Baptism of fire of a Web-based design assistant

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Abstract: DY*N*AMO – a Dynamic Architectural Memory On-line – is a Web-based design assistant to support architectural design education. The tool 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 students with design cases, but that those cases trigger in-depth explorations, stimulate reflection and prime discussions between students, design teachers and professional architects. Whereas previous papers have focused on the theoretical ideas behind DY*N*AMO and on how Web-technology enabled us to translate these ideas into a working prototype, this paper reports on the prototype's baptism of fire in a 4th year design studio. It describes the setting and procedure of the baptism, the participation of the studio teaching staff, and the reactions and appreciation of the students. Based on students' responses to a questionnaire and observations of the tool in use, we investigated whether DY*N*AMO succeeded in engaging students and what factors stimulated/hampered this engagement. Despite the prototype nature of the system, students were noticeably enthusiastic about the tool. Moreover, DY*N*AMO turned out to be fairly 'democratic', in the sense that it did not seem to privilege students with private access to or prior knowledge of computer technology. However, the responses to the questionnaire raise questions about the nature of students' engagement. Three factors revealed themselves as major obstacles to student (inter-)action: lack of time, lack of encouragement by the teachers and lack of studio equipment. Although these obstacles may not relate directly to DY*N*AMO itself, they might have prevented the tool from functioning the way it was originally meant to. The paper concludes with lessons learned for the future of DY*N*AMO and, more in general, of ICT in architectural design education.

1. INTRODUCTION

DY*N*AMO, which stands for Dynamic Architectural Memory On-line, is a Web-based design assistant to support architectural design education. The tool tries to kill two birds with one stone. At short notice, it provides student-architects with a rich source of inspiration, ideas and knowledge for their studio projects, as it is filled with a permanently growing on-line collection of design cases. 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 Case-Based Reasoning (CBR).

Whereas previous papers have focused on the theoretical ideas behind DY*N*AMO (Heylighen and Neuckermans, 2000a) and on how Web-technology enables us to translate these ideas into a working prototype (Heylighen and Neuckermans, 2000b), this paper reports on the prototype's baptism of fire in a 4th year design studio in Winter/Spring 1999. After a brief summary of the former papers, we will sketch the setting and procedure of this baptism, followed by the evaluation of the prototype's performance. Finally, conclusions are drawn for the future of DY*N*AMO and, more in general, of ICT in architectural design education.

2. A DYNAMIC ARCHITECTURAL MEMORY ON-LINE

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 (e.g. rules or models), reasoning is seen as remembering one or a small set of concrete instances and basing decisions on comparisons between the new situation and the old instance (Kolodner, 1993). This cognitive model was inspired by Roger Schank's Dynamic Memory Theory (Schank, 1982) and in turn inspired us to develop DY*N*AMO, a Dynamic Architectural Memory On-line (Heylighen, 2000).

Central to CBR's cognitive model is the claim that human memory is dynamically changing with every new experience (Schank, 1982). Furthermore, the model proposes some specific kind of changes: acquiring new cases, re-indexing cases already stored, and generalising individual cases. DY*N*AMO incorporates this cognitive model and at the same time extrapolates it beyond the individual, so as to embrace and profit from several kinds of interaction that are crucial for the development and renewal of design knowledge. This should result in a design tool that both feels cognitively comfortable to (student-)designers, and offers them a platform

for exchanging insights and knowledge, in the form of cases, with colleagues in different contexts and at different levels of experience.

Therefore DY*N*AMO is conceived as an (inter-)active workhouse rather than a passive warehouse (Schank and Cleary, 1995): 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 students, design teachers and professional architects.

