Conceptual Design of Electronic Product Catalogs using Object-Oriented Hypermedia Modeling Techniques

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Abstract The application of conceptual models that assure both the consistency and usability of Electronic Product Catalogs (EPC's) is a main concern in the e-commerce community, mainly due to the impact a correct design of such interfaces has on the final e-store sales figures. This article describes how the OO-$\mathcal{H}$Method web-interface modeling approach can be successfully applied to the design of Business to Consumer (B2C) application interfaces. In order to address the specific domain semantics, OO-$\mathcal{H}$Method adds a new concept called 'dimension attribute', which is extracted from the datawarehouse field, and defines a comparison function applicable to these attributes. Also, a set of e-commerce Interface Usability Patterns that address some design problems likely to appear on the different store components and a materialization strategy are introduced to complete our proposal. The use of patterns to capture the semantics specifically related to e-commerce applications, and to manage the knowledge captured in the catalog structure, guarantees the reuse of techniques coming from different fields and proven useful for the increment of sales on internet.

1 Introduction

In the last few years the growth of the Internet market has supposed a main challenge for the enterprises, that have had to quickly adapt both its technology and its business processes in order to get its share in such potential benefits. In order to facilitate this evolution, the research community has been compelled to work on the several orthogonal aspects involved in this process, and specially in the design and adoption of new e-commerce practices. Those aspects include concepts such as technology availability, interoperability, security, control of electronic transactions, etc., which apply to every kind of e-business application. In

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this article, however, we will center on Business to Consumer (B2C) and Consumer to Consumer (C2C) applications, where the interface design process and usability features are especially relevant: the (above mentioned) need of integration with the general enterprise business requires a multidisciplinary development process, and the large target audience and customer desired behaviour (coming back, purchasing our items) requires meaningful metaphors and well designed navigation paths. Supporting this assertion, performed research [10] has concluded that improving browsing and navigation capabilities, and especially product lists, is more relevant than visually striking store fronts and can generate significantly higher traffic and sales per store. These are precisely two of the main characteristics defined by means of an Electronic Product Catalog (EPC) [13,9].

EPC's can be seen as Web Information Systems [3] that, in addition to laying emphasis on the presentation of products/services, contain some standard functionality regarding navigation, searching, selection and ordering of products [7,8]. They materialize the paper catalog metaphor, but, due to the fact that they provide a much more powerful source of information on products, and that purchase decisions are usually made on this information, they are considerably more effective. In order to better attain the customer attention and favor a purchase behaviour, EPC's tend to be highly interactive and dynamic. Furthermore, as the consumer is highly sensible to errors (out-of-date, imprecise information and/or communication errors), they need to be specially carefully designed. Both the information quality (accurate and up-to-date information, availability of items, special offers...), its organization and the facilities provided to improve the buyer experience (such as comparison facilities) influence the success of an e-commerce application.

In spite of these facts there is, as far as we know, no clear proposal that specifically deals with the idiosyncrasy of such applications. Efforts are being made among enterprises in conjunction with their immediate trading partners, and the danger is that this relatively narrow focus limits the return on investment possible from each of these initiatives. E-commerce needs a global environment, and the application of a coherent conceptual model can help to achieve it, creating at the same time a common framework for further discussion. Moreover, using a conceptual model the application becomes less sensible to the technological changes which are constantly appearing in this environment. Traditional software engineering techniques, even if they can suffice for a first approach, do not encourage the designer to think about and capture the specific semantics for EPC's. An enrichment of existing modeling techniques would allow to attain a faster, more reliable and thus cheaper development process, together with a better turnover for the enterprises. Following this trend, in this paper we are extending our proposal, known as OO-$\mathcal{H}$Method [6], to fulfill this purpose. Furthermore, we will show how some well known e-commerce interface usability patterns can be applied to improve the effectiveness of EPC's.

