The New Teaching of an Architect: The Rôle of Expert Systems in Technological Culture

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· *The dialectic "local-supernational"*

We already have the EEC, that is the European Economic Community. We have to build the CCE, that is the Common Cultural Europe.

Architects and building engineers of any european country will be allowed to freely practise in any other country of the EEC. Of course, it is not only matter of coming down of the frontiers, of a greater labour mobility. Not even it will be enough that the university degree courses of the different countries agree to and put into effect the EEC common directives.

They need rules and guidelines entering into the merits of practice: rules and guidelines which, rather than a legal and bureaucratic matter, must be the result of a common cultural and technical work, about clear and delimited questions of shared subjects, in which all the community countries be deeply concerned.

Analogously, in the very field of research, the project "Human Capital and Mobility" has in view a greater european scientific and technological competitiveness, through an integration of human and material resources of different research centres, such as in shared-cost research projects and in concerted research actions.

Such an integration is neither easy nor rapid. The political, social, cultural, technological peculiarities of the countries of the European Community certainly constitute an obstacle for the creation of a supernational cultural and technological pool. of common opportunities.

These peculiarities, however, aren't only a restraint for the european community effort of unification and construction of shared goals, constraints, rules, methods, techniques, tools. They mean also a richness, an unrepeatable resourse: they are the result of a historical millenary stratification, which gave rise to urban and architectural contexts, to cultural and technological traditions it would be a serious mistake to waste.

· *Transferring knowledges and technologies, sharing methodologies and working tools*

A Europe united in the name of a homologation, a levelling, a simplification which would remove, or only deaden, these national and local peculiarities, would be a poorer and even less stimulant Europe than the one, in many ways still divided, of today.

So, the first step towards a Common Cultural Europe must be a deep knowledge of the different realities. It is just the dialectic between the peculiarities of the local cultures, on the one hand, and the need for a supernational infrastructure, on the other hand, which can extraordinarily boost the initiatives for the mutual knowledge, the exchange of traditions

and experiences, the scientific and educational collaboration, the preparation of common methods and tools, fit for facing questions at the same time similar and different.

If the field of urban and building recovering, especially in historical centres, is a common european question, we need technical and methodological supports on this subject, in tutorial and professional terms: in the graduate and postgraduate education, in the practice.

We have to operate so that the free mobility of architects and building engineers all over the united Europe be not a traumatic event because of incompatibilities, lacks of understanding, all sorts of obstacles, depending on too different cultural and technical statements. In particular, it's important that this community coordination begin since the graduate courses, but also extend till including the post-graduate phase, so as to cover either the basic education, or the specialization and the early practice.

Therefore, two main ways appear for die scientific and technological collaboration between european community countries in the field of architecture and civil engineering: to transfer knowledges and technologies, to share methodologies and working tools.

Such ways may correspond to two phases. In the first one, the most advanced university and research centres transfer their knowledges and technologies to the ones which undertook the same route only recently and with larger economical limits. In the second phase, one goes from a prevalently one-way action to a construction, at the same level, of common methodologies and working tools, with mutual enrichment through one's own local peculiarities.

- *The common field of urban and building recovering*

A field in which united Europe may find a common interest in the university experimentation, in the basic and applied research, in the preparation of educational and professional tools, is certainly the field of urban and building recovering.

On the other hand, the architectural interventions devoted to recover the building patrimony increased till becoming by far the greater part of the whole building activity. The cultural and economic value of buildings to be recovered (that is obsolete, badly used or disused, to be consolidated or rescued from degradation, to be adjusted in compliance with the regulations in force, to be destined to new functions) is a so high value that it polarizes more and more the interest of administrators, builders, manufacturers, architects, civil engineers, researchers, teachers.

On the other hand, however, the Recovering Culture seems to have fully asserted itself only on the theoretic level. For instance, in Italy the "scissors" between the sophisticated subtlety of the design methodology taught in the universities and the coarse incorrectness of the most interventions in the territory, sometimes even deceptively labeled as "recovering", have not reduced themselves. Even less, as for the general trend, they seem to be going to disappear.

So, we perceive the lack of a diffuse, deep-rooted, correct technical culture. The qualitative level of the training of the technicians engaged in the difficult practice of urban and building recovering is still low on average. Then, we have to make the methodological and technical working tools, simple, efficient, widespread, for a correct action on this field. In particular, they are basic the analysis of the building to be recovered and the respective *diagnosis* , *unescapable* premises for the decisions of the recovering project.