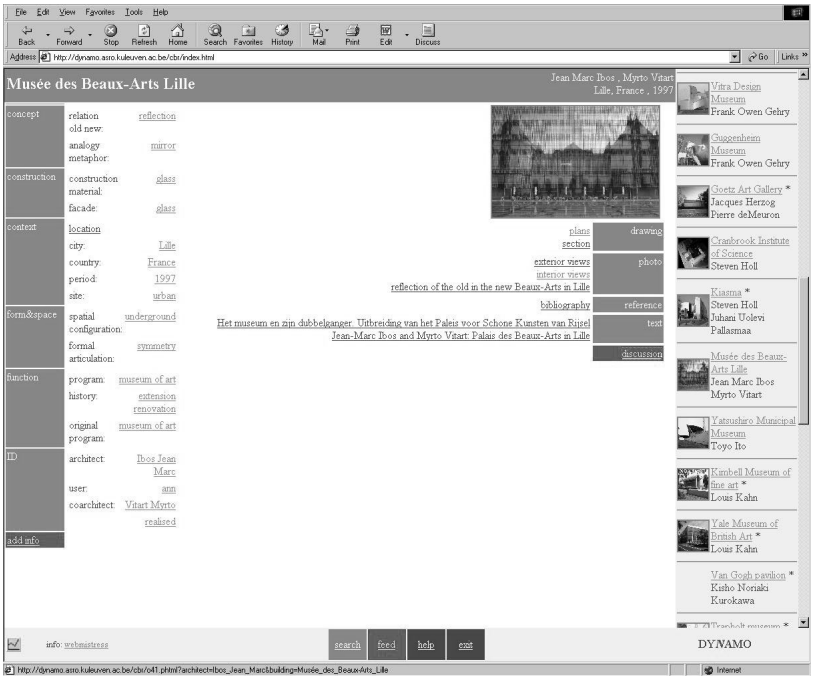

Figure 1. Screenshot of DY*N*AMO's user interface

Translating these theoretical ideas into specifications for a concrete tool, at least two preconditions must be fulfilled: a. The case base should be simultaneously accessible to users at different locations – student-designers in architecture schools and professional architects in design offices. b. The content and structure of the case base must be able to change dynamically as it is used. With these (and other) demands in mind, we have chosen a Web-based approach to build a first prototype, which 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 (see Figure 1).

3. SETTING AND PROCEDURE

3.1 Students and design assignment

All 48 subjects in the study (12 female and 36 male) were student-architects of the 4th year Architecture, Urban Design and Planning at the Faculty of Engineering at the University of Leuven. Having had three years of design education, they participated in the reuse studio as it is an obligatory subject in the curriculum. Ten of them chose to work independently, the remaining 38 split off into two-person teams. The studio was led by Professor Paul Van Aerschot, the titular of the theoretical course on reuse, assisted by three studio teachers.

The students who participated in this design studio could choose one out of two design assignments: either the conversion of a former fabric hall into a public library, or a reorganisation of and extension to their school, which is located in the 16th century castle of Arenberg. Both assignments focus on dealing with an existing building, be it in the form of a reuse or extension project. Students are required to consider the building from multiple perspectives, such as formal articulation, spatial configuration, construction and materials used.

The site of the first assignment consists of the former ateliers of the Belgian Railway Company near Leuven. On this site, three factory halls are to be preserved and converted into a market hall, a public library and an indoor sports hall. Students were asked to design the library, and to investigate possible connections between library and market hall.

The second assignment is to be situated in the Arenberg park, where one campus of our university is located. The castle, which acts as landmark in this park, houses the administration of the Faculty of Engineering as well as the Department of Architecture. The task was to reorganise and optimise the West wing of the castle (design studios, lecture rooms, secretary, photocopy room) and expand it with a reception hall, material museum and exhibition room.

Five solo designers and 13 two-person teams chose the library project, the others – 5 singles and 6 pairs – opted for the reorganisation of and extension to the castle.

