elias of Universidad de Sonora.

We are grateful to Javier A. Espinosa-Oviedo, Hilda Massic-Fernández, and Sulema Torres for their help in the preparation of this volume. Finally, we appreciate the help of René Cruz, Cecilia Curlango Rosas, Ángel G. Andrade, Gloria E. Chávez, Aglay Saldaña Pacheco, Marlenne Angulo Bernal, Jorge Ibarra Esquer, Carmen Andrade Peralta, Ana Serrano, Pablo Navarro Álvarez, Laura Martínez Castillo, Omar Aguilar Villavicencio, Brenda L. Flores Ríos, Larisa Burtseva, Josefina Mariscal, María Luisa González, Linda E. Arredondo, and Juan de Dios Ocampo.

Alexander Gelbukh
Michel Adiba

Mexico City — Grenoble,
October 2008

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Improving Knowledge Flow in a Mexican Manufacturing Firm

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Abstract. Integrating Knowledge Management (KM) in organizational processes has become an important concern in the KM community. Development of methods to accomplish this is still being, however, an open issue. KM should facilitate the flow of knowledge from where it is created or stored, to where it is needed to be applied. Therefore, an initial step towards the integration of KM in organizational processes should be the analysis of the way in which knowledge is actually flowing in these processes, taking into account the mechanisms that could be affecting (positively or negatively) such a flow, and then, to propose alternatives to improve the knowledge flow in the analyzed processes. This paper presents the use of the Knowledge Flow Identification (KoFI) methodology as a means to improve a manufacturing process knowledge flow. Since KoFI was initially developed to analyze software processes, in this paper we illustrate how it can also be used in a manufacturing domain. The results of the application of KoFI are also presented, which include the design of a knowledge portal and an initial evaluation from its potential users.

1 Introduction

Nowadays Knowledge Management (KM) has captured enterprises' attention as one of the most promising ways to reach success in this information era [6]. In order to assist organizations to manage their knowledge, different strategies and systems (Knowledge Management Systems, KMS) have been designed. However, developing them is a difficult task; since knowledge *per se* is intensively domain dependent whereas KMS often are context specific applications. In the one hand, the lack of sophisticated methodologies or theories for the extraction of reusable knowledge and reusable knowledge patterns has proven to be extremely costly, time consuming and error prone [5]. On the other hand, an actual concern is that KM approaches should be well integrated to the knowledge needs of knowledge workers, and to the work processes of organizations [18]. Before developing a KM strategy it is advisable to understand how knowledge transfer is carried out by people in the different processes where the strategy will be applied. Once the forms in which knowledge is flowing

© A. Gelbukh, M. Adiba. (Eds.)
Advances in Computer Science and Artificial Intelligence.
Research in Computing Science 39, 2008, pp. 29-45
Received 04/06/08
Accepted 04/08/08
Final version 10/09/08

through a process have been recognized, it should be easier to identify the problems affecting that flow, and, as a consequence, to propose possible solutions to improve the flow.

In this paper, we illustrate the manner in which the Knowledge Flow Identification (KoFI) methodology [17] was used to analyze a manufacturing process, in order to improve its knowledge flow. The reason for engaging in this study was to assist a manufacturing organization in two main aspects: 1) to improve the training of highly competitive personnel, and 2) to promote organizational learning. The main concern was to develop a KM system to assists the human resources training process, by making useful information and resources available to the employees to promote self-learning and knowledge diffusion. The goal of this paper is to illustrate how the KoFI methodology can help to detect knowledge deficiencies in a manufacturing process, and can also help to design strategies to solve them; in this case a knowledge portal was designed. Hence, in the next section the manufacturing process where KoFI was used is described, after that in Section three we illustrate the different stages followed to improve that process. Then, in Section Four a knowledge portal, designed as a result from the findings obtained after applying the methodology, is described. Section Five depicts the results of a preliminary evaluation of this portal. A discussion of the results of this case study is presented in Section Six. Latter, in Section Seven our approach is compared to existent related work, to finally conclude in Section Eight.

2 The Manufacturing Process

In order to test the KoFI methodology it was used in an industrial company dedicated to the manufacturing of cans. We focused our work on a department where eight processes are carried out. It was decided to focus on one of the most important process: the one in charge of transforming the aluminum rolls into the first versions of the cans (known as "Formation area"). In this test 41 people were involved, including the department manager, the responsible of each area of the department, and the operating personnel, which were integrated by leader mechanics, productive processes mechanics, and machine operators.

It is important to highlight that the company has documented all its processes, and follows standards for documenting almost all its activities. Moreover it has an ISO9001-2000 certification. Because of this, detailed models of the processes were already available.

