

FROM THE BWW CONCEPTUAL MODEL TO THE DESIGN OF FAMILY OF WEB APPLICATION

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Abstract: The phase of analysis and design of a modern web application with its multi-user and multi-device features is surely a real complex task. Moreover during the design, the aspects of ergonomics, usability and human computer interaction have to take into consideration in leading way. To answer to these requirements, many methodologies were born. Such approaches are yet valid for the design of a single WA but became in crisis when the main goal is to develop a framework for family of applications in a specific domain. In this paper, starting from a knowledge base obtained using an ontological approach to BWW, we propose the guidelines of changeover from the domain conceptual model to the Interactive Dialogue Model (IDM) for families of applications. From the IDM model, it will be possible to derive a single application through the specialization. In order to check the validity of the proposed considerations, we create a case study in the environmental domain. Starting from the conceptual model, first we design the IDM model of the family of applications and then we derive from it the IDM model of a specific web application.

1 INTRODUCTION & BACKGROUND

The growing demand of advanced services that must be strictly related to the customer role and work context and must be based on web technology available on several device, has brought the design phase and the following development one to be a real complex task. First the web application designer has to plan the single aspects (information, navigation, etc.) one by one and then to check their possible interactions and architectural choices in order to evaluate the quality of the final product.

Hence to manage the complexity and to support the designer and the developer, many design methodologies like OOHDM (Schwabe, 1996), WSDM (De Troyer, 1998), WebML (Manolescu, 2005), HDM (Garzotto, 1993), IDM (Paolini, 2006) and many prototyping environments was born.

In spite of these efforts, the quality of web application is closely related to the designer modeling experience and to his/her capability of understanding correctly the requirements and the

context in which these requirements must be satisfied.

In addition, now it is not enough to model the single Web Application (WA) but it's important to design a complete family of applications. The single applications that are members of the same family and that are designed for specific stakeholders, solve a specified task or problem into the application domain. Thus the design approaches good for single WA are not more enough. The designer needs methodological tools to represent in an adequate way the knowledge base of entire application domain and from which he/she could derive the specific WA design.

In other words, the conceptual design aims to acquire and store the domain knowledge. The real advantage is not only strictly connected to a deeper domain understanding but also its use during the design phase of final application. This changeover must be controlled thought methodological guidelines.

Currently several languages and practices to model the conceptual design of specific domain and many WA design methodologies exist. But, in

literature and in the market, there is not a single, unique and uniform approach that leads the designer from the domain description (often expressed in ontological language) to the application design and in particular to web application design.

Considering this gap, in this paper we introduce a real experience into a complex environmental domain. In the case study, we design a WA starting from the domain knowledge base.

In the detail, we use the BWW methodology (Wand, 2002) (Rosemann, 2005) (Colomb, 2002) to describe the domain. This model is complete, objective and simple to consult and has features of abstractness and independence from the development technology.

As WA design methodology, we consider the IDM methodology that, even if focused on the WAs, is independent from the specific development technology widening the generality of our considerations.

In this paper we present in the section 1 the introduction and background and we focus on IDM and BWW presenting them; in the section 2, we present the process to derive an IDM design of the application family starting from the BWW conceptual model. In the section 3, we present a case study: in the environmental domain first we design the conceptual model and then we obtain the IDM design of the family of applications; we obtain also a specific application in the application family. Finally, in section 4 we present conclusions and future trends.

2 IDM & BWW IN A NUTSHELL

Interactive Dialogue Model is a design methodology able to describe the communication structure of the information-intensive application where the main goal is to present information to the user; thus, IDM maximises the dialogue between user and application. The IDM notation uses graphical element to model the main aspects of the application using the dialogue content concepts. IDM is made up of two different details level: Conceptual IDM (C-IDM) and Logical IDM (L-IDM). C-IDM is used to discuss with the customer about information and navigation aspect. The designer uses the two main IDM primitives: Topic (and Group of topics) and Relevant Relation. Using these two primitives, a first background about information and its relationship is made. The L-IDM diagram is a detailed design. The designer uses the Topic and the Relevant Relation (as in C-IDM) but the detail level is more careful. In L-IDM diagram, the topics are detailed using the dialogue act that describes the content information.