Since many years in our Department, in close synergy with C.N.R. (Italian National Research Council), we are engaged in channelling our human and material resources in this direction. It's important to set up, to stabilize, to consolidate, to institutionalize a collaboration between research, practice and building industry, since we can recognize converging expectations asserting themselves: the expectations of practice and building industry which demand concreteness and competitiveness to face the market; the expectations of research which needs working applications to affect the civil society, to permanently put an end - in the university - to the melancholy sterility of its theoretic exercises.

Of course, what is fit and worthwhile within a single european country, in this particular instance Italy, may be worthwhile and therefore desirable for united Europe, in order to meet the demand of scientific and technological competitiveness which characterizes, as seen above, the project "Human Capital and Mobility".

The junction of these converging expectations means, in the case in point, to work in concert, with the aim of preparing, using, improving, periodically updating basic tools for a correct action in the field of building recovering.

4. Expert Systems in Recovering Technological Culture

As for the nature of the tools more effective for the application in the field of urban and building recovering, it may be useful to make some remarks about the changes in prospective in the design culture since the sixties and seventies.

If the mythical goal of those years was the control and the rationalization of the project as a process that might be systematized and transmitted, nowadays a more sophisticated conception became ripe: the control within the process of the project is replaced by a context, a base, a support of information and knowledge, which doesn't pretend to enter into the merits of the complicated subjectivity of the designer.

The sense of the changes in these last twenty years could be synthetized saying that then - on the base of a forced analogy design-science - the unsuccessful attempt was made to study and understand the way designers work, in order to reduce it to essentials, to make it transmissible and reproducible; in the nineties, smartened by that unsuccess, we intend a task apparently more modest, but not less demanding: to supply the tools fit to access the representation of the experts' knowledge in delimited fields.

As far as the project in general, and therefore also the recovering project is concerned, the concept itself of knowledge to be represented in an E.S. has to be analyzed. And since we reasonably don't intend to give direct indications for the project, but rather to play a role of support for the decision-making task, the unitary term "knowledge" may be divided into various realities, which have a different degree of authority with regard to design:

- regulations,
- specialist literature having in practice the value of selfregulation,
- exemplary design cases,
- suggestions, warnings, etc.,
- analysis methods,
- procedural methods in the form of heuristics,
- indications, references capable of orientating the user in front of the problem, such as reasoned bibliographies.

But the first act of any knowledge in view of the project must be the deep analysis of the building to be recovered, and the respective *diagnosis* .

In such direction, the tool of an E.S. for the *diagnosis* becomes primary and essential. As seen above, it involves - in the phase either of elaboration, or of validation, or of regime-operation - a close integration between sectors and actors, all interested in this goal, but weakly or not at all coordinated.

Through tools like the Expert Systems, if they are produced, corrected, improved and updated by research, practice and building industry in concert all over Europe, it is possible indeed to realize in consistent terms the permanent education of qualified technicians, not only within a single country, but within united Europe.

The final goal of such a prospect could be a permanent link between different institutions, a European Research & Development Team (maybe within the wider and already operating Community Joint Research Centre), devoted to continuously update and improve the Expert Systems so elaborated, either for undergraduate or graduate and professional users.

5. An Expert System in the graduate classroom

In a previous paper (Amirante, Burattini, Cajati, 1990) it was already discussed the possibility of using an Expert System for *diagnosis* in building recovering not only in a professional but also in an academic environment, in order to obtain an educational help. In particular, either for architect or for building engineer-students, as a student entrance test and as a formative tool.

As for the first aspect, the E.S. should have constituted an instrument for verifying the propaedeutical disciplinary knowledges, and therefore a test for the entrance into the Course of Technology of Building Recovering.

As for the second aspect, the E.S. should have improved the identification of the recovering project goals, providing a multi -disciplinary knowledge and *diagnosis* ground which could make a global synthesis easier.

The tutorial use of the E.S. was expected to permit to the teacher to be free from a heavy educational engagement, to the students an increased awareness of the cognitive tools acquired and the actual application on local sample buildings.

At that time, we only *proposed* to experiment the use of such Expert System in a graduate classroom, simply since we had not yet it ready for the educational check.

In the meanwhile, a great progress was made. The whole problem divided in three sectors (structural, historical-typological, technological), a complete module of the E.S. about the structural *diagnosis* was realized [1]; the two remaining modules - about historical typological and technological aspects - am now being implemented [2].

