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# Adding User Experience into the interactive service Design Loop: A Persona-Based Approach

**Djilali Idoughi*, Ahmed Seffah**, Christophe Kolski*****

*University A. Mira
LMA – Laboratory of Applied Mathematics
Béjaïa, 06000. Algeria
djilali.idoughi@gmail.com

**Department of Computer Science and Software Engineering
Concordia University, Montreal, Canada
& Troyes University of Technology
Troyes, France
ahmed.seffah@utt.fr seffah@cse.concordia.ca

*** Université de Lille Nord de France, F-59000 Lille
UVHC, LAMIH, F-59313 Valenciennes
CNRS, F-59313 Valenciennes
christophe.kolski@univ-valenciennes.fr

**Abstract**: A service is the activity done by an individual or an organization with the goal to helping someone else – an individual, a group or an organization – to achieve something while creating valuable outcomes for the individuals, the organizations and the society. Service designers should then look at how the services work, the ways people interact and the use services, the ways organizations adopt the services we use, and most importantly the new user experiences created for their employees and clients. Design should start with a deep understanding and analysis of the user experiences while designing services with and not just for people. In that direction, approaches to service design share the human computer interaction commitment to developing with and for people useful, usable and accessible services. In this paper, we investigated personas, a well known HCI design method, in defining and designing interactive software services. The starting point of the proposed persona-based design approach is the identification and creation of a set persona representing the key classes of users. The approach enables to extract relevant elements towards deriving the user interface design and the key functionalities defining the service behavior. As an exemplar, a case study from the e-maintenance services of an agro-alimentary group is presented.

**Keywords:** Human-computer interaction, service design, persona, service oriented architecture, interactive web services, e-maintenance services.

## Introduction

Service has been defined as the usage of specialized knowledge and skills, through deeds, processes, and performances for the benefit of another entity including individuals or organizations or the entity itself (Vargo and Lusch 2004). Within the scope of this paper, we are interested by a specific category of

services mainly IT services, also referred to as SaaS (Software as a Service). SasS is a recently emerging model for engineering and deploying software. Software as a service is characterized by the fact that developers and providers offer their independently developed software functions (no longer packaged in the form of a monolithic standalone application) through networks. SasS is based on a service architecture in which components may be bound real-time, just when they are needed by a specific users, and then the binding may be discarded (Bennett *et al*. 2000). Furthermore, with the advent of ambient and mobile technologies age, software as a service is accessible via different forms of user interfaces from various host locations, leading to the massive flow and usage of the service.

Compared to the traditional software development model, the major benefit of SasS is that it leads to highly flexible and agile IT project management that can meet or can be adapted easily to the continuously changing business needs and user requirements. However to be cost-effective, the analysis and design of SasS requires more than addressing the purely technical challenges and functional requirements. This is one of the limits of the existing software engineering approaches to SasS engineering. The human and user interface is a key issue. Narrow, purely technocratic software engineering methodologies are not sufficient for service systems; perspectives and design methods from multiple disciplines are required.

While presentencing avenues for cross-pollinating HCI and service engineering research, Wild and his colleagues highlighted that service engineering is by definition a multidisciplinary domain (Wild, 2010). However, there has been very little theoretical work on multidisciplinary and multi-perspective approaches to service analysis and design. What is specific about how to architect, design, engineer, evaluate, deploy, and manage services and SasS in particular from the end-user perspective? Most of the discussion about the design and human-computer interaction concerns of service engineering up to now tends to consider the broader class of online interactive applications (for instance, (Ryan 2006)) or the more restrictive class of online retailers (Voss 2003).

As a matter of analogy, Niessink and van Vliet (2000) argued that software maintenance can be seen as providing a service, whereas software development is concerned with the development of products. Differences between software products and software as a service came from the fact that the ultimate quality attribute should be assessed from the customer's perspective. Consequently, usability is important and that it should be integrated at all the stage of the service engineering. This in turn implies a need to carry out service engineering through different processes from those used by software development organization.

We argue that HCI can provide two major elements of interest to service engineering: (1) the user-centered mindset and techniques and (2) concepts and framework applicable to understanding the nature of services. In the field of HCI, various methods and tools demonstrated their potential to improve the understanding of user and task requirements, support the iteration of design and evaluation. Among these methods, persona has been extended to capture an integrative picture of the user experience and behaviors. As Cooper and others have observed, personas can engage team members very effectively. They also provide a conduit for conveying a broad range of qualitative and quantitative data, and focus attention on the user experience aspects of design and use that other methods do not.

In this paper, we discuss how methods of user centred design and persona-based design can be appropriated to elicit users' requirements and design ideas for service engineering. In particular, we report on a study on service design and adaptation in a large industry. The proposed persona-based design process enhanced with services engineering probes, we discussed how each of the resulting

services can be tailored to suit a single person. For each of these individual services we specified prototypes that would accommodate the user's needs but are generic in its applicability at the same time.

## Persona as a Service Design Tool

Alan Cooper proposed personas as a tool to model user experience in interactive software design. His original work in 1999 (Cooper 1999) brought the concept of personas from marketing to design; so as to redirect the focus of the development process towards end users and their needs. His work emphasizes personas as being fictitious characters, based on composite archetypes, and encapsulating "behavioral data" gathered from ethnography and empirical analysis of actual users. Archetypes have been used in marketing research (Rind 2007) both as an alternative and as an extension of traditional market segmentation and user profiling. Instead of modeling only "average" users, personas also take into account boundary cases. The underlying belief is that all consumers are a mixture of certain types of users.

The use of persona has proven its worth as a tool to communicate and clarify abstract user descriptions and their goals. Moreover, Parker and Heapy (2006) argued that in the context of service design "Creating for 'real' people can really animate discussions and enable service providers and users to engage emotionally as well as rationally. The personas are then used to better understand the experiences and needs of staff."

This is why, the persona is becoming more and more popular and the need for a common clearly defined standard becomes more and more important. We defined personas as a descriptive model of a class of users, encompassing information such as user characteristics, goals and needs. They are captured in narrative form, and currently, there exist only general guidelines on how they should be represented. Personas are used primarily as a communication tool, with the hope that the information personas contain will "inspire the design team while sustaining the whole user centered design process (Norman 1986) (figure 1).

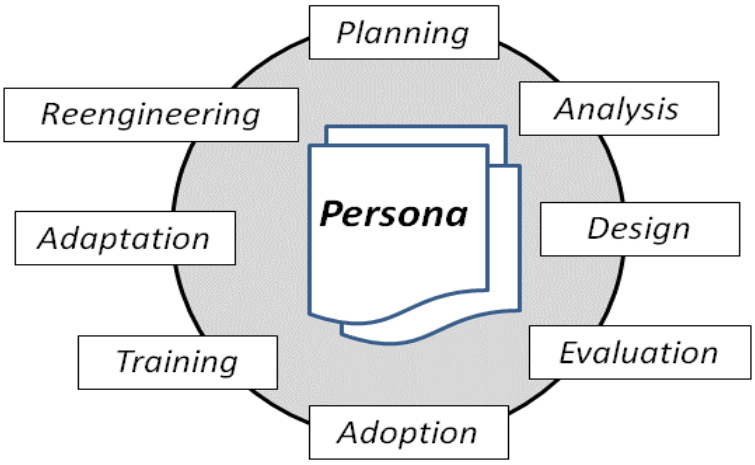



Figure 1. Central role of a persona within a user centered design

However, we find few detailed studies on the information contained in a persona, how this information is represented nor the associated design artifacts. Pruitt and Grudin (Pruitt and Grudin, 2003) encourage a "global" use of personas. This includes attempts to integrate personas in the software development

process and by establishing relationships with other data sets through the use of artifacts such as feature-persona matrices, foundation documents, and task descriptions (although the latter is mentioned, specific examples are not provided). In addition, a focus on ongoing qualitative and quantitative analysis is a central theme of their work. However, there is little discussion on what kind of detailed information is contained in their personas, how they are represented, and how they are mapped to actual data sets. Furthermore, it is unclear if and how precise interaction behavior is addressed in their personas.

Based on the above work, Courage and Baxter (2005) define a set of a persona's components with a textual format which serves as a guide to the construction of personas. These components (adapted from (Courage and Baxter 2005)) may be as follows: Identity, Status, Goals, Knowledge and Experience, Tasks, Relationships, Psychological profile and Needs, Attitude and Motivation, Expectations, Disabilities. These components can act as a guide in building personas. As it will be detailed later, we refine these components to encapsulate the user requirements (see Table 1).

Table 1: Persona components (adapted from (Courage and Baxter, 2005))

| Persona Components | Description |
|---|---|
| **Identity** | Include a first and last name and a picture. It may include a short statement describing the overall life goal. We use also a code of color to distinguish whether the user is a primary, secondary, tertiary, or anti-user of the application. Typically, only primary and in some cases, secondary users are included. |
| **General Profile** | A detailed description of basic demographic information including age, location, job and education degrees, etc. |
| **Goals** | Besides goals related to the application, it includes personal and professional goals as well. |
| **Scenarios** | Three to four scenarios detailed the key tasks including frequency, importance and duration. Such scenarios are described in a second stage after the validation of the key personas. Later on scenarios are reformulated in terms of specific needs (meaning usability requirements), features and interaction schema. |
| **Knowledge and Experience** | Knowledge and experience including education, training, and specialized skills. This should not be limited only to the application. |
| **Relationships** | Include information about user associates, since this could give insight on other stakeholders. |
| **Psychological profile and Needs** | Include information about cognitive and learning styles, as well as needs such as guidance and validation of decisions. |
| **Attitude and Motivation** | Include information about the user's attitude to information technology and level of motivation to use the system. |
| **Expectations** | Information about how the user perceives the system works, and how the user organizes information related to his/her task, domain or job. |
| **Special needs** | Such as disabilities including color-blindness, related to mobility, eyesight (wears contacts), etc. |

## On Services and Service-Oriented Architecture (SOA)

The service oriented architecture (SOA) is an approach for software design which breaks everything down into agile services dealing with one specific need (De Gamma 2003). It also defines the use of services to support the requirements of software users, making them available as independent services accessible in a standardized way (Jardim-Goncalves *et al.* 2006). Reusability, simplicity and interoperability are some design objectives of those services. Unlike the traditional development of

interactive applications, in this approach the business processes, the presentation of information and content (page-screens), and the applicative logic and data are separated into distinct interfaced layers of services. Moreover, SOA is like a paradigm for integrating applications within and across organizational boundaries (Lu *et al.* 2009). In a traditional interactive system development project, the designers often consider separately the design of the various User Interfaces of the underlying applications.