The remainder of the article is structured as follows: section 2 provides a brief introduction to the OO-$\mathcal{H}$Method web-modeling approach, describing the diagrams that are used to capture the relevant properties of a web interface. Section 3 extends our proposal in order to capture the concepts related to EPC's. Some of these concepts have been borrowed from the datawarehouse field. That is the case of the dimension attributes and the compare operations associated to them. Some of the more relevant EPC patterns, gathered in an OO-$\mathcal{H}$Method Pattern Catalog and used to improve the EPC interface, are described in section 4, together with the Abstract Presentation Diagram on which they are applied. Finally, section 5 presents the conclusions and further work.

2 Basic features of OO-$\mathcal{H}$Method

OO-$\mathcal{H}$Method is a generic model for the semantic structure of web interfaces. It captures the relevant properties of a web interface by means of two models: the navigation model and the presentation model. The navigation model is captured by means of the Navigation Access Diagram (NAD). It captures the information which each potential web user (agent) can access and the navigation paths from one information view to another. The presentation model is specified by means of the Abstract Presentation Diagram (APD) and provides a set of default values which might be assumed for all the presentation features in order for a web interface to be automatically generated without further work. To do it, OO-$\mathcal{H}$Method defines the mapping from elements in the NAD to elements in the APD, as well as some possible ways of refinement.

2.1 The Navigation Access Diagram (NAD)

The NAD provides four major conceptual modeling constructs to specify navigational user requirements: (1) Navigation Classes (NC), (2) Navigation Targets (NT), (3) Navigation Links (NL) and (4) Collections (C). Navigation Classes are domain classes whose attributes and methods have been filtered and enriched in order to better accommodate the specific features of hypertext. Navigation Targets group the elements of the model that collaborate in the coverage of a certain user navigation requirement. Navigation Links define the navigation paths through the information. Finally, Collections are hierarchical structures defined on navigation classes which define both the traversal behaviour of each one of the links grouped by the collection and the set of objects on which this collection will apply.

2.2 The Abstract Presentation Diagram (APD)

The APD adopts a template approach [1,4,5,11] for the specification of not only the visual appearance but also the page structure of the web. As far as we know, there are five main aspects that should be specifically considered when generating a web interface, namely, the information to be shown, the layout, the interaction processes, the client functionality and the possibility of multiple simultaneous views. These aspects are gathered in five template types, each one with its corresponding Document Type Definition (DTD) associated. The template types are, namely: tStruct, tStyle, tForm, tFunction and tWindow. These diagrams will be further discussed in the rest of the paper.

3 Extending OO-$\mathcal{H}$Method to cover EPC's semantics

We have already stated that one of the main differentiating characteristics of EPC's is their specially flexible browsing and navigating capabilities. This flexible navigation can be compared to the one we can find in the OLAP domain [17]. In the same way the OLAP user manipulates information in order to visualize the data in a format that allows him to make a business decision, the EPC customer must have the possibility to manipulate the product information contained in the catalog in order to make a buying decision. For a more general perspective of the approach, a small example is going to be employed all along the paper: the online catalog of a music sample store called 'ShopAtOnce'. As a basic explanation (for reasons of brevity) it is assumed that the products (CD's, singles) are classified into categories (pop-rock, jazz, classic, latin music...) through which the user can navigate. The store also sells complementary products: t-shirts with the logos of the different groups, posters etc. The system implements the Shopping Cart Metaphor, directly available from any part of the store. The basic navigation requirements for our sample application have been defined as follows:

- On entering the site, the customer has access to the Hot Deals of the store. S/he will see the name, short description, retail price, saving (compared to the normal price) and a small image of the product.
- Also, the EPC should contain a search capability. There the customer will be able to choose whether s/he wants to search the CD's, either by title or by singer.
- The customer will also be able to navigate through the different categories of CD's. As a restriction, the only products that can be scanned are those that the company has in stock. Whenever the customer is visualizing a product, s/he should be able both to find complementary products (in our case, posters of the selected group, singles etc), add the actual product to the shopping cart and perform comparisons with other products in the catalog.
- At any time, the customer will be able to delete an item from the shopping cart, modify the quantity, print the invoice with the total amount (shipping and tax included) and/or perform the checkout process.

