An architectural Shift+F7
Supporting Concept Development Through Design Cases

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Abstract

This paper describes the linking of Idea Space/E3dAD, a system that captures and interprets the architect's ideas with DY*N*AMO, a dynamic memory of design cases, to support concept development in architectural design. So far, a major obstacle for the breakthrough of digital case bases like DY*N*AMO has been the separateness of these tools from the architect's working environment. Having to leave this environment to consult a case base inconveniently interrupts the design process. The remedy proposed in this paper was inspired by the Shift+F7 shortcut in Ms Word®. Just like this shortcut allows authors to look up synonyms in a thesaurus without having to leave the text, linking Idea Space to DY*N*AMO enables architects to trigger case retrieval 'en passant', that is during the very act of designing.

1 Intro – supporting concept development in architectural design

Implicitly or otherwise, every tool that aims at supporting architects' design process implies a value judgement of architecture. There are different viewpoints to assess the value of architecture, and along with the viewpoint the judgement may vary. At one time in history considerations of form determined architectural quality, later functional ones. Today we assume that what makes an architectural design valuable is its underlying idea. As Bryan Lawson contends, "Good designs often seem to have only a very few major dominating ideas which structure the scheme and around which other relatively minor considerations are organized" (Lawson, 1994). There is nothing wrong with taking this view, provided we are clear about it being *our* view at *this* moment.

The ideas underlying an architectural design are known to architects by many names, ranging from 'image' (Alexander, 1979) over 'primary generator' (Darke, 1978) to 'organising principle' (Rowe, 1987), but most often are called the 'parti' (Leupen e.a., 1997) or 'concept' (Lawson, 1994). They do not necessarily require the addition of an extra ingredient. In fact, every aspect already present in the design situation, e.g. a special feature of the site or programme, or a curious trait of the client, may qualify for this role. Moreover, underlying ideas are rarely found in the singular. In the Institut du Monde Arabe in Paris, for instance, Jean Nouvel combined the need for

sun shading with a ‘Moucharabieh’ pattern and the idea of a light-controlling diaphragm in a camera lens (Sharp, 1990).

The use of these underlying ideas of the design, is constructive in nature and similar to a dialogue (Schön, 1983). Tom Witt compares this process with telling oneself stories (2000). In order to tell a story, that is to explore and communicate their ideas, architects/designers combine different kinds of information and representation. Whereas other research has concentrated on sketches and diagrams (Deering 1996; Gross e.a., 1994, 1996; Igarashi, 1999), this paper focuses on everything the architect/designer jots down: from loose keywords, annotations to images and sketches, labels in schemes, descriptions of ideas, etc.

Coming up with a concept is one thing, translating this concept consequentially into a built artefact is yet something different. Indeed, what makes designing good architecture extremely difficult – and at the same time extremely fascinating – is that this translation is far from straightforward a procedure. Unless there is consistency and continuity from the earliest conceptual phases right through design development to detailed design, those important underlying ideas will get lost. Apparently, this ‘hanging onto the big idea like grim death’ is something architects/designers tend to struggle with (Lawson, 1994). Speculating about digital media in architectural design, the question rises: Can computer technology improve the consistent development of design ideas?

In this paper, we propose to combine two tools as a way of supporting concept development in architectural design (see Figure 1):

1. a design idea recorder/interpreter/associator
2. a case base of architectural designs

E3dAD / Idea Space is a prototype for capturing and interpreting the architect's design ideas (Segers et al., 2001). All design ideas captured are put into a gigantic network, where nodes are words, sketches and images, and where links are relations in meaning of the words and relations made by the user (i.e. time, place and gestures). The interpretation of the design ideas is used then for associative suggestions by the system. The case base is DY*N*AMO, a growing online collection of design cases (Heylighen and Neuckermans, 2000). Each case is represented by a mix of media and characterised by various features, including the underlying concept(s) of the design.

Whereas Idea Space provides architects with an overview of their own, personal ideas, DY*N*AMO can provide examples – both successes and failures – of how related ideas have been developed into built artefacts by other architects. To some extent, the connection between both is analogous to the Shift+F7 shortcut in Ms Word®. Just like this shortcut allows authors to look up synonyms in a thesaurus without having to leave the text they are writing, linking Idea Space to DY*N*AMO enables architects to retrieve relevant cases ‘en passant’, that is during the very act of designing. The architectural Shift+F7 has the advantage of combining a personalised design space – where architects can feel free to jot down just anything – with a collective space – where they can find and share with others interesting insights and ideas.

