4. Communication Interfaces inside the PSIM Environment

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Abstract. This chapter deals with the communication interfaces existing within the PSIM environment. A general overview is given of the term mapping techniques that have been applied in the interfaces. The definition, description and development of term mapping between the components of the PSIM infrastructure are analyzed and some examples are also presented. This chapter concludes with a description of the communication layer of the PSIM environment.

4.1 Introduction

In the other chapters of this book, the PSIM procedure and the overall PSIM environment have been described. In the chapter concerning the architecture of the PSIM environment the necessity of a reference language is stated. The current chapter presents the communication interfaces within this environment. We introduce the term mapping mechanisms, and explain how it is used to support the communication between the actors of the enterprise and the tools and databases. The actors are involved in the design, redesign, renewal, of the enterprise knowledge and in the execution of the primary process.

Each communication interface is built on the basis of term-mapping. A term-mapping links the content of a glossary with the terms of the reference language. A glossary corresponds to a list of terms used in the expert domain with their definition in natural language. The term-mapping provides the necessary support to the navigator to customize the PSIM-user interface and to enable the navigator to realize the links between tools and external data. The information for realizing these links is stored in the communication layer.

In the following, the role of the communication interfaces, the mechanisms used to built them, and their content are described. Section 2 presents the communication interfaces and their role inside the environment. Section 3 introduces and describes me mechanism of term mapping. Section 4 describes how to build a customized PSIM-user interface manager. We present the method used to collect data terms and the structure we adopt to store the information. This is illustrated by an example. Section 5 presents the communication layer, composed of a set of translators existing between the tools and the reference language. Then, section 6 concludes the chapter and presents some ideas for further development.

4.2 The Communication Interfaces in the Environment

In the PSIM environment, the communication interfaces play two distinct roles. The first role is to support the customization of the user interface according to user's rights. The second role is to manage the translations and in this way to support the exchange of information between the different tools, which are the components of the PSIM environment, and external databases. Figure 4.1 shows the architecture allowing the realization of these roles of linking the PSIM-users, the enterprise databases and the different analysis tools. The navigator, though not explicitly represented in the figure, is the component bringing life into this static presentation. Simplifying, we can say that the navigator is the component, which is handling and activating the arrows connecting the other components.

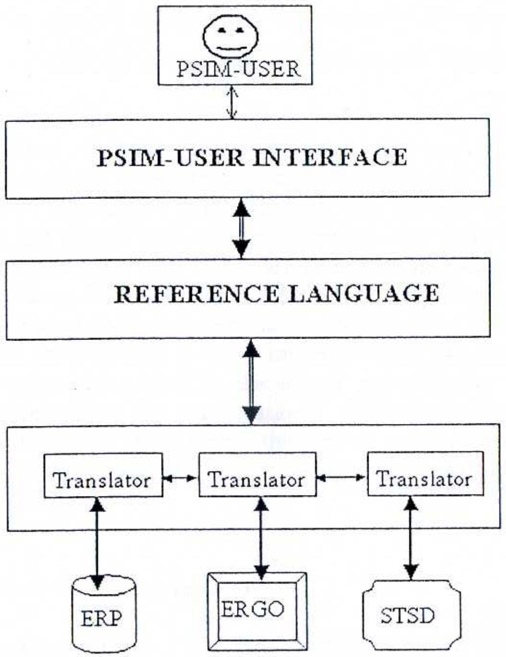


Figure 4.1 The Communication Interfaces in the PSIM Environment

The PSIM environment is composed of three components:

- The *Reference Language*: A central component, which is structured by the PSIM ontology and is presented in Chapter 3,
- A *Customized PSIM-user Interface Manager* allowing the users to access the system in their language (or more precisely the community language they belong to). The term mapping is based on glossaries elaborated by domain experts of a community. Each term of the glossary is mapped to concepts of the reference language,
- A *Communication Layer* allowing, via translators, interaction between different software components such as tools and databases.

The objective of this chapter is the description of the last two components, and particularly the presentation of the techniques used to build them.

The *Customized PSIM-user Interface Manager* allows the sharing of information between different users without forcing them to learn the reference language neither to learn the languages used in other communities. This interface is enacted by the navigator when the user is logged in to the PSIM environment.

The *Communication Layer* manages the exchange of data between tools used in different enterprise analyses, and databases and tools. This exchange of data is realized via a translation mechanism. The translation support consists of providing a semantic communication layer between the different tools.

4.3 Description of the Term Mapping Mechanism

4.3.1 General Description of the Mechanism

Mapping is defined as the mechanism used to convert between structures existing in one component and analogous structures expected by another [1]. The term-mapping is the procedure that manages the exchange of information among experts, among experts and tools, and among tools. In the simplest form a term-mapping expresses the correspondence between a term used in a knowledge domain or by a tool, and the equivalent term from the reference language.