Figure 1 illustrates the NAD of our sample application for a standard customer profile. In this diagram we can identify four main Navigation Targets (NT) which cover the Hot Deals, the Search Catalog and the Scan Products requirements, as well as the Shopping Cart functionality (left out of our model due to the fact that it is a well-known component with a clearly defined behaviour). The NT define the main tasks the consumer can perform when browsing through the EPC. The entry point to the application gathers these four NT. 'Show all'

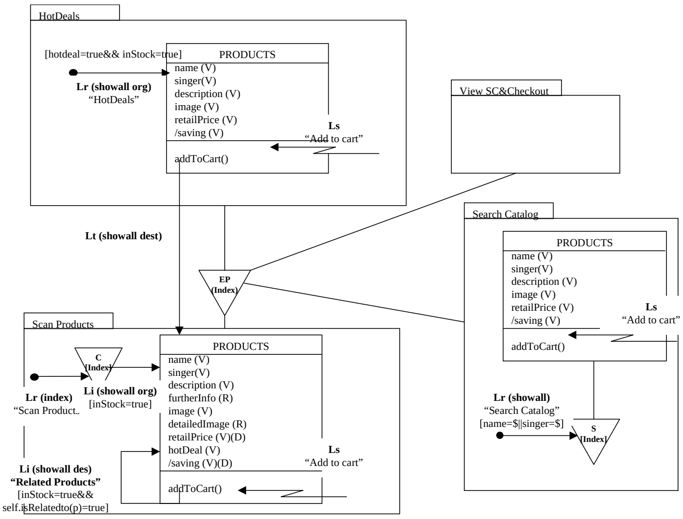


Figure1. *NAD of the ShopAtOnce Electronic Product Catalog*

navigation patterns determine that all the Visible Attributes (V) related to the target objects for a given link or collection will be shown. Whether this visualization is performed on the origin page or by means of a new page depends on the 'org/dest' attribute associated to the navigation pattern. Similarly, the index pattern indicates that references to every object involved in a given navigation requirement are going to be shown together (although possibly paginated), and clicking on any of them will generate a new page with all the visible items of information available. Furthermore, Visible Attributes (V) determine the set of information relevant for the customer. Further details can be obtained by means of a 'More Info' link, generated when the designer characterizes one or more Referenced Attributes (R) on a given class. Restrictions might be applied both to the target population of links and collections, by means of filters. As an example, the 'in Stock=true' filter specifies that only products in stock will be shown as purchase possibilities. On the contrary, filters associated to Service Links (arrow symbols) determine attributes necessary for launching a given class method. In our example we have only one service available: add a product to the shopping cart. The additional characteristic of 'searching complementary products' is modeled by means of an Internal Link and a filter associated that checks for a given association among products in the underlying conceptual schema. Reviewing the requirements, the only operations left are those related to product comparison. This kind of operations, required by the customer and inherent to the buying process, are different from the traditional navigation behaviour the model captures among classes. It involves a new kind of internal, usually bifocal navigation which will be explained later and depends on the semantics of the attributes. Thus, we have introduced a new concept, that of 'dimension attributes', which together with the EPC Comparison Pattern defines the way the customer can get reassured in his/her purchase decision. Both concepts will be developed in the following sections.

3.1 Dimension Attributes

We define dimension attributes (D-Attributes) as attributes on which it is possible to define a comparison process. They define a new kind of navigation paths inside the Product conceptual class. D-Attributes are represented by means of a (D) symbol close to the attribute. An example of such attributes can be seen in Figure 1. Dimension attributes qualify a new kind of object collection that remains implicit in the model. An example about how this comparison process is performed can be seen in Figure 5. On this new kind of navigation path, the possible target set of objects always depends on the values of the attributes considered relevant for comparison (dimension attributes) on the actual product. Also, the set of applicable operators will depend on the attribute type.