The module for structural *diagnosis , at* this point ready for the educational check, was used this year in the Course of Technology of Building Recovering, Faculty of Architecture, Naples, Italy [3]

The main problems raised by the introduction of the E.S. about the structural *diagnosis* in the graduate classroom may be summarized as follows:

- the choice, as for the sample buildings of the structural *diagnosis* exercise, of buildings with technological and historical features corresponding to the ones considered in the E.S. (non-monumental buildings, that is the more diffuse, repetitive architecture, in the historical centre of Naples);
- the necessity of elaborating a model of the real building taken into consideration, in order to bring it back to the structural typologies provided for and classified in the E.S. itself - in the case that such bringing back be not immediate, the necessity of understanding, with the assistance of the teacher, wether it's a matter of inadequacy of the structural typologies of the E.S., which should include also this other case, or, on the contrary, of inability of the student, incapable of soon finding the way to make his/her case to fall within the ones already provided for;
- the adoption, in the analysis of the sample building, of a glossary consistent with the one used in the E.S.;
- immediately connected to the previous point, the verification, by the students, of being or not in possession of the conceptual store, depending on the previous technology exams, indispensable to understand and appropriately answer the questions the E.S. interface presents (in particular, to understand the meaning of the alternatives at every moment proposed, and so to introduce the specific information the E.S. requires in order to proceed till a complete *diagnosis* of the analysed building);
- the comparison of the *diagnosis* given by the E.S., accompanied by all the respective explanations (because of the possibility, inherent to the E.S., of showing and explaining the knowledge bases and the logical processes followed), with the empiric and intuitive *diagnosis* elaborated before the exercise with the E.S. In the case of non-conformity, because partly or completely different causes are identified, or even quite different *diagnoses* are indicated, we have the necessity of finding out whether the discrepancy depends on a mistake in the empiric *diagnosis*, or on errors in the phase of interaction with the E.S. intcrface, or on limits inherent to the E.S. itself.

As we can see, at every moment this experience showed the two-faced feature of the application ol'the E.S. in the graduate classroom:

- on the one hand, it was involved the E.S. itself in its inner running, with regard to its subject and its scientific goals, as an object of a wider research [4] which doesn't consider it exclusively as a tutorial tool;
- on the other hand, it was involved the impact of the E.S. on the classroom, either for the teachers or for the students: its capacity to reorganize 1) the relationships between them, 2) the way to teach of the formers, 3) the way to approach information, to explore, to learn of the latters.

In order to collect and organize the essential data of the experience, the most relevant answers by the students and then the indications helpful to improve either the educational methodology or the structure of the E.S., a tutorial form including the following data was prepared:

- starting formative level (pre-universitary studies; universitary course chosen; "technological" exams passed);
- initial motivations, expectations for the final result (most of all, about the experimental character of the exercise with the E. S. in the field of building recovering);
- level of learning of the general conceptual part (the one which doesn't fall within the exercise with the E.S. and is taught in the traditional educational way);
- impact of the exercitation at the computer (reactions, difficulties, critical points: relevant especially because most students of the Course had almost no "hands-on" experience);

- experimentation with the structural module of the E.S. (remarks by the students, to put in systematic terms, helpful in view of 1) the validation of the structural module, 2) its further use as a tutorial tool;
- specific proposals for the improvement of the structural module of the E.S. (students' proposals, also in this case in view, on the one hand, of the validation, on the other hand, of the tutorial efficiency).

From the viewpoint of the inputs for the validation, the students of the Course remarked some cases in which the E.S. logical structure showed lacks or faults: for example, not to consider, with regard to the fissures of the building masonry, textures of mixed mateiials, with the consequent impossibility to compute the respective differentiated behaviours; not to contemplate some ways in which the structural stresses may occur, so that it was not possible to the students to communicate with the E.S. about this aspect; to present some altematives, in the questions asked to the users, which later on showed themselves to have no influence on the *diagnosis , at* least in the cases the students had examined.

From the viewpoint of the inputs for the tutorial efficiency, some students required more precision and detail by the interface in indicating the location data of the *diagnosis* (for instance, where die settling occurs). Other students required further technical explanations and a photographic documentation by way of example, presented through interface, besides the "helps" already provided for during the interaction with the series of alternative questions asked to the user. Other students noticed the lack of a more detailed reduction to essentials of the building, in order to more precisely introduce the description of the effects demanded by the E.S. for proceeding towards the *diagnosis* . Finally, some students remarked, in praise of the interface structure, that the E.S. had given the same result of the empiric *diagnosis* , but with a complete explanation, point by point, of the route followed for arriving to such result.