In L-IDM, the designer can model the access structures to the specific information. Each topic can have one or more Introductory act that represents the entry point to the topic's information. L-IDM allows to model the operation thought the operation act.

To model the page design that is not taken in care in the IDM methodology, it's possible to use the design methodology named P-IDM (strictly connected with IDM). P-IDM allows to organize the information content in several views and each view is made up of contents.

The main element in the ontology BWW (Bunge-Wand-Weber) is the *thing*, which models the "things" that have a physical existence in the real world. The thing is characterized through the *Properties*. Every thing has at least one Property and every Property belongs at least one thing.

The properties can also be classified in *Intrinsic Properties*, that regard a single thing, and *Mutual Properties* that is shared between two or more things. *The Law* can bind the value of the property. There are two types of law: *Natural* (physics laws) or *Human* (designer defined). A property can have only one type of law.

The values assumed from the property define the thing *state*. The *Event* can change the state because can act on its thing. The chronological collection of the several states constitutes the *History*, while the set of events constitutes the *Process*. If a property change of a thing modifies an other property of another thing the two things are defined *Coupled*.

The things that have property in common can be collected in *class*. The *System* is the collection of things that are defined coupled.

More things can form a *Composite thing* when they are essential part of its existence (as an example the thing machine is a composite thing because it is composed from the things engine, wheels, etc..).

3 THE MIGRATION PROCESS

Starting from these methodologies, we focus on the process to derive the IDM diagram from the BWW model correlating one by one the single elements of two methodologies.

The final output of this process will be a general model of a family of applications. From this model, applying the specific requirements of the stakeholders, it is possible to derive the IDM model of a specific web application.

In fact, starting from domain model without considering the specific stakeholders, the output could be only general. This approach has the great advantage that it is independent from the stakeholder requirements and, thus, all the applications that

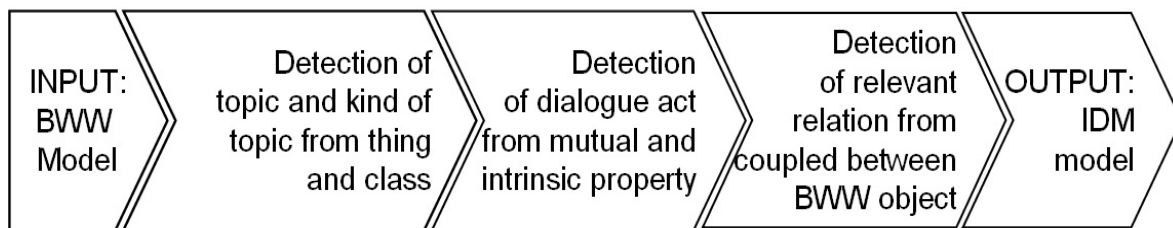


Figure 1: The IDM design process of a WA family.

could be derived from the IDM general model will be coherent and homogenous between themselves.

From this point of view, the IDM output model must use only the elements that characterize the application domain and that could not be used to describe specific aspects of the stakeholders needs.

Thus, the elements Kind of Topic, Dialogue Act and Relevant relation are sufficient to describe the model of a family of applications because they represent only concrete concepts that are independent from stakeholder requirements and from the designer choices.

On the contrary, the designer must not consider the other IDM elements like Transition Act, Introductory Act and Subject Strategy; in fact, these elements that define the access structures closely related to the operating strategies of the stakeholders, will be used during the design of the specific applications.

In order to define a correspondence between BWW conceptual model and IDM design methodology, it is necessary to consider the semantic of the BWW elements. Considering the IDM nature, only the BWW elements containing information have to be inserted into the IDM model: thing, class and history.

In fact, the things describe and represent the real objects of the application domain while the classes group them according to their common properties. Moreover, the information on the lifetime changes of a thing or class is collected in the history. In the detail, the thing and the history correspond to the IDM Topic while the class to the IDM Kind of Topic.

It is possible to characterize the kind of topic defining the dialogue acts. There is a relationship between the BWW properties (Mutual, Intrinsic and Composite) and the dialogue acts.

