DY*N*AMO in Action
Development and use of a Web-based design tool for architecture

Ann Heylighen and Herman Neuckermans

Department of Architecture
University of Leuven, Belgium
ann.heylighen@asro.kuleuven.ac.be | herman.neuckermans@asro.kuleuven.ac.be
http://www.asro.kuleuven.ac.be/asro/english/onderz/caad.HTM

Abstract
Addressing the subject of Case-Based Design (CBD), the paper describes the development and use of a Web-based design tool called DY*N*AMO. The tool is firmly rooted in the Dynamic Memory Theory underlying the CBD approach. Yet, rather than adopting it as such, we have tried to enrich this approach by extrapolating it beyond the individual. This extrapolation stimulates and intensifies several modes of interaction. Doing so, DY*N*AMO tries to kill two birds with one stone. At short notice, it provides architects and architecture students with a rich source of inspiration, ideas and design knowledge for their present design task, as it is filled with a permanently growing collection of design cases that is accessible on-line. Its long-term objective is to initiate and nurture the life-long process of learning from (design) experience as suggested by the cognitive model underlying CBD, and Case-Based Reasoning in general. DY*N*AMO is therefore conceived as an (inter-)active workhouse rather than a passive warehouse: it is interactively developed by and actively develops the user's design knowledge. Whereas previous papers have focused on the theoretical ideas of DY*N*AMO, this paper points out how Web technology enables us to implement these ideas as a working prototype. Furthermore, an annotated scenario of the system in use is described.

Keywords
Case-Based Design, Web technology, architectural design

Introduction
Case-Based Design is one of the applications of Case-Based Reasoning (CBR), a theory and technology within the field of Artificial Intelligence based on a memory-centered view of cognition (Kolodner 1993). DY*N*AMO, the design tool described in this paper, can be considered a CBD tool in so far that it was inspired by the Theory of Dynamic Memory underlying this cognitive model (Schank 1982). Yet, rather than adopting it as such, DY*N*AMO, which stands for Dynamic Architectural Memory On-line, tries to enrich this model by extrapolating it beyond the individual. This extrapolation comes down to stimulating and intensifying interaction, not only between a single user and a computer system, but also between design cases, among (student-)designers and between architectural practice and education.

DY*N*AMO's objective is twofold. At short notice, it provides architects and architecture students with a rich source of inspiration, ideas and design knowledge for their present design task, as it is filled with a permanently growing collection of design cases that is accessible on-line. Its long-term objective is to initiate and nurture the life-long process of learning from (design) experience as suggested by the cognitive model underlying CBD, and CBR in general.

DY*N*AMO is therefore conceived as an (inter-)active workhouse rather than a passive warehouse: it is interactively developed by and actively develops the user's design knowledge. Previous papers have focused primarily on the theoretical ideas of DY*N*AMO. By contrast, this paper points out how Web technology enables us to implement these ideas as a working prototype and describes an annotated scenario of the system in use.

Why Web technology?

In (Heylighen & Neuckermans 2000), we have given a description of the 'ideal' DY*N*AMO, a design tool that supports (student-)architects during conceptual design by means of concrete design cases, while respecting the complexity and richness of architecture (Heylighen 2000). Translating these theoretical ideas into specifications for a concrete tool, at least three preconditions must be fulfilled:

1. Cases must be represented with as much and as varied information as possible. Furthermore, they should be easily connected to other cases, as these are to act as background knowledge for their interpretation.
2. The case base should be simultaneously accessible to users at different locations – student designers in architecture schools and professional architects in design offices.
3. The content and structure of the case base must be able to change dynamically as it is used.

With these three demands in mind, we have chosen a Web-based approach to build our prototype. Using Web technology to build a working prototype of DY*N*AMO has several advantages. DY*N*AMO should be able to provide users with a case representation that is as varied and as rich as possible. A first advantage of Web technology is that it supports virtually any format of (digital) information, ranging from text and images over video and sound to CAD and even VR models. Web browsers have evolved in such a way that they can display most of these formats, and if not, the Web still allows to exchange the information. Furthermore, by using HyperText, information about one case can easily be linked to information about other cases. Secondly, the Web makes DY*N*AMO accessible to various users spread around the world. If we store the case base on a server machine, any architect or architectural student who has access to the Internet and disposes of a standard Web browser, can consult the tool. Moreover, although DY*N*AMO provides users with a large amount of information, this information does not occupy any disk space on their personal computer, since it is stored once on a central server machine. An additional advantage of adopting a Web-based approach is that today many people, and especially students, have grown accustomed to using the Web. This means that they are already familiar with the interface of the programme, and thus will probably learn to use the tool without much effort.