The data used to analyze the process was captured through interviews, and by analyzing documents and information systems. Nineteen employees were interviewed by using the long interview technique, but adjusting the interviews to the following format: the general data of those interviewed, the main activities performed, knowledge sources known by them, and their level of knowledge about the process. The duration of the interviews ranged from 30 minutes to 2 hours, depending on the level of responsibility of those interviewed. Additionally, a total of 119 documents and systems were also analyzed, of which 24 were discarded because they were duplicated.

3 Applying the KoFI Methodology

Before presenting the results of applying the KoFI methodology, we will present a brief description of the methodology. Then, we will focus on the results of the analysis of the manufacturing process.

3.1 Description of the KoFI methodology

The KoFI methodology was designed to aid in the analysis of software processes from a knowledge flow perspective [14, 17]. It was defined to assist in three main areas: 1) to identify, structure, and classify the knowledge that exists in the process studied, 2) to identify the technological infrastructure which supports the process and affects the knowledge flow, and 3) to identify forms with which to improve the knowledge flow in the process.

KoFI is orientated towards helping to analyze specific work processes. Therefore, it is necessary to define the specific process and model it. The process models are later analyzed following a four stage process, to finally identify and describe the tools which, positively or negatively, affect the flow of knowledge. Thus, based on the main activities of KoFI, the methodology is divided in three phases (see Figure 1):

- **The process modeling phase**, consisting of the definition and modeling of the process to be analyzed, using a process modeling language which provides elements to represent the knowledge involved in the process. It is recommended to model the process at different levels of abstraction. First, a general view of the process can be defined with a general and flexible process modeling technique. In our case, we have used an adaptation of the Rich Picture Technique [9, 14]. To perform a detailed analysis, a more formally constrained language should be used.
- **The process analysis phase**, which involves the identification and analysis of knowledge sources, topics, and flows, as well as the problems affecting the flow of knowledge. The main result of this phase is the definition of a knowledge map of the process, which can be structured towards the definition of an ontology of knowledge sources and topics, considering their relationships with other elements of the process, such as activities or roles.
- **The knowledge flow support tools analysis phase**, consisting of the analysis of the tools that might be useful knowledge flow enablers. To accomplish this phase, a framework has been proposed [16], which define four main steps to analyze information systems as knowledge flow enablers. First, the application domain of the system is defined. This includes identifying the use, scope, and domain of the knowledge managed. The second step consists of identifying the structure of such knowledge. Later, the third step focuses on defining the KM activities being supported by the tool. Finally, the fourth step consists of the definition of the main technical aspects considered important for the tools.

After the application of the methodology, information should have been obtained which is useful, for example, in defining the knowledge base of the process, discovering the problems affecting the flow of knowledge and the mechanisms through which knowledge is flowing, and making proposals to improve the knowledge flow.

In the present work, we focused on analyzing a manufacturing process in order to propose a KM system. Thus, for this study the methodology was applied only until phase two. That means we did not apply the final phase of the methodology. Therefore, in this paper we will focus on the process analysis phase. Detailed information about how to perform the other two phases can be found in [15] for the process modeling phase, and in [16] for the knowledge flow support tools analysis phase.

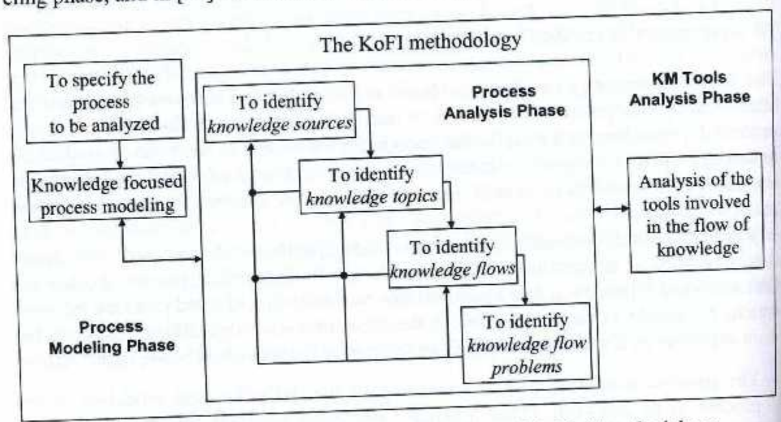

Fig. 1. The four steps of the process analysis phase of the KoFI methodology.

The process analysis phase of KoFI is composed of four steps as shown in Figure 1, which are performed in an iterative way, since each step might provide information useful for the others preceding it. Also, in that manner the products of each step would evolve to incorporate the new items found in each iteration. Next we briefly describe the four steps of the process analysis phase of KoFI.