In the detail, the designer has to consider only the properties of the things that are translated into IDM with topic; for example, if the "topic" is derived from a history, its dialogue acts will contain the properties of the things or classes to which the history is referred or the properties of the events that generated the history.

After the description of the information objects, it is necessary to design their connections. The relevant relations describe the navigational aspects own of domain applications between the several kinds of topics or topics. According to the analysis of the BWW interaction types, the BWW elements that better represent the IDM concept of relevant relation are the coupled relation between the things or classes. In BWW model, these connections describe the mutual influence between two things in the meaning of mutual property change.

If in BWW model a thing/class has a relation with itself, the IDM model will present a multiple relevant relation that links more instance of the same topic. Thus, the IDM model is completed with the relevant relation.

In table 1, it's presented the schema of relation between the BWW model and IDM model:

Table 1: The relation between the BWW element and IDM element.

BWW Element	IDM Element
Class	Kind of Topic
Thing	Topic
History	Topic
Thing Property	Dialogue Act
Class Property	Dialogue Act
Event Property	Dialogue Act
Thing/Class Couplet	Relevant Relation

According with these considerations, the IDM design process of a WA family of specific domain is described into the figure 1.

After the definition of the IDM model, it is possible to derive the single applications using specialization technique. In the single application, the Transition Act, Introductory Act and the Subject Strategy are modeled. These elements describe the views and the access structures according to the requirements of the specific stakeholders.

Table 2: The BWW property and IDM dialogue act.

Name	BWW element Type	BWW Property	IDM element Type	IDM Dialogue act
Agency/ Organization	thing	Intrinsic: <i>name, function, Territorial scope</i>	topic	Dialogue act: <i>name, function, Territorial scope</i>
Subject	class	Intrinsic: <i>name, placement, constraint, category</i>	topic	Dialogue act: <i>name, placement, constraint, category</i>
DIA	class	Mutual: <i>name, delivery_date, purpose, DIA_state</i>	topic	Dialogue act: <i>name, delivery_date, purpose DIA_state</i>
OST	class	Intrinsic: <i>name, dimension, category, constraint</i>	topic	Dialogue act: <i>name, dimension, category, constraint</i>
FIA	history	Indicator Property: <i>value, place</i> FIA Property: <i>description</i>	kind of topic	Dialogue act: <i>value, place, description</i>

4 THE CASE STUDY

In order to verify the proposed approach, we produced a case study based on the environmental domain. The knowledge of case study has been realized into an industrial research program promoted by private company and Italian Government. The research program, developed with standard UML technique, aims to create a framework to acquire, to process and to disseminate environmental information, according to international Agreements and European and National Regulations, intended to satisfy needs of the operative structures of Public Administrations. The framework has to allow the generating of families of applications which are customized for specific needs and can share a common base (Paiano, 2006) reducing realization time and improving quality.

In the case study, before the BWW conceptual model has been realized, and then applying the IDM migration process, the design of application family has been produced.

4.1 The Environmental Domain and the BWW Model

We consider the environmental protection: the habitat of all the organisms and the organic structures of systems and subsystems. Environmental protection has considerably evolved in the last years. In the sixties, the public administration main goal was the control laid down by law. Today great importance is given to the knowledge acquisition of the factors that affect heavily the environment quality. This choice is determined by the high growth rate of the population

and by the evolution of the productive system that makes pressure on the environment.

Today, monitoring activity and environmental control is not only developed by the local government (Municipality, Provinces, and Regions) but also by several associations, organizations and agencies.

To improve the quality of the environment, organization and institution nets were born in order to facilitate the collaboration for applying a common environmental policy. The efforts to collect and to deliver environmental knowledge in the Italian and European areas do not match with the regional institutional levels, because the technological infrastructures do not support informative exchanges.

The figure 2 shows a scratch of the BWW conceptual model of environmental domain. In order to make legible the model, for the derived things and classes, the diagram shows only the mutual properties (for the classes) or the intrinsic properties (for the things) that are **not** in common with the class father.

In order to obtain the BWW domain design, we detect only the real environmental objects that will become things or classes. Thus, the real object **Agency/Organization** has been modeled with one thing.