Most documents on the Web are written in HyperText Markup Language (HTML). Yet, if we want to build a convincing prototype of DY*N*AMO, simply filling its case base with HTML files will not do. Indeed, in order for the tool to be dynamic, users must be able not only to consult the case base, but also to manipulate its content and structure. HTML pages, however, are static in nature: they do not change unless someone manually edits the file and alters the content. In other words, each time the content or structure of the case base changes, every single HTML file containing information that is affected by this change needs editing. A way out for this problem is offered by the Common Gateway Interface (CGI), which connects Web servers to so-called CGI scripts (Craig 1996). In essence, a CGI script is a software programme that communicates with Web documents. Via the gateway, such scripts can receive input from and send output to

Web Browsers, which allows to create much more dynamic and interactive Web pages than HTML as such.

CGI scripts can be written in almost any programming language. For our prototype, we have chosen to write scripts in PHP, a server-side, cross-platform, HTML-embedded scripting language (Web_PHP 2000). Our choice was motivated by the fact that, unlike most other scripting languages, PHP was developed specifically for the task of programming for the Web, which allows to create much more powerful Web applications. A very interesting feature of PHP scripts is their fast access to commercial databases. In DY*N*AMO, we have opted to structure and organise memory by means of a Microsoft® Access database. Via an Open Database Connectivity (ODBC) driver, Access databases can communicate with PHP scripts. In summary, PHP scripts seem to be cut out to put dynamics and user interaction into our DY*N*AMO prototype, as they can (a) receive input from DY*N*AMO users via CGI, (b) based on this input, either look up information in or manipulate DY*N*AMO's database via ODBC, and finally (c) send the result of this operation via the server back to the user.

In addition to PHP, a second scripting language we have used to build our prototype is JavaScript. Although, at first sight, JavaScript shows striking similarities with PHP, there is an important difference between both. PHP code is read and executed at the server side and remains completely opaque to clients. JavaScript code, on the other hand, can be read and executed by a Web browser, i.e. at the client side (Kentie 1996). Yet, why should DY*N*AMO want to execute programmes at the client side? PHP scripts, as we have pointed out, are able to receive input
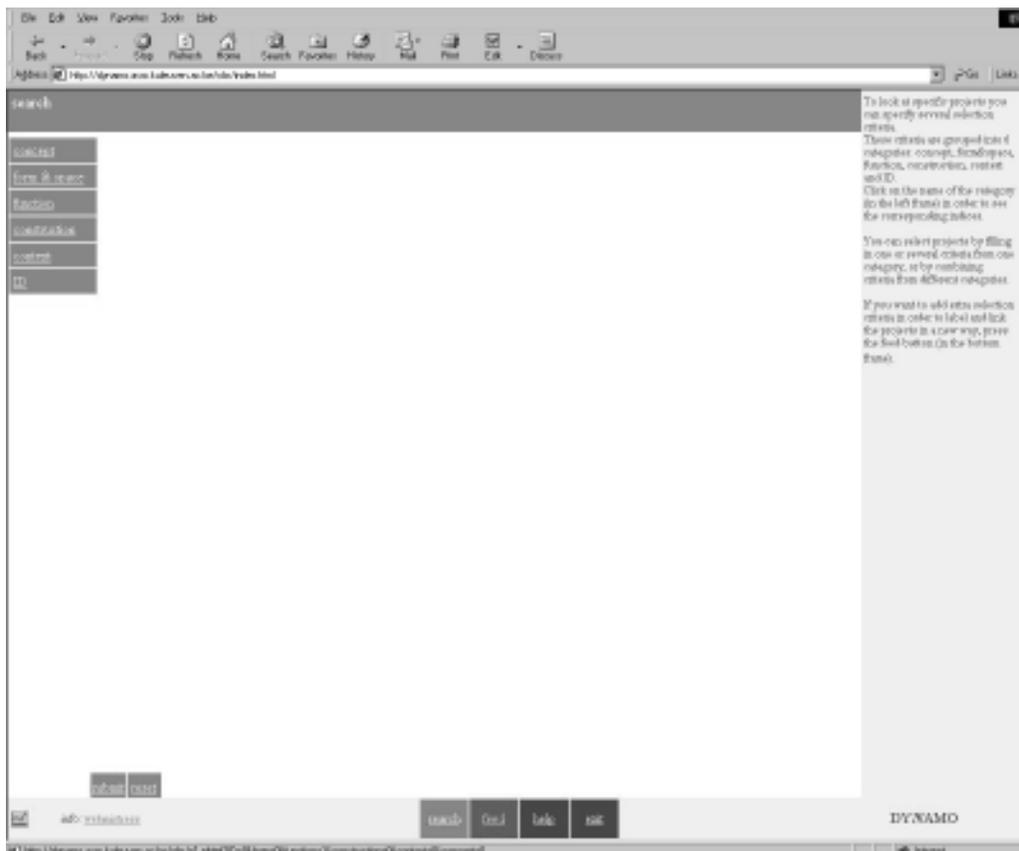