3.2 Navigation on dimension attributes

We have already stated that both the customer browsing an EPC and a marketing or sales analyst browsing an OLAP application have a similar aim: extracting objective information on which to base a decision (either a purchase or a management decision). In fact EPC's can be seen as the front-end from which to gather all the information needed to apply OLAP operations. Aggregating and disaggregating products can be seen as navigating either through class hierarchies, class aggregations or even hierarchical collections. However, unlike on OLAP roll-up and drill-down operations, this aggregation/disaggregation means a change not only in the layout but also in the set of objects being visualized. Up to now we have not encountered the necessity of including a new kind of link that just changes visualization without affecting target population of the link. However we do not discard the possibility of performing such enrichment in the future. Other OLAP operations can be defined (although statically) by means of a different visibility scope for attributes (slice) or filters on links and collections (sub-population that can be thought as a sub-cube to be worked on). However, there have been identified some internal navigation needs, namely the comparison need, which is similar in both kinds of applications. In OLAP systems comparisons are usually visually performed, together with an interpretation of the data. As the visualization is usually made by means of tables, this comparison way appears appropriate. However, when trying to buy a product, we are given lots of additional information, and so the comparison becomes more confusing. By letting the user know the semantically relevant differentiating attributes (dimension attributes), together with its corresponding comparison operations, we are facilitating the purchase decision adoption and thus improving the interface usability. Once the navigation facilities are clearly defined through the classes and attributes of the system, it is time to go one step further and generate an abstract interface that gathers the main features of the EPC.

4 Generating the EPC front-end

Following the navigation semantics captured in the NAD diagram, a default APD diagram can be generated and, from there, an EPC interface prototype can be derived in an automated way. However, there are some characteristics that can contribute to the improvement of the EPC usability features. Although the rapid development of the web business environment makes difficult the identification of best business practices, some of these features have already been identified in the e-commerce literature [14] and have thus been integrated in the Pattern Catalog [2] already available in OO-$\mathcal{H}$Method. Furthermore, in the e-commerce environment, companies cannot wait, as time means possibly a loss in the market share. So, we consider that, by providing this set of EPC interface patterns, we are helping the designer to identify what works without having to 'try and err', and so they are likely to improve the general effectiveness of the application while shortening the development period. In the next section we are going to show the main EPC patterns applied to our sample application. In OO-$\mathcal{H}$Method there is a set of rules that directly apply to the NAD concepts to generate a default diagram containing a set of Abstract Pages belonging to one of the five possible page templates defined: tStruct, tForm, tWindow, tFunction and tStyle. These rules fall out of the scope of this article.

4.1 EPC Patterns and APD Refinement

The EPC Pattern chapter is, as the rest of the OO-$\mathcal{H}$Method Pattern Catalog, user centered, that is, it provides additional mechanisms to fulfill the user requirements. The EPC patterns captured in the catalog offer alternative solutions to well-known product navigation and visualization problems. Due to the lack of space, in this article we will just show the patterns that have been applied to the default APD generated from the NAD in order to refine it. Next we are providing an informal description of such patterns:

- Comparison Pattern [12]: It gives information about the buying context of the customer. The problem it tries to solve is the lack of confidence of the customer on being getting the best deal when scanning traditional product Catalogs. There, the products are usually shown one by one, without further references among them. To avoid this discomfort feeling and improve the usability of the EPC we need a mechanism to provide comparison information. The solution is to implement a mechanism that allows the customer to compare, at any time, the product s/he is considering to buy according to a set of attribute dimensions previously defined, and allow further navigation through this comparison. There are several comparison possibilities: we can distinguish between bifocal comparison (default implementation), which implies that the product on which the comparison is initiated is never lost, and unifocal comparison, which provides new dynamic navigation collections that become independent of the original product.

– Shopping Cart Visibility Pattern [15]: It provides direct access to the state of the purchase from any page in the EPC. The problem it tries to avoid is the customer not being confortable when adding items to the cart just in case s/he decides not to buy it afterwards. There have been found some e-stores where you could not see what you had bought (and all the data associated, such as shipping costs, total amount etc) until you performed the checkout process, and even then you could just either accept the whole purchase or roll back the whole transaction. The solution is implementing the Shopping Cart as a component reachable from any navigation requirement, either by means of a global menu (default implementation) or by means of links from every page of the EPC.
– Payment Pattern [13]: It provides alternative payment methods in case the customer is not confident on the transaction security. The solution is always provide the possibility to contact a person (either by telephone, by fax etc) and finish the transaction over that other media. The easiest way of implementation, and thus the one by default, is giving on every page the e-mail and telephone of the sales office so that the customer has this information always available. It can also be enriched by means of a help page dealing with the possible payment policies of the store.