In the following sections (2 and 3) we describe these two main components of our architectural Shift+F7, after which section 4 switches attention to the connection between both. We conclude by briefly mentioning topics for future research.

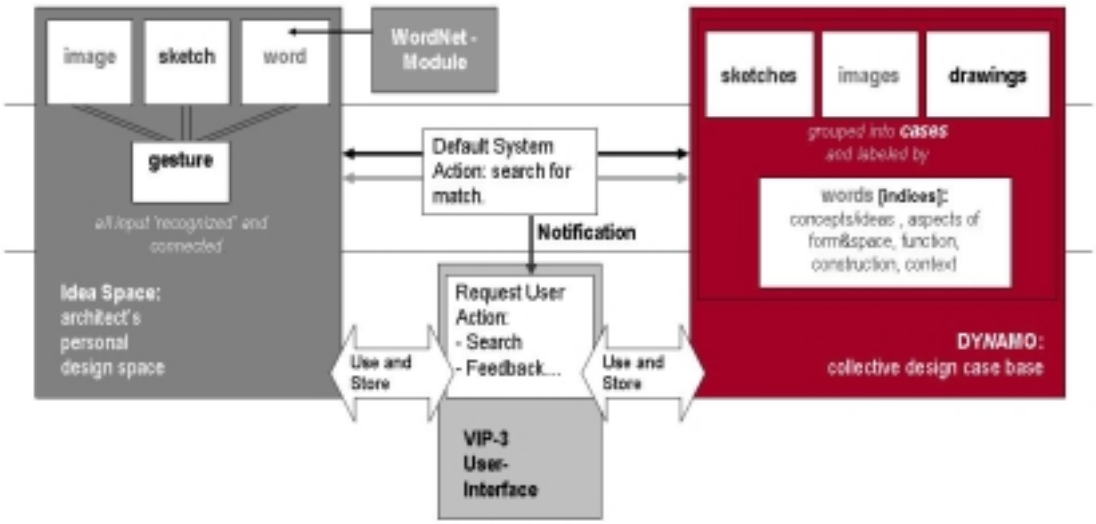

Figure 1: Scheme of the architectural Shift+F7

2 Idea Space

Architects, we have mentioned, do not only sketch during design. They combine different kinds of information and representations. We contend that all design information represented should be seen as small parts of ideas and contextual information, which are used to construct the design, to dialogue, or to tell stories. All these elements are captured and constitute a network, as if part of the frame of reference is being made explicit. This network of information is called the Idea Space. The Idea Space is part of the E3dAD system, and focuses particularly on everything the architect writes down. We can think of descriptions of ideas, the annotations to writing, images and sketches, further more loose keywords and the writing in schemes or schemas.

The combination of text, image, sketch and/or draft can provoke new associations, which keep the design process going. An overview of all representations supports the architect in combining the different kinds of information. Finke et al. (1992) have defined cognitive structures used in creative cognition, and of particular importance amongst these are so-called *pre-inventive structures*. Pre-inventive structures are internal representations like novel visual patterns, object forms, mental blends (conceptual combinations, metaphors and blended mental images), category exemplars, mental models, and verbal combinations. These are made explicit in sketches and writing. In doing so architects provide themselves with an external memory, visual cues for association and a physical setting in which thoughts are constructed. Suwa et al. (1998) have stated this for sketches, but in fact it holds for every representation that architects use.

In Idea Space all representations can be used and are placed next to each other, so they can interact in influencing the architect's development of ideas. Creative cognitive processes serve to generate and explore the pre-inventive structures. The ideas that are made explicit (sketches, text) can be altered or related to other ideas.

Ways of doing so are making changes in attributes or contexts of ideas, or making combinations with other parts of the network. In all cases new relations and ideas are formed.

While designing and putting ideas on paper, all information that is made explicit by the architect/user is captured by the system. The system deals with words, sketches and images as being nodes of a huge network of information (the Idea Space). To begin with, relations between nodes are made by the user: what ideas are put down in a particular brief space of time, what ideas are written next to each other, and what ideas are connected by marks like arrows, frames or encircling. Additional links are made by the system. In trying to 'understand' what the architect has written, the system analyses all written information by checking words in pairs in Wordnet (Fellbaum, 1998). Wordnet is a lexical reference system the design of which is inspired by current psycholinguistic theories of human lexical memory. English nouns, verbs, adjectives and adverbs are organised into synonym sets, each representing one underlying lexical concept. Different relations, like antonyms, hyponyms and meronyms, link the synonym sets. The relations or links in the Idea Space are then named.

