

Destination: Practice – Towards a maintenance contract for the architect's degree

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Abstract

Addressing the subject of Case-Based Reasoning (CBR) in architectural design, we present a Web-based design assistant for student- and professional architects called DYNAMO. Its main objective is to initiate and nurture the life-long process of learning from (design) experience as suggested by CBR's cognitive model. Rather than adopting this model as such, DYNAMO extrapolates it beyond the individual by stimulating and intensifying several modes of interaction. One mode – the focus of this paper – concerns the interaction between the realm of design education and the world of practice. DYNAMO offers a platform for exchanging design efforts and insights, in the form of cases, between both parties, which perfectly chimes with the current tendency towards life-long learning and continuing education. Just like our university advises graduates to 'Take a maintenance contract with your degree', architecture schools may encourage recently qualified architects to subscribe to DYNAMO. To what extent the tool can fulfill this role of maintenance contract is discussed at the end of the paper, which reports on how DYNAMO was used and appreciated by professional architects at different levels of expertise.

Keywords

Case-Based Reasoning, Web-Based Learning, Digital Repositories

1 Introduction

DYNAMO is a Web-based design assistant, at first stage for architecture schools, yet with the intention of expansion into the office setting. It can be considered a Case-Based Reasoning (CBR) system in so far that it is rooted in the Theory of Dynamic Memory, which underlies the CBR approach. Whereas previous papers have focused on the theoretical ideas behind DYNAMO, on the translation of these ideas into a working prototype, and on how student-architects have used and appreciated this prototype (Heylighen and Neuckermans 2000a, 2000b, 2001), this paper switches attention to its expansion into the office setting. After briefly introducing the roots and rationale of the tool, we will point out its potential to improve not only design education, but also professional practice. To what extent our prototype can realize the latter potential is discussed at the end of the paper, which describes DYNAMO's first confrontation with professional architects.

2 The DYNAMO Idea(I)

CBR is a relatively young theory and technology within the field of Artificial Intelligence, based on an alternative view of human reasoning. Rather than linking abstract pieces of knowledge (rules or models), reasoning is seen as remembering concrete instances (cases) and basing decisions on comparisons between the new situation and the old instance (Riesbeck and Schank 1989; Kolodner 1993). Following the Theory of Dynamic Memory, CBR's cognitive model claims that human memory is dynamically changing with every new experience (Schank 1982). The model does not only claim *that* memory changes, but also specifies some supposable sorts of changes: *acquiring new cases* by storing fresh experiences in memory, *re-indexing cases* that are not immediately stored in the right place, and *generalizing individual cases* that belong under the same heading.

Attempts to implement this cognitive model resulted in a whole range of CBR applications, which take on many faces to meet various problem-solving needs. Their use for design is concerned with the recall and reuse of relevant design experience. Examples of such systems are CADRE (Hua, Faltings and Smith 1996) and SEED (Flemming and Aygen 1999) for building

design, FABEL for technical buildings with complex installations (Schmidt-Belz and Hovestadt 1996), ARCHIE-II (Domeshek and Kolodner 1993) and PRECEDENTS (Oxman and Oxman 1994) for public building design, CASECAD and CADSYN for the structural design of buildings (Maher, Balachandran and Zhang 1995) and IDIOM for apartment floor layouts (Smith, Stalker and Lottaz 1996).

Convinced of the importance of concrete cases in architectural design, and inspired by Dynamic Memory Theory, we decided to develop a Dynamic Architectural Memory On-line, in short a DYNAMO. Physically, DYNAMO consists of:

- 1) a growing collection of cases – the actual memory content: Cases are entire building designs, both built and unrealized 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 characterized by various features, which serve as filter criteria during retrieval and/or as links to related cases.
- 3) a user interface to consult and modify memory.

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 1).

