Adding User Experience into the Interactive Service Design Loop: A Persona-Based Approach

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Adding user experience into the interactive service design loop: a persona-based approach

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Approaches to service design share human–computer interaction’s (HCI’s) commitment to developing with and for people useful, usable and accessible services. However, there has been little explicit interaction between the emerging service sciences and the interaction design communities. This article explores HCI’s actual position and opportunities to service design and requirements and vice versa. We propose a design framework for service-oriented interactive systems integrating the concept of persona. This enables to extract relevant elements towards deriving the design of the main functionalities of the user interface. This framework is applied to a case study of the e-maintenance of an agro-alimentary group.

Keywords: human–computer interaction; persona; service-oriented architecture; interactive Web services; e-maintenance

1. Introduction

A service can be defined as the application of specialised knowledge and skills, through deeds, processes and performances for the benefit of another entity or the entity itself (Vargo and Lusch 2004). Services have been existing as an important economy for hundreds of years. Modern service industries are created on top of the latest achievements of modern science, information technology (IT) and modern management. Integrating IT with modern management theories can significantly change our lives and our society. In order to speed up the development of modern service, a new multi-disciplinary research and academic effort is required.

As Internet technologies continue to grow, and the Web moves more and more from brochureware towards open platforms, there is a growing opportunity for new interactive services. Among this, Software as a Service (SaaS) is a recently emerging trend where software developers and providers offer their independently developed software functions (no longer packaged in the form of a monolithic application) through networks. Furthermore, with the advent of ambient technologies age, services can be accessible from various host locations, leading to the massive flow and usage of information.

As a consequence, the services that were previously processed, handled and separated as merely ‘mass-application’ are now accessible as individually targeted and personalised services. Beyond SaaS, the long-term goal of our research is to investigate engineering of interactive computing systems (EICS) concerns as part of the emerging discipline of service sciences. A practical goal is providing the premier platform for service designers’ community interested in designing SaaS applications, all the core design models necessary to create rich services based on user experiences studies on current and emerging SaaS. The following are the overall goals of our research:

(1) Investigate the avenues to integrate HCI concerns (and mainly the related design methods such interaction design, user experience design and scenario-based design) into services design defined in the emerging field of service sciences and management,

(2) Explore the wider implications of service design facing the building of a framework for the design of Interactive Computing Systems as Services

(3) Incorporate persona into the service-oriented architecture (SOA) approaches to address the design challenges in particular of software as a service

Our research aims to define and validate a design framework integrating the concept of persona as suggested by Pruitt and Grudin (2003). A sub-objective
is to establish relationships between user experiences variables and other data sets through artefacts such as matrices of persona characteristics and tasks descriptions. Moreover, a focus is made on qualitative and quantitative analysis of the data collected through the persona as we may explain it through the proposed approach.

2. Persona as an interaction design tool

Personas have been used in marketing research both as an alternative and as an extension of traditional market segmentation and user profiling. Borrowed from marketing research on consumer behaviours, Alan Cooper first introduced personas as a tool to model the user experience (Cooper 1999). The goal was to redirect the focus of the development process towards end users and their needs. He defined personas as being fictitious characters, based on composite archetypes, and encapsulating ‘behavioural data’ gathered from ethnography and empirical analysis of actual users. Instead of modelling only ‘average’ users, personas also take into account boundary cases as well as specific class of users with special needs. The underlying belief is that all users are a mixture of certain types of users.

Overall, the persona as user experience design tool becomes more and more popular and the need for a common clearly defined standard becomes more and more important. There is a clear need in all types of organisations for a format that will take into account all realities of life and will allow for future evolution.

We defined personas as a descriptive model of the user, encompassing information such as user characteristics, goals and needs. First, our personas are captured in narrative form, and currently, there exist only general guidelines on how they should be represented. Within our framework personas are therefore used primarily as a communication tool, with the hope that the information personas contain will ‘inspire’ members of the design team while sustaining the whole user centred design process (Norman 1986) (Figure 1).

In theHCI field, we find few detailed studies on the information contained in a persona, how this information can be represented and used to derive design artefacts. 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 artefacts 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 behaviour 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 serve as a guide to the construction of personas. These components (adapted from Courage and Baxter 2005) may be as follows: Photograph, Identity, Status, Goals, Knowledge and Experience, Tasks, Relationships, Psychological profile and Needs, Attitude and Motivation, Expectations, Disabilities (for more details, see also Seffah et al. 2009). These components are in text-based form and can act as a guide in building personas. As it will be detailed later, we refine these components to encapsulate the requirements for service design (see Table 1).