With this information, the system is able to identify regularities, structures or patterns in the Idea Space in two ways. It searches for keywords that the architect uses often and compares to what words or sketches these were related earlier in the design session, or in former design sessions. In addition, it searches for returning combinations of types of links. We can think of structures consisting of 'synonyms' versus 'antonyms'. These regularities or structures are used to provide the user/architect with feedback during design.

Feedback from the system is twofold: an overview of ideas (the idea space) with the possibility to represent them in multiple ways (restructured or not), and suggestions for continuing development of ideas (associations). The overview of ideas is related to a certain period or (combination of) word(s). The user can retrieve the ideas that s/he came up with in a certain period and see them as put on ‘paper’. Since such an overview helps reflecting on these design ideas, the system acts as an advanced diary. Optionally the relations made by the system can be displayed too, which is especially interesting when words are related indirectly. For by showing the intermediary word(s) as well, the system might make the user aware of certain relations or give new ideas: suggestions for continuation. The user can also retrieve the ideas related to a specific word or combination of words. In time one might have thought differently about an idea or issue while designing. When looking back at words, sketches or images previously associated, one may be remembered of something important or perhaps even see a development and proceed to the next step. In this case the system can be considered a sort of design partner. The regularities in the network do not only provide the system with the most suitable structure to present the Idea Space to the user; they also serve as input for the system to suggest associations. In this way the system aids the architect in associative reasoning. It may discover gaps in the structures and then make a suggestion to user. Furthermore, if the user requests a certain type of association, the system can provide different items related to a word, which can be useful in brainstorm sessions.

3 DY*N*AMO – A Dynamic Architectural Memory On-line

The second component of our architectural Shift+F7 is DY*N*AMO, which stands for Dynamic Architectural Memory Online. DY*N*AMO is a collective Web-based design assistant that tries to kill two birds with one stone.

At short notice, it provides architects with a rich source of inspiration, ideas and design knowledge, as it is filled with a permanently growing collection of design cases by and from different architects. Especially in the early, conceptual stage of the design process, previous design cases provide grist for a number of decisions to be made (Domeshek and Kolodner, 1992). Being themselves end results of initial concepts, cases are cut out to illustrate how a particular idea can be pursued through all aspects of an architectural design.

DY*N*AMO's long-term objective is to initiate and nurture the life-long process of learning from (design) experience as suggested by the cognitive model underlying Case-Based Design (CBD). Being rooted in the Theory of Dynamic Memory, this model claims that human memory is dynamically changing with every new experience (Schank, 1982): it acquires new cases by storing fresh experiences in memory; re-indexes cases that are not immediately stored in the right place; and generalises individual cases that belong under the same heading. Inspired by this model DY*N*AMO is conceived as an (inter-)active workhouse rather than a passive warehouse: it is interactively developed by and actively develops its users' design knowledge. Its most important feature is not merely that it presents cases, but that those cases trigger in-depth explorations, stimulate reflection and prime discussions between architects/designers in different contexts and at different levels of expertise. Physically, DY*N*AMO consists of:

1. a growing collection of cases – the actual memory content: Cases are entire building designs, both built and unrealised projects, and are represented by a mix of text, photos, graphics, 3D models, facts and figures, video and sound.
2. a database that structures this memory: In this database, each case is characterised by various features, so-called indices, which serve as filter criteria during retrieval and as links to other cases having common characteristics. These features include the underlying concept(s) of the design as well as aspects of form and space, function, construction and context. If we consider cases encapsulations of design knowledge, this web of indices further enhances each case's value. It allows users to approach a project from different perspectives and to situate it in relation to other projects.
3. a user interface to consult and modify memory: The interface allows users not only to consult and navigate between cases in memory, they can also change and improve memory as suggested by CBD's cognitive model, i.e. by adding new projects (possibly self-designed), making links between them or creating extra indices.

The case collection and database are stored at the server side; the interface can be viewed with a standard Web browser at the client side (Figure 2).