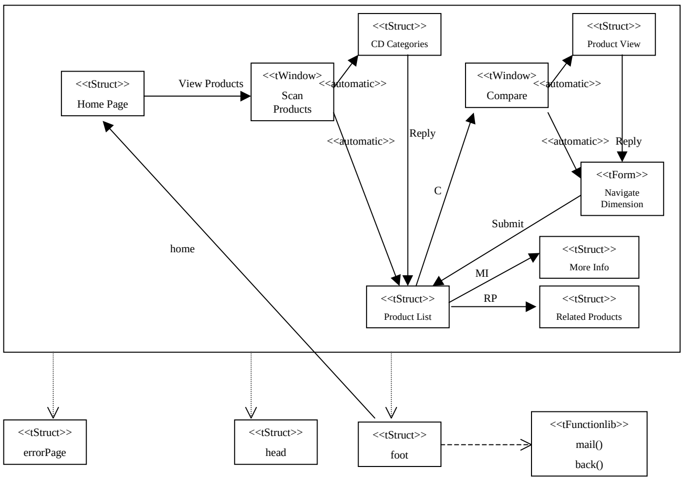


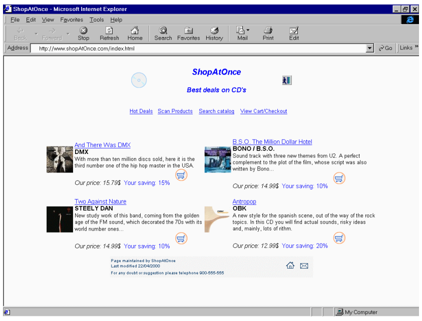
Figure2. *Partial APD of the ShopAtOnce Electronic Product Catalog*

Just note that, apart from these patterns, we have also applied other more general ones, such as the Location Pattern [16] by means of including a header and footer on every page, and the Confirmation Pattern in order to confirm the goods purchase. Figure 2 shows a partial view of the default APD diagram, which has been enriched with the patterns defined above. This diagram describes the Abstract Page Structure of the Scan Product Navigation Targets.

As previously stated, the modeling constructs of the APD consist of a set of templates expressed in XML. From these templates, a materialization strategy allows the automatic generation of the EPC interface in the desired environment. One possible implementation, based on HTML technology, will be described in the following section.

4.2 Generated Interface

Figures 3 to 5 illustrate the prototype generated from the refined APD. The process is as follows: first, the generator tool looks for the Entry Point Collection of the application. In our example the navigation mode is set to ‘index‘, and the chosen interaction technique (whose configuration process goes beyond the scope of this article) is a text menu bar which will remain visible on the top of every screen (see Figure 3).


ShopAtOnce - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit
Address
Go Links
My Computer

http://www.shopAtOnce.com/index.html

ShopAtOnce

Best deals on CD's

Hot Deals Scan Products Search catalog View Cart/Checkout

And There Was DMX
DMX
With more than ten million discs sold, here it is the third number one of the hip hop master in the USA.
Our price: 15.79$ Your saving: 15%

B.S.O. The Million Dollar Hotel
BONO / B.S.O.
Sound track with three new themes from U2. A perfect complement to the plot of the film, whose script was also written by Bono...
Our price: 14.99$ Your saving: 10%

Two Against Nature
STEELY DAN
New study work of this band, coming from the golden age of the FM sound, which decorated the 70s with its world number ones...
Our price: 14.99$ Your saving: 10%

Antropop
OBK
A new style for the spanish scene, out of the way of the rock topics. In this CD you will find actual sounds, risky ideas and, mainly, lots of rithm.
Our price: 12.99$ Your saving: 20%

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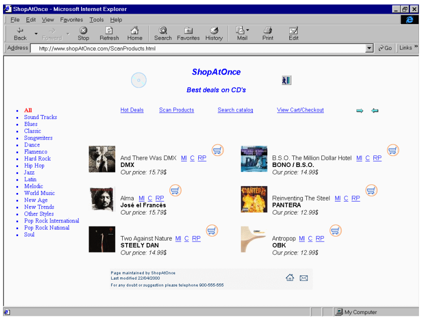
For any doubt or suggestion please telephone 900-555-555