Figure 1.
DYNAMO's
clusters of
search
criteria.

from DY*N*AMO users, and use this input to query or manipulate the database. User input can be obtained in several different ways, for instance by asking the person who views a Web page to press a button, tick an option in a check box or fill in a form. Equipping DY*N*AMO's Web pages with JavaScript allows us to check this user input before it is sent to the server and, in case of incorrect or incomplete information, immediately prompt the user to adjust it. Obviously, it is much more efficient and timesaving to perform this check at the client side, as it saves users from having to wait until the connection with the server is established. Only when the user input is complete, the information is transmitted to the server side and processed by the PHP script. Taken together, PHP and JavaScript thus enable us to meet the demand for dynamics in our tool at both server and client side.

A possible user scenario

Using the technology outlined in the previous section, a first prototype of DY*N*AMO has been built (Segers 1998), and has subsequently been further developed, extended and refined (Heylighen e.a. 1998; Heylighen and Neuckermans 2000). In essence, the prototype consists of three major ingredients: 1. a collection of design cases – the actual memory content of DY*N*AMO; 2. an underlying database that organises and structures this memory; and 3. a user interface allowing to both consult and modify memory. The memory content and structure are stored at the server side, the interface consists of a standard Web browser at the client side. Rather than describing each of these ingredients in more detail, however, we will introduce the prototype by showing it in operation. We will present an annotated scenario of the system in use.
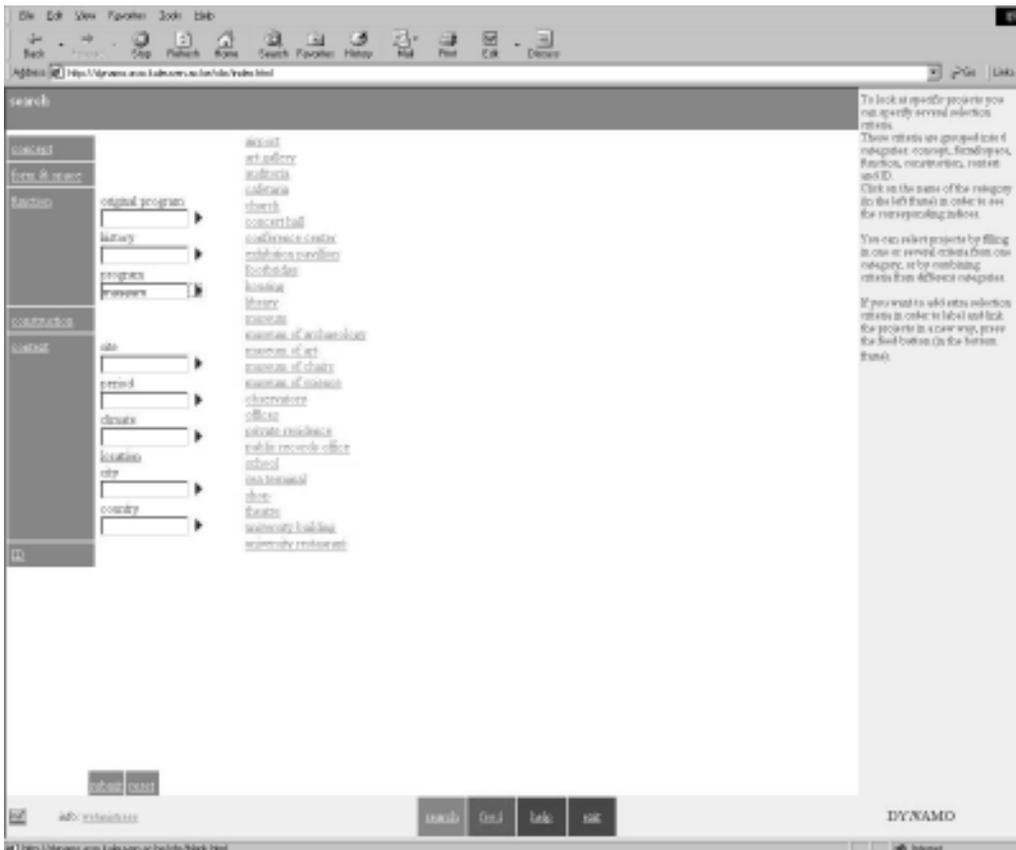