Confrontations between DY*N*AMO and potential users have been surprisingly successful (Heylighen and Neuckermans, 2001a, 2001b). Despite the tool's prototype nature, both student and professional architects have reacted favourably to using it during design and would like to use it again for future design tasks. A major drawback, however, seems to be the tool's separateness from the architect's actual design environment. As already mentioned, DY*N*AMO can be accessed through a

standard Web browser. User friendly as such browsers may be, they are not particularly compatible with an architect's designerly way of working, especially not during concept development.

In a pilot study with professional architects, for example, videotapes clearly illustrated the gap between DY*N*AMO on the one hand and the designer's paper and pencil on the other hand. The architect must first realise that previous cases may provide useful information, try to find relevant cases in DY*N*AMO (which is the convenient shortcut for: switch to the browser, type in the URL, specify one or more selection criteria, screen the cases that meet these criteria and pick out the relevant information), and finally carry the information back to the paper and pencil environment. Each step of this process – realising that cases may be useful, finding relevant ones, and transferring the corresponding knowledge to the design – interrupts the design process considerably.

In order to fully integrate the process of consulting cases with the very act of designing, users must be able to go swiftly back and forth between their design environment on the one hand and a case base on the other hand. In this respect, the ideal would be if DY*N*AMO could be accessed from within the design environment itself instead of through a Web browser, as is currently the case. Therefore we propose a scenario for case retrieval that is interwoven with the architect's activities during concept development.