4.3.2 Categories of Term Mapping

Generally, there are two main categories of mapping *'one-to-one'* and *'non-one-to-one'*. In the majority of the cases a term corresponds to a single concept in the reference language models. But for several cases, no one-to-one mapping exist between a domain term and a reference language concept, especially when there are different perspectives linked to the subject of the study. These terms have a common property: they correspond to a composition or a set of reference language concepts.

One-to-One Relationship between Terms and Concepts

About 80% of the terms that are mapped to reference language concepts have a *'one-to-one'* relationship. This one-to-one mapping exists if the term *i* from the domain B corresponds to a single concept j in the reference language. That means that i and j have the same plain definition.

Non-One-to-One Relationship between Terms and Concepts

Most of the terms with *'non-one-to-one'* relationship have two origins. This relationship results from a difference of granularity in the fundamental element studied in a knowledge domain and the granularity used in the ontology to represent the enterprise. This difference in granularity complicates the term-mapping procedure, to overcome it, the finer concept is introduced into one of the enterprise ontology taxonomies that permits to transform this *'non-one-to-one'* relationship into two *'one-to-one'* relationships.

Another problem arises because different perspectives exist for analyses. Several domains of expertise may use terms that do not represent concepts with existing corresponding terms in the ontology. These terms usually designate a sub-system of the instantiation of the enterprise primary process. In this case, the object of study corresponds to the verification of one or several properties of the sub-system.

STSD Tool		Common Language
Job of Y	→	*The set of organization elements the human resource Y is managed by*

Box 4.1 Example of 'non-one-to-one' relationship

The term *job* as used in socio-technical system design illustrates a *'non-one-to-one'* relationship. The term *job* refers to the sub-system formed by the set of organization elements, which manage a particular human resource. Box 4.1 shows the mapping of the term *job* in the ontology. The term *job* is defined as a collection of activities that can be performed by a precise employee. These activities can be sorted according to their type. Types are related to the speciality the activity has. In the PSIM ontology, this speciality is related to the organizational element managing the activity. Socio-technical experts have agreed that the different type of activities performed by an employee is more important than the list of the activities s/he performs. On the other hand in the model, the activities that an employee can perform are related to the organizational element s/he is managed by and the organizational element characterizes the type of activity it manages. Therefore, the term *job* has to be mapped to the set of organizational elements managing the human resource considered.

4.4 PSIM-User Interface Manager

A general structure of the PSIM-user interface manager is based on the previous description of the term mapping mechanism. The suggested methodology for the development of PSIM-user interface manager has facilitated the design of a well-structured, well-formed, comprehensive and convenient information structure, con-

taining understandable terminology and providing fluent communication among all PSIM users and the tools.

The realization of the interface manager inside of the PSIM project is based on the glossaries provided by domain experts, in our case in ergonomic and socio-technical science. The starting point is a plain definition for each glossary's term the experts uses in their domain. An equivalent corresponding expression was looked up or constructed in the reference language.

4.4.1 Methodology of Collecting Data

One of the main concerns about the PSIM-user interface manager is the development of a consistent and uniform collection of definitions for all the terms. An extensive participation of people involved in the PSIM procedure and other experts in different areas is required in order to collect and represent available information about terms and design the PSIM-user interface manager entries. Generally it is a complex collaborative activity where participants can input, comment, refine and vote for the items that have to be included and their definitions.

The proposed methodology was not just based on human factors and their purposes. The algorithm used consisted of the following steps:

I. *Concept domain categorization*: to identify from which domains concepts will be extracted and included in the glossary (Ergotool environment, STSDtool environment, logistics, navigation, etc.),

II. *Initial collection of terms*: from the above mentioned domains and their initial grouping and sorting. The terms are alphabetically sorted here,

III. *Identification of necessary and sufficient concepts*: a choice of a reasonable amount of concepts, in order to sufficiently cover each domain, but not to cause cognitive overload and overlap between the several concepts, terms and their definitions,

IV. *Development of the End-User Part*: to collect definitions of the chosen concepts from all available sources, such as dictionaries, user guides, etc. It should be mentioned here that an in-depth and wide-scope knowledge and understanding of the whole enterprise model is required for this step,

V. *Ontology definition of each concept*: Taking under consideration the structure of the PSIM ontology and its taxonomies, generic entities and relationships, it is aimed for here to provide an appropriate definition of each concept understandable from the Navigator and the other tools. In depth understanding of the PSIM ontology is required here,

VI. *Other information*: all other information related to each concept and not fitting to one of the two above mentioned fields (steps IV and V) are presented to the last part of glossary,

VII. *Collecting feedback on the proposed set of terms*: enterprise employees and experts assigned with such a task update the "prospective" definitions, refine additional information, resolve conflicts, add/delete terms. It is proposed that every person involved in this process has a different position in the company. PSIM ontology experts have to provide feedback for the ontology definitions of the concepts,

VIII. *Check of the final glossary*: Expert designers check the final output of the whole development process and comment on it.