3. On services and the SOA

Initiated by IBM, service science is an emerging field of research and development that attempts to incorporate approaches from established fields such as Computer Science, Operation Research, Engineering, Management Science, Social and Cognitive Sciences while addressing the various theoretical and practical aspects of service design and engineering (Spohrer et al. 2007). Just like Computer Science plays a critical role for IT industry, we believe that service science will play a similar role for the modern IT-based service industry from both technology/computing and management perspectives.

Among the large variety of IT-based services, one can mention the highly promising SaaS. SaaS can be viewed as a model of software deployment whereby a provider licenses an application to customers for use as a service on demand. SaaS software vendors may host the application on their own Web servers or upload the
application to the consumer device, disabling it after use or after the on-demand contract expires. The on-demand function may be handled internally to share licences within a firm or by a third-party application service provider (ASP) sharing licences between firms.

Another example of IT-based service is Web services that provide a standardised 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 organisations 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 in 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 graphical user interface (GUI). Web services instead share business logic, data and processes through a programmable interface across a network. The applications interface, not the users. Developers can then add the Web service to a GUI (such as a Web page or an executable programme) to offer specific functionality to users.

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 (Chauvet 2002, Kadima and Monfort 2003). 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 composable themselves.

SOA 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).

Many service-oriented approaches have been proposed in the SOA domain such as: IBM-SOMA (Services Oriented Modelling and Architecture), Degamma- SODA (Services-Oriented Development of Application), Unilog/Orchestra- Praxème (Vauquier and Bonnet 2006) and the service-based user interface approach (Idoughi 2008, Idoughi et al. 2010). These different methods cover all the software development lifecycle (analysis, design, implementation and deployment) by federating already existing approaches such

<table>
<thead>
<tr>
<th>Persona components</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identity</td>
<td>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 colour 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.</td>
</tr>
<tr>
<td>General profile</td>
<td>A detailed description of basic demographic information including age, location, job and education degrees, etc.</td>
</tr>
<tr>
<td>Goals</td>
<td>Besides goals related to the application, it includes personal and professional goals as well.</td>
</tr>
<tr>
<td>Scenarios</td>
<td>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. Latter on scenarios are reformulated in terms of specifics needs (meaning usability requirements), features and interaction schema.</td>
</tr>
<tr>
<td>Knowledge and experience</td>
<td>Knowledge and experience including education, training, and specialised skills. This should not be limited only to the application.</td>
</tr>
<tr>
<td>Relationships</td>
<td>Include information about user associates, since this could give insight on other stakeholders.</td>
</tr>
<tr>
<td>Psychological profile and needs</td>
<td>Include information about cognitive and learning styles, as well as needs such as guidance and validation of decisions.</td>
</tr>
<tr>
<td>Attitude and motivation</td>
<td>Include information about the user’s attitude to information technology and level of motivation to use the system.</td>
</tr>
<tr>
<td>Expectations</td>
<td>Information about how the user perceives the system works, and how the user organises information related to his or her task, domain or job.</td>
</tr>
<tr>
<td>Special needs</td>
<td>Such as disabilities including colour-blindness, related to mobility, eyesight (wears contacts), etc.</td>
</tr>
</tbody>
</table>
as: BPM (Business Process Management) for the business process modelling, EA (Enterprise Architecture) for the design of the system architecture and OOAD (Object Oriented Analysis and Design) for the object-oriented modelling of the system components.

However, most of these SOA-based method fail to address the HCI concerns. Idoughi (2008) and Idoughi et al. (2010) suggested a design of services from an HCI perspective. In this research, we extend this original framework. In this article, we focus mainly on the first phases of the framework without dressing too much detail along with the concept of a persona. The underlying concepts of the service-oriented approach and of the Web services constitute the fundamental elements of the global framework along with exploiting the concept of persona in order to design a service-oriented interactive system.

4. Proposed framework for incorporating persona in service design

Within our approach, we defined a composite interactive application as an application in which one or more services are used to tailor the information presentation to platform and to the users’ profiles (Idoughi and Kolski 2006a).

In the context of composite interactive applications design, the proposed extended service-oriented approach create and use persona in five 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 and prototyping. The Figure 2 highlights the central role of the personas within a user-centred design as stated above (Figure 1).

4.1. Stage 1: Business analysis

The first stage is to identify the different actors implied and their business objectives or goals while modelling the business context in which the targeted interactive system will be used (Donatelli et al. 2005, Idoughi 2008, Idoughi et al. 2010). This stage tends to discover a first set of possible business services. This stage consists of a hierarchical decomposition of the business domain into functional domains yielding to a set of business processes giving rise to a set of business use cases. These cases are possible candidate for the high-level business services Zimmerman et al. (2004).