Figure 2. Clicking on the cluster 'function' causes to appear the criteria it comprises.
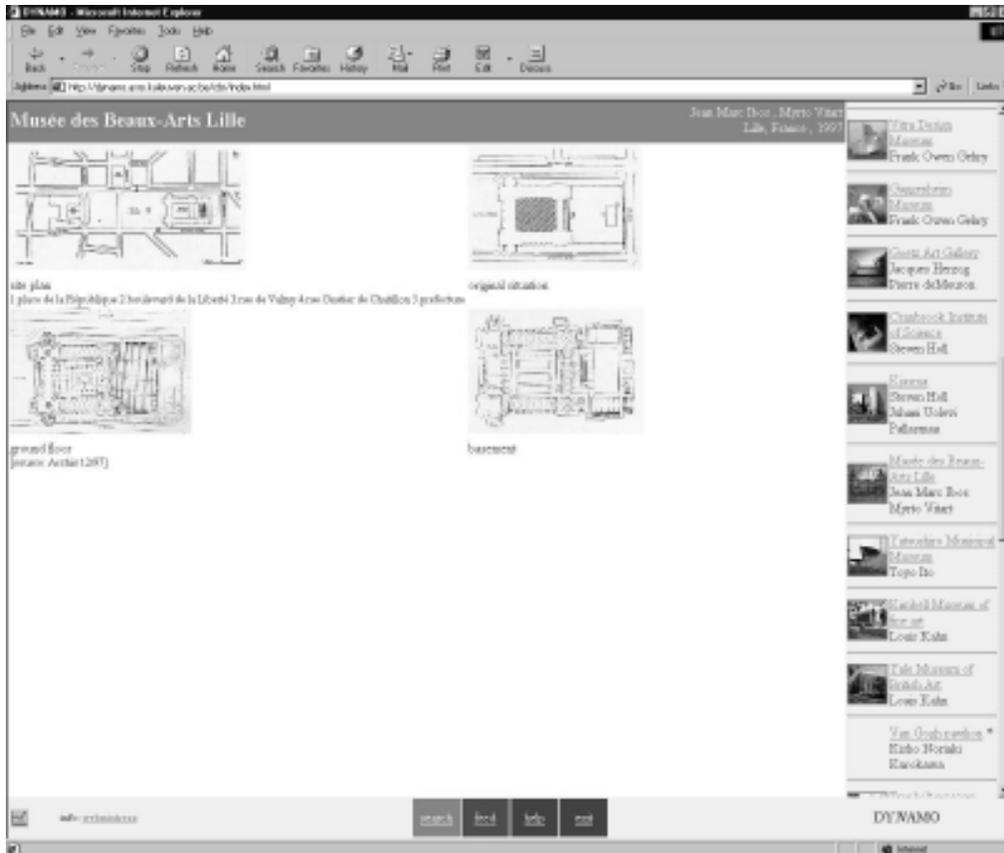
The scenario describes how a DY*N*AMO user perceives and interacts with the tool. To place yourself in the proper context, imagine yourself in a design office or studio, as a (student-) architect involved in the task of designing say a ceramic museum on an urban site. You have just read the brief and you are looking for ideas to get started.