The agency is linked with the indicator from which they obtain information on the environment state. The indicators have a physical existence and in the BWW conceptual model there is the thing **Indicator**.

If the indicator value exceeds the threshold value because of a phenomenon or fact of ambient importance (FIA), the agency putted in charge of the environment protection generates an alarm. The changes of the indicator thing are described through the **History_FIA**.

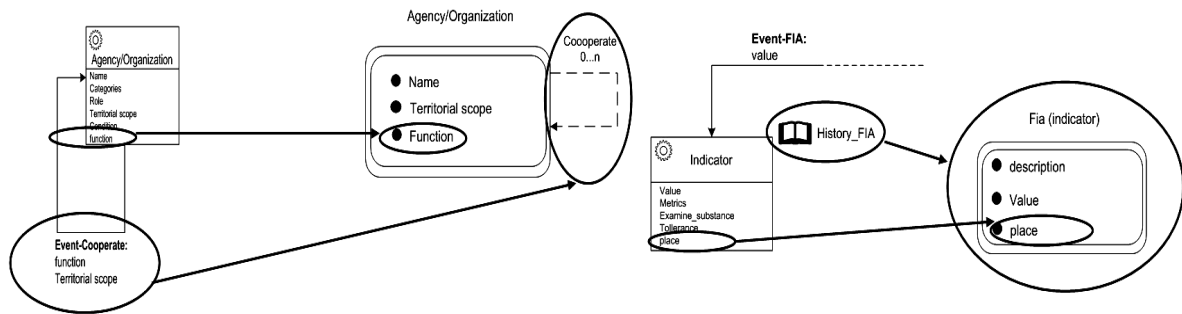


Figure 3: Example of dialogue act definition.

The environmental protection area is described with the class **OSS** (*Objects, Subject, and Structures*). This class describes and catalogues generically the structures and the subject presents on the territory. Class OSS is specialized in subclass **OST** that represents the Subjects, Objects and Structures of anthropic type and **SOI** that represents the class **Subject** (the physical person, the company, etc..) and **Organisms** (birds, mammals, etc.).

The **Agencies** control and take in care the environment thought the emanation and the performance of proceedings, of regulations and of laws. These government instruments are represented in the BWW model through the class **DIA** (dispositions, proceedings and laws).

After the design of things and classes, the mutual and intrinsic properties must be defined. As an example for thing Agency/Organization the intrinsic properties are:

- Category that defines the agency type: municipality, province, region etc.;
- Role that allows to describes the agency tasks on the territory;
- Territorial scope that indicates the action area of the agency;
- Condition that indicates the condition of the agency; it can assume the values of alarm, attention, monitoring, etc.;
- Function that contains the information of the several activities that the Agency can do.

In the same way, it is possible to find the mutual property for the classes; it's clear that the properties defined for the parent class must not be defined for the derived classes because they are inherited in the subclass.

The relations between thing/class describe the thing/class interaction thought the events. As an example, **Event-FIA** puts in relation the OSS class with the Indicator thing through an event that changes its property *Value*; in the same way, the events Event-AlarmState and Event-Emanation can be modeled.

Thus all the existing relations in conceptual model BWW are modeled, obtaining an objective design of the environmental domain at a high level abstraction.

4.2 From BWW Model to IDM Model

Starting from the environmental conceptual model, the migration process described above has been applied.

Thus as first step, the BWW elements that characterize the domain information have been identified. In the case study, we consider the elements: Agency/Organization (that will generate a topic because it is a thing), Subjects, DIA, OST (that will be topic because they are classes) and the FIA (that will be a kind of topic because it is a history).

After the topic, we define the dialogue acts analyzing the BWW property. Table 2 shows the dialogue act.

The dialogue acts related to the kind of topic FIA derive from the properties value and localization of thing Indicator (to which the FIA history refers) and from the property description of the event-FIA that concur to define the history itself.

Mutual properties *constrains* and *category* of OSS class will be associated as dialogue acts of the IDM topic (like topic *Subject*) that represent the classes derived from OSS. The figure 3 shows some illustrative examples.