According to the KoFI methodology, the first step of the analysis is to identify the knowledge sources involved in the process. This includes the identification of all those sources of information or knowledge that could be being used or could be useful for performing the different activities composing the processes. Those sources could include the people consulted by the personnel in charge of the process, such as their colleagues, external consultants or other experts; the information systems supporting the process, such as the intranet, simulation tools, etc.; or documents, such as memos, reports, tutorials, tools' user manuals, etc.

The second step focuses on the identification of the main knowledge topics or areas related to the activities performed in the process. For instance, knowledge required to perform the activities, or created from them. It is important to identify and classify the knowledge related to the sources found in the preceding step. An important result of this step might be the identification of important knowledge topics not stored anywhere, or that might be stored in sources not used or difficult to find. In short the identification of possible loss and misuse of knowledge.

These first two steps include the classification of the sources and topics found, which can be made through the definition of a taxonomy and an ontology of knowledge sources and topics. In fact, knowledge taxonomies are considered an important initial activity towards the development of KM systems [12]. The ontology should make possible to relate the different sources to the knowledge that can be obtained from them, and vice versa, i.e. relate the knowledge to the sources from where it can be obtained, or where it is stored.

The third step focuses on identifying the manner in which knowledge is flowing through the process. To accomplish this, it is required to analyze the relationships between the knowledge sources and topics, to the activities of the process. This includes the identification of the activities where the topics and sources of knowledge are being generated, modified, or used. It is important to identify knowledge dependencies, such as knowledge topics generated in an activity and required in other; and knowledge transfers mechanisms, such as knowledge transferred from one activity to another through a document, or through an interaction between different roles or persons. This type of analysis can be useful to identify three main issues related to knowledge flow:

1. *important knowledge flow enablers*, that means, channels, sources, or information systems being used to facilitate knowledge flow;
2. *knowledge flow bottle necks*, that means, situations that could be negatively affecting the flow of knowledge; and
3. *knowledge that could be not flowing at all*, for instance, knowledge that is being lost because it is not stored anywhere, or knowledge not used because people ignore it exists.

Finally, the fourth step of the analysis consists of identifying and classifying the main types of problems detected and which affect the knowledge flow. KoFI proposes to do this by defining problem scenarios [14], a technique based on explaining a problem in the form of a story describing a common situation. Once described this common problem, one or more alternative scenarios are also proposed in order to illustrate the manner in which such a problem could be addressed. Those alternative scenarios would be latter useful to extract the main requirements to propose the KM strategy to follow, or the KM system to develop.

In the following subsections we describe the manner in which the four analysis steps of KoFI were carried out in the manufacturing company.

3.2 Identifying Knowledge Sources

In the first step of the analysis, the identified sources were very diverse. The identification of the sources was done through the interviews performed to the personnel of the company, and the analysis of documentation and information systems. To facilitate its management, and following the recommendations of the KoFI methodology, once the different sources were identified, we proceeded to classify them. To do this a taxonomy of knowledge sources was defined, which included four categories of sources:

1. **Documents**, group of all those sources which consist of physical or electronic documents. It includes three subcategories: a) *processes' documents*, grouping all the documents related to the processes followed in the studied company's area, b) *technical documents*, referring to specialized documents with information of the tools and machines used in the process studied, and c) *organizational documents*, consisting of documentation of the organizations life and culture, such as organizational rules, or norms.
2. **Information systems**, refer to the sources consisting of information systems used in the company. This category includes two subcategories: a) *query systems*, consisting of all the systems used to search for information, and b) *transactional systems*, which refer to transactional applications used in the company.
3. **People**, groups all the different types of people involved in the process. It has been divided in four subcategories: a) *staff* which groups all the people working in the studied Company's area, b) *specialists* refer to people with specific knowledge who might be consulted by the staff, c) *external clients* to represent the final clients of the process, and 4) *internal clients* to refer to users or clients of the process whom work in other areas of the company.
4. **Others**, is a category used to group those sources not included in the preceding categories. Particularly it includes two subcategories: a) *problem analysis* which are tools used by the process' participants to analyze and solve problems, and b) *simulation tools*, which are tools available in the company to support the simulation of processes offline.

Each source was described by assigning it a unique identifier, a name, a description, its type and category, its location, its format, and the main knowledge topics which could be obtained from it. This last was useful for the following step which was the identification of the knowledge topics involved in the process, and to start relating the different knowledge sources to the knowledge that can be obtained from them.