You start up DY*N*AMO by typing its URL in a standard Web browser. Figure 1 shows the first screen you see after logging on. Along the bottom edge of the screen, user control buttons allow to exert control over your interactions at any moment, by switching from the search to the feed mode (or vice versa), asking for help, quitting the programme or starting over with a new search. When opting for the search mode, as you apparently did in figure 1, you are presented with six clusters of search criteria: ID, concept, form&space, function, construction and context. Clicking on the name of a category causes to appear the criteria or so-called indices it comprises (figure 2). You may request cases that show one specific feature, or cases that meet a combination of criteria from one or more categories. In order to do so, you simply fill out the index field(s) of interest. Alternatively, you may press the arrow next to the field(s), in order to get a list of index values that are currently available in the case base. In the screen shot presented, you have selected the category *function*, pressed the arrow of the index *current programme*, and selected the index value *museum* from the list. Upon submission, DY*N*AMO displays a list of cases that meet the criteria you specified. The rightmost frame in figure 3 gives an overview of all projects in DY*N*AMO with the functional programme museum. Projects marked with an asterisk (*) are newly entered, which means that they have not yet been examined for correctness and completeness.

Figure 3. The rightmost frame gives an overview of all projects in DYNAMO with the functional programme museum, the leftmost frames display information on one particular museum.

Figure 4. The white frame in the middle gives a preview of the plans available.

In order to have a closer look at a particular case, you can click on the corresponding name or thumbnail picture, after which more detailed information on the project appears in the frames on the left. Judging from the dark grey top frame, you want more information on the extension of the Musée des Beaux Arts in Lille designed by Ibos & Vitart. In addition to the name of the building and architect(s), this frame displays the location of the project – both city and country – as well as the period in which it was designed and/or built. The white frame in the middle displays a photo of the selected case together with an overview of what information is currently available on the project. At present, the case content of the Musée des Beaux Arts comprises several drawings (plans and sections), photographs (both interior and exterior views), a bibliography and two articles from architectural magazines. Each piece of information can be viewed by simply clicking on the corresponding link. When selecting the link *plans*, for instance, you first get a preview of the different plans available – a plan of the site, existing situation, ground floor and basement (figure 4). One additional mouse click allows to view the plan of your choice in more detail.