At first stage, DYNAMO was developed for design education, more specifically for studio teaching. However, as Section 3 will point out, its full potential will be exploited only when used in professional design offices as well. Henceforth, DYNAMO-users will therefore be referred to as (student-)architects or (student-)designers, meaning students participating in a design studio and/or professional architects working in an architectural firm. Both kinds of users are actively involved in designing.

Being intended to assist (student-)architects during conceptual design, DYNAMO's objective is twofold. In the short term, its case collection provides (student-)designers with a rich source of inspiration, ideas and knowledge to draw from during design. Its long-term objective is to initiate and nurture the life-long process of learning from (design) experience as suggested by CBR's cognitive model.

This model provides us with a plausible explanation of how people, and more specifically designers acquire (design) knowledge. Yet, like all design theories, it privileges one particular view of design, thereby obscuring other equally valuable aspects. In case of CBR, design is considered predominantly a cognitive activity, whereas the social aspects of acquiring design knowledge are largely underplayed. In architecture, however, concepts and insights are developed and renewed as much through interaction as by individuals in isolation. The view of architectural design as a sequence of cognitive operations entirely conducted within one brain has been found wanting in interviews with world-famous architects (Lawson 1994). Moreover, empirical studies have identified conversation as a key-factor in the development of meaningful design concepts (Heylighen, Bouwen and Neuckermans 1999).

DYNAMO can become an important theatre for this interactive process of concept generation, by

offering a platform where different modes of interaction can take place, and simultaneously by acting as a repository to nurture these interactions and store their results. To this end, DYNAMO is conceived as an interactive workhouse rather than a passive warehouse (Schank and Cleary 1995): it is interactively developed by and actively develops its users' design knowledge.

A first mode of interaction DYNAMO supports is the confrontation among different design cases. As already mentioned, every case is labeled with several features, so-called indices, and linked to cases having common characteristics. These features include the underlying concept 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.