However, in a service oriented approach, the designers only concentrate once on the User Interface for all the applications involved. The main benefits of the approach consist in reducing the development costs and complexity, as well as enabling complex organizations to make their business processes and business logic seamlessly accessible via some relevant web technologies. According to (Kounkou *et al.* 2008), the risk is that SOA researchers see such architectures as being solely concerned with application-to-application interaction ignoring the fact these applications are carrying out activities for people. Despite a variety of perspectives within the process modeling communities (Melao and Pidd 2000), there is sparse evidence that a user-centered perspective is being taken in such process modeling effort (Pring and Lo 2009). Therefore, work in progress is moving towards remedying by integrating HCI knowledge into the SOA development lifecycles practices (Kounkou *et al.* 2008).

Another example of IT-based service is Web services. The term *Web services* describes a standardized way of integrating Web-based applications using the XML, SOAP, WSDL and UDDI open standards over an Internet protocol backbone. Used primarily as a means for businesses to communicate with each other and with clients, Web services allow organizations to communicate data without intimate knowledge of each other's IT systems behind the firewall. Web services allow different applications from different sources to communicate with each other without time-consuming custom coding, and because all communication is via XML. Web services are not tied to any one operating system or programming language. For example, Java can talk with Perl, Windows applications can talk with UNIX applications. Unlike traditional client/server models, such as a Web server/Web page system, Web services do not provide the user with a user interface, mainly a GUI. Web services instead share business logic, data and processes through a programmatic interface across a network. Developers can then add the Web service to a GUI (such as a Web page or an executable program) to offer specific functionality to users.

SOA (Service-Oriented Architecture) is an underlying architectural infrastructure to SaaS, Web services and many IT-based services technologies. It offers a set of best practices, design activities, guidelines that may be applied by using one or more technologies. Moreover, SOA encourages the development of services around business functions offered by an application. Other applications communicate with this application via one or more services in order to accomplish the desired business task. Moreover, SOA consists of building standard human-computer interfaces such that to access different business functions that may be exposed through different business systems. These functions can be essentially those previously invoked by the different business systems belonging to an enterprise and its ecosystem (Seshadri 2007).

The services may have different functions such as transform data, route messages, request databases, apply a business policy, prepare information that may be used by a user interface, orchestrate communications between different services. One of the most known services is a web service which represents a function (or an applicative service). It can be accessed from another application through internet by using available transport protocols. A composite application is one way of composing

applications from some reusable parties. It employs SOA principles. Its characteristics are exposed as web services that can be composed themselves.

Many service oriented approaches have been proposed in the SOA domain such as: IBM-SOMA (*Services Oriented Modeling and Architecture*), De gamma - SODA (Services Oriented Development of Application), Unilog/Orchestra - Praxème and the services-based user interface approach (Idoughi *et al*. 2010). These different methods cover all the software development lifecycle (analysis, design, implementation and deployment) by federating already existing approaches such as: BPM (*Business Process Management*) for the business process modeling, EA (*Enterprise Architecture*) for the design of the system architecture and OOAD (*Object Oriented Analysis and Design*) for the object oriented modeling of the system components.

Most of these SOA-based engineering methods lack to address the HCI concerns. Some methods for the design of services (Alonso-Rasgado *et al*. 2004, Morelli 2006) have adapted and merged existing approaches such as persona into service design (Parker and Heapy 2006).

## Proposed framework for incorporating persona in service design

Our aim is to refine and extend the general SOA design framework while integrating human actors and their experiences. We defined a composite interactive application as an application through which one or more services are used to adapt the presentation of the information to distribution canal and to the users' profiles. Therefore, the final user may access and use the required and needed information whatever his/her access mode.

The main goal in integrating the persona in the design framework is: (1) to be able to offer a simple and efficient communication mean to the design team, developers, the final users, business actors; (2) not to give a complete precise description of a theoretic user model but instead to give a simple and good description of the user such that to make possible the system design. The persona not being a real user, the central idea is to construct the user interface accordingly to its description. This description must highlight some pertinent elements from which we can derive conceptual aspects of the targeted interactive system.

Hereafter, Personas are used as part of a user-centered design process for designing services. The key focus of user-centered design is that users play a critical role in the design of easy-to-use services throughout the entire development process. Interaction throughout the design process is necessary between users and developers in order to understand and define the context of use, the tasks, and how users are likely to work with the future services-based system (ETSI 2002).

The Persona-centric service design methodology clusters all stakeholders involved in a service system as personas. Personas can be of two types. One is 'User Persona' who will be the final user of the service, and the rest of the stakeholders are denoted as 'Role Persona' (Hosono *et al.* 2009).

Therefore, with the design of the composite interactive application in mind, the proposed extended service oriented approach integrating the concept of persona is described through five main stages (Figure 2): (1) Business analysis, (2) User and task analysis, (3) Requirements analysis and elicitation, (4) Services identification, services and user interface specification, (5) Interactive service mock-up & prototyping.

The figure 2 highlights the central role of the personas within a user centered design as stated above (figure 1)

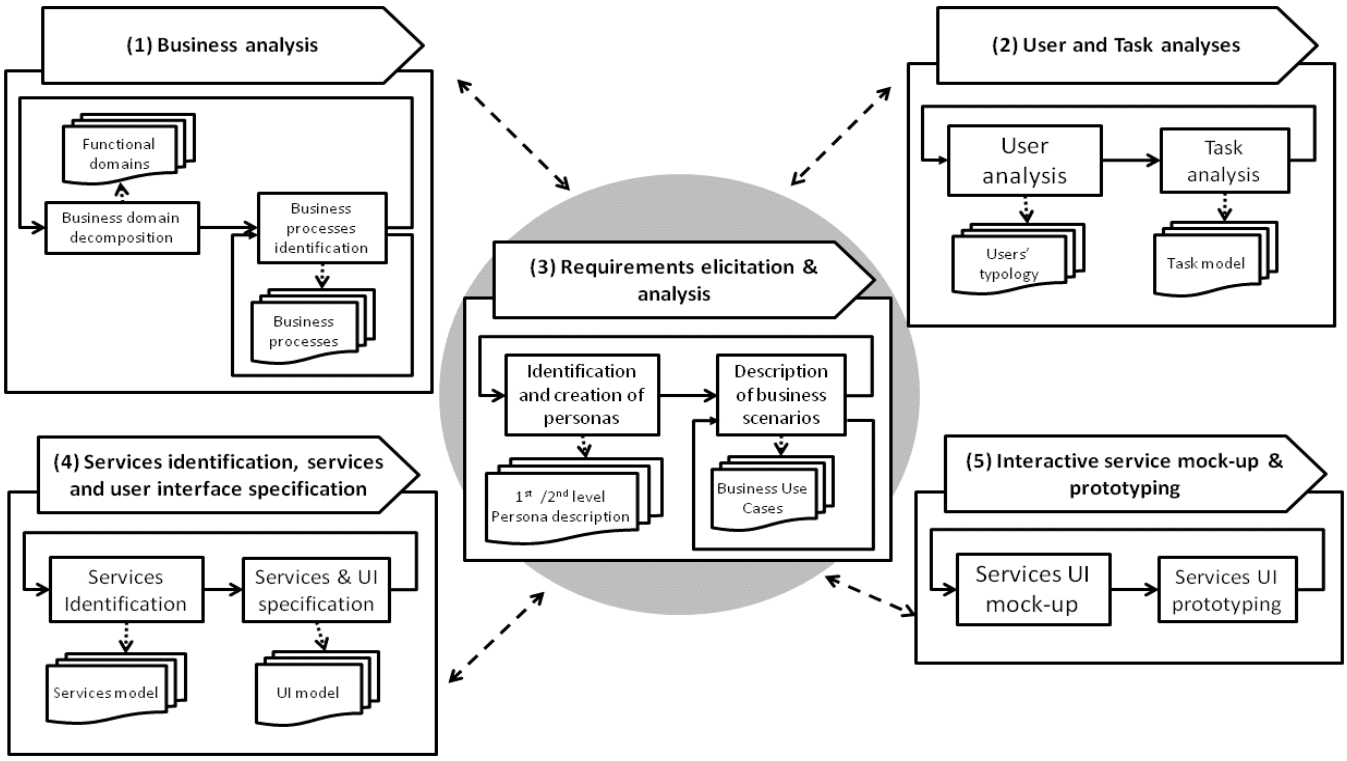



Figure 2: Overview of the proposed framework

**Stage 1: Business analysis**

The first stage is to understand stakeholders' requirements through business process analysis, identification of different human actors implied, their business objectives or goals. This may be regarded as a step within a context design method which helps a cross-functional team come to agreement on what their customers need and how to design a system for them. Then we modelize the business context within the complex organization in which the targeted interactive system will be used (Donatelli *et al*. 2005). This stage tends to discover a first set of possible business services. It consists mainly of a hierarchical decomposition of the business domain into functional domains yielding to a set of business processes, thus giving rise to a set of business use cases. These may be considered as good candidates for the high level business services (Zimmerman *et al*. 2004). In this stage, it is about identifying potential users (human actors, such as customers, employees, partners, etc.) of the target system, along with their needs and goals (in the next stage, personas will correspond with narrative descriptions of these potential users, see figure 4).

This analysis is carried out through two main sub-stages (figure 3): (1) business model components identification; business analysis aims to identify and highlight main modeling elements such as: the business process map which can be represented by UML activity diagrams showing up the different business activities, the business actors and the exchanged business entities, the business goals which can be represented by UML class diagrams tracing the use cases support, (2) Business use case identification; we highlight the main business use cases supporting the business objectives along with the corresponding UML interaction diagrams.