3.2 Procedure

Before the start of the assignment, DY*N*AMO was supplemented with information (primarily plans, sections and photographs) on several significant reuse projects and libraries, some of which were suggested by the studio teachers. Originally, we hoped that studio teachers would actively participate in loading the case base with relevant cases, yet simply getting them to make a list of projects already required quite an effort. Instead of the teachers, we collected information on these projects and added this information to DY*N*AMO's case base. At the start of the assignment, students were given a demonstration of how the prototype worked. All students participating in the studio were allowed to use the tool for as long and as often as they liked. By assigning each user – student or studio teacher – a user name and password, we could keep track of who logged on to the system and when. The system could be accessed not only from the computer class at school, but from every PC connected to the Internet. Students were able to consult the projects provided, write on-line comments, as well as add other cases they found relevant to the assignment. A DY*N*AMO help desk was set up to help students with using the tool, answer questions and respond to technical problems.

Aside from having access to DY*N*AMO, the design project was conducted as usual. Students met in the studio roughly twenty hours per week, spending much of this time either working alone or in pairs, or discussing their project with the studio teachers.

After the conceptual phase of the assignment, students were given a questionnaire in order to examine whether DY*N*AMO succeeded in engaging students. With an eye to future improvements, the questionnaire also asked how students liked several aspects of the tool, such as the interface, choice of cases or selection criteria. Some questions dealt with elements that may influence student engagement, such as whether or not students have a PC at home, like surfing on the Internet, or used CAD software to model their project. From the 48 students who participated in the studio, only 19 filled in the questionnaire. For this reason, the results in sections 4 and 5 are based on a sample of 19 students only.

Based on the students' replies to the questionnaires and logons registered by the system, the following sections will attempt to answer two questions: Did DY*N*AMO succeed in engaging students to explore the design cases provided? And what factors stimulated or hampered this engagement?

4. STUDENT APPRECIATION

From the 48 students who participated in the studio, 35 (73%) effectively made use of the system. Because the study described here represented DY*N*AMO's baptism of fire, we consider this percentage a reasonable level of success, all the more since using the tool was far from being stimulated by the studio staff. To the question whether they felt encouraged by studio teachers to use DY*N*AMO, 85% of the respondents answered in the negative. Only 11% had the impression that teachers were informed about the content of the case base. Judging from the registered logons, two of the four teachers had a look at the tool, be it only once or twice.

Unfortunately, the questionnaire, which was designed to examine whether students found the tool engaging, had much less success. As already mentioned, only 19 students (40%) filled in the questionnaire, which still represents a reasonable response given the strict time schedule of the assignment.[i]

4.1 Informal appreciation

The question whether they wanted to use DY*N*AMO again in future design projects, was answered positively by all respondents except for two. According to one of both, "it seems a very interesting tool, but we simply don't have time to use it." Rather than from lack of time, her colleague seemed to suffer from fear for design fixation, as he comments: "The chance of being original diminishes as information increases. EVERYTHING HAS ALREADY BEEN DONE. There are just some things that I'm not yet aware of."

When asked how they liked DY*N*AMO, it was evident from the answers that most respondents found the system engaging. The responses indicated that students were first of all attracted by the quality of the visual material and, to our surprise, by the tool's inherently 'ecological' nature. According to one third of the respondents, DY*N*AMO would finally offer a solution to the waste of paper caused by making copies in the library. Other strong points frequently popping up in the responses are the colour interface, the variety and scope of information and, compared to the library, the quick and easy way to find projects of interest. One, presumably extremely disorderly student especially appreciated the fact that, unlike paper copies, DY*N*AMO can never be lost.

The responses also indicated that, although students found the tool engaging, they were not necessarily engaged in ways that met with our expectations. In principle, we expected that students would consult cases in DY*N*AMO, but also actively participate in adding and commenting on

projects. Yet, none of the students exploited the opportunities for active participation. One student seemed to find the idea of 'information *from* students *for* students' quite compelling, even to the extent that he devoted a great deal of attention to praising it in the questionnaire. However, this same student then showed little or no interest in putting this idea into practice. This goal was probably too ambitious given the very limited time schedule of the assignment.