3.3 Identifying Knowledge Topics

The identified knowledge topics were also very diverse, ranging from organizational behavior to special machine maintenance. In this step we did not focused on describing each topic in detail, but on identifying the main knowledge required in the process. The topics identified were classified, according to the utility of such knowledge in the activities of the process, in three categories:

1. **Product line activities** which includes knowledge about the operation of machines, about processes, and about quality of the processes and products. It is divided into four subcategories: a) *product quality*, consisting of knowledge about the specifications and attributes of products, and the inspection process; b) *machine maintenance*, consisting of knowledge about the applications and procedures for conducting machines' maintenance (preventive, corrective or predictive maintenance), and knowledge about the spare parts of machines; c) *operation*, which includes knowledge related to the management and operation of machines, equipment and tools used in the process; and d) *information technology (IT) application*, which consists of knowledge about the software systems for consulting and registering information about machine operation.
2. **Organizational culture**, is all that knowledge that employees must have about the company, its internal organization and norms, etc. It includes only one subcategory which is knowledge of the company.

3. **General knowledge** is a category defined to group all those topics and areas of knowledge that the employees might have, and which are not directly related to the process operation. It is subdivided into four subcategories: a) *resource management*, related to knowledge about the internal control procedures; b) *IT management*, refers to knowledge about the use of tools, and systems available; c) *personnel management*, groups knowledge and skills for managing people, such as leadership, personnel coordination, etc.; and d) *other individual knowledge* is where all those individual knowledge and skills such as writing skills, foreign languages knowledge, etc. are grouped.

Once identified, the main knowledge topics were described assigning them a unique identifier, a name, a description, its classification, and information to know where such topic could be useful, and why and how knowing it could benefit the organization or the person who knows about it. With the knowledge topics descriptions, a knowledge dictionary was developed for the process.

3.4 Identifying Knowledge Flows

In this step we modeled the knowledge required in each activity of the process, the knowledge that each role needs to perform these activities, and the knowledge sources consulted or generated in each activity, following an adaptation of the Rich Picture technique [9]. Figure 2 presents an example of this type of diagrams, in which the knowledge required in the "Lift trucks operation and management" process are represented. The figure shows the role in charge of such activity, the experience, skills and knowledge it provides to the activity, and the main source of knowledge used in the activity, which is an application for managing security rules and regulation of the company.

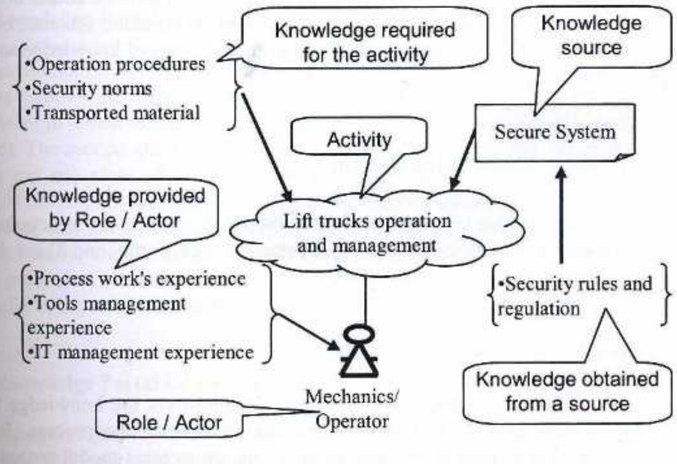

Fig. 2. Example of an adapted rich picture to analyze knowledge flows.

This type of models helped us to identify the relationships between the knowledge sources and topics, and the activities of the process. The above allowed us to create a knowledge meta-model (described in Section 4), which was used as the structure for developing a Knowledge Map useful to identify the knowledge that might be obtained from each source, and the activities in which the sources or the knowledge were being used or generated. This map was used in the construction of a Knowledge Portal (described also in Section 4). This portal was proposed to solve some of the main knowledge flow problems observed, as it is described next.

3.5 Identifying Knowledge Flow Problems

The final step of KoFI proposes to identify and classify the main problems affecting the knowledge flow in order to propose alternatives to minimize or avoid them. In our study, it was observed that some areas of the process were not well supported with documentation. For instance, there was not enough documented information on the use of certain mechanical and electrical tools; therefore, that knowledge resided only in people's experience. An additional problem was the identification of important knowledge sources that were not being used. Some reasons for the last were the difficulty for consulting some of the existent sources, either because they were unknown to the potential users, or because they were difficult to find by employees.