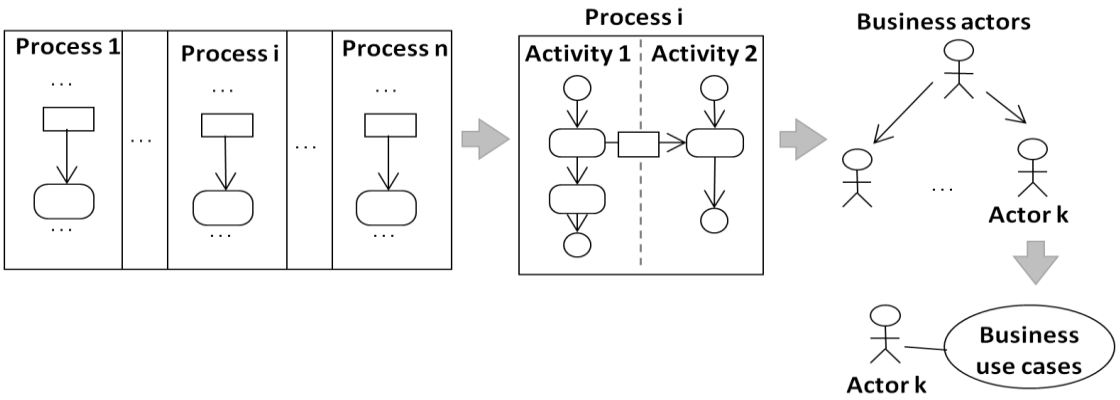


Figure 3: From process map to business use cases

**Stage 2: User and task analysis**

The user analysis consists of defining the users' profiles of the future interactive system. In this service design process, personas have a similar role as character profiles. They help the design team to individuals as they can reference them in different design decisions (Moritz 2005).

This can be achieved by collecting and gathering relevant qualitative data and pertinent information about the potential users of a service by exploring some ethnographical techniques such as interviews, contextual observations, questionnaires, etc. (Hackos and Redish 1998, Johanson and Messeter 2005). Mainly, it consists of considering the whole human actors that may be implied in a global business process. This may concern for example, the business actors implied in a strategic level of the complex organization with strategic objectives and needs as regard to the business process; the human operators inside or outside the organization; or some other human actors who collaborate and work with the organization such as partners, suppliers, etc. All these human actors with different profiles have consequently different needs and requirements as regard to the targeted user interface of the interactive system that must be considered along the design process.

However, the task analysis consists of linking the objectives, tasks (and sub-tasks) and actions that may be accomplished within the organization relatively to a specific set of business processes (Diaper and Stanton 2003). Moreover, it enables also to gather and collect pertinent and relevant data and information on many aspects of these tasks. The main result of this stage is a set of usage patterns and workflows including identifiable users' behavior. This may allow classifying service usage modes through users' models. This step may be regarded as a context enquiry which is an explicit step for understanding who the customers really are and how they work on a day-to-day basis. The design team conducts one-on-one field interviews with customers in their workplace to discover what matters in the work.

Afterwards, we analyze the obtained results in order to highlight a set of behaviors and similar objectives which allow us to obtain personas (figure 4). These personas are in fact globally identified in this second stage and detailed in the next one.

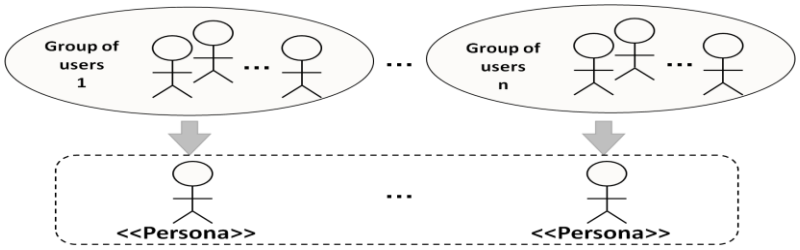



Figure 4: From groups of human actors to personas (1st level persona description)

**Stage 3: Requirements elicitation and analysis**

Creating a set of personas requires a considerable effort. Socio-psychological characteristics must be very punctually defined, needs and goals must also be well investigated and related to the service that will be designed (Marcengo *et al.* 2009). This third stage is about analyzing the data and the functions to be associated with the personas. The analysis should be carried out for every created persona. This may prioritize the personas accordingly to their objectives, their behavior and their interactions with other personas within different contexts.

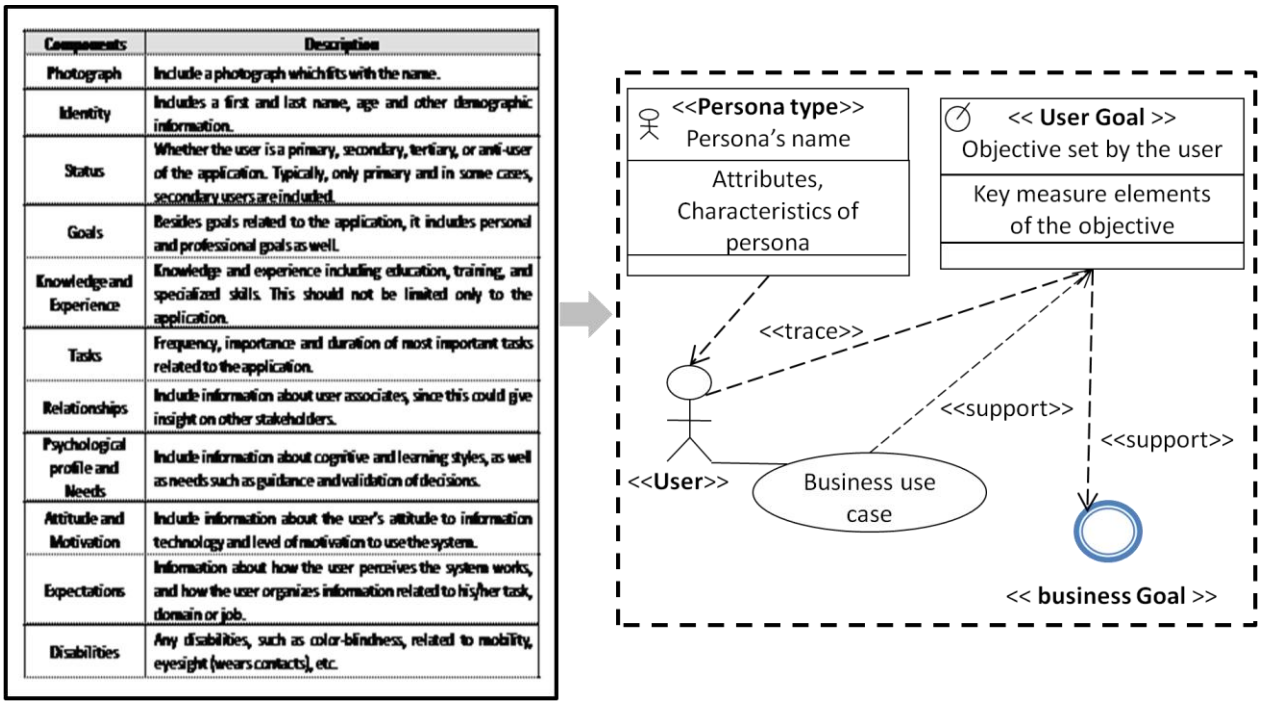
- **Identification and creation of personas**

In this sub-stage, it is about identifying and creating the personas representing archetype users. Persona form similar objectives and behaviors of the users (human actors) identified above. Each persona encapsulates the whole knowledge (goals, tasks, competencies, etc.) about the potential user of the service which is gathered through the stage above. Therefore, we consider the design only for a representative and not exhaustive set of identified personas. Moreover, we create the personas accordingly to the principle given in. Once the persona identified and created, we proceed and make our design process focus only on those personas not for the whole users. That is, we focus our design for that or that persona. These personas help to predict the behavior of the users in order to guide the design towards the main and essential functionalities.

Personas are usually described in a textual form. In this stage, we consider the textual form of a persona as a first level of persona description (table 1). As we have already stated above, a persona can serve as a good communication tool between the project team. Hence, for a modeling purpose, we have to go further, towards the second level of the description. For this purpose, we extend this 1st description level by borrowing the principle given by the USBD (Unified Scenario Based Design) method (Donatelli *et al.* 2005) which consists of using UML diagrams to model the persona along with its objectives (figure 5). We use the UML class diagram to describe each persona along with its attributes (name, tasks, etc.) as well as the user's objectives along with some attributes expressing the elements that can measure the achievement of the objective. This represents the 2nd level description of the persona.

As we can see from the persona components description in table 1 above (1st level of persona description), we can relatively easily extract some pertinent modeling elements (2nd level of persona description) shown in the figure 5. For example, from the identity component, we can highlight the persona types (primary, secondary), its attributes and characteristics; from the goals component, we can highlight goals related to the service, it includes personal and professional goals as well. From the

scenario component, firstly, we can extract some key measure elements of the objective such as: frequency, importance and duration of the key tasks achieving the objective. Secondly, we can highlight after the validation of the persona some elements that can be reformulated in terms of specifics needs which may be achieved by relevant interactive services (next sub-stage).



| Components | Description |
|---|---|
| Photograph | Include a photograph which fits with the name. |
| Identity | Includes a first and last name, age and other demographic information. |
| Status | Whether the user is a primary, secondary, tertiary, or anti-user of the application. Typically, only primary and in some cases, secondary users are included. |
| Goals | Besides goals related to the application, it includes personal and professional goals as well. |
| Knowledge and Experience | Knowledge and experience including education, training, and specialized skills. This should not be limited only to the application. |
| Tasks | Frequency, importance and duration of most important tasks related to the application. |
| Relationships | Include information about user associates, since this could give insight on other stakeholders. |
| Psychological profile and Needs | Include information about cognitive and learning styles, as well as needs such as guidance and validation of decisions. |
| Attitude and Motivation | Include information about the user's attitude to information technology and level of motivation to use the system. |
| Expectations | Information about how the user perceives the system works, and how the user organizes information related to his/her task, domain or job. |
| Disabilities | Any disabilities, such as color-blindness, related to mobility, eyesight (wears contacts), etc. |



Figure 5. Mapping of the textual form (1st level) and UML diagrams (2nd level) persona description

- **Description of business scenarios**

Based on the persona documents (textual form persona description, figure 6 left) created, scenarios of user activities are developed to describe scenes in which personas use the service, and how they interact. The development of scenarios of user activities allows to specify what users want, the functions they need and where and how they need them, and to understand what communications they want and how they want them. They will become a basic design of the desired service and help define user requests. Scenarios can then be developed based around activities of the persona.