Returning to the screen of figure 3, the frame on the left lists the characteristics of the project at stake. Additional characteristics can be specified by pressing the *add info* button and completing one or more fields in the dialogue box that pops up (figure 5). If, after having viewed the information available, you want to share your view on the project with other DY*N*AMO users, the *discussion* button leads to a dialogue box for writing and submitting an on-line comment. Once you are done with the Musée des Beaux Arts, you have the opportunity to
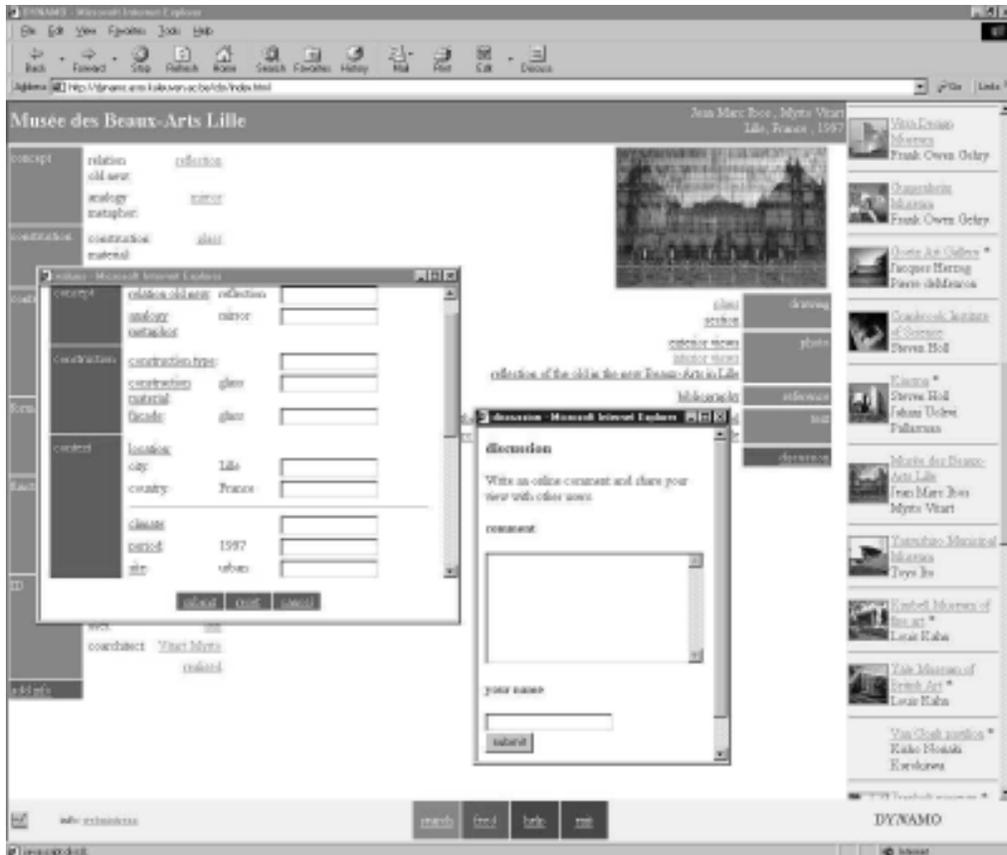
Figure 5. Dialogue boxes for adding information and on-line discussion.

browse to other cases that have features in common with the project at issue. When you click on one of the characteristics in the left-hand frame – for instance, the spatial configuration *underground* – the rightmost frame will display a new list of projects that share the selected characteristic. Alternatively, you may start a new search or switch to the feed mode by using the control buttons at the bottom of the screen.

Apart from specifying extra characteristics and writing on-line comments, there are two ways in which you can feed the case base: either by submitting information on a case or by creating a new (kind of) index. Imagine you got quite curious about Ibos & Vitart's museum, even to the extent that you decide to pay it a live visit. Once returned from your trip to Lille, you may want to share the photos you have taken with other DY*NA*MO users. When selecting the option *case submission*, a dialogue box requests you to fill in the case's ID – architect, building and your name (figure 6). Pressing the arrows next to the former two fields calls up a list of architect and building names that are currently available in the system. This allows you to check whether the case is already present in the case base and helps avoiding spelling mistakes. Since the Musée des Beaux Arts is indeed mentioned in the list, you can complete the case's ID by a simple mouse click. In order to add your photos to this case, the lower half of the screen asks you to select the *file* you want to submit, specify the *type* of the file (e.g. 3D model, text, drawing or, in this case, photo), give a concise *description* of the information it contains (view of the entrance hall, for instance) and identify the *source* of the information (figure 7). If this source is a document on the Web, you do not have to select the file, but instead fill in the *URL* so that the system can create a link to the file. As soon as these data are submitted, a new dialogue box pops

Figure 6. Case submission in DYNAMO (I).

up with the request to specify as many optional indices as possible (figure 8). Upon pressing the submit button, the project's indices are updated in the database, while the photo is transmitted to the subdirectory 'Musée_des_Beaux_Arts' in the directory 'Ibos_Jean-Marc' on the server. The procedure to submit information on a new case is completely analogous, the only difference being that you have to type the ID features instead of selecting them from the list.

Apart from adding information on cases, however, you can also feed the case base by creating a new index. If you like colourful architecture, for instance, you may want to label and link projects by colour. In order to do so, DY*N*AMO asks you to specify the index name (in this case *colour*), type of index (verbal, numeric or multiple), and give a concise description of what the index name denotes (for instance, 'main colour of the façade'). Because it is very important to choose a unique name for each index, the arrow next to this field once again allows to display a list of all index names that are already available in the system. As soon as you submit the required information, a new column is created in the cases table of the database, which allows, from now on, to label and select cases by their colour.