After identified the information units (kind of topic) and theirs component (dialogue acts), the navigational relationships have to be defined. According to the migration process, the navigational relationships will be derived from the BWW coupled relations between the things or classes.

According to the BWW domain conceptual model, the IDM relevant relations are:

- The thing Agency/Organization has the *Event-Emanation* relation (with the class DIA) and *Event-cooperate* (with itself), thus in the IDM diagram the relevant relation *Cooperate* (of

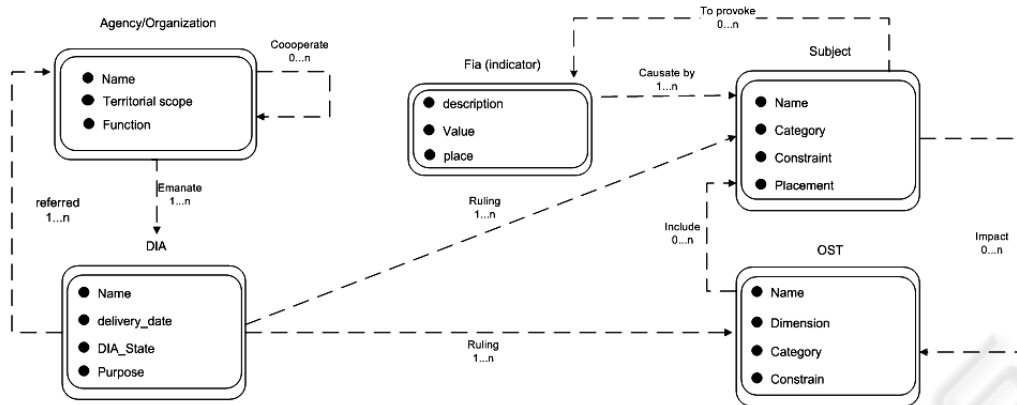


Figure 4: The IDM schema obtained applying the migration process.

topic the Agency/Organization with itself) and *Emanates* (with the topic DIA) will be inserted.

- The kind of topic DIA has three relevant relations with topics OST, Subject and Agency/Organization. Relevant relation *Ruling* is defined starting from the BWW coupled relation *Event-Ruling* between DIA and OSS; in fact, the DIA is in relation also with class the OST and Subjects because the coupled relations are inherited from the subclass.
- The relevant relation *referred* between the DIA and Agency/Organization is not present in model BWW but we defined it because it's the inverse relation of relation *Emanate* that is present in BWW conceptual model.
- The topic Subject has the relevant relation *Impact* with the OST topic derived from the coupled relation *Event-established* that Subject inherits from the class *SOI*; moreover, the relevant relation *Include* (its inverse) has been inserted. The topic Subject introduces also a navigational relation with the FIA: the coupled relation *Event-FIA* that exists between class the OSS (inherited by Subjects), and the Indicator thing; in fact, the FIA topic derives from the history-FIA of Indicator. The inverse relation *Caused-by* has been inserted between the FIA and Subjects in order to optimize navigation; the direct relation exists yet in the BWW model.

In figure 4, there is the IDM output diagram obtained applying the migration process to the BWW domain model.

After obtained the IDM model of the family of applications in the environmental domain, a real application (not related to our regional territory) is

derived from it: the official web site of the Authority of basin of PO River (<http://www.adbpo.it>).

The site supplies the news of the tasks developed by the authority and it gives the opportunity to a generic customer of acquire information about the agency structure, about the several authority projects, about the project managers. In figure 5, the IDM model is showed.

In order to verify the generic IDM model, the reverse engineering of the web site has been produced. The output model has been compared with the IDM model of the family of applications. The IDM model of web site of the Authority of basin of PO River has been turned out totally integrated in the general IDM model.

Furthermore, we have the need to verify if the original BWW domain representation is able to describe a specific application not considered before in order to acquire the domain knowledge.