In the software design context, there are various definitions of scenarios and approaches to their use. (Carroll 1995). The persona-scenario method is a design technique to help provide the service that users want to use. The development of a persona and scenarios of user activities based on personas enables designers to go beyond an obscure image of people such as customers and users and to deepen understanding of users and their activities.

Therefore, from the scenario component persona description, we extract relevant business scenarios (for each persona). Afterwards, we determine the essential functionalities for the services-based interactive system from these scenarios (figure 6).
These scenarios detail the key tasks including frequency, importance and duration. Such scenarios are described in a second stage after the validation of the personas. In the next stages, scenarios are reformulated in terms of features and interaction schema.

The requirements in terms of services corresponding to the essential functionalities go through persona identification. As it is illustrated in the figure 6, the scenarios extracted from those personas are expressed as business use cases. They correspond to appropriate services operations that match defined requirements that may compose the interacting business services with the different interactive service components associated with each persona as it is illustrated by the figure 7.

Therefore, we proceed to the following sub-stages in order to obtain a set of the interactive system services: (1) services identification, (2) services and user interface specification. Please note that, by lack of space, in this paper we only present the sub-stage 1.

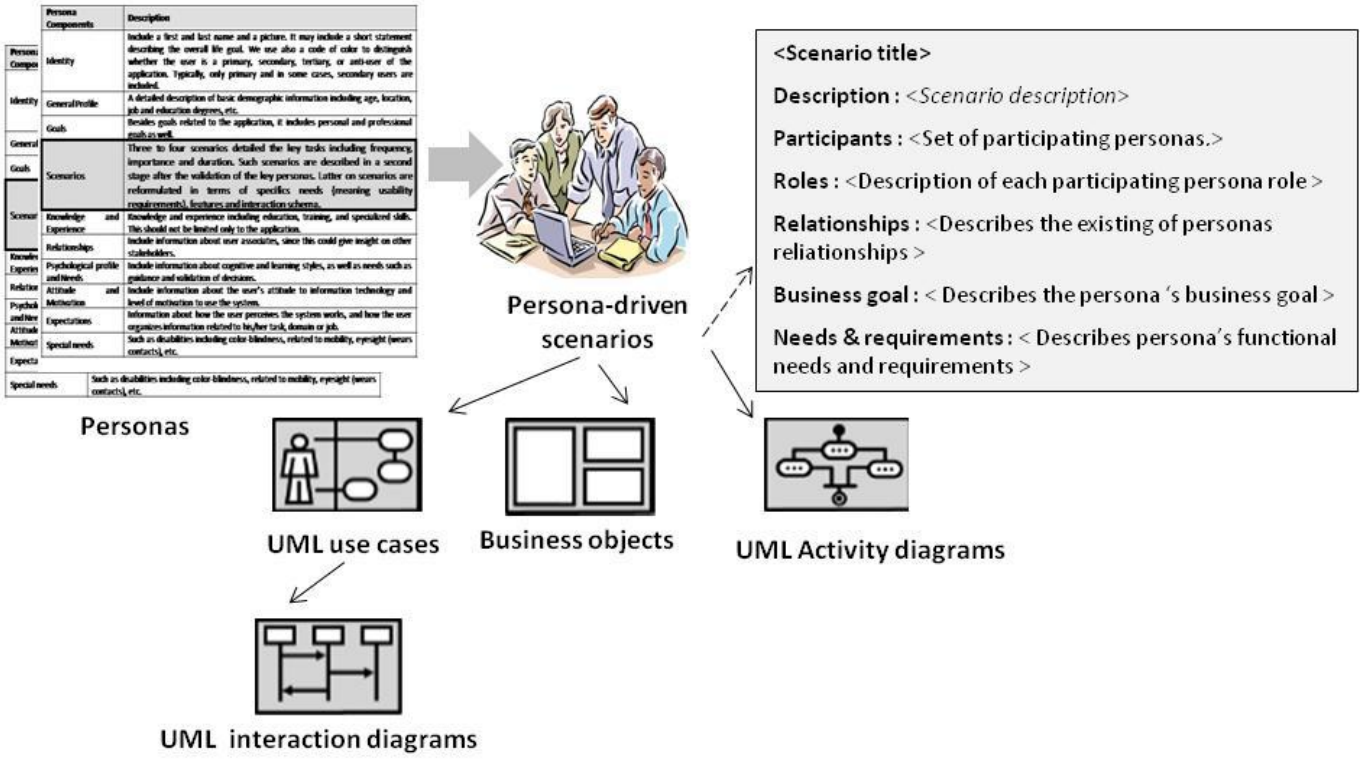



Figure 6. Extraction of business scenarios from the scenario component persona description

**Stage 4: Services identification, services and user interface specification**

The text-based components (Table 1) can act as a guide in building personas. In this step, we fine-tune these business use case components to better fit the requirements for designing the services (figure 7).
UML use cases models have been used in the description of scenarios as a method for eliciting the persona's requirements. In this stage, the persona method is used to model interactions at the user interface level as it has been already used at the business abstract level.
Therefore, this stage aims at identifying and then designing appropriate persona and services interactions.

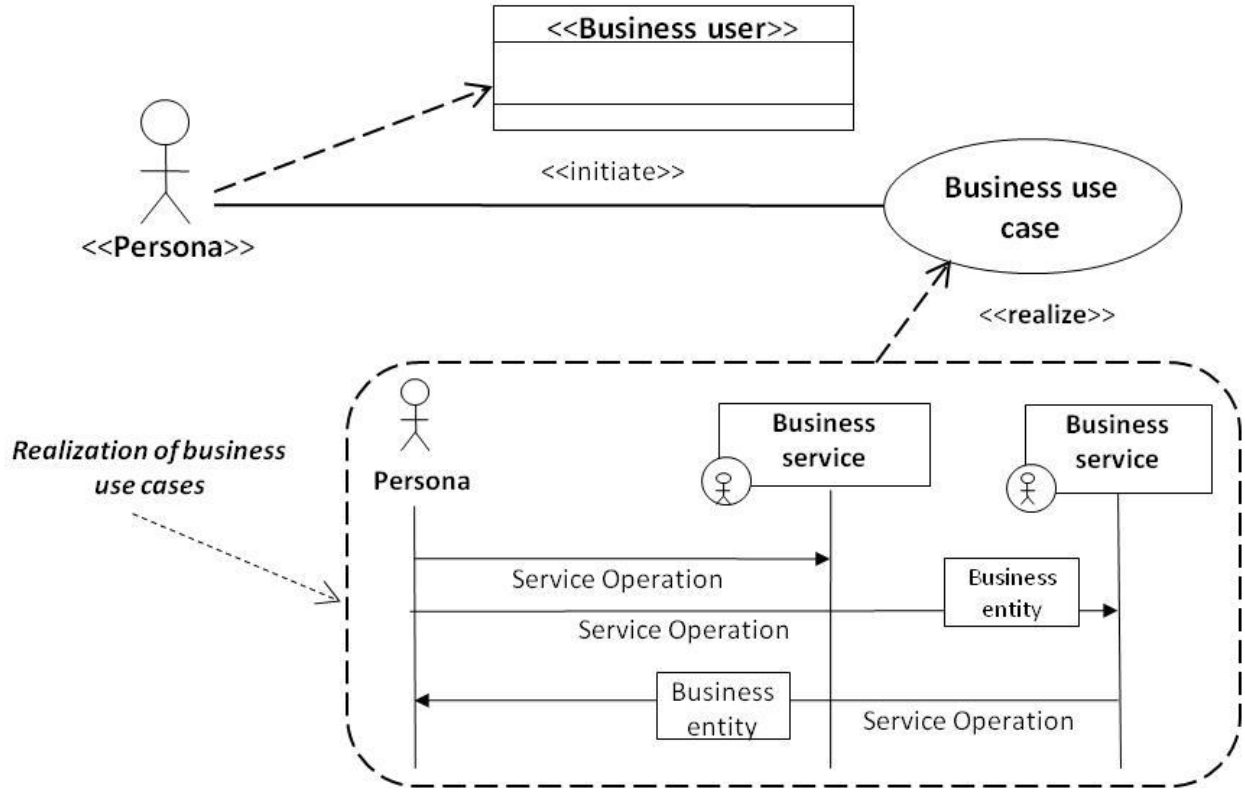



Figure 7. Example of business services derived from the created personas

Based on the associated scenarios to the created personas, we may identify therefore the business services (figure 8). Afterwards, we specify the services and user interfaces components in order to their realization and their deployment as broadly illustrated by the figure 9 (not considered in this article). Figure 9 portrays: (1) a persona-driven business use case models which are the results of the two first stages; (2) extraction of business scenarios from the scenario component persona description which is the result of the third stage; (3) specification of the services and user interfaces components which can be extracted from the corresponding scenarios. Let us note that process is carried out iteratively.