Asked about the drawbacks of DY*N*AMO, no less than 13 of the 19 respondents mentioned the obvious fact that you need a computer to consult the system. Despite serious efforts of our university, students do not always have easy access to computers, let alone to the Internet, and this may have prevented DY*N*AMO from functioning the way it was originally intended to. As one student put it: "If, during design, you just want to check something about a façade, a joining detail, a certain layout, then it's much simpler to consult the paper copies lying next to you on your table, than to wait till the next day to bike through the rain to the computer class." Yet, even for well equipped students, the medium by which DY*N*AMO makes cases available seemed to function as a brake: "It's difficult to go through during spare moments, say a train journey." However, the very fact that this student thinks of consulting the tool on the train suggests that he appreciates rather than questions its usefulness. Apart from the medium, respondents apparently had little to complain about. One student seemed disappointed by the number of cases in the system: "Once there are more projects, I'll come and look again," another complained about the fact that "you always have to press the submit button."

Finally, it should be noted that, to our surprise, students' responses were hardly affected by the prototype nature of the software. Most errors, such as JavaScript error messages, did not appear to disrupt students. However, they were occasionally frustrated by the slowness of the computers in the classroom, puzzled by platform-incompatibilities or confused by browser-dependencies. All in all, the DY*N*AMO helpdesk received five e-mails and one phone call.

4.2 Formal appreciation

In addition to an informal appreciation, students were asked how they liked specific aspects of DY*N*AMO by rating them on a five-point scale. Students could choose from *very poor*, *poor*, *neutral*, *good* or *very good*. Their responses were coded from 1 to 5, with *very poor* corresponding to 1 and *very good* to 5. The frequency and mean scores of their responses are displayed in Figures 2 to 4. Mean scores that differ significantly from a neutral 3 score in a paired *t* test are indicated by an asterisk (*).

Given DY*N*AMO's ambition to assist conceptual design, the questionnaire asked to what extent students felt supported by the system in this stage of the design process. On average, student opinions about the support for exploration, concept generation and concept development fluctuate around a neutral 3 score: 3.17, 2.94 and 2.88 respectively (Figure 2). None of the means are significantly different from 3 in a paired *t* test.

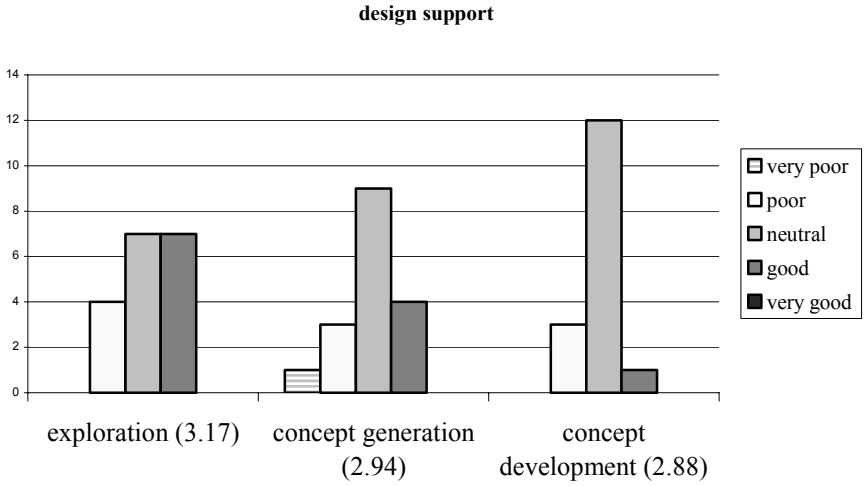

Figure 2. Frequency of student responses to the question whether they felt supported by DYNAMO during conceptual design. Mean scores are mentioned between brackets

Obviously, the extent to which DY*N*AMO can support designers is closely related to the quality of the case base. As for any CBD tool, its effective performance largely depends on the richness, diversity and number of cases (Oxman and Shabo, 1999). Asked about DY*N*AMO's case base, students seemed to be enthusiastic about the choice of the cases and selection criteria, yet remained neutral as to the case content (see Figure 3).

