IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 3, No 1, May 2010
ISSN (Online): 1694-0784
ISSN (Print): 1694-0814

A Situational Approach for Web Applications Design

Naoufel Kraiem, Semia Sonia Selmi and Henda Hajjami Ben Ghezala

RIADI Laboratory, National School of Computer Sciences, University Campus Manouba, 2010, Tunisia

Abstract

The paper introduces a situational approach for Web applications design. We, first, define development situations and identify their specific characteristics through situational factors in projects. Using these situational factors, the most appropriate design process-model is selected. A meta-modeling technique is proposed that integrates the Map formalism for modeling existing design process-models.

Based on COMET meta-model we have redefined most proven existing web applications development methods into method components that we have stored in a components base to be selected. Finally, a new method of useful method fragments is assembled.

The approach provides three types of guidance: (1) guidance in the selection of the most appropriate design process-model, (2) guidance in the selection of the most appropriate method components and (3) guidance in the application of selected method components. The method developed was validated in a case study and proposed tool was validated empirically.

Keywords*: web application, web development method, method engineering, situational method, web-oriented situational method.*

1. Introduction

The Web has very rapidly evolved into a global environment for delivering different kinds of applications ranging from small-scale to large scale applications. However, most applications often fail since their development is often on an ad-hoc basis, without the support of appropriate methodologies able to manage the high complexity of information. Consequently, considerable attention has been given to Web engineering. This discipline is concerned with the establishment and the use of engineering and management principles and disciplined and systematic approaches to the successful development, deployment and maintenance of high quality web-based applications.

In order to manage the overall complexity of development, several methodologies and approaches have been proposed.

They should provide guidelines for performing activities and suitable models for expressing the results.

The development of a web application should not be an event, but a process. This process will consist of a set of manageable activities. In fact, it is important to be guided by a sequence of steps to be performed, to know how the different steps co-operate and how they fit into the development process as a whole. Each design activity should address different concerns at the proper stage and at the proper level of abstraction.

However, we have concluded that there are a number of gaps in existing modeling approaches, particular with regard to the level of guidance provided. Some approaches do not provide real guidance during design. In this context, some do not consider one or more basic dimensions of web design. We mention, for instance, the method proposed by [28] for the web information systems development which does not include presentation design in its life cycle, in spite of, the importance of aesthetic aspect in web design. For those which do, they do not explain steps to achieve them, as in the case of RMM [12] that includes a requirements analysis phase in its life cycle without explaining how a designer should do to achieve this activity.

However, as stressed above, some engineering activities should be carefully guided in order to maximize quality of result. The second issue addressed in this work is the need for better web design approaches being more specific to particular kinds of web applications. Most of proposed approaches consider design in the same way for all web applications. They propose only one process that should be followed during design of all applications. However, some particularities in term of complexity of the application, potential users and others should be considered.

More specifically, the work in this paper is partially motivated by conclusions derived in both Method Engineering discipline and Web Engineering discipline [4]. It was observed that there is no existing full-featured approach that one can use to develop different kinds of applications with different requirements. Consequently, if one wants to develop more than one application, he might need to use more than one methodology.

In this research, we propose an approach that covers existing methodologies transparently. It takes as input the application requirements and decides which process to follow. It provides web designer with the ability to move

through the basic design steps. We have adopted the meta-model MAP as modeling formalism, offering different ways to guide achievement of design activities. The MAP provides guidance to a lower level abstraction through associated guidelines.
Before advancing in the description of the approach, we judge important to define the notion of method since it will be frequently used throughout this paper. One of the results obtained by the meta-modeling community is the definition of any method as composed of a product model and a process model [21]. A product model defines a set of concepts, their properties and relationships that are needed to express the outcome of a process. A process model comprises a set of goals, activities and guidelines to support the process goal achievement and the action execution. Therefore, method construction following the meta-modeling technique is centered on the definition of these two models.

The remainder of the paper is organized as follow. We present, first, motivation and our contribution. Second, we give an overview of the proposed approach. Finally, we describe how the approach provides guidance in (1) selection of the most appropriate design process-model, (2) selection of the most appropriate method components and (3) application of selected method components.

2. Motivation and Contribution

To understand deeply the discipline of Web engineering, we have established a Web Engineering Framework. To outline limits of existing methods we have proceeded to the evaluation of seven methods among the most referenced ones in literature RMM [6], UWE [16], WSDM [5], OOHDM [11], Takahashi Method [28], WebML [2] and HFPM [20] according to the different views of the framework. This evaluation revealed three limits in particular.

- Informational aspect dominates the process design. We have noticed that the majority of methods do not consider all aspects having to be considered during design process. Let us mention, for instance, the method proposed by Takahashi [28] and WSDM method for the design of respectively web information systems and kiosk applications. Both approaches do not include a presentation design step in their life cycle, despite the importance of aesthetic aspects in web development.

- All existing methods are prescriptive (except HFPM). In fact, they prescribe a list of tasks to be done without considering (n) either the development situation at hand (n) or designer experience.

- Some methods are lack of guidance. They prescribe phases in their life cycle without describing how to achieve them. This is the case of RMM method, which includes both requirements analysis and User-interface screen design phases without explaining what a designer should do to achieve these activities.

Considering all these issues, we propose to relax the prescription of web design process model and cover all aspects that should be considered during web applications design. Situational Method Engineering responds to this need by offering techniques to construct methods by assembling reusable method components stored in a method repository. Brinkkemper [1] has defined the Situational Method Engineering as "the discipline to build project-specific methods, called situational methods, from parts of existing methods, called methods fragments".
We talk, henceforth, about Web oriented Situational Method Engineering that proposes to support construction of web development methods based on a reuse strategy. By assembling reusable method components originating from different web development methods, a new method can be tailored to the project situation at hand. New methods can, thus, be constructed by selecting the most appropriate components to a given situation from the method repository. Web oriented Situational Methods discipline favors the construction of modular web development methods that can be modified and augmented to meet the requirements of a given situation.

3. Overview of the Approach

When the web designer, who is the end user of our approach, decides to begin the design of a web application, he/she is invited to characterize the current situation of its web application to be developed by a set of situational factors. Based on introduced situational factors, the most appropriate design process-model is selected at different levels of abstraction.
The selected process-model comprises several steps delivering each of which delivers a particular product model. In fact, we have adopted this principle conformingly to existing methodologies which often advocate a model-driven approach, inspired by the separation-of-concerns principle. In order to tackle the complexity of the problem, each model in the system focuses on a different aspect of the design and often also a different level of abstraction.
The different steps which constitute the selected process-model are achieved by method components. The latter are defined accordingly to the meta-model for modular methods [22] and stored in a method repository in order to be selected.
To be able to select the most appropriate method components, we have fixed a set of selection criteria for each product model involved. We have used the multi-criteria analysis approach to select the most appropriate method components.

Selected components are, then, assembled and transformations from instances of one model into instances of the next model are taken place to, ultimately, reaching the final result in the form of a Web situational method.
In this sense, our solution is based on the following aspects which were be further detailed in this paper: (1) a list of classified product models [26], (2) a set of situational factors characterizing the current situation, (3) a web applications design process model providing required guidance during design [26], (4) a set of selection criteria for each product model and (5) a tool supporting the proposed approach.
We propose a multi-process approach offering panoply of web applications design process-models. We adopted the meta-modeling technique for abstracting all these process-models in a common process meta-model which is based on a set of product models each concerning a particular aspect of design.
To achieve this task, we need to adopt process model formalism. As our solution provides many alternatives and paths, strategic oriented process models seem to be the solution. In particular, the MAP formalism belonging to this class can be employed to model the design process as we intend to do; that is why we keep it for our solution.
In the following, we present first, a list of classified product models. Second, we describe the different situational factors characterizing the current situation of development we give a brief description of the MAP formalism.