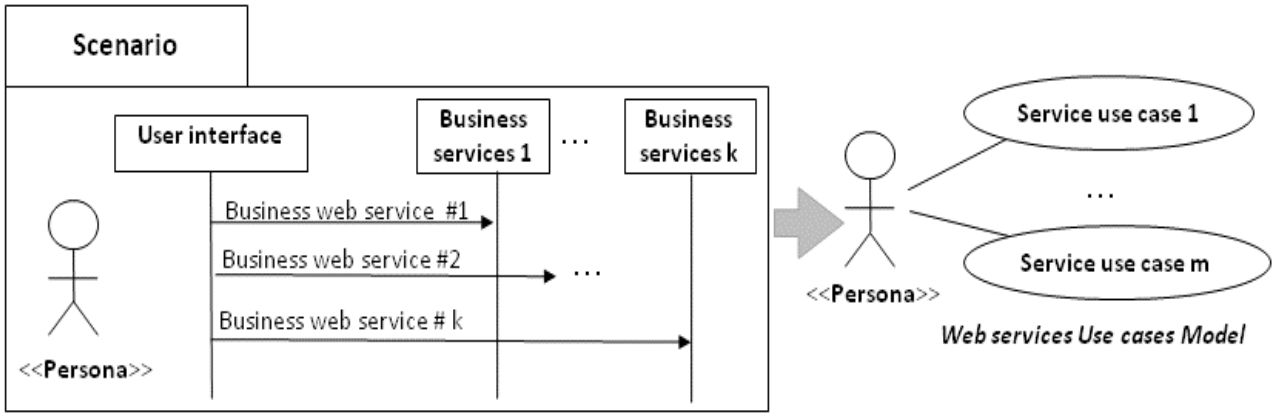



Figure 8. Example of business usage of Web services

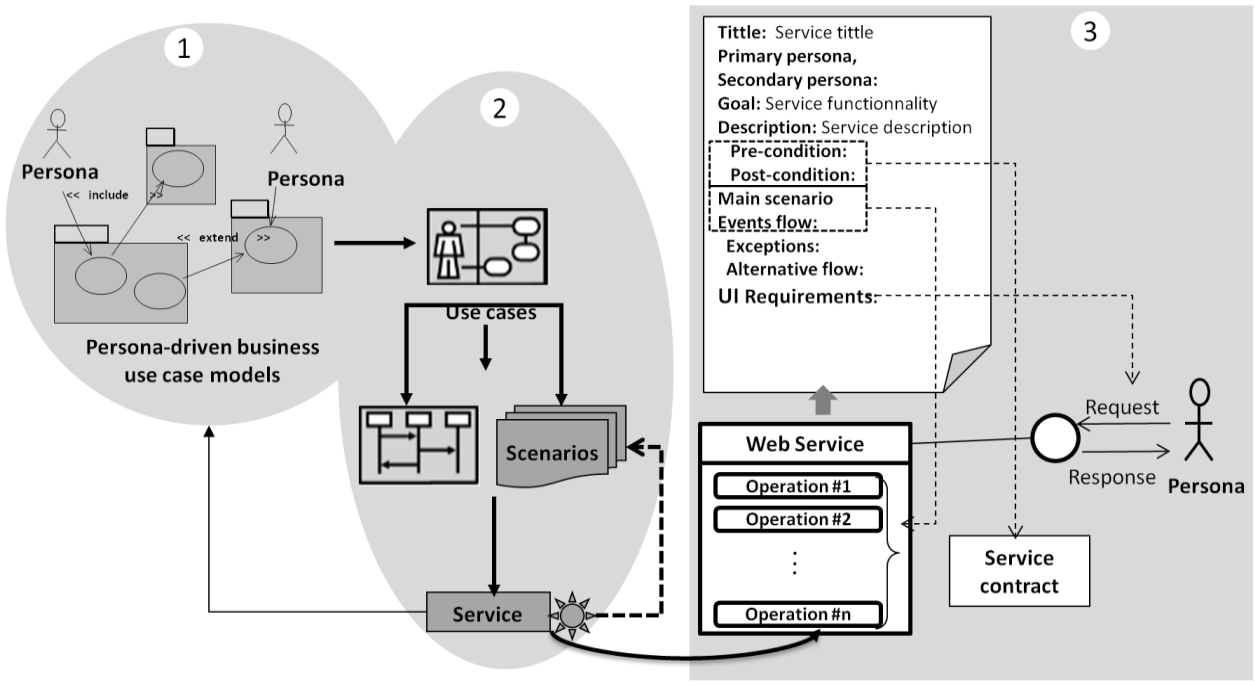



Figure 9. Services identification, services and user interface specification global process

**Stage 5: Interactive service mock-up and prototyping**

Prototyping a design is a common practice in a number of design fields. The less tangible nature of service can make it harder for designers and users to visualize that nature of a service. Prototyping of the elements of a service can remedy this (Wild 2007). Parker and Heapy (2006) recommend the use of prototypes, personas, and the measurement of service experience as well.

This stage is about conducting the user interface specification by constructing and designing the interactive services mock-ups and prototypes which perform the service-based user task as might be described by the extracted scenarios above (figure 9). This consists in defining services interaction diagrams including the user interaction objects within the interactive services components (figure 9, part 3) as illustrated by the figure 10.

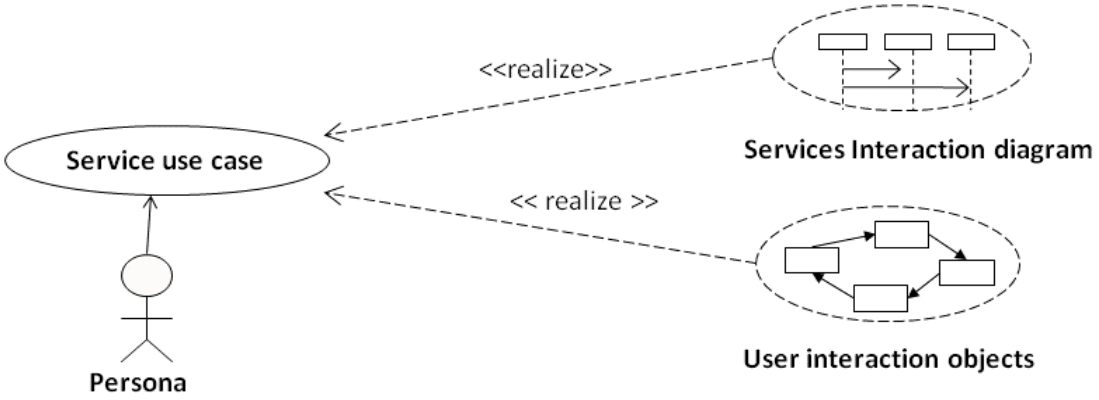



Figure 10. From a persona description to user interaction objects

Before moving forward to the design and implementation stage (out of scope of this article) of the whole set of the identified interactive services (stage 4, figure 9, part 3), we proceed to the mock-ups and prototyping of the user interface of these services. The figure 11 expresses how the interactive services mock-ups can be elaborated and validated iteratively using personas from user experience scenarios. Therefore, the mock-ups evoluate towards prototypes which are validated iteratively as well.

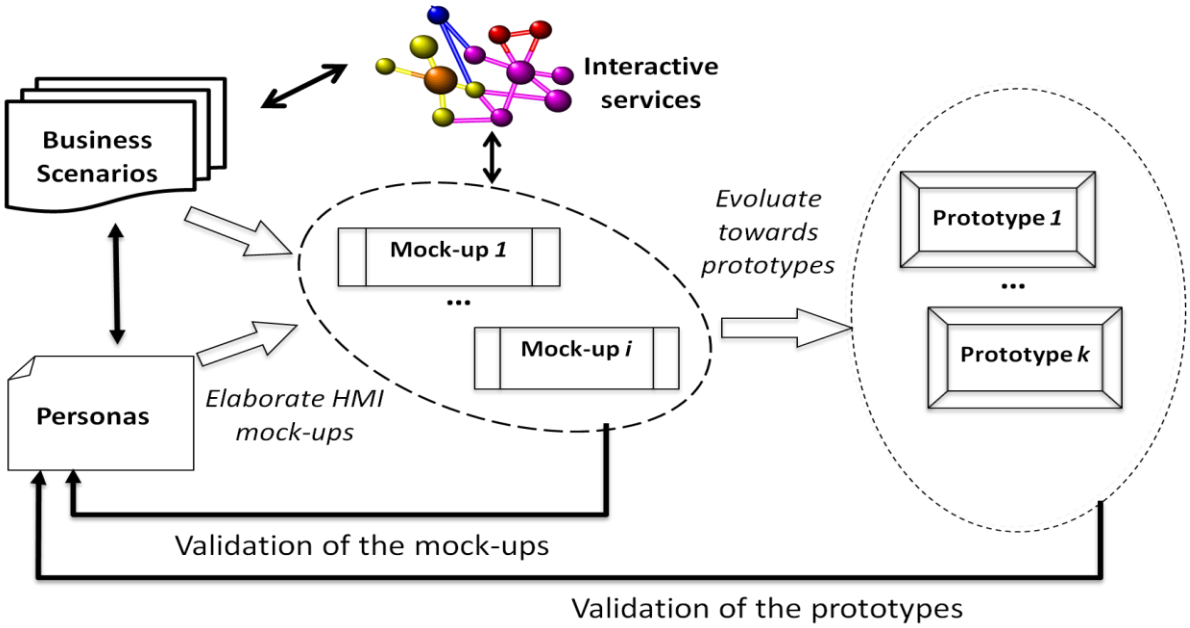



Figure 11. Use of personas in the mock-up and prototyping iterative process

## A Case Study: E-Maintenance Service Design

Our exemplar is related to industrial e-maintenance in a very large agro-alimentary (relating to food processing industry - industries involved in the mass production, processing, and inspection of food products made from agricultural commodities) organization with several branches. The maintenance process is seen as a tasks sequence (or activities), carried out by some actors (human or not) in order to carry out objectives laid down by the organization. The maintenance management becomes more complex when many implied systems and diverse types of information exchanged between these systems are concerned. The maintenance dedicated systems consist of a set of applications such as management applications, support software and hardware enabling the management of the whole maintenance process.

The maintenance management can imply several types of computing systems, some of them concern technical aspects (Supervisory Control and Data Acquisition system, computerized maintenance management system, etc.), and others concern management aspects, such as the ERP (Enterprise Resource Planning). On the other hand, these applications, often gathered around a specific business function and isolated within different departments of the company are limited in terms of human-machine interfaces, and thus are badly equipped to communicate with other applications.

This is called functional silos applications. It generates several disadvantages, such as: incapacity to set up transversal business processes (that is to say, crossing the borders between departments of the company), the redundancy of information and its processing, difficulties of evolution and to reuse the software components hidden in the applicative silos.