6. Expert Systems and the "formal versus informal" question

As we already noted, this experience involved an impact of the E.S. on the classroom, in the sense of its capacity to reorganize the relationships between teachers and students; the way to teach of the formers; the way to approach information, to explore, to learn of the latters.

Some authors made a thorough theoretical study about the question of the impact on teacher model [5]. Here I don't pretend to give any direct contribution in this direction. But the demands and the modifications induced by the introduction of an E.S. in the classroom, I give a very short account of, anyway constitute a testimony of the relevance such experience has, in a more or less conscious manner, on teacher model.

First of all, it may be pointed out the role of the formal "helps" in the E.S. interface, in relation to the wider and informal help teachers can give to students. The experience involved moments in which teachers were excluded from the direct relation student-computer. But later it followed the phase of the comments, teachers and students together, about the meaning of the experience itself. At that moment teachers played again their own rôle, which can't be expropriated by the computer: to range over a wider problematic area, of which the students' experience at the computer was only a subject (metalinguistic rô1e of the direct informal interaction teacher-student, with respect to the direct formal interaction student-computer).

Another aspect of the experience refers to the presentation of the contents of the topic area D "CAAL Formal versus informal structure": << new systems in which the access to knowledge and information can be made in a random way and guided by personal and subjective criteria >>. Well, in relation to that, the system we experimented (the structural module of an E.S. for *diagnosis* in the field of building recovering) is an exception.

In fact, the structure of such system presents in the interface a prearranged sequence of questions the user has to answer for proceeding till the *diagnosis ; as* an optional choice there is only the possible access, if need be, to the "helps". Certainly, that isn't the necessary structure of an E.S., but rather only the one we believed the most suitable for the structural module of a system exclusively aimed to *diagnosis.*

The access to knowledge and information in a random way and according to personal and subjective criteria seems, on the contrary, indispensable in the interaction with an E.S. aimed to the recovering project decisions. In such case, for instance, the personalized access may concern the way of' "sailing" between the various forms of knowledge (see above the paragraph "Expert Systems in Recovering Technological Culture") helpful as support to the design decisions.

The formalized, strictly sequential structure of the kind of E.S. we experimented was of some merit in promoting a livelier dialectic with the informal aspects, very sprightly and full of contributions by students, which expressed themselves in the classroom out of the constraints of the interaction with the E.S. interface.

7. Conclusions

In comparison with the initial working hypothesis, to experiment an E.S. for building recovering not only in a professional, but also in an academic environment, the experience in the Course of Technology of Building Recovering turned out to be positive. And that either for the students or for the teachers.

For the students, the experience turned out to be, positive above all because of:
- the conceptual and procedural lucidity introduced by the formal rigidity itself of the interface (the rô1e of formative tool);
- the capability of' the E.S. to synthetize in its own questions the verification that the students mastered the basic elements necessary for attending the Course (the rô1e of entrance test);
- its characteristic of tool in the future usable also in the early practice, even if on higher levels of complexity.

For the teachers, the experience turned out to be positive above all because of:
- the rôle of the E.S. as a catalyst of methodological and conceptual clarity, for the teachers themselves even before than for the students;
- its rôle as an element ordering the flow of information and knowledges in the interaction teacher-student, emphasizing the dialectic "formal versus informal";
- the confirmation of the substantial maturity of the E.S. as a tutorial tool (except some improvements) but its need of further elaboration for working as a guide in the practice: indications useful within the comprehensive research in progress about an E.S. in the field of building recovering.

A long further way has probably to be gone in order to lead an E.S., already operating as a tutorial tool, till such a performance level that it be equally effective in the practice, for novice or anyway non-expert practitioners.

But this way, if agreed in a wider prospect, that is in a growing european collaboration between different research centres and local realities, is precisely the task we have before us.

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Notes

[1] Such research was realized, and is going to be further developed, within the P.F.E (Progetto Finalizzato Edilizia), on a grant of the C.N.R. (Italian National Research Council), by the research team directed by Prof. Ing. Ernesto Burattini and composed by Prof. Ing. Michele Pagano, Ing. Fabrizio Tammaro, Doct. Massimo De Gregorio.
[2] For the technological module of the E.S. see, in these proceedings, the paper by Prof. Arch. M.I. Amirante and Arch. S. Rinaldi.
[3] The Course was held by Prof. Arch. M.I. Amirante with the collaboration of Arch. S. Rinaldi and Arch. C. Cajati.
[4] See notes 1 and 2.
[5] See Z. Chen, 1991.