Comparing the diagram of figure 5 with the environmental domain model of figure 1, it is possible to place in relation the diagram elements with those of BWW model. During the comparison, we have to consider not the name of dialogue acts or properties but the information that it represents. In the detail, we have the following information:

- **Agency** topic: it is referred to the Agency/organization of BWW conceptual model; in fact, it describes the same information that have been of the thing property: the dialogue Act *Description/presentation* has the same of the Role, the dialogue act *territorial authority* the same of *territorial scope*, *Structure and publishing* with the property *Function*.
- **Planning** topic: it traces the information about the active tasks on the river basin, of the deliberations and valid rules; therefore, it is a collection of dispositions, of tasks and of actions. Thus, it is a member of the most

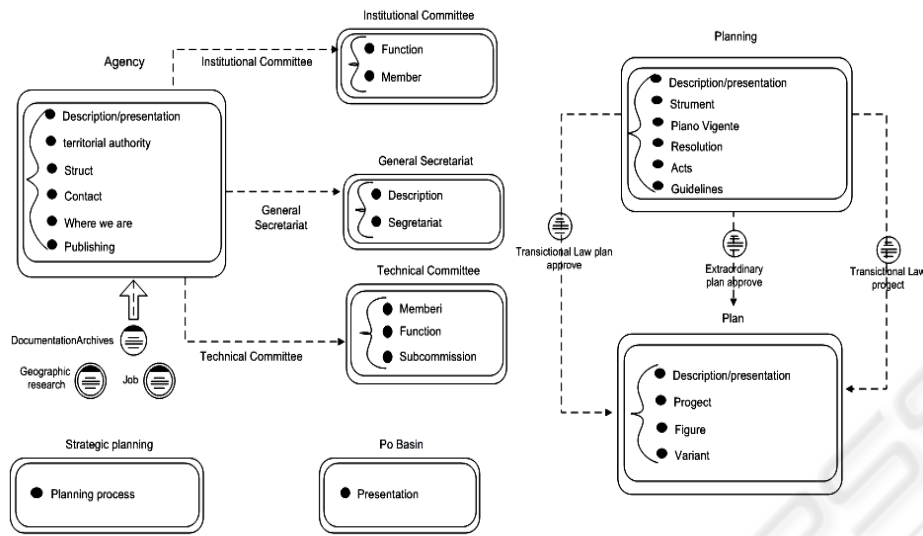


Figura 5: The IDM model of www.adbpo.it.

general class DIA to which is related in BWV. The not perfect comparison in BWV underlines the general model character; in fact, it must guarantee the presence of the generalizations of the elements that constitute the domain, and not their specific requests.

- **Plans** topic: it is a specialization of the *DIA* class; in fact, the dialogue acts *description/presentation* and *plan* can be related to the *Purpose* property, while the dialogue act *variance* to the *History_DIA*.
- **Strategic Planning** topic: It is refereed to the DIA class because it describes the purposes and the several phase of action plan.
- **Institutional Committee, General Secretariat, Technical Committee** topics: they are specialization of the thing Agency/Organization because represent several institutional organisms that collaborate into the decision process about the tasks on the basin of the Po river.

In order to highlight, these existing relations between the two models are showed into the table 3: in the two column are related the topic of the river basin of the Po and the BWV concepts.

Table 3: The relations between the two models.

IDM model topic of www.adbpo.it	BWV domain element model
Agency	Agency/Organization
Planing	DIA
Po Basin	hydrographical basin
Strategic Planning	DIA
Institutional Committee	Agency/Organization
General Secretariat	Agency/Organization
Technical Committee	Agency/Organization
Plan	DIA

5 CONCLUSION AND FUTURE WORKS

The problem to have a model of a family of applications that, describing the domain knowledge allows to derive specific applications, has in literature a methodological gap. This paper is an attempt to cover this gap proposing a design process of a family of applications that uses as input an ontological model. In the detail, this study focuses on the changeover from ontological BWV model to a model of WA design using IDM methodology. In order to verify the output models and therefore also the proposed considerations, we present a case study: the reverse engineering of an existing application. The obtained model has been perfectly compatible with the output IDM model of the family of applications. As next research step, we are

planning an editor that will integrate the BWW-IDM methodology in order to support the WA designer in the design of the conceptual domain in BWW, of the IDM schema of family of applications and in the derived WAs.

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