However, the suggested SOA based approach enables the coexistence of several types of systems implied in the e-maintenance. In addition, these services have the capacity to provide the end users a coherent view of the e-maintenance system thanks to the persona and through a composite interactive application as illustrated in figure 12. Figure 13 shows an interactions diagram between a persona and the various services invoked through a composite application of e-maintenance.

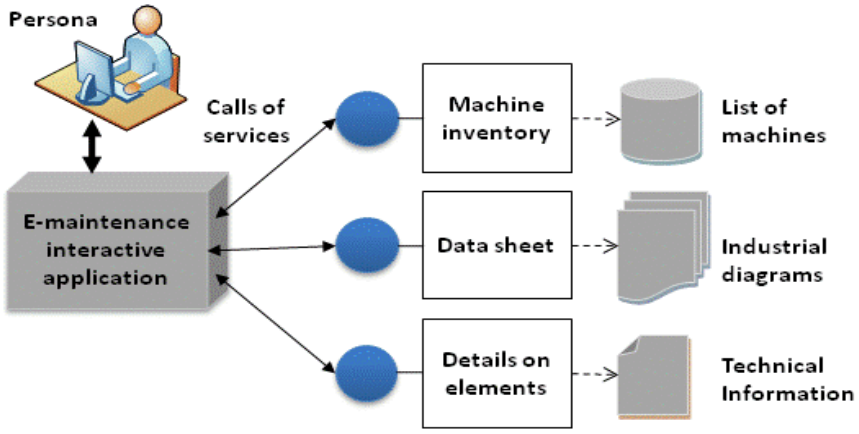



Figure 12. Example of target application of E-maintenance

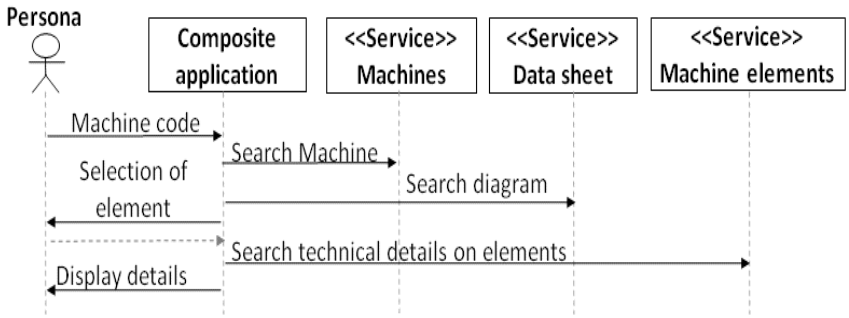



Figure 13. Relationships between persona, composite application and services

To be able to develop such an application, we apply the suggested approach as follows.

**Business analysis**

During this stage, a first set of possible business services are identified. We have conducted hierarchical decomposition of the business domain of the studied organization into functional domains. This has given a set of maintenance business processes associated to a set of business use cases (This part of the stage is not presented here for the sake of space). This set of maintenance business use cases is considered as good candidate for the high level maintenance business services such those obtained and presented in figure 14.

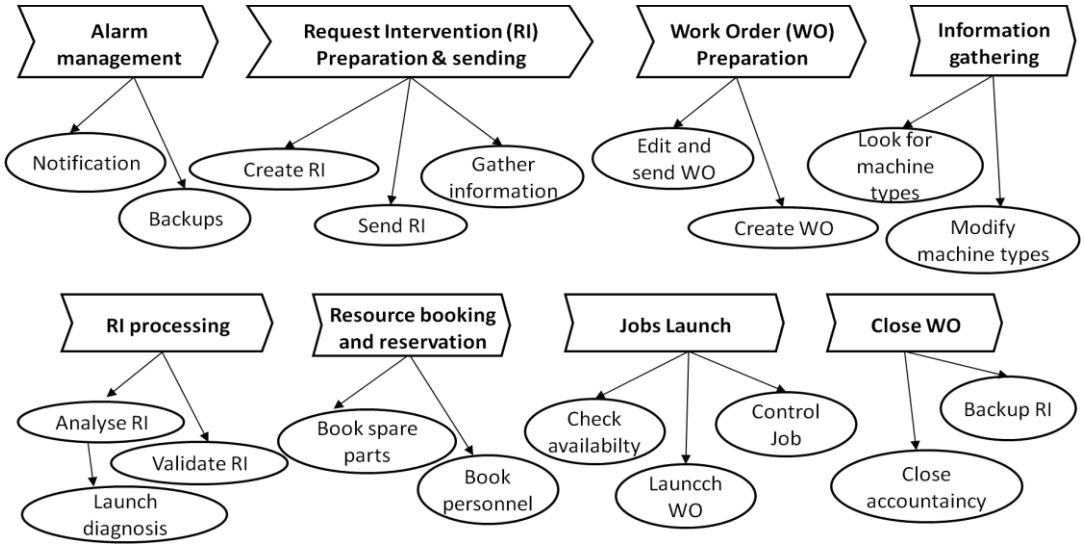



Figure 14. Example of candidate business services for e-maintenance

**User and task analysis**

In the user analysis, we are interested in the human actors concerned by the existing business context, by thus deducing all information relating to their profiles and their business needs. This information is useful for the specification of HCI relating to the e-maintenance system concerned.

At the end of this stage, we obtain a human actors' typology intervening in e-maintenance within the organization object of our study. Figure 15 shows a typology of the personnel concerned (mechanical Foreman, Foreman, planning Agent, mechanical engineer, electric Foreman, mechanical Operator, electrical Operator, automation Operator, etc.). For lack of place, we do not give the resulting tasks corresponding to the various users above.

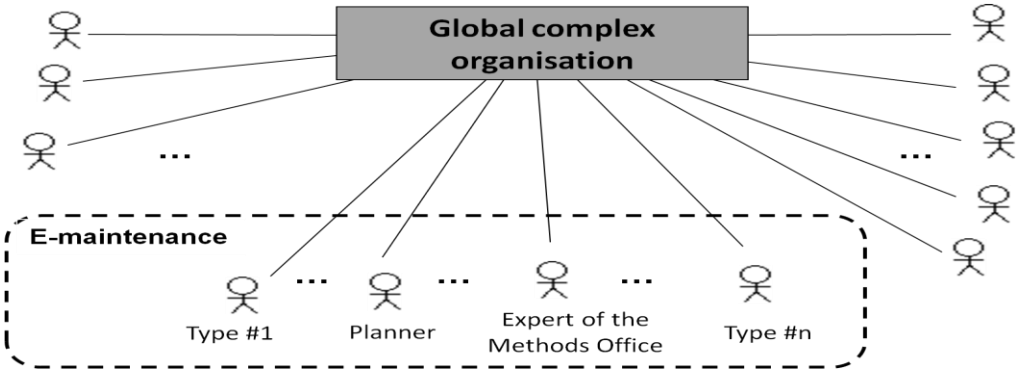



Figure 15. Typology of the maintenance personnel concerned

**Identification & creation of personas**

After having identified the principal users of the future system and their various tasks of e-maintenance, it is a question of now identifying a representative and non exhaustive set of persona, by grouping all the users above having similar objectives and towards whom we direct our development. Among principal

personas identified in accordance with the description given in the figure 5 above, one quotes for instance: the head of Methods Office, the operator of Methods Office, the expert of Methods Office, the maintenance manager, the foreman, the maintenance operator, etc. Figure 16 shows an example of some identified and described maintenance persona.

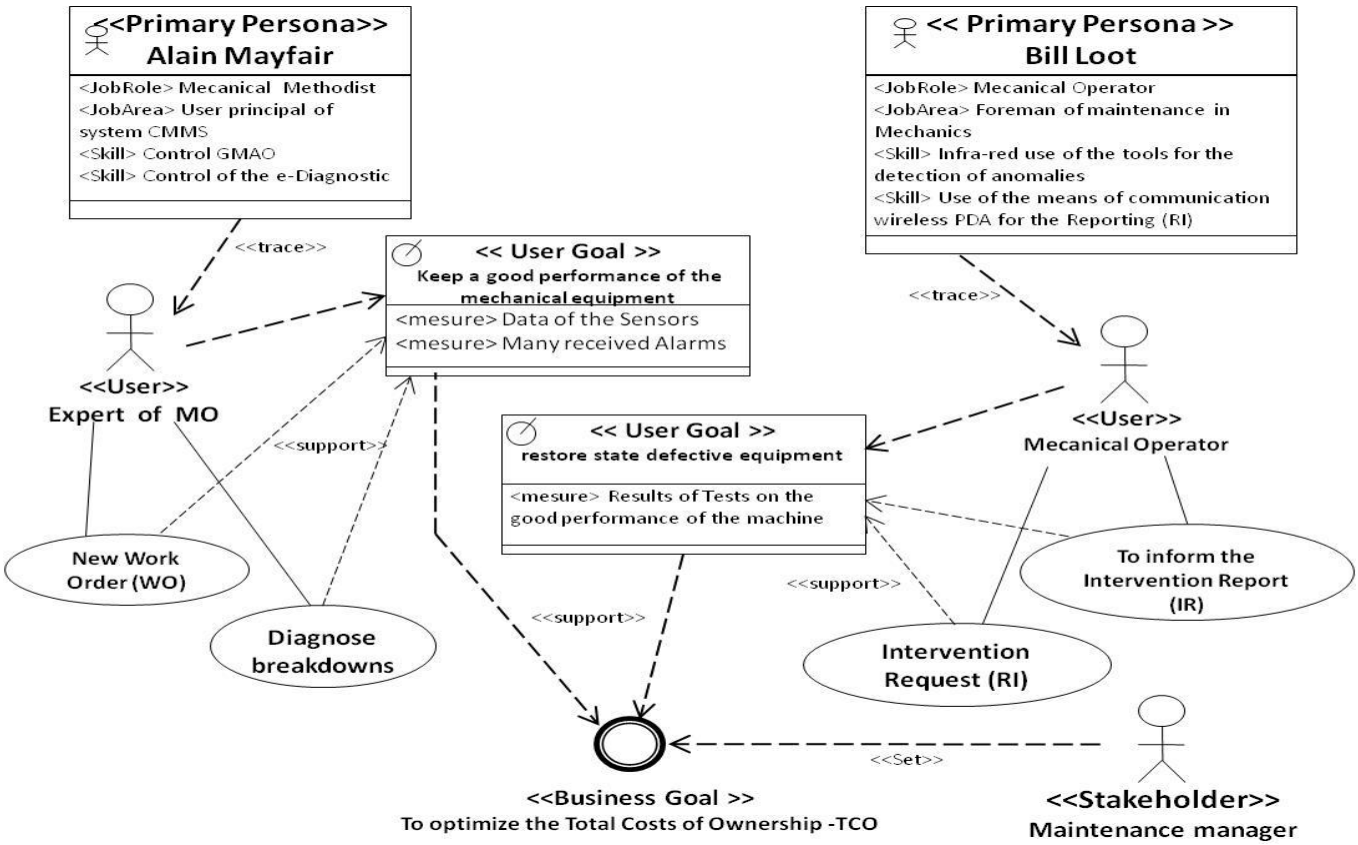



Figure 16. Example of maintenance personas

**Description of business scenarios**

In this stage, for each persona created, we create the scenarios relating to it. For example, one of the plausible scenarios being able to imply both personas (Alain Mayfair and Bill Loot), consists in detecting anomalies and sending an alarm towards the control room. Thus, we could have to design a tool or an interactive service dealing with the anomalies which have occurred. Then, what are the functionalities which might be offered by this tool? I.e. what services should we conceive which can satisfy both personas in question? And what can each persona do from the considered interactive service? For better understanding a design directed by the personas, we choose two target examples of persona expressed by tables 2 and 3.