Current status and further development

At present, DY*N*AMO is a working prototype that contains more than 80 indexed cases from 53 different architects. Cases are labelled and linked by 17 (kinds of) indices, which are clustered into six categories. Whereas access to the first version was mainly a privilege of Netscape® users in Windows environments, the prototype has meanwhile made substantial progress in terms

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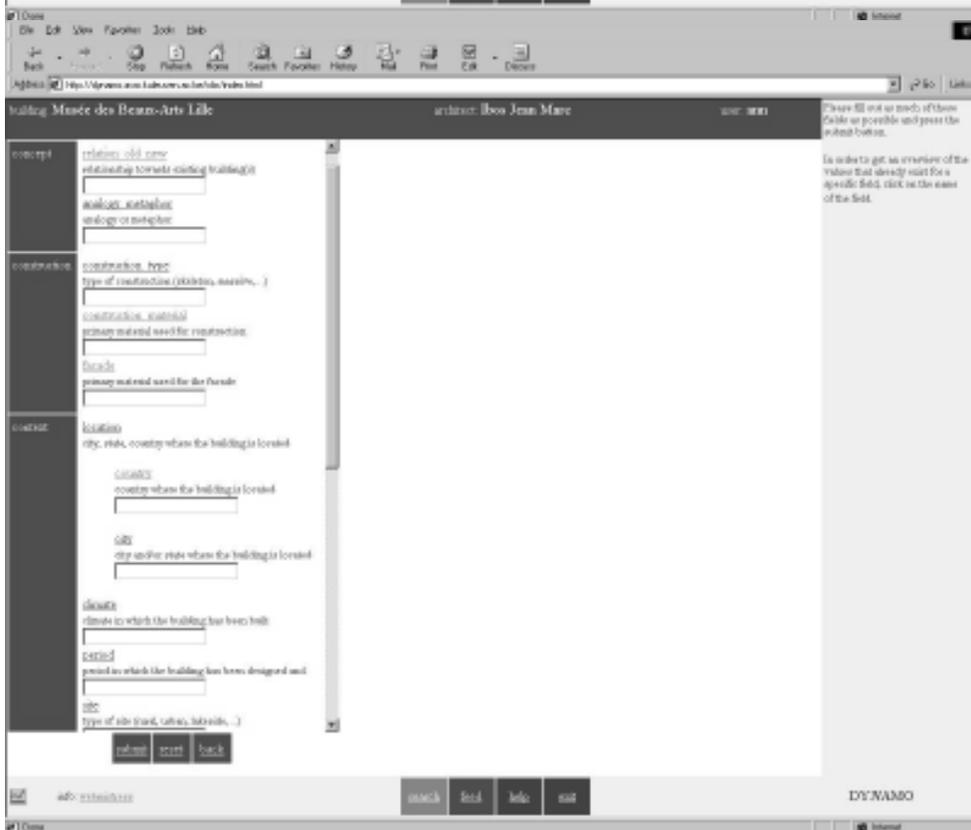*Figure 7
Case
submission in
DYNAMO (II).*

*Figure 8.
Specifying
optional
indices.*

of compatibility. The most recent version has been tested successfully on several browsers, machines and platforms, including UNIX (SGI O2) and Apple (Apple PowerMac 7100 and 7200). Despite this improvement, however, DY*N*AMO remains a prototype system and should be further developed from a prototype into a fully-fledged design tool, so as to account for user needs it is currently unable to deal with effectively. This development first of all requires its integration within IDEA+, an Integrated Design Environment for Architecture that aims at supporting architects from the very start of the design process (Hendricx e.a. 1998). The role of DY*N*AMO in this environment is to provide IDEA+ users with a rich source of inspiration and information in the form of design cases. In order to fully integrate the process of consulting cases with the design process, users must be able to swiftly go back and forth between the case base on the one hand and the IDEA+ modeller, i.e. the module they are using to develop their design, on the other hand. In this respect, the ideal would be if DY*N*AMO could be accessed from within the modeller itself instead of through a Web browser, as is currently the case.

Acknowledgements

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