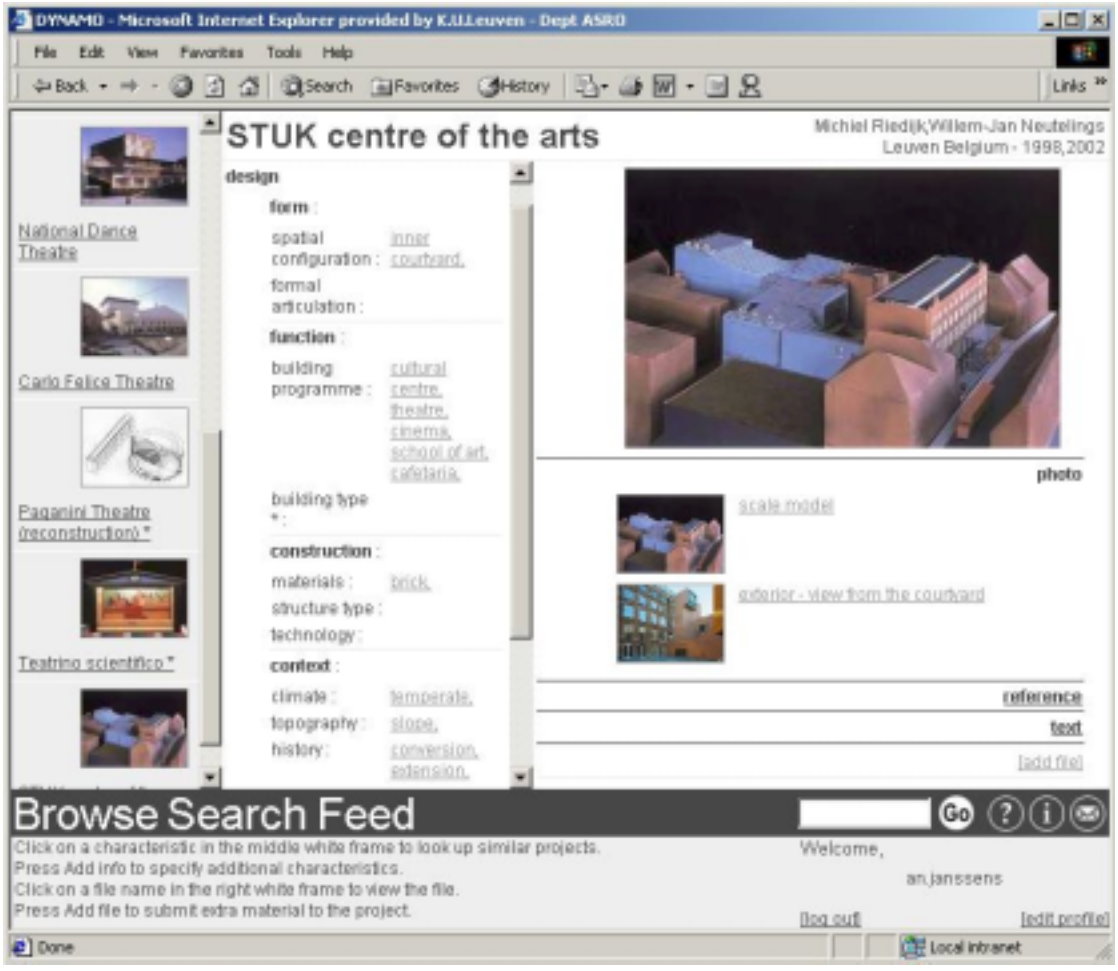

Figure 2: Screen shot of DY*N*AMO

4 Triggering case retrieval by design ideas

The scenario we propose makes use of the Visual Interaction Platform (VIP), developed at IPO/ Center for User-System Interaction (Aliakseyeu et al., 2001). VIP's major advantages are that action and perception spaces coincide, two-handed interaction is possible, and multiple users can collectively interact at the same time, using separate interaction elements. Using VIP feels like working on real paper, be it that this paper is augmented with a projection of a virtual paper. In case of the architectural Shift+F7, the latter contains both Idea Space and DY*N*AMO. Since action and perception spaces coincide, there is no interruption of the design process. The architect/user writes things down, makes sketches, and can consult Idea Space and/or DY*N*AMO whenever s/he likes. By adding all information on the real paper (captured by the system and made virtual as well) and the 'virtual' paper, the Idea Space of nodes and links is being constructed on the fly.

How then does this architectural Shift+F7, i.e. the connection between Idea Space and DY*N*AMO work? Idea Space recognises the different representations used by the architect, whereby words are treated in a special way: the Wordnet-module searches for word-pairs, having a semantic or lexical relation. DY*N*AMO for its part uses these words or word-sets as input to continuously search the case base. If a word(-set) coincides with the content of a case's index (i.e. with its underlying concept or an aspect of its form and space, function, construction or context), a notification pops up in the perception space. If interested, the architect can study the case in more detail and/or browse to related cases. Moreover, the architectural Shift+F7 allows inserting images, sketches, or text from DY*N*AMO into the Idea Space, either by making a reference or by simply dragging the material into the network. The advantage is that, at all times, the architect can trace back which information from other designs/cases was used as hint, source of inspiration or solution. This also works the other way around: starting from material (i.e. an image, sketch or text) from DY*N*AMO one can detect when and where in the design process this information was used, since this is all stored in Idea Space.

DY*N*AMO offers access to cases through various issues that are at stake during design. Suppose, for instance, that the architect is thinking of using windows that provide a wide view for the user of the building to be. If this quality, of windows providing a wide view, is not explicitly mentioned in the case base, the architect can browse through the cases and label and link the relevant ones by this new issue. While DY*N*AMO is meant for collective use – all architects can add to the case base and have access to the corresponding ideas – Idea Space is personal like a diary. Nobody but the architect using the system can access the ideas in his/her Idea Space, even if they are connected or related to cases in DY*N*AMO. Just like Mase et al. (1998) deal with creativity in conversation, the architectural Shift+F7 has the advantage of combining a personalised design space – where architects can feel free to jot down just anything – and a collective space – where they can find and share with others interesting insights and ideas.

Summary and future work

Consistently developing design ideas into a built artefact has been identified as one of the most fascinating difficulties facing architects during design. In order to support

this development, we have proposed an architectural Shift+F7, which links a personal idea capturer/interpreter/associator with a collective dynamic memory of design cases. This should allow architects to consult relevant cases from the early conceptual stages of the design process on without having to leave their working environment. Through the explicit link between early ideas and concrete cases, we believe that this tool will act as a permanent source of inspiration, in providing all sorts of design information related to the current issue they are working on. Moreover, it will draw architects' attention to all aspects of the ideas they conceive, thus stimulating the awareness of the downstream implications of their concepts.

We are the first to admit that further evidence is needed for the value of our architectural Shift+F7 idea. Therefore, we are planning first of all to build a prototype interface between Idea Space and DY*N*AMO. A further step is to use the prototype in a pilot study with architects in different contexts and at different levels of expertise. Although this scenario still lies largely in the future, we are already aware of some important problems to be dealt with, such as the ambiguousness of the information the architects will provide the system with – architects can interpret words, ideas or sketches in multiple ways – and the identification of relevant information to provide the user with. Indeed, finding or tracing the 'right' information in a structure as large as Idea Space plus DY*N*AMO is far from trivial a task. We do not want the system to find exactly the same as the architects have in mind, but to provide them with relevant ideas that can help advance their design process. The key challenge here will be to find material that is both sufficiently like *and* unlike the architects' design ideas.

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