To address this problem, it was decided to develop a Knowledge Portal to facilitate the access to all the available sources, according to the areas, processes, or activities for which they are useful. Additionally, the portal would provide ways for pointing out to all those knowledge areas for which no sources exist. The last should be useful to identify all those areas for which knowledge sources should be created. Moreover, providing means for including those new sources easily was also a requirement for the portal. Additionally, it was also decided that the portal should provide access not only to documents, but also to other types of sources, such as information systems, or support tools, in order to promote the use of all the available types of knowledge sources of the company.

4 Design of the Knowledge Portal

In this section we describe the next: 1) a meta-model developed for structuring the knowledge map used into the portal, 2) the structure of such portal, and 3) the design of its user interface.

4.1 Meta-Model

The proposed meta-model, represented in Figure 3, comprises the knowledge types and sources involved in the knowledge generation and acquisition process. To develop it, we adapted a general knowledge sources and topics meta-model proposed as part of the KoFI methodology.

In the meta-model the knowledge concepts are integrated with the knowledge topics and sources. The knowledge concepts are required, generated or modified by the activities within the studied area, which are described as work definitions. In turn, these work definitions can be represented as processes, activities or decisions. Each knowledge concept/source association contains information about the knowledge level it requires. Finally, the available format and location for consulting each source are specified.

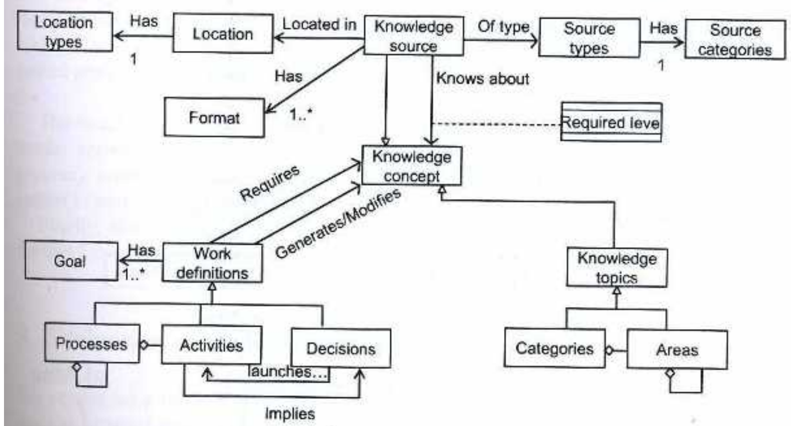

Fig. 3. Meta-model of knowledge types and sources.

4.2 Knowledge Portal Structure

The meta-model was used as a base to design the structure of the knowledge portal. Figure 4 shows the resulting general structure of the portal. This structure comprises a first level in which initial interfaces (pages) are accessible (e.g. home and registration pages). The second and third levels are pages which correspond to the manufacturing areas and sub-areas of the organization, respectively, according to the rich picture models developed during the analysis. The fourth level corresponds to pages on the processes that integrate each of the sub-areas identified from the involved knowledge flows. Finally, the fifth level presents all the identified knowledge sources for the specific process of the sub-area. This structure is representative of all and each of the manufacturing sub-areas, as identified during the analysis.

4.3 Knowledge Portal UI Design

The design of presentation and navigational features of the user interfaces (pages) also emerged from insights identified in the analysis and initial phases of design.

These include information about the identified knowledge flows, the main sub-areas of the organization, and the structure of the portal previously identified, which

resulted in the options included in the menus and main layout sections of the pages. These allow users to find the required information by simply identifying the specific area in which information is generated or required, and following the resulting navigational structure (area → sub-area → process) to locate the specific knowledge source, instead of just alphabetically (or randomly) browsing through the information.

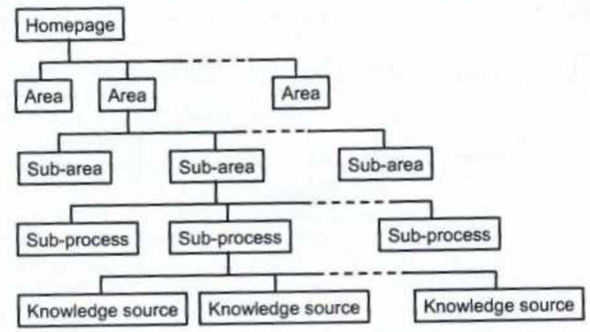

Fig. 4. General structure of the Knowledge Portal.