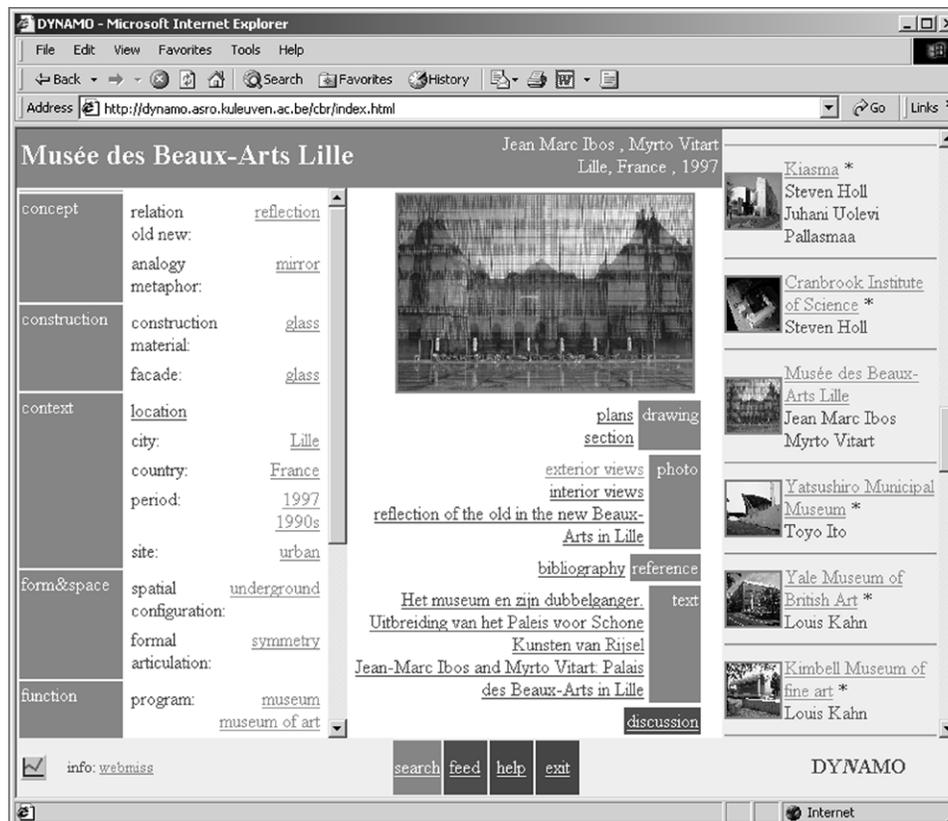


Figure 1. Screen shot of DYNAMO's user interface

Secondly, DYNAMO is interactive in the traditional sense of human-computer interaction. Users cannot only use indices to consult and navigate between cases in memory, they can also change and improve memory as suggested by CBR's cognitive model, i.e. by adding new projects (possibly self-designed), making links between them or creating extra indices.

Thirdly, DYNAMO supports and stimulates interaction among individual (student-) designers in different contexts and at different levels of expertise. 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 students, design teachers and professional architects. After having consulted a particular project, users can write an online comment to share their view with other DYNAMO-users. In addition, newly added cases or indices may act as points of departure for discussion in the studio or office by highlighting specific aspects not initially shared.

3 Between education and practice

The focus of this paper, however, is yet another mode of interaction that DYNAMO aims to support: interaction between the realm of design education and the world of practice for which student-architects are being prepared. In most architecture schools today, the relation with practice mainly consists of hiring practicing architects for studio teaching. Being accessible to both students in architecture schools and professionals in architectural firms, DYNAMO provides an opportunity to expand and intensify this relationship, which would be highly beneficial for both practice and education.

3.1 From an educational perspective

From the perspective of design education, the benefits of a closer relationship with practice are obvious and have been discussed many times before. In the studio, student-architects are engaged into realistic, yet limited design projects. Studio projects typically cover the way from brief to sketch design, at best preliminary design, but never reach the stage of building/realization. Moreover, they are necessarily deprived from interaction with and input from clients and/or users, which play a prominent part in practice. In-

tuitively, giving students access to real-world cases seems a promising remedy to compensate for these limitations. Thanks to their concreteness, cases can communicate a rich body of knowledge and experience in a short period of time, and confront students with the full complexity of real-world design projects. Recent research has confirmed this intuition empirically, revealing that exposure to cases effectively improves students' design performance (Heylighen 2000). DYNAMO gives student-architects access to a permanently growing collection of cases, and thus to the design knowledge and experience of professional architects. Moreover, it makes these cases available through issues students are struggling with in their own design projects.

Besides individual students, also design education at large would benefit from a closer relationship with practice. According to a report of the European Round Table of Industrialists, education's inertia in reaction to changes in society has produced a considerable gap between the schooling one needs in today's complex world and the schooling one receives effectively (ERT 1995; De Corte 2000). This so-called educational gap just keeps growing due to phenomena like globalization, the increasing impact of ICT and the exponential growth of our knowledge, which is said to increase these days in leaps and bounds (Solomon 1999).

In order to cope with this knowledge explosion and educational gap, the ERT report propounds the *learning society*: a society in which individuals, groups and companies are learning permanently. Rather than the sole concern of schools and universities, learning is considered a life-long activity that takes place in partnership between students, teachers, parents, professionals and society at large.

It is obvious that pursuing the learning society has serious implications for the realm of education: developing students' learning capabilities becomes at least as important as teaching the knowledge and skill needed to practice a specific profession (Lammertyn 2001). In case of architectural education, DYNAMO can help schools to take up this challenge. As already mentioned,

most architectural schools try to bridge the educational gap primarily by hiring professional architects for studio teaching. DYNAMO offers the prospect of reinforcing and widening this bridge. Input from practice – design projects as well as indices – keeps schools informed about the constantly changing problems and processes within the profession and the society at large, enabling them to formulate assignments of topical interest. This does not mean that education should submit its agenda unconditionally to the hot topics in practice. Instead, it should take those topics further and, not hindered by ‘practical’ constraints, act as an experimental laboratory, a think tank for the field of architecture.