As indicated by the asterisk (*), the means for case choice and selection criteria – 3.56 and 3.61 respectively – are significantly higher than 3 ($p < .05$), whereas for case content – 3.28 – no significant difference is found. The positive rating for selection criteria chimes with the fact that students did not exploit the opportunity to create new indices. When asked why they did not, the majority of the respondents replied that DY*N*AMO's criteria were OK. Only one respondent suggested to add a criterion, or rather to do away with multiple criteria. He would prefer to simply select cases by typing in a keyword – whether this word pertains to a project's concept, context or

whatever – and let the system search across different indices to find a matching case.

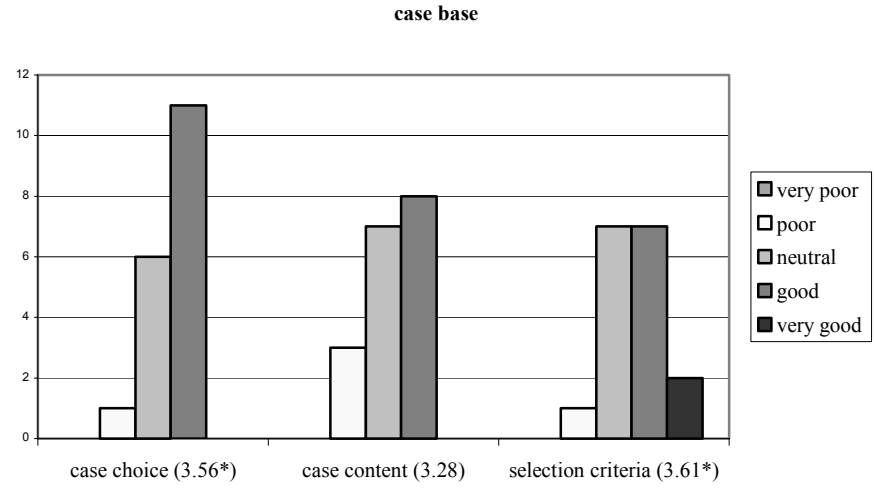

Figure 3. Frequency of student responses to the question how they liked specific aspects of DY*N*AMO's case base. Mean scores are mentioned between brackets and marked with an asterisk (*) when significantly different from the neutral 3 score in a paired *t* test ($p < .05$).

Finally, the questionnaire tried to find out whether the prototype was perceived as user-friendly. User-friendliness is a characteristic of every commercial software application, at least if we may believe their ads and salesmen. Although this characteristic is increasingly recognised as decisive for the success of an application, few people can describe what it actually consists of. Whether or not users perceive a programme as user-friendly turns out to depend on a cocktail of (sometimes subjective) factors (Froyen, 1999; Monden, 1999). Therefore, instead of asking for a general appreciation of DY*N*AMO's user-friendliness, the questionnaire solicited how students liked several ingredients of this cocktail: the interface, language used, programme speed, finding speed, ease of learning, ease of use and help contents. The interface of the prototype takes the form of a simple Web page, allowing users to interact by mouse clicks or typing. With an eye to using DY*N*AMO across architecture schools (and design offices) in different countries, the interface is written in English. The speed of the programme refers to how fast the system reacts to and processes user input, the finding speed to whether users can easily find the information they are looking for. An essential ingredient of user-friendliness is whether or not the programme

is easy to learn, without intensive study or months of unproductive bungling (Richens, 1989). Once the user has grown accustomed to the programme, it should be easy to use, without too much errors, serious (mental) effort or regular resort to the help button (Monden, 1999).