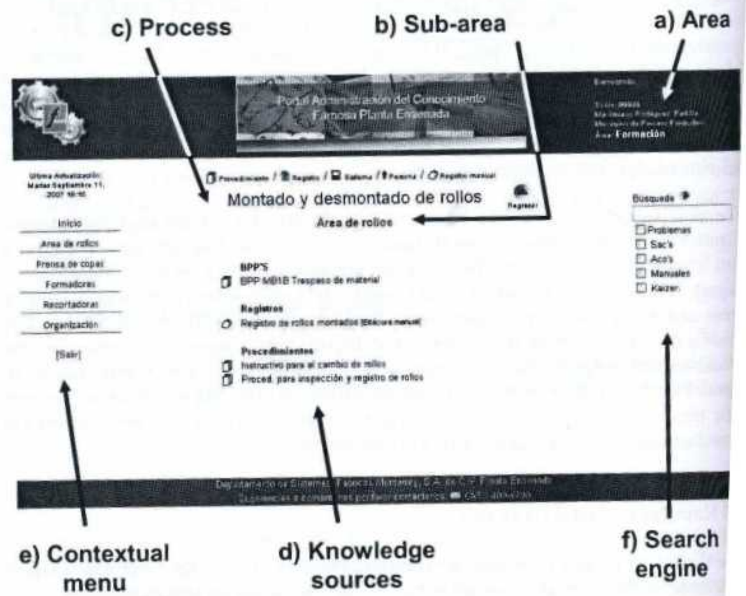

Fig. 5. Example of the page contents and layout of the Knowledge Portal.

Figure 5 depicts an example of the layout and content of a page from the current prototype for the "Formation" area.

The information provided includes the name of the manufacturing area being consulted (5.a), the name of the specific sub-area (5.b), the name of the selected process within the sub-area (5.c), and most importantly, links to knowledge sources (and types) available for that process (5.d).

Additionally, the page includes a "contextual" sub-area menu to facilitate navigation through the information (5.e), which is always available while the user stays in that particular sub-area of the portal. Also, it includes access to a search engine (5.f) which allows a search to be performed by simply specifying a keyword on the required topic, and optionally, the "places" in which the information should be searched for.

The interface in Figure 5 represents the final destination for users looking for a particular knowledge source whom, by following only three links (area → sub-area → process), arrive at the knowledge sources (either documents, systems or people) required to perform their intended activities.

Finally, this design adheres to the organization's established standard guidelines for this kind of applications.

5 Evaluation of the Knowledge Portal

We conducted a preliminary evaluation in one of the production areas to both determine the impact and acceptance level of the users on the system, and to provide support for the decision-making process concerned with the continuation of the system's implementation in other areas of the organization. The evaluation considered aspects concerning perception of usefulness and ease of use [4].

The evaluation consisted of

1. **an introductory session**, in which the system was presented to the users, and its functionality demonstrated to them. This included examples on how to search for and retrieve knowledge sources by means of navigating through areas, sub-areas and processes, as well as through the search engine; and
2. **the application of a questionnaire** containing 12 questions referring to perception of usefulness (6) and ease of use (6). Each evaluation session (induction and application of the questionnaire) was done in approximately one hour.

The subjects of the study were 41 employees of the "Formation" area for which the prototype was developed. The subjects included leader mechanics, process mechanics, operators and process engineers, whose participation was voluntary. The sample was divided into 4 groups according to the natural operative processes (3 groups of ten people and 1 of eleven). The application process of the evaluation was completed in three days.

5.1 Analysis and Discussion of Evaluation Results

The subjects had positive appreciations with regard to the knowledge portal, as it is reflected in their answers in the questionnaire. Figure 6 shows the answers to the

questions about the perception of usefulness of the tool. The users perceived that the portal would allow them to increase their productivity and to perform their tasks more easily (82.93% "Agree" in both cases), although some of them had doubts regarding the fact that this would increase their productivity (24.39% "Have Doubts"). Only one person (2.44%) "Disagreed" that the tool would help him/her to complete his/her tasks faster.

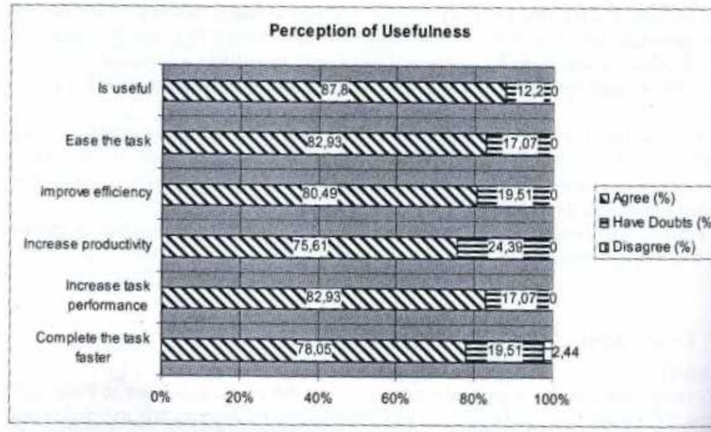

Fig. 6. Perception of Usefulness.