3.2 From a professional perspective

From a professional’s point of view, DYNAMO’s benefits are perhaps less obvious, yet therefore not less real. For besides the realm of education, pursuing the learning society affects the world of practice too. Indeed, if learning is considered a life-long activity, this implies that professionals need to continue education after graduation or, as our university puts it, to take a maintenance contract with their degree.

Meanwhile several professions including architecture have taken this challenge seriously, as shown by various (sometimes mandatory) continuous education initiatives. In the US, quite a few states mandate architects to complete x hours of continuing education per year for retaining licensure. These initiatives, however, often turn to traditional teaching formats like seminars, colloquia or lecture series. Interesting as these may be, such formats are not particularly compatible with architects’ daily routine, especially not in times of deadlines. That is not to mention the time and effort needed to assimilate the course material afterwards. By contrast, DYNAMO proposes a maintenance contract that is *interwoven* with architects’ everyday activities by offering continuous education ‘en passant’, during the very act of designing. For design cases do not only provide support to students and novices, but also to expert designers.

Evidence for this claim is given by an empirical study on visual analogy in design, in which experienced architects were asked to solve a specific

design problem. They were provided with visual displays of both within-domain sources (cases) and between-domain ones, and were asked explicitly to use analogy during design (Casakin and Goldschmidt 1999). Strikingly, the expert who had chosen to relate to within-domain sources only accomplished the task successfully, whereas his colleague who had focused almost exclusively on between-domain sources produced a poor design. Anecdotic as this evidence may be, it clearly illustrates the potential of cases to support also expert designers. In practice, however, hardly any support for learning from previous cases exists. Instead, existing design support concentrates on modeling, evaluation and management. The reason is obvious: the biggest problem in developing learning support is not only mentioning certain aspects, but enforcing people to reflect on them (Reymen 2001).

DYNAMO may help fill this void by providing a growing body of ‘course material’ that is easily accessible during design and in terms of issues architects are facing day by day. By opening up the rich diversity of project types, innovative concepts and new technologies, the tool provides perspective to both novice and expert architects. Even the most seasoned professional will benefit from exposure to a diverse set of cases – both successes and failures – whether designed by colleagues or student-designers. Although the latter seems rather unlikely, professional architects indeed may draw fresh insights from student work, providing alternatives for mainstream approaches in practice. This refreshing twist on what learning from experience is expected to be, has recently been acknowledged by several world-leading companies. These companies have set up so-called ‘reverse mentoring’ projects to encourage senior executives to learn from upstart colleagues (Timberlake 2001).

But let us return to the field of architecture. DYNAMO, we have argued, offers a vehicle to integrate continuing education with architects’ daily design activities, without overburdening their already swamped agenda. Unlike ‘traditional’ continuing education initiatives, the lessons its cases teach are accessible to architects all the time and structured to fit their ‘designerly way of think-

ing' (Cross 1982). All they need is a computer and Internet connection. Moreover, the tool's interactive approach to (re-) indexing does, if not enforce, then at least stimulate architects to reflect on and draw lessons from previous design experiences. Besides individual practitioners, however, the profession at large would benefit from such form of continuing education as well. By documenting successes and failures of practice, DYNAMO enhances the body of knowledge of the profession substantially, and stimulates reflection on current trends and methods in practice.

4 A confrontation with practice

Having sketched DYNAMO's promises for the world of architecture, the question arises to what extent it can fulfill these promises effectively. So far, a prototype of the tool has been (and is being) used and evaluated by diverse groups of student-designers. By contrast, this section reports on its first confrontation with professional architects. The confrontation aimed at getting an impression of DYNAMO's suitability as maintenance contract for the architect's degree, and at getting feedback on its relevance for practice.

Four architects – two junior and two expert designers – were invited to use DYNAMO during a two-hour design session. Both juniors had 5 years of experience as practicing architect, their senior colleagues 13 and 19 years respectively. Although not 'world-famous' architects, the latter can be considered expert designers in that their work has attracted major design awards and/or won important competitions.