3.1 The Typical Phases of Web Applications Design and their classification

Existing Web development methods consider the design phase as a phase of product models delivery, addressing each one a particular concern of design. A typical web application development method has the following phases [7] [9]:

- Conceptual design: describes the organization of the information managed by the application, in terms of pieces of content that constitute its information base and their semantic relationships. Modeling aims to construct a conceptual domain model without commitment to any specific detail for navigation paths, presentation and interaction aspects.

- Navigation design: concerns the facilities for accessing information and for moving across the application content. The navigation structure should be carefully designed through a navigation model by providing the web designer with the comfortable navigation spaces.

- Presentation design: affects the way in which the application content and the navigation commands are presented to the user. This is described in a presentation model.

- Requirements analysis: gathering and forming the specification of users and/or stakeholder requirements. This step delivers a requirements analysis model.

- Adaptation modeling: the success of web applications is largely dependent on user satisfaction which is achieved by, for example, easy-to-use interface and well structured navigational architectures. The most effective technique to leverage these features is adaptation. It consists on delivering them to the right user at the right time in the right format. This phase presents the objects that participate in the adaptive functionality and describes how this adaptation is performed [16]. It aims to construct an adaptation model which is based on a user model.

- User modeling: aims to construct a user model which contains information that represents the view the system has of the knowledge, goals and/or individual features of user.

- Business process modeling: apart from simple web sites, web applications are derived from conventional transaction processing systems. These applications support critical business processes and workflows that are important part of the organization's core business model. These business functions must be supported and consequently web design methods need to provide the ability to represent these functions and their related design artifacts. It is an important activity in particular for the e-business applications design.

- Business modeling: deals with identifying and understanding the relevant elements in a specific domain and their relationships [29]. An important part of enterprise business modeling is the creation of a high-level domain model that depicts the main business entities and their relationships that are of interest to an organization. This model does not need to be very detailed. It provides a basis from which to begin more detailed modeling efforts.

The first four phases could be supported during the design of any web application. However, others are specific to some web applications types. In fact, adaptation modeling and user modeling phases are both performed when designing adaptive applications. User modeling phase can be also performed when designing a user-model based application. Web designer, in such case, intends to adopt a user-centered approach focusing on user requirements and characteristics. This has the advantage to solve disorientation and cognitive overload problems.

Although existing web development methods recommend achievement of the aforementioned phases and

consequently to deliver associated product models, we have noted that they do not consider them with the same degree of importance. In fact, they focus on the informational aspect by delivering: conceptual model, navigation model and presentation model. This is can be justified by two reasons: (1) at the early beginning of the web, web applications have primarily the role of disseminating information to users. This made methods privilege information dimension and derived aspects such as navigation and presentation; (2) informational dimension is recognized as fundamental in the design of any web application type [7] [13].

However, web applications are evolving from simple web sites to more and more complex and sophisticated applications. Consequently, others aspects besides the informational dimension should be considered during their design.

Based on this analysis, we have classified these models in two classes: Common models class and Features models class. The first class comprises conceptual model, navigation model and presentation model. The second class contains requirements analysis model, adaptation model, user model, business model and business process model.

As the proposed approach proposes panoply of web design process models, we have adopted the MAP as modeling formalism. In the following, we present an overview of the MAP and its associated guidelines.

3.2 The MAP Formalism

A MAP is a process model which allows designing several processes under a single representation. It is a labeled directed graph with intentions as nodes and strategies as edges between intentions [24]. The directed nature of the graph shows which intentions can follow which ones.

According to the meta-model illustrated in Figure 1, a MAP is composed of one or more sections. A section is a triplet <source intention I, target intention J, strategy Sij> that captures the specific manner to achieve the intention J starting from the intention I with the strategy Sij.

Error! Reference source not found. An intention is expressed in natural language and is composed of a verb followed by parameters. Each MAP has two special intentions "Start" and "Stop" to begin and end the navigation in the MAP. Each intention can only appear once in a given MAP. For more details see [24].

4. Guidance in the Selection of the Most Appropriate Design Process Model

The process meta-model for the web applications design formalized using MAP is shown in

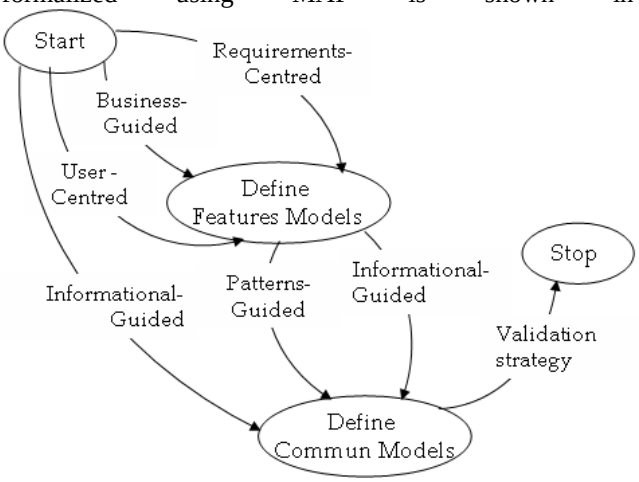


Fig 1. It contains two core intentions "Define Common models" and "Define Features models" in addition to "Start" and "Stop" intentions.

To allow designer going through the different intentions of the MAP, the approach provides a set of factors called Situational Factors. They guide designer during navigation in the design process model. The next subsection describes the proposed situational factors.

4.1 Situational Factors

The first step in the approach is to analyze the projects, categorize them in situations, and identify their specific requirements. The categorization of situations is based on their distinguishing characteristics. According to [1] and [17] stressed the importance of distinguishing development situations.

Karlsson [15] defines a characteristic of a development situation as: «a delimited part of a development situation, focusing on a certain problem or aspect which the method configuration aims to solve or handle». To achieve this purpose, we have proposed a list of situational factors characterizing current development situation. They help designer to choose the appropriate strategy among those presented in the MAP.

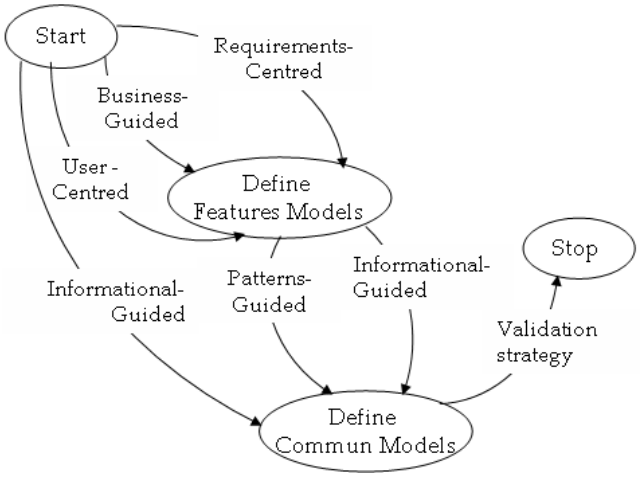


Fig 1. The Web Design Process Model

We have identified the following factors [27]:

- *Application type*: {kiosk application, Web Information System, Adaptive application, e-commerce application}.

All aforementioned types are obviously web applications; however they are different in term of deliverable models during design process.