Figure 7 shows the answers to the questions about the perception of ease of use. As can be seen, although most of the users perceived that it was easy to learn to browse through the information (85.37% "Agree"), some had doubts concerning the ease of finding information (39.02% "Have Doubts"), and even more users had doubts concerning becoming experts on the use of the tool (46.34% "Have Doubts"). A possible explanation could be that a little more than a third of the users had doubts concerning the clarity of the presented interfaces, as well as about the interaction flexibility that these provide (34.15% in both cases).

In general, most of the users considered the knowledge portal as a useful (87.80% "Agree" – Figure 6) and easy to use tool (68.29% "Agree" – Figure 7) for the accomplishment of their work.

5.2 Additional Comments to the Evaluation

During the evaluation, we observed that results seem to be related to how much participants use information systems in their daily work. People with more experience using information systems, and particularly internet based systems such as web portals, were more positive about the knowledge portal. Therefore, it is recommended that for constructing the final version of the portal, to consider this situation in order to identify how it can influence the final acceptance of the portal, particularly within the people who do not use computers regularly in the company.

Finally, formal evaluation of KM systems is a difficult concern since results emerge only in the long time, and are influenced by many external factors. Thus, it was out of the scope of this work to formally evaluate the usefulness of the knowledge portal. However, we expect to continue the evaluation during practice, when the final version of the portal is completed and in use in the company.

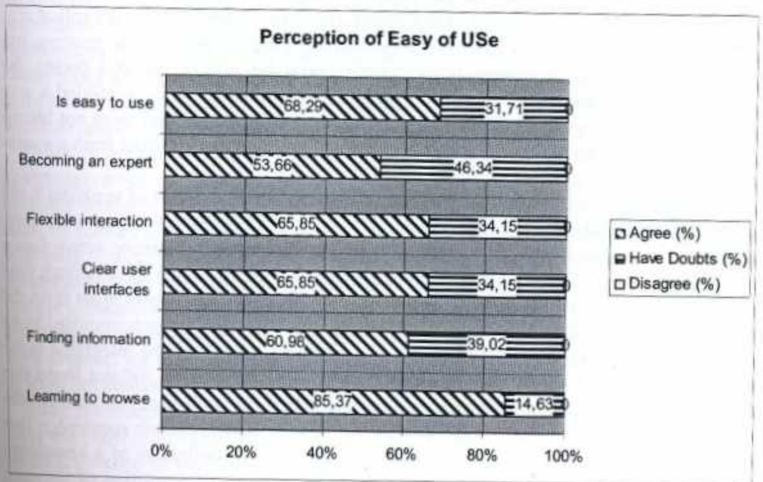

Fig. 7. Perception of Easy of Use.

6 Discussion and Lessons Learned

The KoFI methodology was initially developed to aid in the design of KM approaches to improve software processes. In this initial application domain, the methodology was useful to propose the design of a KM tool, and to structure and create a knowledge map of the studied process. It can be argued that software processes differ from manufacturing processes in that they have different knowledge requirements. In fact, software processes have been considered to be more knowledge intensive and dynamic than common industrial processes [13], such as the one studied here (the production of aluminum cans). Nevertheless, we have learned some important lessons from this study comparing it to the other studies we have done [14-17].

In the previous studies, we analyzed two software maintenance processes to identify knowledge management needs. These processes were not formally defined, so there was not a model of such processes. Instead, we required to construct the entire model of the processes from the interviews we made to the people responsible of such processes.

In the present study the processes were much more formally defined and documented. Nevertheless, it was decided to create models of the process to explicitly represent the knowledge sources and topics involved in it (as we exemplified in Section 3.3). The reason for this was that the process models were made with a common business process modeling language, which has not explicit representation of knowledge related issues. From the models we made, we were able to identify knowledge requirements and sources, which were not identified from the existent process models of the company. This observation has given us insights to argue that independently of how well defined and documented the process could be, if there is not an explicit representation of the knowledge and sources involved in the activities of the process, important sources and knowledge requirements could be lost or ignored during the analysis. Thus, in this case, the steps proposed by the methodology, provided a way for identifying important knowledge requirements and problems that were not identified before. Even though the process was well defined and documented from a manufacturing (or business) point of view.