A week before the design session, participants were given a demonstration of the prototype and a brief manual in case they wanted to 'practice' using the tool at home. Already during these demonstrations, we received useful comments, primarily from the expert designers:

- According to one expert, it would be difficult to sell the idea of submitting self-designed projects to architectural firms unless the system would be open to journalists and potential clients. Apparently, this architect considered DYNAMO first and foremost as an excellent marketing channel. It was only afterwards, when discovering the different keys to access cases, that she seemed to appreciate its potential as design instrument.
- Her colleague immediately named a few keys he would add to the current set. He too seemed to make a prob-

lem about submitting projects to DYNAMO, but came up with a proposal of his own to solve it. If architectural firms submit only a selection of material (the main concept, a few photos, a simple plan) and mention the possibility to inquire further particulars at the office, they can tune what they release to the type of inquirer (student, journalist, competitor).

At the start of the actual design session, architects were asked to design an extension to our architecture school, which is located in a 16th century castle (Figure 2). The task was to reorganize and optimize the West wing of the castle (design studios, lecture rooms, secretariat, photocopy room) and extend it with a reception hall, material museum and exhibition room. Apart from having access to DYNAMO, the architects could go about the task as they preferred. After two hours, they were supposed to come up with a general concept for the optimization and extension of the castle. The session was videotaped and a log file recorded the DYNAMO consultations.

Upon completion of the session, participants were given a questionnaire asking their opinion about several aspects of the prototype. The following sections are based on the chat with the architects immediately after the session and their responses to the questionnaire.

4.1 Informal appreciation

From the four participants, three made effective use of the system during the design session and completed the questionnaire. Number four found designing in the presence of a camera too stressful and quit the session after one hour.

The question 'Would you like to use DYNAMO again for future design tasks?', was answered positively by all respondents. One of the juniors would use the tool primarily for comparing different lines of thought. He expects such comparison to restrict the aspect of 'trial and error' by helping him exclude or select certain options earlier in the design process and take design decisions in more rapid succession.

When asked how they liked DYNAMO, it was evident from the reactions that most participants found the tool relevant and useful. Both junior and expert designers were first of all attracted by the possibility to access cases by concepts, aspects

of form and space, characteristics of the site, etc. rather than by architect or building name. This allows for (re-)discovering surprising projects and for saving time when looking for relevant cases. At the time of the study, one of the experts was involved in the design of a building at the water-side. Her firm's collection of magazines undoubtedly contains documentation on several interesting waterfront projects, yet locating them would take quite a while. By contrast, DYNAMO's index 'site' enables her to find such projects in no time.

Asked about the drawbacks of the prototype, three designers mentioned the (still) limited number of cases available. At the time of study, the case base contained 120 cases by about 85 different architects. One of the juniors was somewhat disappointed by the fact that many of these cases are well known, and thus do not offer much of a surprise.

4.2 Formal appreciation

Besides an informal appreciation, participants were asked how they liked specific aspects of DYNAMO, by rating them on a five-point scale. They could choose from *very poor*, *poor*, *neutral*, *good* and *very good*.

Given DYNAMO's ambition to assist conceptual design, the questionnaire asked to what extent designers felt supported by the system in this stage of the design process. On average, their opinions about the support for exploration, concept generation and concept development fluctuated around good, neutral and good respectively. Immediately after the session, one of the juniors mentioned that he would use the tool not so much in the two first hours of the design process, but rather when developing a concept. Similarly, his senior colleague found the tool more useful for concept development, or when dealing with a particular program. Yet, in addition, he could very



Figure 2. The Castle of Arenberg

well imagine himself browsing through the case base independently of any specific design task, just by way of loading up his conceptual battery. In this respect, he considers DYNAMO an excellent 'artificial fertilizer'. The latter comment may be more important than first meets the eye, for it suggests that supporting conceptual design does not necessarily mean being used during the conceptual stage of the design process.