4.4.2 Structure of the Term Mapping

The main question that arises is what will be the structure in which to store the information of the term mapping. What information should be available for each concept (term)? The content of the PSIM-user interface manager, based on the existing PSIM-environment, is not restricted and could be expanded. Indeed new tools or domains can be added to the PSIM-environment (N_{th} tool, new expertise domain) or new terms can be introduced in an existing domain in the PSIM-environment. It is pointed out that it is necessary to select a reasonable amount of terms and to display the most important ones to avoid cognitive overload.

Table 4.1 illustrates, how available information and data are provided in four columns. The second column 'link' contains information concerning the origin of the term named in the first column. In this case, the domains using the term, are indicated. Each term may have different definitions (from reference language and plain English point of view) when it is fetched from different domains. This is the case of a term belonging to the *'non-one-to-one'* category of mapping.

The column 'DEF_USER' contains a simple definition in plain language. It is given to support the end-users. The content of the column aims for a kind of vocabulary and provides comprehensive definitions of terms and an in-depth analysis of each term, in such a way that all employees of the enterprise (managers, decision makers, operators, designers, etc.) can understand the meaning no matter which is their position in the company, their general knowledge and experience. If this part of the interface manager is considered from the general PSIM environment point of view, it is said that it is related to the end-user view, as discussed in the previous chapters.

Next to the plain definition of each term, an equivalent definition in terms of the reference language is proposed. In this column (the fourth), the terms are described in accordance with the ontology generic entities (objects, activities, information, human resources, technical resources, etc.) and the generic relations between them (relevance, is involved, etc.).

From the previous discussion it is apparent that each concept can be defined infor-mally and formally. Informal definitions are for end-users, and formal definitions (based on PSIM ontology) are for the Navigator, the PSIM environment architects and the application tool developers.

Finally, other information related to each concept is given in the last column, i.e. enlarged term definitions, including examples, similar terms, terms having broader, narrower, opposite meaning, etc. This could include information such as relations to other terms or synonyms and closely related concepts, thus providing the semantic surrounding ('neighborhood') of the concept and unification and consistency of the terminology used.

Table 4.1 The General Proposed Structure for the Glossary

TERM	LINK	DEF_USER (Plain English)	ONTOLOGY DEFINITION	OTHER
Concept N	*STSD*	*An everyday definition in understandable language for any user*	*Relative meaning (view) of concept in ontology and STSD tool*	
	ERGO		*Relative meaning (view) of concept in ontology and ERGO tool*	
	ERP-OLAP		*Relative meaning (view) of concept in ontology and ERP-OLAP tool*	
	TOOL n		*Relative meaning (view) of concept in ontology and n_{th} Tool*	

4.4.3 A PSIM Example of Term Mapping

The term-mapping procedure is mainly determined by the domain. For instance, Ergonomy studies the human's movements that are realized when an activity is performed. So, in this domain, the concept step is a fundamental element. This is the

Table 4.2 Part of PSIM Glossary with Terms of STSD and ERGO Tools

Concept	Link	User Definition	Ontology Definition	Other
Compensation Possibility	*ERGO*	*Possibility to eliminate the differences between the work load of the several resources (human and technical), and workplaces.*	*An information element related to the PSIM procedure which aims to eliminate the differ-ences between the work load of the several resources.*	
Equipment	*ERGO*	*The set of tools used for handling, mounting, orien-tation and fixation of assem-bly. Thanks to them more efficient assembly, less re-quired leading time, less physical load.*	*The set of technical resources and applications that a regular activity needs to be completed.*	
Process	*STSD*	*A series of transformations during the throughput, by which the inserted element changes in place, shape, measurements, function or other characteristics.*	*One or more sequences of regular production activities linked by routing activities in such a way that the output of each regular activity is the routed input in the next regular activity*	
Delivery time	*STSD*	*The time between placing an order and the delivery of the requested products*	*An information element IA relevant. This information can be known only by running the instantiation of the enterprise model. This information has another one, which indicates the unity of time used.*	

reason why, in the ontology, the concept *step* has been introduced. In this way, it is possible to overcome problems carried by finer granularity, and to ensure that the term-mapping of the ergonomic concepts are of the one-to-one kind.

The socio-technical domain studies transversal facts. That means that they focus on the relationships between the people inside the different processes of the enterprise (primary and secondary), and between technical resources and human resources during the performance of activities. From this feature of the socio-technical science result the majority of terms referring to sets of entities (leading to complex term-mapping).