On average, students seemed either neutral or positive about DY*N*AMO's user-friendliness (see Figure 4). They liked the look and language of the interface, found the programme easy to use and were satisfied with the help contents. As indicated by the asterisk, the mean scores for these four aspects – 3.31, 3.65, 3.50 and 3.47 respectively – are significantly higher than 3 ($p < .05$). Programme speed, finding speed and ease of learning were judged neutral by the students, as no significant difference between the mean scores – 3.12, 2.83 and 3.38 – and the neutral 3 score was found.

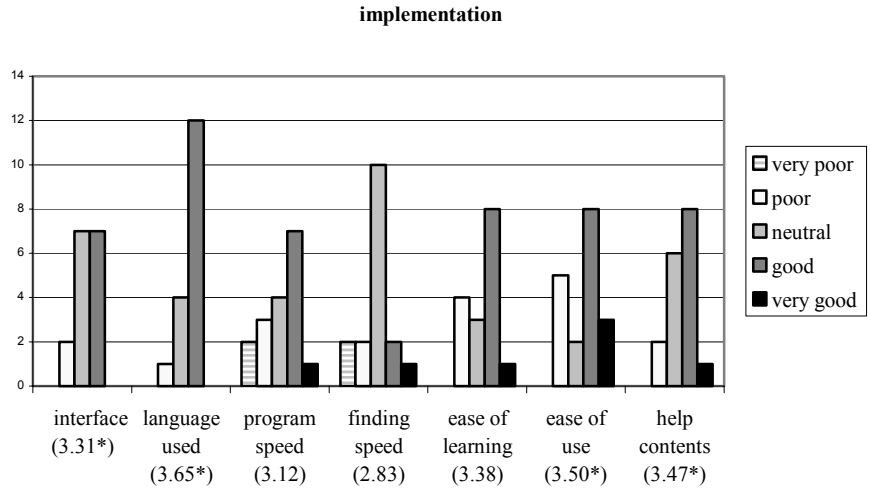

Figure 4. Frequency of student responses to the question how well they liked specific aspects of DY*N*AMO's user-friendliness. Mean scores are mentioned between brackets and marked with an asterisk (*) when significantly different from the neutral 3 score in a paired *t* test ($p < .05$).

In summary, there is significant evidence in students' responses that they found DY*N*AMO engaging. Three quarters of the participants effectively made use of the tool, and nearly all respondents would like to use it again in the future. Serious questions arise, however, about the nature of this engagement, since none of the students has taken up the offer to go deeply into cases. When asked how they liked specific aspects of the prototype, students were either neutral or positive. In particular, the case content, ease

of learning, programme and finding speed of DY*N*AMO received a neutral 3. Positive scores were given to the system's choice of cases and selection criteria, look and language of the interface, ease of use and help contents.

5. STIMULATING AND/OR HAMPERING FACTORS

Although DY*N*AMO managed to engage 35 participants in the studio, there remains a group of 13 students who could not be made to use the tool. Moreover, between the 35 DY*N*AMO users, there were considerable differences in terms of frequency of use. Judging from the logons registered by the system, some students had a look at the tool only once, others were logged on repeatedly. Therefore, the second objective of our evaluation was to find out what factors stimulated or hampered student engagement. The hypothesis being explored was that students who had access to the tool at home, are more computer-literate or used CAD software to model their design, would deploy DY*N*AMO more easily than others.

In order to examine this hypothesis, the questionnaire asked about students' personal computer equipment, how often they surf on the Internet, and whether they used a CAD package for this specific design project. Furthermore, we collected the scores students received for the CAAD course, which were used as a measure for their computer literacy. Subsequently, we calculated the correlations between, on the one hand, how often students made use of the system as recorded by the system and, on the other hand, the factors reflecting their computer equipment, familiarity with the Internet, use of CAD software and level of computer literacy.