Obviously the extent to which DYNAMO can support design is closely related to the quality of the case base. As for any CBR tool, its effective performance largely depends on the richness, diversity and number of cases. Asked about DYNAMO's case base, designers seemed enthusiastic about the choice of cases and selection criteria, yet remained neutral about the case content. Regarding the case content, one junior expressed his hope that the current quality level could be maintained when scaling up the system. In his opinion, a challenge to DYNAMO is to offer both numerous *and* high-quality projects. Otherwise, either the possibilities for comparing among cases would remain too limited, or finding useful cases would require too much effort.

Finally, the questionnaire tried to assess whether the prototype was perceived as user-friendly. Although user-friendliness is increasingly recognized as decisive for the success of an application, few people can describe what it actually consists of. Whether or not users perceive a program as user-friendly seems to depend on a cocktail of (sometimes) subjective factors (Monden 1999). Therefore, instead of asking for a general appreciation of DYNAMO's user-friendliness, the questionnaire solicited how designers liked several ingredients of this cocktail. On average, the architects seemed quite enthusiastic about these ingredients. They were positive about look and language of the interface, program speed, finding speed and ease of use, and even very positive about ease of learning and help contents.

In general, DYNAMO's first confrontation with practice has put us in a hopeful mood. The architects' reactions after the session and responses to the questionnaire have encouraged us to continue development of the prototype and have helped

fix priorities for further work. In particular, they have drawn attention to the need for quality control and to architects' skepticism towards submitting (self-designed) cases. Furthermore, they have pointed out the need to test DYNAMO's efficiency and effectiveness for practice over a longer period of time, giving designers and/or design firms access to the tool throughout all stages of the design process. In preparation to this more adventurous excursion into practice, we are currently conducting an in-depth analysis of the protocols (including videotapes, sketches and log files). This should allow us to develop a more profound understanding of how DYNAMO interacts with architects' design process, and to identify possible differences in user profile between expert and novice designers.

5 Conclusions

Inspired by CBR's cognitive model, we are developing a Dynamic Architectural Memory On-line for student- and professional architects. We have argued that this memory offers the prospect of building a bridge – made up of cases – between practice and education, by facilitating productive exchange of design efforts between both parties. In addition, we have described DYNAMO's first confrontation with novice and expert practitioners. Although these practitioners represent different generations and approaches to architectural design, obviously they do not cover the full range of design practices. Moreover, the two-hour design sessions represent but a fraction of a real-world design process, which makes the study rather limited. Studies of this nature cannot produce results that may be generalized. They are nevertheless important as preliminary work in the development of effective design support. As such, the study has produced positive reactions and useful feedback for further work. In general, architects have reacted favorably to consulting DYNAMO and would like to use it again for future design tasks. Regarding the issue of submitting personal projects, however, especially the experts seemed less enthusiastic. If future confrontations with practitioners confirm this reaction, it may become a heavy burden on DYNAMO's future, for without their submissions there will be little to consult.

Therefore we would like to conclude by directing a call for collaboration to design practice and education. It is obvious that DYNAMO does not only *enhance*, but also heavily *depend on* both parties. Indeed, the commitment of architecture schools and design firms to sustain a long-term effort is vital to the development and maintenance of the tool. This effort includes releasing material on new cases, as well as updating cases already stored (by adding post-occupancy evaluations, for instance). In case of successes, this should not be much of a problem – when a design worked out particularly well, (student-)architects are happy to show it – yet submitting material on failures is likely to require some courage. In this respect, the DYNAMO's concept is perhaps rather naïve and the future may force us to reconsider it. Nevertheless, it perfectly chimes with the current trend towards life-long learning, and allows integrating continuous education with architects' daily design activities. Therefore, until further notice, we stick to our naivety. With the commitment of both practice and education, we believe DYNAMO to have a fair chance as maintenance contract for the architect's degree.

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