In the previous subsection was described the pròposed structure for information storage. Table 4.2 presents some terms extracted from the ergonomic and STSD glossaries.

4.5 Communication Layer

The communication layer's role is to support the exchange of data between different applications. Indeed, some applications are providing data, which are needed as input for the analyses by other applications. In the following, we concentrate on the realization of the connection for the tools developed inside of the project (the STSD and ERGO tool) with other tools (ERP system for example).

Each of the tools manages its own database following its own logic, using its own ontology [2]. The ontology used in each of the cases is locally defined and reflects the paradigm to which the tools are dedicated. Thus the terms, used by the different tools to describe identical things, are very seldom the same. The role of the Communication Layer is to provide for each tool a 'translator', which will translate (map) the internal tool terms in (with) those defined in a reference language. The use of the reference language allows us to decrease the complexity, in accordance with the number of 'translators' needed to support the communication procedure between all the tools.

In order to realize the connection between tools and external databases, the list of the external data, needed as input to the STSD and ERGO tool, is collected. First, the structure used to store the data and the necessary information, that the system has to provide to the navigator is presented. Then, it is described how the term-mapping is used to support the communication between tools.

4.5.1 Structure

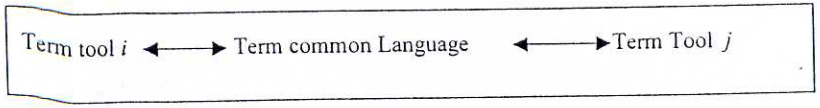
In the communication layer, the data and related information are stored in a table. This table contains all the information needed by the navigator to identify the location and the format of the data to provide to the tool, which needs it. Table 4.3 describes the data structure for storing this information.

Table 4.3 The Structure of the Stored Data

Data name	Format	Definition	Ontological def.	Tool	Input	Output

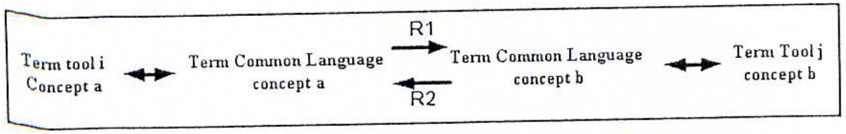
4.5.2 Application of the Term-Mapping

The simplest case we have encountered is when the two domains term (name of the data) are mapped to the same ontological term. That means that to a term in a language A, a single other term correspond in the reference language, which is translated in a single term in the language B. In this case, the concepts are shared 1:1. The sequence of translation is represented in the Box 4.2.



Box 4.2 Simple Translation

Sometimes, the difference of viewpoints can lead to a difference of granularity in the concepts manipulated in the analysis. We were confronted to this problem when we tried to translate the term *action* used in ergonomic analysis into a corresponding term in an ERP system and support the exchange of information concerning the associate concept. The ergonomic term *action* corresponds to the notion *step* in the ERP system. This notion *step* in the ERP system does not exist independently of the concept *activity*: it is used in *sequence* to describe the *procedure* of an *activity*. In this case, the ontology has to support this translation. This is the reason why we introduced in the ontology the relationship between the concept *step* with the *activity procedure*. To support the exchange of data in this case the general schema of Box 4.3 is followed.



Box 4.3 Complex Translation Type 1

In table 4.4 some examples of term-mapping contained in the communication layer are shown. A term-mapping of some ergonomic, STSD and ERP data are described. These term-mappings constitute the bases for the enactment of the translators. The data proposed are exchanged between the different tools; some of them are producing these data, others are only using it.

Table 4.4 Example of Extracted Data from the Communication Layer

Data name	Format	Definition	Ontological def.	Tool	Input	Output
Cycle time	*#sec.*	*Time needed to perform an activity.*	*Information, related to the time needed to perform the activity, that an activity has.*	*ERGO*	X	
Frequency	*#products /time*	*Number of the products produced per unity of time, considering an activity.*	*Information element Frequency an activity has.*	*ERGO*	X	
Working hour per shift	*# hour*	*Number of hours per shift.*	*Information contains in the behavioral model the organization element has.*	*STSD*	X	
Work-out time	*#sec.*	*Duration of an activity or task.*	*Information, related to the time needed to perform the an activity, that an activity has.*	*ERP*		X

4.6 Conclusions

In this chapter, the communication interfaces of the PSIM environment were presented. Firstly, we described the roles of each of these interfaces: the customized PSIM-user manager and the communication layer. Secondly, we presented in detail the term-mapping, the basic mechanism applied in the construction of these interfaces, and the way in which we apply this mechanism to build the two interfaces. We provided for each of these interfaces examples of term-mappings extracted from the existing PSIM-environment interfaces.

Research is ongoing on the further systematization and generalization of the method to establish term-mappings between expert glossaries and the reference language. The results of this research will influence the management of the access to tool-managed external databases.

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