Figure3. ShopAtOnce entry point


ShopAtOnce - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit
Address
Go Links
My Computer

http://www.shopAtOnce.com/ScanProducts.html

ShopAtOnce

Best deals on CD's

- All
- Sound Tracks
- Blues
- Classic
- Songwriters
- Dance
- Flamenco
- Hard Rock
- Hip Hop
- Jazz
- Latin
- Melodic
- World Music
- New Age
- New Trends
- Other Styles
- Pop Rock International
- Pop Rock National
- Soul

Hot Deals Scan Products Search catalog View Cart/Checkout

And There Was DMX MI C RP
DMX
Our price: 15.79$

B.S.O. The Million Dollar Hotel MI C RP
BONO / B.S.O.
Our price: 14.99$

Alma MI C RP
José el Francés
Our price: 15.79$

Reinventing The Steel MI C RP
PANTERA
Our price: 12.99$

Two Against Nature MI C RP
STEELY DAN
Our price: 14.99$

Antropop MI C RP
OBK
Our price: 12.99$

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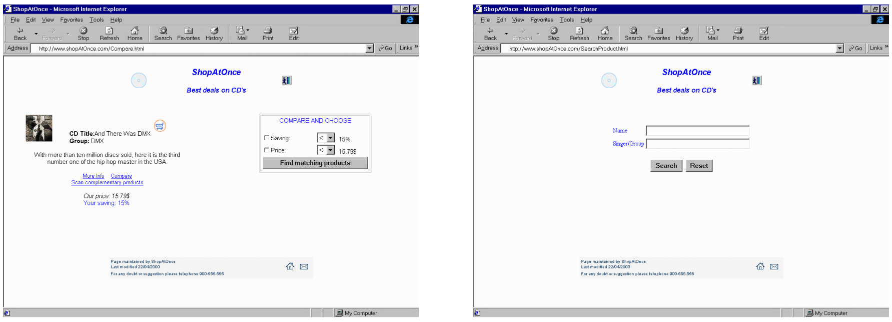
Figure4. ShopAtOnce Scan Products

Moreover, we can observe that the requirement link of the Navigation Target ‘HotDeals‘ has a ‘show all in origin‘ navigation pattern associated. This fact causes the home page to be enriched with the result of selecting all the CD’s categorized as Hot Deals (which is specified by means of the corresponding filter). Besides, as the ShopAtOnce store has decided not to offer anything that is out-of-stock (as stated in the navigation requirements), the condition ‘inStock=true‘ guarantees that all the products listed conform the restriction. Also, the existence of a service link pointing at the ‘addToCart‘ function causes a Cart symbol to appear on every product. Also, we can observe how the information showed is that categorized as always Visible (V) in the NAD diagram. The existence of a link to a more detailed view of a given product is justified by the fact that there is a Traversal Link from the HotDeals NT to the Scan Products NT. As this link is given no name, the identifying attribute of the hotdeal is considered as the linking text.

The generation of the ‘Scan Products‘ screen (see Figure 4) follows a similar process: as there is a Classifying Collection with a ‘show all in origin‘ navigation


ShopAtOnce - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit
Address
Go Links
ShopAtOnce
Best deals on CD's
COMPARE AND CHOOSE
Find matching products
More Info Compare
Scan complementary products
Name
Singer/Group
Search Reset
My Computer

http://www.shopAtOnce.com/Compare.html

CD Title:And There Was DMX
Group: DMX

With more than ten million discs sold, here it is the third number one of the hip hop master in the USA.