The analyses of these correlations, however, yielded no results of statistical significance. The extent to which students made use of the prototype does not correlate significantly with any of the factors analysed. This seems to suggest that DY*N*AMO is fairly 'democratic', in the sense that it does not seem to privilege students with private access to or prior knowledge of computer technology. For the time being, the question why the tool did not manage to engage 13 of the 48 participants thus remains unanswered.

6. SUMMARY AND CONCLUSION

This paper has given an account of DY*N*AMO's baptism of fire. It has described how the system was used and appreciated in a 4th year design studio devoted to reuse. Based on students' responses to a questionnaire and logons registered by the system, an attempt was made to investigate whether

DY*N*AMO managed to engage students into in-depth explorations of design cases, and what factors stimulated or hampered this engagement.

Despite the prototype nature of the system, the answers to the questionnaire seem to suggest that students indeed found DY*N*AMO engaging. Questions arise, however, about the nature of this engagement. None of the students who used the tool exploited the opportunity to feed the case base, be it by writing an on-line comment, adding a project or indexing cases in a new way. Currently, DY*N*AMO's ability to engage students seems to come from the quality and colours of its visual material and the paper it saves, rather than from the opportunities for (inter-)action it offers. In part, the problem might be due to the strict time schedule of the assignment. Other possible explanations are the lack of enthusiasm on the side of the studio teachers, or problems of computer equipment. At the time of the assignment, the studio was not yet equipped with computers to consult DY*N*AMO, let alone with input devices (scanners, digital cameras) to add information. Although these obstacles – lack of time, of encouragement by the staff, and of equipment in the studio – may not relate directly to DY*N*AMO itself, they might have prevented the tool from functioning the way it was originally meant to. Actively encouraging students to consult and feed the case base and providing hardware devices to do so, could probably enhance the system's ability to engage students in (inter-)action considerably.

Other obstacles, however, do relate to DY*N*AMO itself and thus are to be charged on our own bill. Although students' were enthusiastic, they also have pointed out some aspects of DY*N*AMO that leave considerable room for improvement. Awaiting extra encouragement and computer equipment, the prototype was therefore significantly modified following this evaluation. First of all, we did away with the platform incompatibilities and browser dependencies of the system. Furthermore, the user interface was given a profound facelift to help users find their way more easily and quickly in the case base, and to make opportunities for (inter-)action immediately attract the eye.

The analyses to examine the question on stimulating or hampering factors, yielded no results of statistical significance. The extent to which students made use of the prototype does not seem to correlate significantly with personal access to or knowledge of computer technology, which suggests DY*N*AMO to be relatively 'democratic'.

Taken together, the evaluation of DY*N*AMO's first performance puts us in a hopeful mood concerning the future. There are, however, pitfalls in trying to evaluate the tool's performance. As already mentioned, its most important feature is not merely that it presents cases, but that those cases trigger in-depth explorations, stimulate reflections and prime discussions among students and studio teachers. The latter must help students understand

the relevance of retrieved cases through appropriate indexing and helpful on-line comments. Despite our firm intentions to actively involve the studio staff in the development of our prototype, we could hardly get them to have a look at the tool. As far as this involvement is concerned, we do not hesitate to say that DY*N*AMO's performances are more than below par.

Therefore, we would like to end this paper by stressing the need to adopt a broad(er) perspective when trying to assess the use of ICT applications in architectural design education. The effective performance of any such application does not only depend upon the sophistication of the software or the attractiveness of the interface, but also upon how it is introduced by teachers, perceived by students and supported by the school. If we are to develop tools that effectively support architectural design education, the influence of the context in which this education takes place should not be underestimated. Judging from DY*N*AMO's baptism of fire, to put dynamics into a case base is one thing, to 'dynamise' the context it is meant for is yet something different.

7. ACKNOWLEDGEMENTS

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[i] Apart from lack of time, another factor that may explain this moderate response rate is the fact that students were asked to complete the questionnaire by the 1st author, a research assistant not formally involved in the studio, who has obviously less authority than the design teacher(s) in charge of the assignment.