- *Service complexity*: {Low, Medium, High}

Application complexity is measured through the complexity of services offered by application. Being more complex than kiosk applications, Web Information Systems should be designed differently, by giving more attention to services modeling dimension.

- *Similarity with others applications*: {Low, Medium, High}

The similarity with others applications factor specifies if the designer has already participated in the development of similar applications belonging to the same domain. It is to notice that web applications belonging to a same domain have similar structures and provide similar services. Thus, during design process, proposed approach considers designer profile by offering to him the possibility to reuse their past experiences.

- *User-application adaptation*: {Low, Medium, High}

This factor determines the adaptation degree of the application to users. A user-application adaptation having a high degree is specific to adaptive applications. When designer consider user aspect during design process a user-centered approach, this factor will take Medium value. In other cases, this factor will be of a low degree

- *Problem clarification*: {Low, Medium, High}

This factor reveals either the problem description of the current project is well defined and clarified or not.

- *Designer Experience*: {Low, Medium, High}

The approach considers the different profiles of designers such those having long experiences. In fact, they can exploit the different design patterns collected and stored to be employed.

Situational factors guide designer during the navigation in the design process model. We show, in the following section, how the proposed approach employs these aforementioned factors during the design process.

4.2 Selection of the Most Appropriate Web Design Process-Model

The choice of a particular path among those of the Map presented in

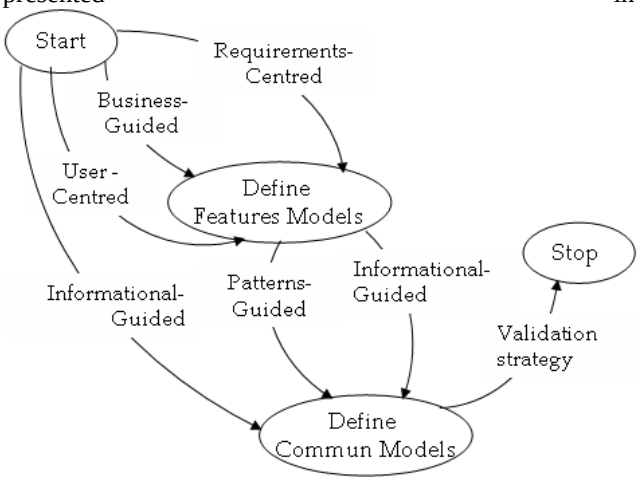


Fig **1** depends largely on purpose of designer in terms of web application type to be designed. A more in- depth analysis of the process MAP shows that designer is guided deeply and in flexible ways. Associated sections are refined to a lower level of abstraction proposing various techniques available to achieve the corresponding intentions.

From the "Start" intention, the designer is faced to a choice of two alternatives. He can either progress to achieve the "Define Features Model" intention or the "Define Common Model" intention.

When designing a simple web site (kiosk application) which problem description is well identified and requirements are well defined, designer should progress to "Define Common Model" intention. In others cases, designer should progress to "Define Features Model" intention.

When progressing to "Define Common Model" intention, designer can perform only one strategy named Informational-guided strategy. However, if he/she intends to progress to "Define Features Model" intention, he/she is faced to three alternatives. These strategies can be performed in parallel or alternatively depending on given situation:

- Business-guided strategy is followed when designer intends to develop an e-commerce application. In this case, he/she needs to conceptualize both Business Model and Business Process Model. Also, it is followed when

current application is a Web Information System (WIS) which is characterized by a high complexity of service. In such case, we provide designer with the ability to design a Business Process Model.
This strategy will be refined with a strategic guideline: a MAP at a lower level of abstraction. This latter contains two intentions: "Define Business Model" and "Define Services Model".

- User-centered strategy can be performed when designing an adaptive application. In this case, designer needs to consider users aspects and/or adaptation techniques through a user model and/or an adaptation model.

- Requirements-centered strategy helps to gather and form specification of users and stakeholder requirements.

All aforementioned guidelines associated to these strategies are refined through a MAP at lower level of abstraction. We have to stress that these three strategies can be performed alternatively or together. Let's take the example of an e-commerce application where requirements are all the time different and several. In fact, such application is characterized by both a high complexity of services and heterogeneity of clients. Consequently, all strategies Requirements-centered, User-centered and Business-guided strategy must be followed and achieved in this case.
Once "Define Features Model" intention is achieved, designer should progress to the "Define Common Model" intention either following informational-guided strategy or patterns-based strategy. We should recall that he/she can design a kiosk application and in this case, he/she follows also informational-guided strategy from "Start" intention. Being in one or other situation and at a lower level of granularity, refinement of this strategy is done through a MAP providing panoply of paths and strategies from "Start" and "Stop" intentions. It contains three core intentions: "Define Conceptual Model", "Define Navigation Model" and "Define Presentation Model" as it is shown by

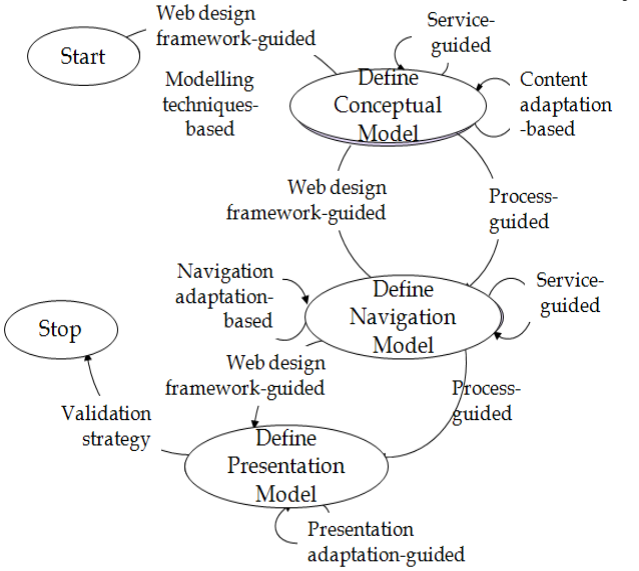


Fig 2.

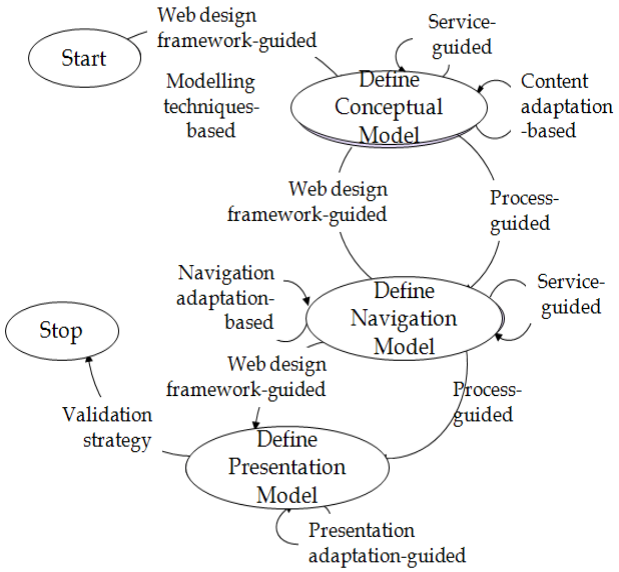


Fig 2. Refinement of the Informational-Guided Section at a lower level of abstraction.