This stage is divided into two sub-stages (Figure 3): (1) business model components identification; business analysis aims to identify and highlight main modelling elements such as: the business process map which can be represented by unified modelling language (UML) activity diagrams showing up the different business

Figure 2. Overview of the proposed framework.
activities, the business actors and the exchanged business entities and 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.

4.2. Stage 2: User and task analysis

The user analysis consists of defining the users’ profiles of the future interactive system. 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 and so on (Hackos and Redish 1998, Johansson and Messeter 2005, Robert 2003). 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 organisation with strategic objectives and needs as regard to the business process; the human operators inside or outside the organisation; or some other human actors who collaborate and work with the organisation such as partners, suppliers and so on. 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 organisation 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 phase is a set of usage patterns and workflows including identifiable users’ behaviour. This may allow classifying service usage modes through users’ models.

Afterwards, we analyse the obtained results in order to highlight a set of behaviours 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 3. From process map to business use cases.

Figure 4. From groups of actors to personas (1st level persona description).
4.3. Stage 3: Requirements elicitation and analysis
This third stage is about analysing the data and the functions to be associated with the personas. The analysis should be carried out for every created persona. This may prioritise the personas accordingly to their objectives, their behaviour and their interactions with other personas within different contexts.

4.3.1. 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 behaviours of the users 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 according to the principle given in Seffah et al. (2009). Once the persona has been 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 behaviour of the users in order to guide the design towards the main and essential functionalities.

Personas are usually described in a textual form Seffah et al. (2009). In this stage, we consider the textual form of a persona as a first level of persona description. As we have already stated above, a persona can serve as a good communication tool between the project team. However, for a modelling purpose, we have to go further, towards the second level of the description. Hence, in this article, we extend this first description level by borrowing the principle given by the unified scenario based design (USBD) 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.

As we can see from the persona components description in Table 1 above, we can relatively easily extract some pertinent modelling elements shown in the Figure 5. For example, from the identity component, we can highlight the persona types (primary and secondary), its attributes and characteristics; from the goals component, we can highlight goals related to the application, it includes personal and professional goals as well. From the scenario component, first, we can extract some key measure elements of the objective such as: frequency, importance and duration of the key tasks achieving the objective. Second, 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).

![Figure 5. UML class diagram for the 2nd level persona description.](image-url)
4.3.2. Description of business scenarios

From the scenario component persona description, we extract relevant business scenarios (for each persona). Afterwards, we determine the essential functionalities of the 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 Web services corresponding to the essential functionalities go through persona identification. As illustrated in the Figure 6, the scenarios extracted from those personas are expressed as business use cases. They correspond to appropriate Web services operations that match defined requirements that may compose the interacting business services with the different interactive service components associated with each persona (Figure 7).

Therefore, we proceed to the following 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 place, in this article we only present the stage 1.

4.4. Stage 4: Services identification, services and user interface specification

The persona components (see 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 of service design (Figure 7).

UML use cases models have been used in the description of scenarios as a method for eliciting the persona’s requirements for a service design. 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.

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 realisation 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.

4.5. Stage 5: Interactive service mock-up and prototyping

This stage is about conducting the user interface specification by constructing and designing the
interactive services mock-ups and prototypes which perform the Web 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.

Before the detailed design and implementation stage of the whole set of the identified interactive services (stage 4, Figure 9, part 3), we suggest to prototype via mock-up the user interface of these services. Figure 11 shows how the interactive services mock-ups are elaborated and validated using personas and the associated business scenarios.

5. An exemplar from e-maintenance service design

Our exemplar is related to industrial e-maintenance in a very large agro-alimentary organisation 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 organisation. 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 involves several types of computing systems, some of them are used in operational processes and systems (Supervisory Control and Data Acquisition system, computerised 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 functioning silos applications (Fournier-Morel et al. 2006). 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.

In addition, this leads to other difficulties related to the human–machine interactions; indeed new possibilities inherent to the mobility of the human actors, the co-operative tasks and the communication devices (personal digital assistant (PDA), telephone, smartphone etc.) usable by the human actors are badly dealt with (Idoughi and Kolski 2006b, Idoughi and Kolski 2007).

However, the SOA based approach suggested enables the coexistence of several types of systems implied in the e-maintenance thanks to the emergence of a layer of services. In addition, these services have the capacity to provide the end users a coherent sight 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.