We will thus define a scenario for each persona. For the *Expert of the MO* persona (persona #1), we extract for example the scenario #1. For the *Planner* persona (persona #2), we extract for example the scenario #2: Reservation of resources.

| | |
|---|---|
|  | Alain Mayfair, 49 years old<br>*Expert of the Methods Office (MO)*<br>He belongs to the category of the MO staff. |
| **Scenario #1:** The *supervisor in chief* takes note of the notification of alarm, decides to create to send an intervention (IR) towards the *expert of the MO* via the WIFI network. The nominal scenario is as follows:<br>1. The *expert of the OM* receives the intervention request (IR) on his PDA, starts the diagnostic tools as well as the data acquisition on the SCADA (Supervisory Control And Data Acquisition) system;<br>2. He sends a request for creating a work order (WO) towards the *planner* present in the MO. The latter proceeds to the reservation of the resources and the editing of a work sheet (WS), he sends it to the chief maintenance operator (foreman for example) via his PDA. | |

Table 2. Example of tasks of maintenance associated with the Expert of the *Methods Office* persona.

| | |
|---|---|
|  | Bill Loot, 42 years old<br>*Planner*<br>He belongs to the category of the maintenance operators. |
| **Scenario #2:** The planner launches a request for supply (SR) in order to reserve the necessary resources to the intervention in terms of spare parts. Once the SR received, the storekeeper checks stock and proceeds to the provisioning. At the end of this operation, the storekeeper confirms the availability of the resources to the OM. The nominal scenario is as follows:<br>1. The *planner* creates and sends a SR to the stock management service.<br>2. The *storekeeper* checks the availability of the resources requested and notes a lack. Then he decides to launch a Request for Purchase (PR) for the purchase service.<br>3. The *purchase service agent* carries out the processing of the PR and creates a purchase order (PO), he sends it to a supplier.<br>4. The *supplier* processes the PO, delivers the requested spare parts and carries out the creation and the emission of the invoice.<br>5. With the reception of the spare parts, the purchase service informs the stock management service about the delivery of the required resources. The latter establishes a delivery sheet and updates stock.<br>6. At the end of the provisioning operation, the *storekeeper* informs the *planner* by validating the received SP. | |

Table 3. Example of tasks of maintenance associated with the *Planner* persona

It will be noticed that several personas can be implied: planner, storekeeper, the purchase service agent and the spare parts supplier. In addition, other users belonging to the various departments (commercial, accountancy, etc.) are also implied but in an indirect way in the business processes relating to maintenance management. In the persona approach, we refer them by secondary persona.

**Services identification, services and user interface specification**

In this stage, it is about determining or extracting the essential functionalities of the system or the interactive service from the beforehand selected scenarios. Indeed for,

(1) The persona #1, it is necessary to design the pages for the user identification dedicated services, the initialization of the WO (Work Order), the selection of the maintenance operators necessary for the intervention, the view of the state of the machines in a production unit, the consultation of work of maintenance in progress, the input of forms dedicated to IR (Intervention Request) and SR (Request for Supply) creation;
(2) For the persona #2, it is necessary to design the pages for the user identification dedicated services, the initialization of the WO (Work Order) , the selection of the suppliers, the view of the state of the required resources, the consultation and the follow-up of the request for resources in progress, the input of forms dedicated to IR (Intervention Request) and SR (Request for Supply) creation; and sending, the selection of the spare parts, the visualization of the result of the reservation of the resources, etc.

While thus proceeding for the whole personas created, we manage to propose only the essential services or functionalities for the created personas. From the scenarios associated with the personas created, we

can identify business web services (figure 14) for which we will specify the components and interfaces for their realization and deployment (steps not covered in this paper). Figure 17 shows a use case diagram associated with the various possible scenarios of the e-maintenance within the studied organization. We highlight scenarios associated with the personas #1 and #2.

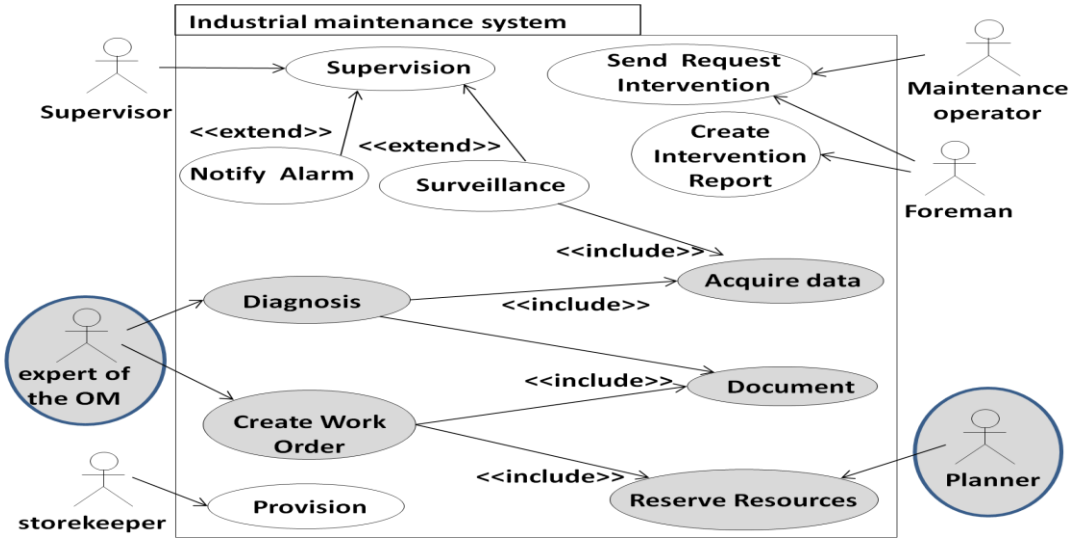



Figure 17. Use case diagram associated with the various possible scenarios of e-maintenance

During this stage, we highlight also the various operations of each web service (figure 18). Through these operations, we highlight the various elements that might constitute the user interface. Indeed, it consists of conceiving the services dedicated to the information presentation which will be integrated in the composite application.

It is thus about of combining descriptions of the web services supporting the business logics of the e-maintenance with information relative with the user interface. In other words, the description of the web services is increased with information on the user interface in order to generate concrete user interfaces coherent with the different personas.

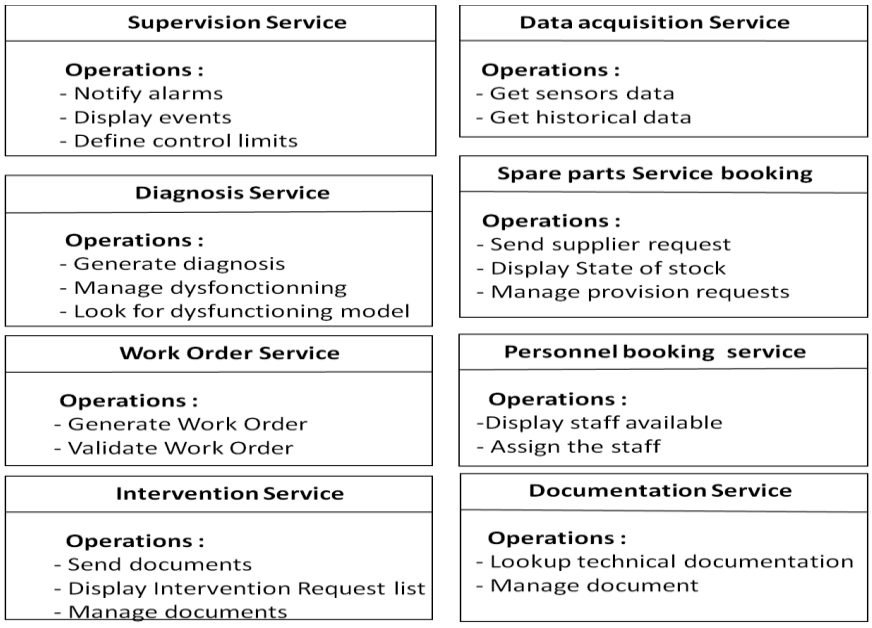



Figure 18. Operations linked to the business services in connection with personas created

Figure 19 shows an example of an interaction diagram between different personas (persona #1 and persona #2) showing some services with their respective operations.