Beginning from the "Start" intention, designer is faced to two strategies to achieve "Define Conceptual Model" intention. The modeling techniques-based strategy is applied when designer decides to start from scratch and to adopt a well known conceptual data-model like ER model or any Object-Oriented technique to define conceptual model.
By applying web design framework-guided strategy, designer has experience in current domain and has, already, designed similar applications in similar domain. Designer can reuse conceptual schemas already elaborated during

similar past projects. He should only personalize and adapt hot-spots according to specificities of the project at hand.
While defining the conceptual model, Service-guided strategy and/or Content adaptation-based strategy can be followed respectively when designer intends to enrich model with concepts associated to business process modeling and/or application being designed is an adaptive one.
Once the "Define Conceptual model" intention is achieved, designer progresses to achieve "Define navigation model" intention either by following web design framework-guided strategy or process-guided strategy. The process-guided strategy allows to be guided by a particular method selected as the most appropriate one from method components repository. The same strategies are, also, proposed to achieve "Define Presentation Model" intention oriented, here, presentation dimension. Navigation in the MAP is stopped by the validation strategy aiming to validate the different product models defined.
Once the most appropriate design process-model is selected, we proceed to the selection of method components which are stored in a method repository. The selection process is based on a list of criteria employed by a multi-criteria method.

5. Guidance in Method Components Selection

We describe in this section how the approach allows selection of the most appropriate method components given a selected design process. The selection step is realized based on a set of selection criteria associated to each defined product model. Designer is invited to attribute values to these criteria every time process-guided strategy is selected.

5.1 The Proposed Selection Criteria

We have fixed a set of selection criteria characterizing the following product models: user model, adaptation model, navigation model and presentation model.

a) The selection criteria of user model

Based on literature study [14] [16] [19] [30], we have listed the following criteria (Table 1):

- Granularity describes the level at which users are represented.

- Acquisition Technique expresses how users' information are collected.

- Characteristics specific to domain indicates if domain specific knowledge of users is modeled in the user model or not.

- Characteristics independent from domain indicates if other knowledge of users are modeled in the user model.

- Preference indicates if user can express his preference at a content dimension, navigation dimension and presentation dimension.

Table 1. User Model Criteria and their Values

Criteria	Possible Values
Granularity	Group, User, Group/User
Acquisition Technique	Explicit, Implicit, Explicit/Implicit
Characteristics	
Domain Specific	Yes, Partially, No
Domain Independent	Yes, Partially, No
Preferences	
Content	Yes, Partially, No
Navigation	Yes, Partially, No
Presentation	Yes, Partially, No

b) The selection criteria of Adaptation Model

Web applications should henceforth satisfy various requirements such as the need to be accessible from everywhere, at every time and from every platform. This leads to characterize an application by ubiquitous [3]. In order to cover all these aspects, we have identified a set of criteria [18] [13] [16] [30] [8] which their possible values are presented in Table 2:

- Adaptation Dimensions indicates dimensions of the application that are object of adaptation: Content, Navigation, Presentation, Functionalities.

- Adaptation Degree that are expected from the web application. It can take one of the following values: Minimal, Adaptive and Adaptable.

- Environment Context determines if the web application can be adapted according to these attributes: Location, Time, Device and Network.

Table 2. Adaptation Model Crteria and their Values

Criteria	Possible Values
Adaptation Dimensions	
Content (DC)	Yes, Partially, No
Navigation (DN)	Yes, Partially, No
Presentation (DP)	Yes, Partially, No
Functionalities (DF)	Yes, Partially, No
Adaptation Capabilities	
Minimal (CMin)	Yes, Partially, No
Adaptativity (CAdav)	Yes, Partially, No
Adaptability (CAdab)	Yes, Partially, No

Context related to Environment	
Location (C.L.Location)	Yes, Partially, No
Time (C.L.Time)	Yes, Partially, No
Material (C.L.Material)	Yes, Partially, No
Network(C.L.Network)	Yes, Partially, No

c) The selection criteria of Navigation Model

As for navigation model we have identified the following selection criteria. Table 3 presents possible values of these criteria.

- Notation (NOT) indicates the standardization degree of the notation.

- Implicated Dimensions (DIM) indicates dimensions considered during design.

- Adopted approach (APP) to define the navigation model can be either Bottom-up or Top-down or Mixed.

- Access Structures (StrAc) are additional navigation nodes allowing access to navigation objects.

Table 3. Navigation Model Criteria and their Values

Criteria	Possible Values
Notation (NOT)	Standard, Mixed, Proper
Implicated Dimensions (DIM)	Static, Dynamic, Static/ Dynamic
Access Structures (StrAc)	Yes, Partially, No
Adopted approach (APP)	Bottom-up , Top-down, Mixed

d) The selection criteria of Presentation Model

We have identified the following selection criteria for the presentation model which their possible values are presented in Table 4:
- Notation indicates with which notation presentation model will be defined.

- Implicated Dimensions: this attribute indicates dimensions considered during design.

- Multimedia Support determines if method takes in consideration multimedia dimension.

- Synchronization of interface objects indicates if method describes temporal relations between different Medias in particular when dynamic media such as video and audio are implicated.

Table 4. Presentation Model Criteria and their Values

Criteria	Possible Values
Notation	Standard, Mixed, Proper
Implicated Dimensions	Static, Dynamic, Static/ Dynamic
MultiMedia Support	Yes, Partially, No
Synchronization of interface objects	Bottom-up, Top-down, Mixed

Once the most appropriate design process is selected, we proceed to the selection of method components based on aforementioned criteria by employing the AHP multi-criteria method.

5.2 The Analytic Hierarchy Process Method

To achieve selection of most appropriate components we propose to employ a multi-criteria method such as the Analytic Hierarchy Process (AHP) method [25].
AHP allows both quantitative and qualitative criteria to be compared using informed judgments to derive weights and priorities.
The first step of AHP consists in determining analysis criteria, in our case, selection criteria associated to product models. Next step aims to elaborate binary comparison, in order, in one hand, to identify importance of one criterion relatively to others, and in the other hand, evaluate method components relatively to every criterion. Introduced values during evaluation should be conformed to the AHP table [25].

5.3 The Components Selection Process

To achieve intentions included in the selected design process, designer is invited to introduce his preferences by giving priorities between selection criteria as illustrated in

$$MC = \begin{pmatrix} & \text{NOT} & \text{DIM} & \text{StrAc} & \text{APP} \\ \text{NOT} & 1/1 & 3/1 & 3/1 & 7/1 \\ \text{DIM} & 1/3 & 1/1 & 5/1 & 5/1 \\ \text{StrAc} & 1/3 & 1/5 & 1/1 & 3/1 \\ \text{APP} & 1/7 & 1/5 & 1/3 & 1/1 \end{pmatrix} V_{PC} = \begin{pmatrix} 0.5111 \\ 0.3154 \\ 0.1198 \\ 0.0535 \end{pmatrix}$$

***Fig* 3.**

$$MC = \begin{pmatrix} & \text{NOT} & \text{DIM} & \text{StrAc} & \text{APP} \\ \text{NOT} & 1/1 & 3/1 & 3/1 & 7/1 \\ \text{DIM} & 1/3 & 1/1 & 5/1 & 5/1 \\ \text{StrAc} & 1/3 & 1/5 & 1/1 & 3/1 \\ \text{APP} & 1/7 & 1/5 & 1/3 & 1/1 \end{pmatrix} V_{PC} = \begin{pmatrix} 0.5111 \\ 0.3154 \\ 0.1198 \\ 0.0535 \end{pmatrix}$$

Fig 3. Evaluation Matrix of selection criteria corresponding to Navigation Model and its eigen vector

For instance, the value 7/1 evaluated between notation (NOT) and Adopted Approach (APP) indicates that designer judges that the first criterion (NOT) is much more important than the second criterion (APP).
In another side, methods such as OOHDM, WebML, WSDM and UWE, examples of web development methods allowing the production of navigation model are evaluated in method repository.