Other important issue was that the strategies proposed as a result of applying KoFI in the different studies had different requirements. In the first studies (software engineering domain), we observed that the KM systems required to be more active than a traditional KM tool. It was observed that software engineers did not have enough time to capture or search for knowledge, neither for using new tools totally apart from the development environment they were working with. Thus, the systems required to be capable of performing some KM tasks in an autonomous way, and be integrated to the current tools being used by the engineers. In the present study we did not found this situation. However, an important issue was observed. In both types of studies (the previous ones, and this one), regardless of the type of KM approach required, a first step towards the development of such approaches was the definition of a knowledge map of the process, which consisted of the identification and definition of the main knowledge topic required in the process, the main knowledge sources, its relationships between them, and the activities performed. All this information was obtained during the application of the methodology. Form this observation we argue that creating a knowledge map of the process, in which the knowledge sources and topics are classified, and its relationships identified, should be an initial step, independently of which type of KM tools or strategies will be proposed.

Finally, we want to highlight the fact that, although the analysis of knowledge flow support tools was not a main concern during the present study, some important information systems being used as knowledge flow enablers were identified and considered into the portal. For instance, some reports and simulations that are obtained from external systems are accessible through the knowledge portal. To do this, the portal has some connections to other applications available in the company. Thus, this study helped us to confirm that the methodology is helpful in identifying knowledge flow support tools available for the process, in order to consider them as part of the KM proposals.

7 Related Work

Integrating KM into work processes is one of the main concerns of the KM community [18]. However, most of the organizational KM strategies are not well integrated to organizational processes [8]. In order to reduce this gap, some works have been proposed in literature. Perhaps the work most related to our own, is that of Kim et al. [7], whom have studied knowledge flows in a manufacturing firm through their own method including a special type of knowledge flow diagram. In their study, Kim et al. demonstrate that knowledge flow analysis can be a means towards understanding the relationships between the knowledge and the process studied. The main difference between KoFI and the proposal of Kim et al. is that the former was developed to be more practical, being not only a way to analyze a process, but also a means through which to propose practical solutions.

Other authors have also proposed approaches for modeling knowledge flows, or knowledge involved in work processes, i.e. [1, 11, 19]. However, most of the approaches we have found are either orientated towards developing specific KM systems, or require special tools or process modeling languages for their usage. Before proposing a specific approach for managing knowledge in an organization, it is important to analyze the organizations' work processes from a knowledge flow perspective [10], since supporting knowledge flow should be the main focus of KM [2]. Additionally, to have a successful integration of KM strategies into the organizational work process, we must consider the current technological infrastructure [3], which is an issue not addressed in the other works we have found in the literature.

Thus, the main contribution of our work is to use an approach which explicitly takes this observation into consideration. That means, we have not only cover most of which is covered by previous studies, we also have taking as an important concern the identification of the current technical infrastructure, in order to include such infrastructure as part of the KM strategies or systems proposed, and perhaps as the basis of them. We have illustrated how the KoFI methodology was used for proposing means to improve the knowledge flow in a manufacturing company. This should be accomplished not only by developing new systems, changing organizational culture, and so on, but also by integrating the current infrastructure and the actual work being done by the people in charge of the organizational processes.

8 Conclusion

In this paper we have illustrated the use of the KoFI methodology to analyze a manufacturing process in order to improve the flow of knowledge in it. The main result of the study was illustrating the usefulness of the KoFI methodology in a manufacturing setting; particularly for the design of a knowledge portal based on the real work structure of a company. Since KoFI was initially developed to be used to analyze software processes, this study has provided us with the initial evidence to argue that KoFI is open enough to aid in the design and construction of different types of KM approaches, and in different application domains. However, more case studies are required to continue evaluating the benefits and limitations of KoFI in different settings.

Other important result of this study is the knowledge portal per se, which integrates the knowledge sources available, and presents them to the users by following an organizational structure which emerges from the application of the different steps proposed by KoFI. Unfortunately, evaluating if the portal will allow the company to improve the training of highly competitive personnel and to promote organizational learning can only be made after a long period of time using the portal in real practice. However, the preliminary evaluation of this portal has led us to believe that it could help to accomplish this, since such a portal was considered to be highly useful and ease to use by the employees of the company. As future work, we are planning to apply the KoFI methodology to the analysis of all the remaining company's processes, in order to extend the use of the portal to the entire organization. This should help us to continue evaluating the benefits and limitations of KoFI and the portal.

Acknowledgments

This work is partially supported by UABC, project 0191 of the XI Convocatoria Interna de Proyectos, the MELISA project (grant PAC08-0142-3315) financed by the Consejería de Educación y Ciencias de la Junta de Comunidades de Castilla-La Mancha, Spain, and CALIPSO (TIN20005-24055-E) supported by the Ministerio de Educación y Ciencia, Spain. The authors acknowledge the support provided by FAMOSA-Ensenada, for the realization of this project.

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