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

5.1. Business analysis
During this stage, a first set of possible business services are identified via a hierarchical decomposition of the business. This decomposition resulted in 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 place). The set of business use cases is considered as good candidate for the high level maintenance business services such those obtained and presented in Figure 14.

5.2. User and task analysis
The user analysis deals with the human actors including all information related to their profiles and their business needs. This information is required for the specification of HCI relating to the e-maintenance system concerned. The output of this stage is a human actors’ typology. Figure 15 shows a typical typology of the personnel concerned (mechanical foreman, foreman, planning agent, mechanical engineer, electric foreman, mechanical operator, electrical operator, automation operator etc.).

5.3. Identification and 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 and so on. Figure 16 shows an example of some identified and described maintenance persona.

5.4. 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 (Alan Mayfair and Peter Born), 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? That is, what services should we design that can satisfy both personas in question? To better understanding the structure of a design derived from personas, we choose two target examples of persona expressed by Tables 2 and 3.

We then 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.

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.

5.5. 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,
persona #1, it is necessary to design the pages for the user identification dedicated services, the initialisation 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

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

Alan Mayfair, 49 years old
Expert of the Methods Office (MO)
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:
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;
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.

Figure 16. Example of maintenance personas.
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 initialisation 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 visualisation of the result of the reservation of the resources and so on.

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 17) for which we will specify the components and interfaces for their realisation and deployment (steps not covered in this article). Figure 10 shows a use case diagram associated with the various possible scenarios of the e-maintenance within the studied organisation. We highlight scenarios associated with the personas #1 and #2.

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

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

<table>
<thead>
<tr>
<th>Bill Loot, 42 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planner</td>
</tr>
<tr>
<td>He belongs to the category of the maintenance operators.</td>
</tr>
</tbody>
</table>

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:

1. The planner creates and sends a SR to the stock management service.
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.
3. The purchase service agent carries out the processing of the PR and creates a purchase order (PO), he sends it to a supplier.
4. The supplier processes the PO, delivers the requested spare parts and carries out the creation and the emission of the invoice.
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.
6. At the end of the provisioning operation, the storekeeper informs the planner by validating the received SP.

Figure 17. Use case diagram associated with the various possible scenarios of e-maintenance.
5.6. Interactive service mock-up and 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).

![Table: Supervision Service and Data acquisition Service](image)

**Supervision Service**
- Operations:
  - Notify alarms
  - Display events
  - Define control limits

**Data acquisition Service**
- Operations:
  - Get sensors data
  - Get historical data

**Diagnosis Service**
- Operations:
  - Generate diagnosis
  - Manage dysfunctioning
  - Look for dysfunctioning model

**Work Order Service**
- Operations:
  - Generate Work Order
  - Validate Work Order

**Intervention Service**
- Operations:
  - Send documents
  - Display Intervention Request list
  - Manage documents

**Spare parts Service booking**
- Operations:
  - Send supplier request
  - Display State of stock
  - Manage provision requests

**Personnel booking service**
- Operations:
  - Display staff available
  - Assign the staff

**Documentation Service**
- Operations:
  - Lookup technical documentation
  - Manage document

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

We have to highlight that when referring the iterative and incremental global approach described in Idoughi (2008) and Idoughi et al. (2010), various evaluations are done to further details the previous prototypes for each persona (Figure 21).

6. Discussion and further investigations
To build a tighter fit between user experiences (how people work and use a service) and design (the way that service features are presented and can be used), we propose a novel design method based on a set of core user-centred design principles which we have enriched with ‘engineering-like’ concepts such as reuse and traceability. The method is based on two key design artefacts, 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. Second, 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 article, 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 persona 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.

7. A concluding remark
Although popular, persona is a relatively new and unknown technique to a wide variety of specialists in interaction and media design. Moreover, as any new creation it undergoes a rapid cycle of evolution that also influences its use and effectiveness in a design
process. 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 of IT-based services.

For example, Blomquist and Arvola (2002) reported that less than half of the members 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.

Recent studies (Rönkkö 2005) have demonstrated that application of personas may be ineffective in rapidly developing product categories. Rönkkö presented an example of a telecommunication market project where the personas have been used during high-level design. However, in the process many tradeoffs and modifications have been made. In fact, initial requirements have been partially overwritten with modification dictated by the market and competition: ‘It [Telecommunication Industry] produces artifacts with potential usability, and not the other way around. Designing new, hot and advanced technical components for the mobile device has a higher priority than satisfying pre-identified user groups.’

Another common problem with the application of personas is lack of a clear standard and description of information. In fact, Grudin and Pruitt (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 people) and 40.5% of US population over 65 years old have at least one type of the sensory, physical or mental disability, 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 among 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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