The method expert has the responsibility to compare methods according to every criterion of all product models as illustrated by Fig 4.

$$MM1 = \begin{pmatrix} & \text{OOHDM} & \text{WSDM} & \text{UWE} & \text{WebML} \\ \text{OOHDM} & 1/1 & 5/1 & 1/5 & 2/1 \\ \text{WSDM} & 1/5 & 1/1 & 1/7 & 1/3 \\ \text{UWE} & 5/1 & 7/1 & 1/1 & 7/1 \\ \text{WebML} & 1/2 & 3/1 & 1/7 & 1/1 \end{pmatrix}$$

$$V_{PM1} = \begin{pmatrix} 0.2057 \\ 0.0718 \\ 0.5791 \\ 0.1109 \end{pmatrix}$$

Fig 4. Methods Evaluation matrix / Notation (NOT) Criteriom and its eigen vector

Recall that existing methods do not support product models definition with the same degree of importance. For employed notation, most of methods except UWE method based on UML standard employ mix notation. OOHDM, for example, combines OO technique with its proper notation (context, etc.) and WebML integrates content units with XML. Evaluation matrix and associated eigen vector are shown in Fig 4. For instance, the value 7/1 between UWE and WSDM means that the component of UWE method associated to the navigation model definition is much more important that WSDM component relatively to Notation criterion. This is due to the fact that UWE is entirely based on the standard UML language.

$$\left(\begin{pmatrix} \text{V}_{\text{PM1}} \\ 0.2057 \\ 0.0718 \\ 0.5791 \\ 0.1109 \end{pmatrix} \begin{pmatrix} \text{V}_{\text{PM2}} \\ 0.4646 \\ 0.0611 \\ 0.3313 \\ 0.0659 \end{pmatrix} \begin{pmatrix} \text{V}_{\text{PM3}} \\ 0.22 \\ 0.1641 \\ 0.3098 \\ 0.1633 \end{pmatrix} \begin{pmatrix} \text{V}_{\text{PM4}} \\ 0.0769 \\ 0.0769 \\ 0.0769 \\ 0.0769 \end{pmatrix} \right) \times \begin{pmatrix} \text{V}_{\text{PC}} \\ 0.4837 \\ 0.3582 \\ 0.1174 \\ 0.0406 \end{pmatrix} = \begin{pmatrix} \text{V}_{\text{AHP}} \\ 0.2947 \\ 0.0788 \\ \mathbf{0.4381} \\ 0.0995 \end{pmatrix}$$

Fig 5. The most appropriate method calculated by AHP vector

The same principle of evaluation is taken for all criteria of a particular product model. All eigen vectors obtained from evaluation matrix (in this case 4 vectors) form a matrix which will be multiplied by the eigen vector obtained from designer comparison matrix. As shown in Fig 5, the highest value in the AHP vector corresponds to the most adequate method that is UWE in this example.

At this level, proposed approach continues to guide designer during application and employment of the selected components as they are stored in a method repository and redefined according to NATURE [10].

6. Guidance in Method Component Application

We propose to still continue guiding designer in the application of selected method components. Consequently, designer is not obliged to look for published documentation about the selected method to achieve his goal. It deals with formalizing the method process model through a set of different steps and activities to execute.

The Method Base stores the components of the methods. The base is organized in two levels: method knowledge level and method meta-knowledge level [22]. Method knowledge level stores the content of the method components, which are the components themselves, whereas the meta-knowledge level describes the reuse context of every component in its descriptor. Therefore, every method component in the method base has a descriptor represented in the meta-knowledge level.

Our approach for assembly-based Situational Method Engineering aims at constructing a method in order to match as well as possible the situation of the project at hand. It consists in the selection of method components from existing methods that satisfy some situational requirements and their assembly. Our approach is requirements-driven, meaning that user must start by eliciting requirements for the method. Next, the method components matching these requirements can be retrieved from the method base. And finally, the selected components are assembled in order to compose a new method or to enhance an existing one.

A method is a set of coupled method components expressed at different levels of granularity. A method component is autonomous and coherent method part supporting the realization of some specific activities. This view permits to reuse components of a given method in the construction of new ones.

Based on the observation that any method has two interrelated aspects, product and process, we integrate these two aspects in the same module [22].

In our approach, the selected component represents the step of a product model definition [27].

The interface of the method component captures the reuse context in which the method component can be applied. It is formalized by a couple <situation, intention>, which characterizes the situation that is the input of the component process and the intention that the component achieves.

Besides, a descriptor is associated to every method component. It defines the context in which the component can be reused.

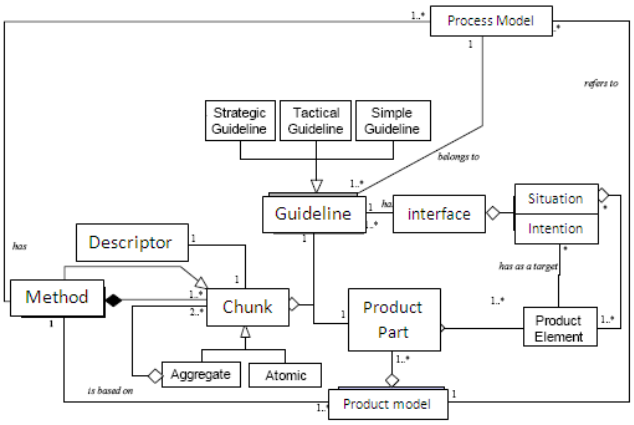


Fig 6. The Meta-Model for Modular Methods

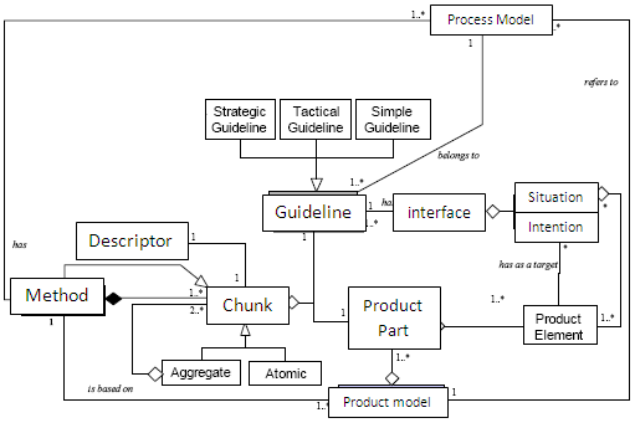


Fig 6 shows the meta-model for modular methods. According to this meta-model, a method is also viewed as a method component of a highest level of granularity. The body of the method component captured a part of method process model called guideline that can be considered as reusable and a part of its product model needed to perform the process encapsulated in this guideline. A guideline embodies the method knowledge to guide the user in achieving an intention in a given situation. Three types of guideline are distinguished: simple, tactical and strategic.

- A simple guideline may have an informal content describing the manner to proceed to handle the situation in a narrative form. It can be an executable plan of actions leading to some transformations of product under construction.

- A tactical guideline is a complex guideline which uses a tree structure to relate its sub-guidelines with others. This guideline follows the NATURE process modeling formalism [10].

- A strategic guideline is a MAP [24].

We have chosen to conform to the component structure proposed by [22] for the advantage to combine at the same time strategic and contextual approaches (NATURE) [10].

When a method provides different manners and alternatives to achieve the set of activities of its process model and they can be refined at a lower level of abstraction by another type of guideline, we should formalize process model through the strategic guideline. In other case, it is possible to use NATURE formalism.