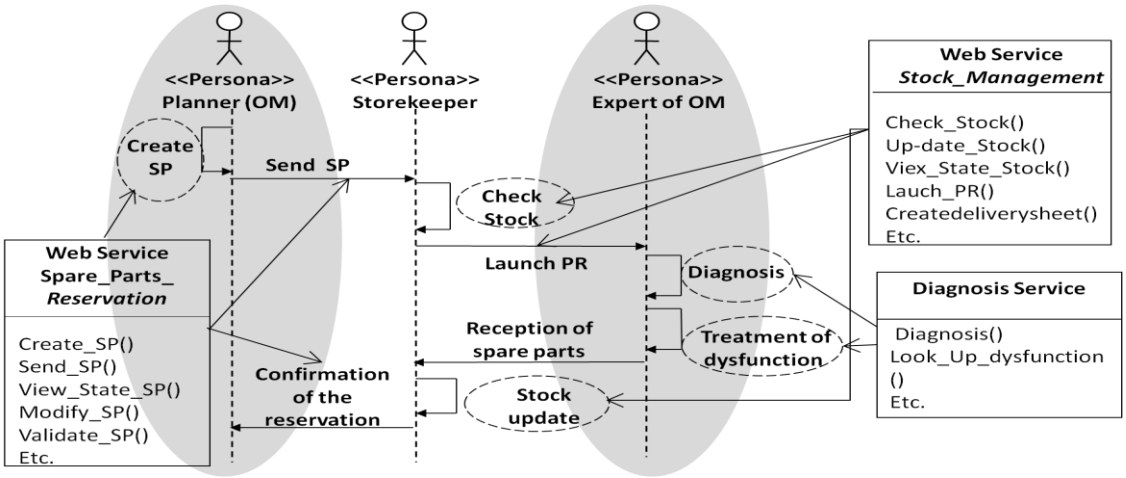



Figure 19. Expression of an interaction diagram (e.g. reservation of spare parts) in terms of business services and their respective operations.

**Interactive service mock-up & prototyping**

Thus all the elements of user interface which can be specified in an abstract way (without worrying about the technical or implementation aspects) can be considered mainly from the mock-up/prototyping angle for example. Thus, we proceed to visual design of the screens of the storyboards above for the corresponding personas and their objectives.

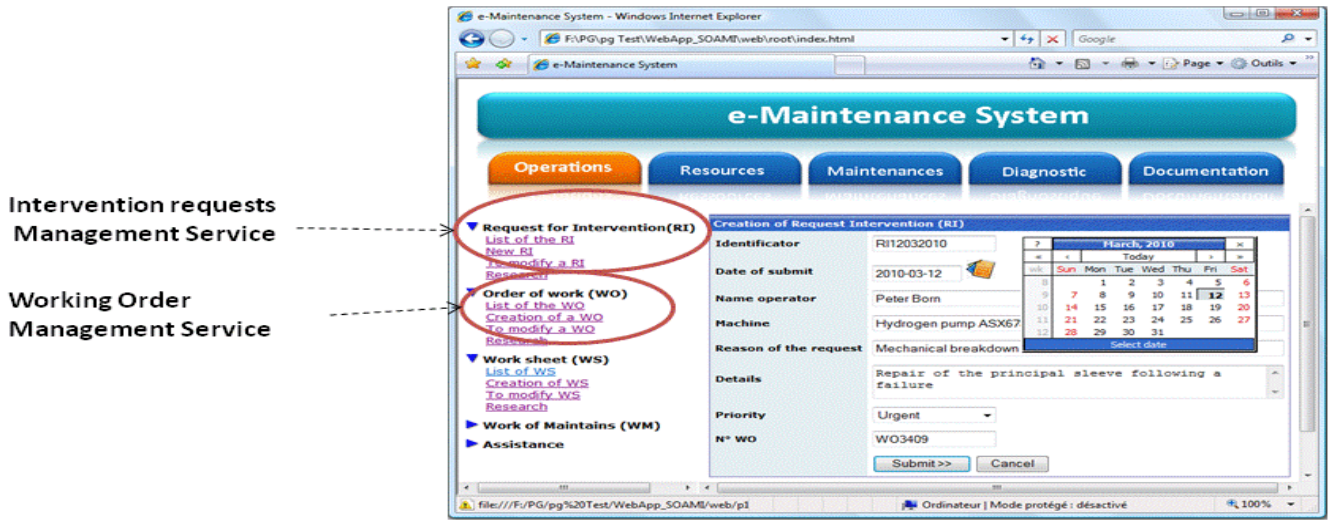



Figure 20. Main visual screen design for interactive services

Also let us note that, while referring to the iterative and incremental global approach described. Various cycles integrating evaluations using the personas gradually make it possible to refine, complete these elements of specification, and to be directed gradually towards the design, then the implementation (not covered in this paper). We give hereafter an outline of interactive services prototyped for each persona (figure 21).

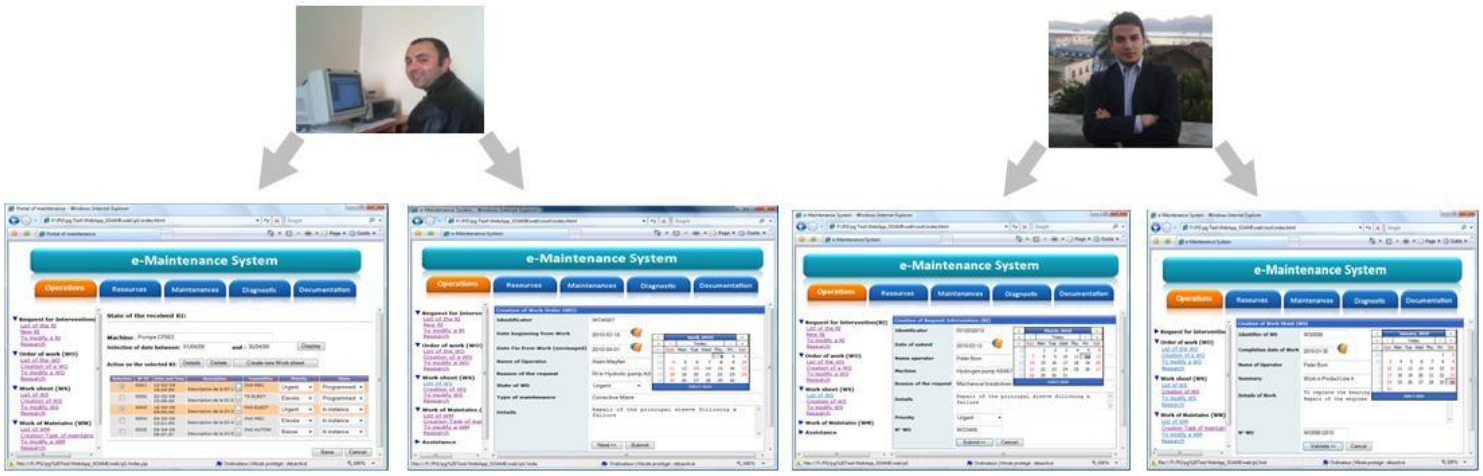


Figure 21. Example of mock-ups/prototypes of interactive services relating to the two personas

## Discussion and Further Investigations

To build a tighter fit between user experiences (how people work and use a service) and design (the way that a service features are presented and can be used), we propose a novel design method based on a set of core user-centered design principles which we have enriched with "engineering-like" concepts such as reuse and traceability. The method is based on two key design artifacts, personas and scenarios, and consists of six major milestones. First, we briefly describe these stages while detailing how the

information the initial set of user descriptions are refined and transformed into a conceptual design. Secondly, we describe a case study from a real-world example in which the first author has been involved. As an attempt to better assist designers in using the proposed method, we developed a supporting persona format. The format involves a set of ingredients, qualitative attributes that quantify the user experiences.

In this paper, we mainly focus on the two first phases of the processes without detailing the clustering approach, the way that users are grouped into persona. Clustering, a key critical task in our approach can be described as a process consisting of an iterative grouping of users based on some parameters and adjustment of these parameters. In order to alleviate the load put on the designer during user grouping phase, we need to design and implement a set of automated grouping techniques. Additionally, we are conscious of the fact that automatic clustering cannot account for all possible exceptions; therefore, we have to provide means for manual clustering and a possibility for interaction with automatic clustering algorithms. The designer can use automatic clustering methods to produce rough results and gain some insight into user groups. At the same time, a process can be followed exactly and semi-automated clustering can be performed by using per variable (or as we call it sequential) grouping and manual drag and drop operations. Furthermore, we need to translate the quantitative user experiences attributes collected via personas into quantitative variables that are machine-readable meaning usable by the automatic clustering.

Another drawback of the proposed method and the use of persona is linked to the focus on particular classes of users. This may contract the scope of design ideas – creative design. Persona typically should serve also help in expanding the scope of ideas, though it is more relevant as an information gathering step, and thus typically expands more than it contracts. This is the most complex activity in the design process. Choosing the type of user to focus on involves consideration of diverse concerns during the first two stages of the method. Exploratory user research will help identify classes of users who are not well supported by existing services or those who are indirect users. These are ideal candidates for focusing on to get a broad understanding of the widest set of possible users. In the first stage which will remain manual, a designer should try to document in a concrete way what these users are performing which activities.

## A Concluding remark about Persona as a Design

Although promising, the use of personas as a design tool is relatively new technique to the wide variety of services. However, lack of a common standard designed for evolution, unclear usage guidelines and lack of integration into a design process are some of the major challenges encountered while working with persona as a technique for understanding user experiences and incorporating into the management and engineering methodologies of services. Blomquist and Arvola (2002) reported that less than half of the development members generally knew the personas' names used in the project and most did not recognize their faces. Because most of the members were not aware of whom the personas were, the discussions related to needs (during design and development) were extremely difficult. In fact, scenarios have been reported to play a greater role than personas themselves.

Another commonly problem with the application of personas is lack of a clear standard and description of information. Pruitt and Grudin (2002) report that it is difficult to apply the recommended approaches without a clear understanding of persona identification and characteristic inclusion. In the same vein, few published efforts describe projects using personas with disabilities. While 6.9% of the US population over the age of five has a disability (accounting for almost 19 million of people) and 40.5 %

of US population over 65 years old have at least one type of the sensory, physical or mental disability (US Census Bureau, 2005), very few projects have attempted to construct and integrate a persona with disabilities. The Treasure Board of Canada with cooperation of industry has provided a document Accessibility Domain Architecture amongst other things containing a Disability/Persona Matrix including 10 personas with unique disabilities used to enhance the accessibility to the Government of Canada's Information

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