□ Saving: < 15%
□ Price: < 15.79$

Our price: 15.79$
Your saving: 15%

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http://www.shopAtOnce.com/SearchProduct.html

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Figure5. ShopAtOnce Comparison Process and Search Facility

pattern associated, this collection will show its structure directly on the page. However, from the collection to the navigation class there is also a ‘show all in origin‘ navigation filter associated. This causes the generation tool to create a tFrame page that makes possible the two simultaneous views. Initially, the first option (show ALL products) is activated. The ‘show all‘ navigation pattern has an ‘items per page‘ attribute associated, which is in this case set to six. This attribute tries to avoid both overwhelming the customer with too much information on a single page and having to scroll through it, and causes the ‘next‘ and ‘previous‘ arrows to appear on the top of the screen. Next to the identifying attribute of the product there are three options: ‘C‘ (for Compare), although we could have designed an icon for a more intuitive navigation) brings the customer to the Comparison screen (see Figure 5). ‘MI‘ would give the user a more detailed view of the class. Although not shown in the storyboard, this page would show all the referenced (R) attributes of the product together with the visible ones, the option of adding the item to the cart and a back button to the previous screen. Last, but not least, the ‘RP‘ link would bring the user to a new screen showing the Related Products (t-shirts of the group, posters and whatever item the customer might be interested in). This link comes from the Li showed in the NAD, and thus the navigation pattern associated also specifies its layout. In order to define the Comparison screen we have to again gather information from the NAD (see Figure 1): we can see the dimension attributes specified on this target. Those are the retailPrice and the percentage saved by the customer that buys at our store over the official price. As stated above, the customer will be able to compare products based on these articles. In order to implement this feature, we have followed a ‘bifocal approach‘: the generation tool automatically generates a reduced view of the main product, and on the right side of the screen it opens a new view which starts by a tForm page. On this tForm we specify both the attributes on which we want to compare, and the operators we want to apply. The operators will depend on the type of attribute. A number attribute will have the options ‘greater than‘, ‘equal‘, ‘distinct‘ or ‘lower than‘. An string attribute will provide the ‘similar to‘ operation and will allow the use of masks. The sample screen for this example can be seen in Figure

5. Once the user has entered the desired values, the system will show, together with the product being compared, an index page containing all the product that match the comparing conditions. The last requirement is that of searching a product either by singer or by CD name. The resulting screen is, again, of the type tForm. When introducing either of the two fields (or both), the resulting page will give you an index page of type tStruct, containing the objects that match your query with all the specified attributes (showall pattern).

5 Conclusions and further work

An EPC has a well defined structure, which facilitates the automatization of many of the processes involved in the construction of e-commerce sites. As an example we could give the Site Server (www.microsoft.com/siteserver) from Microsoft or the Intershop web site (www.intershop.com), where we can find e-commerce general software solutions. However, in order to provide the customer with semantically relevant navigation and facilities through the catalog, the specific characteristics of the product must be taken into account. As an example, we can look for clothes color-matching to the one we are buying, but we rarely will look for a car color-matching to the one we are visualizing. Similarly, a tool that helps the user choose the correct t-shirt size is not usually provided by a general tool. On the other hand, existing OO modeling approaches are usually far too general, and thus obligue to model again and again the same recurrent concepts common to every EPC application, making the modeling experience rather tiring. Moreover, modeling approaches without possibilities of code generation lead to too long development periods, which cannot be afforded by enterprises competing in an e-commerce environment.In this context, the main contributions of our work could be summarized as follows:

- Application and extension of the OO-$\mathcal{H}$Method modeling approach to cover the idiosyncrasy of EPC's.
- The description of the way for obtaining a natural integration of the main OLAP operations (slice, dice, roll-up, drill-down) in an OO-$\mathcal{H}$Method model.
- The extraction of some usability concepts and its capture in the model by means of patterns with its corresponding APD materialization.

We are aware that the code generated up to now is much simpler than that provided by some commercial wizards. Even if has been proven that appalling interfaces do not seem to have much impact on the purchase attitude, we are currently working on the improvement of this design appearance by constructing a new tool that, departing from the Abstract Pages, give the designer more control both on the different interaction techniques and on the layout of the elements. Also, we are interested in the integration of the catalogs generated with OO-$\mathcal{H}$Method with other EPC systems. There are several alternatives, one of which could be the integration with the eCo System, a framework developed at CommerceNet(www.commercenet.com). As we are already generating abstract pages defined in XML, we think that, whatever the approach finally taken, the translation process will be rather straightforward. The interaction among systems is necessary in order to interact with software agents and search engines.

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