The study of the state of the art that we have conducted on web development methods has revealed that methods are prescriptive. They propose a set of sequential steps delivering each one a specific product model. The next step is based on the product model delivered in the previous step. From the linear aspect characterizing web applications development methods, we have represented them through a tactical guideline.

7. The Proposed Tool: WISDAp

WISDAp tool is developed to support web design phases as suggested by our approach. It consists of three subsystems: (1) guidance in the selection of the most appropriate web design process-model, (2) guidance in the selection of the most appropriate method components and (3) guidance in the application of selected method components. The overall architecture of WISDAp tool is depicted in

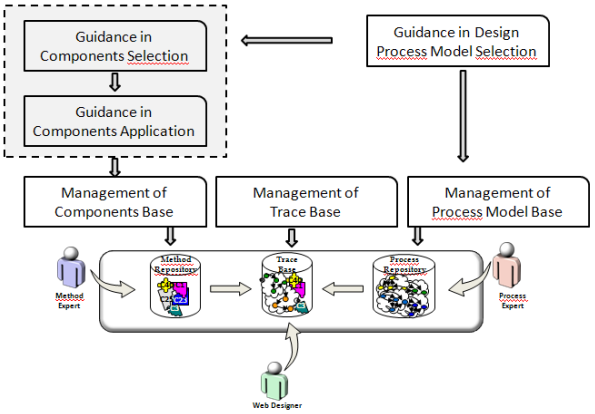


Fig 7.

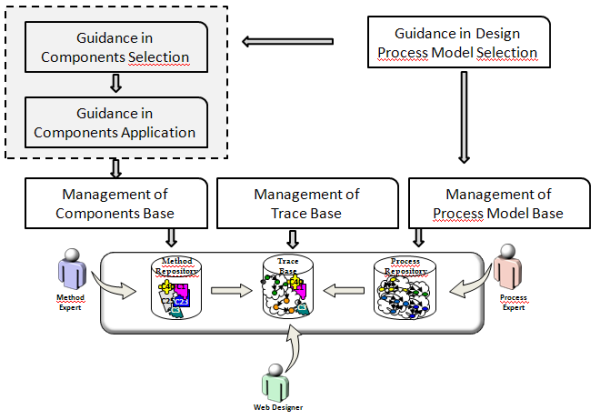


Fig 7. Architecture of WISDAp tool.

7.1 Architecture of WISDAp

To ensure success of use of our developed tool, main actors implied are:

- Administrator is charged with the administration of the environment. It is responsible for the attribution of the passwords and logins to the other users. Indeed, method engineer and design engineer cannot respectively handle the base of methods and the base of design process models that afterwards being authenticated.

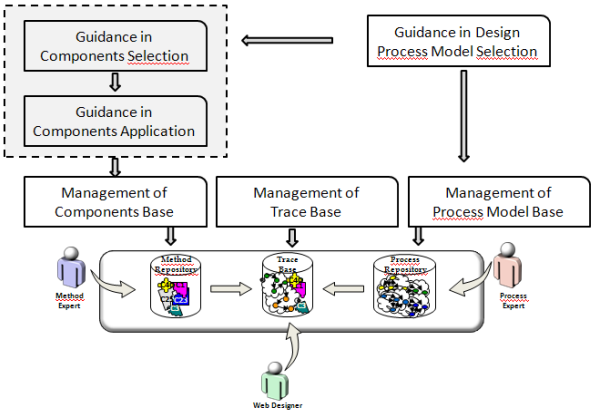
- Design engineer can add new process models of design with all the details associated in the base process models.

- Method engineer can, for example, add new methods in the base of methods and/or proceed to comparisons of one method to the others.

- Web designer is the end user of the web design environment. At the time of its first access, he/she is invited to register to be able to authenticate later on. The web designer starts by defining a new project while specifying the name of its project and a description. Thereafter, he/she will be guided during the stages process while starting by allotting values to the list situational factors allowing characterizing the current situation.

The web designer can, also, consult the base of methods to be informed about the list of the stored components.

To achieve aims of our approach, we have created the three following databases (see Fig 7):



- Base of process models containing all possible paths and alternatives to guide web designer in to the choice to most appropriate web design process model.

- Base of method components storing the set of method components. It permits the selection of the most appropriate component in each web design step.

- Base of Trace which stores the different projects previously achieved.

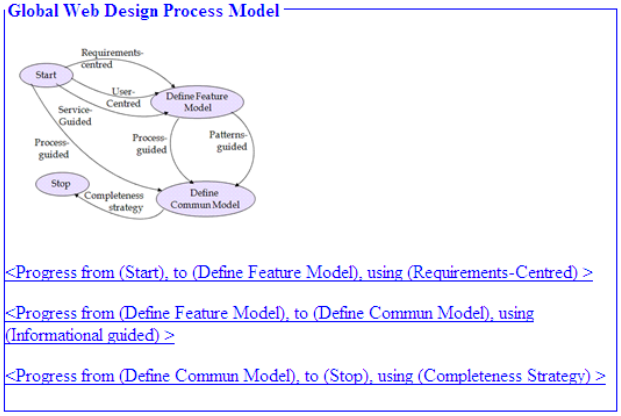
7.2 Example of Interfaces

Once authenticated, web designer should characterize current development situation through the proposed list of situational factors as illustrated by Figure 9.

Fig 8. List of situational factors.

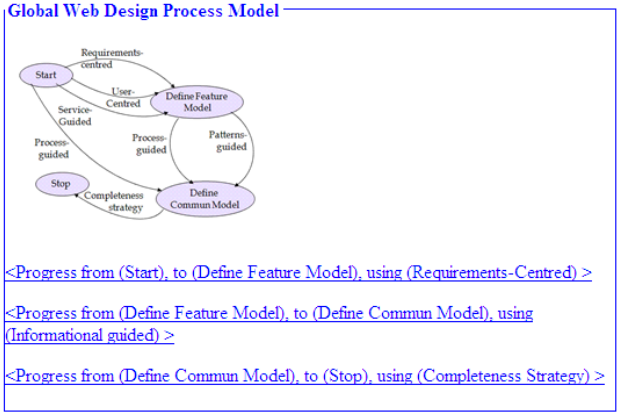
Fig 8. List of situational factors.

Introduced situational factors help web designer in choosing the appropriate strategy among those presented in the MAP.



Fige 9 shows the most appropriate design process model according to introduced situational factors. Each link

displayed shows the most appropriate design process model at a low level of abstraction.



Fige 9. The appropriate design process model according to introduced situational factors.

For instance, web page of

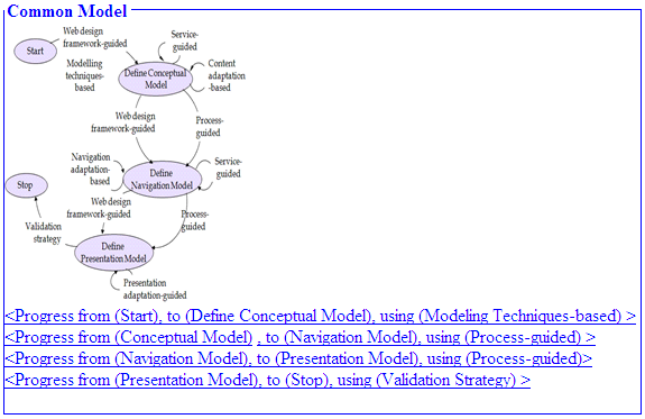


Fig 10 displays the MAP corresponding to "Informational-guided" strategy of the process meta-model.

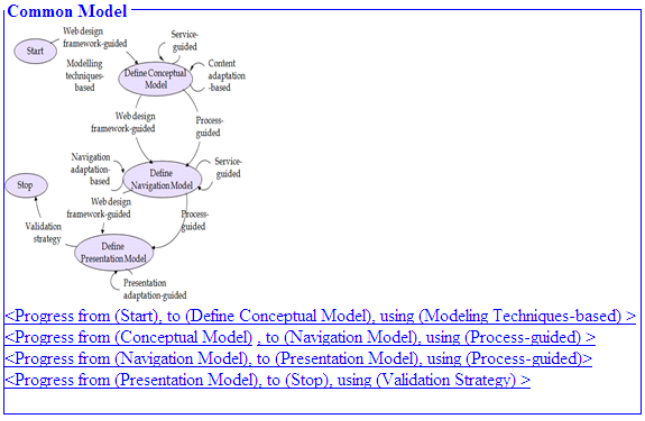
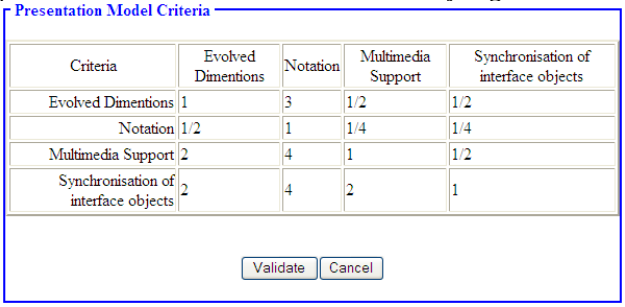


Fig 10. The appropriate design process model refinement of "Informational-guided" strategy.

When web designer intends to define Presentation Model, he/she is invited to introduce his preferences according to presentation model criteria as illustrated by Fig 11.



Criteria	Evolved Dimentions	Notation	Multimedia Support	Synchronisation of interface objects
Evolved Dimentions	1	3	1/2	1/2
Notation	1/2	1	1/4	1/4
Multimedia Support	2	4	1	1/2
Synchronisation of interface objects	2	4	2	1

Fig 11. The AHP matrix of presentation model criteria.

Once web designer validates introduced values in displayed matrix, AHP method is amerced to get out the most appropriate method component. Consequently, web design has to follow given guidelines of selected method component to achieve his goal that is, here, the definition of presentation model.

7.3 Empirical Study and Results

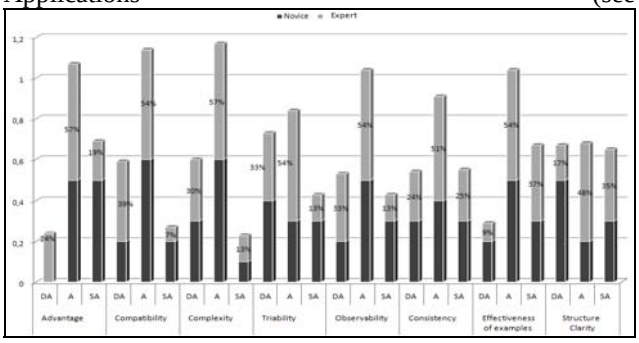
To validate our proposed approach, an empirical evaluation was completed. The evaluation method for assessing the effectiveness of the methodology was defined on the basis of the Diffusion Theory [23] which examines the rate and the motivations of adoption of a technological innovation by a group of potential users. The Diffusion Theory demonstrates that a technological innovation has chances to be successful if its quality is appreciated by the community of adopters.

The Diffusion Theory defines five perceived quality attributes of an innovative product, which can be also considered the five characteristics of a successful innovation: Triability, Observability, Relative Advantage, Complexity, and Compatibility. The quality of the document presenting the proposed approach was also assessed by means of three other attributes: Consistency, Effectiveness of the examples and Structure Clarity.

We have, at the beginning, worked with two classes of about 60 students in master: students specialized in multimedia that we classified as "Expert" and others who follow "computer security" discipline classified as "Novice". We have let them know in detail the proposed approach. We have provided students with a document presenting an in-depth explanation of the approach with examples and were then asked to provide structured feedback. Obviously, the number of sample users is not representative of the community of web designers. However, it gives an initial interesting feedback on how such a systematic approach to requirements is considered by web professionals. On the basis of the perceived quality

criteria, an online questionnaire with eight key questions was designed. For each question the evaluators could choose among the following options to express their level of agreement: Strongly Agree / Agree / Disagree.

In general, students consider proposed approach as a good-quality and effective proposal for designing Web Applications (see Fig **12**).



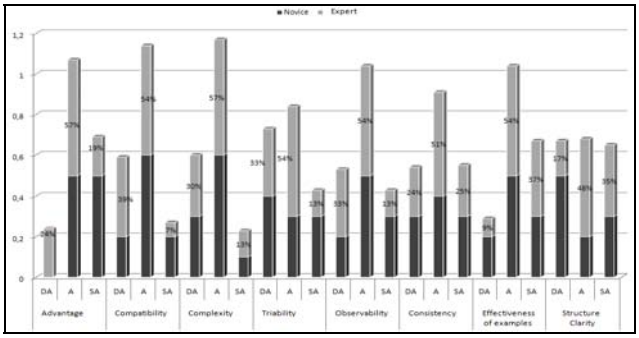


Fig 12. Synopsis of students' responses.

- Relative Advantage: No "Novice" student has expressed his non satisfactory relatively to this criteria. This is explained by the different types of guidance that the approach proposes and the coverage of the most web design aspects.
76% of "Expert" students have strongly agreed or agreed. This denotes the expected advantage of the proposed approach. However, 24% have expressed their non satisfactory. After having discussion with them, they have explained that they are used to use a simple web page editor for developing their web sites.

- Compatibility: 39% of "Expert" students have expressed that the approach is not compatible with their manner of developing web applications. This percentage was explained by two reasons: (1) they are used to develop web applications without any modeling and in ad-hoc manner and (2) they didn't have any idea about the MAP formalism.

- Complexity: only 30% of "Novice" students and 30% of "Expert" students have disagreed about this criterion. This denotes the usability of the proposed approach making it possible its adoption by a large number of end users.

- Triability: 33% of "Expert" students have disagreed. They have criticized the limited number of web development methods adopted in the approach.

- Observability: more than 60% of "Expert" and "Novice" students were persuaded of results and benefits of the approach.

In general, besides a general positive appreciation of the approach, students made also suggestions for improvements, such as detailing a process guide that might lead in the components assembly. This is part of future work to be done.
Although approach is finalized, we have observed that to be efficient, we have to store, in method repository, components issues from different web development methods. At present, besides to OOHDM and UWE methods, we are working at method re-engineering of others methods.

8. Conclusions

The paper has presented our proposed approach subscribing in the context of Web oriented Situational Method Engineering discipline. The advantage of this method is that we can reuse relevant, established method components of existing methods. In this way, an optimized method for every development situation is being developed.
We have begun by describing the web design process model which is formalized with MAP formalism. It guides web designer in the design of his/her web application at different levels of abstraction. We have focused, after that, in describing how the approach guides during selection of the most appropriate components through fixed criteria. The approach provides, also, guidance in the application of selected method components. In the last section, we have presented some interfaces of the developed tool supporting the approach.
At present, we are actually focusing on developing guidelines to assemble and integrate method components to constitute a web oriented situational method. We are working on a model-driven approach based on MDA technique. We have achieved assembly of product models through a set of defined rules. The process models assembly is under development.

References

[1] Brinkkemper, S. (1996). Method engineering: engineering of information systems development methods and tools. Information & Software Technology 38(4), 275-280.

[2] Ceri, S., Fraternali, P., Bongio, A., Brambilla, M., Comai, S., & Matera, M. (2002). Designing Data-Intensive Web Applications. Morgan Kaufmann Publishers Inc.

[3] Chakraborty, D. & Chen, H. (2000). Service discovery in the future for mobile commerce. Crossroads 7, 2, 18-24.

[4] Christodoulou, S. P., Styliaras, G. D., & Papatheodrou, T. S. (1998). Evaluation of hypermedia application development and management systems. In Proceedings of the Ninth ACM Conference on Hypertext and Hypermedia : Links, Objects, Time and Space (Pittsburgh, Pennsylvania, United States, June 20 - 24, 1998). HYPERTEXT '98. ACM, New York, NY, 1-10.

[5] De Troyer, O.M.F. & Leune, C. (1998). WSDM: a User-Centered Design Method for Web Sites. Computer Networks and ISDN Systems, volume 30, No. 1-7, (pp. 85-93).

[6] Diaz, A., Isakowitz, T., Maiorana, V. & Gilabert, G. (1997). Extending the capabilities of rmm: Russian dolls and hypertext. In 30th Hawaii International Conference on System Sciences (HICSS-30). volume 6. (pp 177-186). IEEE Computer Society.

[7] Fraternali, P. (1999). Tools and approaches for developing data-intensive Web applications: a survey. ACM Comput. Surv. 31, 3 (pp 227-263).

[8] Garlatti, S. & Prié, Y. (2004). Adaptation et personnalisation dans le Web sémantique. Revue I3 Information-Interaction - Intelligence, volume Numéro Hors-série Web sémantique.

[9] Ginige, A. & Murugesan, S. (2001). Web Engineering - An Introduction. IEEE MultiMedia 8(1). (pp 14-18).

[10] Grosz, G., Rolland, C., Schwer, S., Souveyet, C., Plihon, V., Si-said, S., Ben Achour, C. & Gnaho, C. (1997). Modeling and Engineering the Requirements Engineering Process: An Overview of the NATURE Approach. Requirements Engineering Journal, 115-131.

[11] Güell, N., Schwabe, D., and Vilain, P. (2000). Modeling Interactions and Navigation in Web Applications. In Proceedings of the Workshops on Conceptual Modeling Approaches For E-Business and. S. W. Liddle, H. C. Mayr, and B. Thalheim, Eds. Lecture Notes In Computer Science, vol. 1921. Springer-Verlag, London. (pp 115-127).

[12] Isakowitz, T., Stohr, E. A., & Balasubramanian, P. (1995). RMM: a methodology for structured hypermedia design. Commun. ACM 38, 8, 34-44.

[13] Kappel, G., Pröll, B., Retschitzegger, W. & Schwinger, W. (2003). Customisation for ubiquitous web applications a comparison of approaches. International Journal Web Engineering Technol. 1(1): 79-111.

[14] Kappel, G., Retschitzegger, W. & Schwinger, W. (2000). Modeling Customizable Web Applications. Kyoto International Conference on Digital Libraries, 387.

[15] Karlsson, F. (2002). Bridging the gap between method for method configuration and situational method engineering. Promote IT, Skövde, Sweden.

[16] Koch, N. (2001). Software Engineering for Adaptive Hypermedia Systems: Reference Model, Modeling Techniques and Development Process. Softwaretechnik-Trends 21(1).

[17] Kumar, K. & Welke, R. J. (1992). Methodology Engineering: a proposal for situation-specific methodology construction. In Challenges and Strategies For Research in Systems Development, W. W. Cotterman and J. A. Senn, Eds. John Wiley Information Systems. John Wiley & Sons, New York, NY, (pp 257-269).

[18] Lee, H. & Lee, C. (2000). Using Scenario for building hypermedia systems. Proceedings of the INFORMS KORMS.

[19] Montero, S., Díaz, P. & Aedo, I. (2002). Requirements for Hypermedia Development Methods: A Survey of Outstanding Methods. Proceedings of the 14th International Conference on Advanced Information Systems Engineering (CAiSE '02).

[20] Olsina, L. (1998). Building a Web-based information system applying the hypermedia flexible process modeling strategy. Proceedings of the 1st International Workshop on Hypermedia development.

[21] Prakash, N. (1999). On method statics and dynamics. Inf. Syst. 24, 9, 613-637.

[22] Ralyté, Y. & Rolland, C. (2001). An assembly process model for method engineering. Proceedings of the 13th Multi International Conference on Advanced Information Systems Engineering, CAISE'01, Interlaken, Switzerland.

[23] Rogers, E. M. (1995). Diffusion of Innovations. The Free Press.

[24] Rolland, C., Prakash, N. & Benjamen, A. (1999). A Multi-Model view of Process Modeling, Journal of Requirements Engineering, 4, 169-187.

[25] Saaty, T. (1980). The Analytic Hierarchy Process. McGraw Hill International.

[26] Selmi, S., Kraiem, N. & Hajjami Ben Ghezala, H. (2007). Toward Web oriented Situational Methods. IEEE International Conference on Information Reuse and Integration, Las Vegas.

[27] Selmi, S. (2008). Proposition d'une Approche Situationnelle de Développement d'Applications Web. Unpublished doctoral dissertation, Ecole Nationale des Sciences de l'Informatique.

[28] Takahashi, K. & Liang, E. (1997). Analysis and design of Web-based information systems. In Selected Papers from the Sixth international Conference on World Wide Web (Santa Clara, California, United States). P. H. Enslow, M. Genesereth, and A. Patterson, Eds. Elsevier Science Publishers Ltd., Essex, 1167-1180.

[29] Ushold, M. & King, M. (1995). Toward a Methodology for Building Ontologies. Workshop on Basic Ontological Issues in Knowledge Sharing.

[30] Villanova-Olivier, M. (2002). Adaptabilité dans les systèmes d'information sur le web: Modélisation et mise en oeuvre de l'accès progressif. Published doctoral dissertation. Institut National Polytechnique de Grenoble.

Dr Naoufel KRAIEM : (PhD of University of Paris VI) is currently a senior researcher in the RIADI laboratory at the National School of Computer Sciences of Tunis.
His research interests lie in the areas of information modelling, Software Engineering and CASE tools. His research work has been supported by funding of the CNRS, INRIA, MRT (Ministry of Research and Technology and Industry) and by the Commission

of the European Communities under the ESPRIT Programmes (BUSINESS CLASS) and UNIDO (National Network of Industrial Information Project).

Semia Sonia Selmi is currently a senior researcher in the RIADI laboratory at the National School of Computer Sciences of Tunis. She obtained a Master degree in Applied Computer Science into Management from the High Institute of Management (ISG) of Tunis, Tunisia in 1998, and a PhD in Computer Science from the National School of Computer Sciences of Tunis in 2008. The research areas of Dr. Selmi include situational method engineering and Web Engineering disciplines. She has participated in Franco-Tunisian research projects. Her work had been published in various international conferences and workshops (ICWE, INFORSID, EDMEDIA, IRI). Dr Selmi is involved in the organisation of the international conference CAISE'10.

Prof. Henda Ben Ghezala is currently Professor of Computer Science in the department of Informatics at the National School of Computer Sciences of Tunis. She leads a Master degree in 'ICIS'. She is the president of University of Manouba.
Her research interests lie in the areas of information modeling, databases, temporal data modeling, object-oriented analysis and design, requirements engineering and specially change engineering, method engineering. She is Director of the RIADI labs.