CABMAS (COMPUTER AIDED BUILDING MANAGEMENT SYSTEM): DEVELOPMENT OF AN INTEGRATED COMPUTERISED PLATFORM FOR THE MANAGEMENT OF INFORMATION FLOWS ADAPTED TO SMALL AND MEDIUM SIZE BUILDING COMPANIES.

Albert Dupagne, Pierre Mathus

ABSTRACT

The basic objectives of the CABMaS research project (EC-DG XII, BRITE-EURAM II, CRAFT) had been the definition and the organisation of a computer platform aimed at managing the information flows needed by the various actors involved in the numerous stages of the building process, from the first contact with the client to the final compliance checking. Efforts have been made to produce a set of computerised tools easily manageable by non-IT specialised users, supporting these different processes and managing their associated information.

The SME involved in the project has specialised in single-family house production. Confronted with an increased competition and a difficult market, it wished to improve its production process without increasing its turnover and preserving its status of SME. This SME asked an evaluation of its internal information flows management so that to develop an integrated, coherent computerised solution to improve it and to reduce the losts inherent in it.

Information flows management was considered by the research team as a significant source of knowledge that could be used by the company to improve its production process. The information had thus to be stored as a dynamic knowledge base, of successful (and unsuccessful) past experiences. This knowledge base consists in an actual management support system, integrating the informations coming from the many sub-groups of the SME. Thanks to the structure of the information system, concrete experiences coming from the working-place can be exploited by company's commercials at the early stage of the process to guarantee a coherence between the client needs and the enterprise capabilities.

The computer platform in its state of development is presently used in the company every day practice.

Keywords : Computer Integrated Construction, Building sector, Man-Machine interface, Case Base, Knowledge Base.

1. INTRODUCTION

CABMaS had been part of the European DG II Industrial and Materials Technologies (Brite-Euram II) research programme, under the heading of « Cooperative Research » (CRAFT). The administrative coordinator and prime contractor was Mr Philippe Geens, director of T.PALM (be), a property developer and contractor for individual houses. The other contractors were : Edificios Europa (Porto, pt), J.A. Da Silva (Porto, pt), EMPEC (Lisbon, pt), Barobra (Lisbon, pt), Hazaer & Co (Brussels, be). R&D performers were : LEMA-ULg (Liège, be), CSTC (Brussels, be), IST (Lisbon, pt).

At the end of the research project, a European Interest group has been created. It is aimed at taking care of the best possible development of the developed tool. It is constituted of part of the research partners and part of new industrial partners.

2. PROBLEMS OF THE COMPANY FACING THE BUILDING SECTOR

Confronted with a construction sector becoming more and more competitive, the company wished to improve its production process in order to reduce the inherent losses in it without increasing its own turnover; this in order to preserve its status of SME. In order to seize its step, we expose hereafter the points towards which it firstly directed its action, as well as the contextual elements inherent in the building sector which induce the internal problems of the company.

The process within the entreprise : information costs and management

By analysing its own experiment in the sector, the company could conclude that 12% of its turnover (which is about 2 billions Belgian francs which means about 500 private houses a year) were lost due to problems of information management (flow, internal communication, maintenance, coordination). These uncontrolled losses are mainly due to the lack of coherence and integration inherent in the heterogeneous system set up to transmit and process the data since the stage of « capture » of the needs expressed by the customer-builder until the end of the construction phase.

Indeed, the procedural chain of production is entirely covered and taken in charge within the company. This one has its own commercial delegates, architects, managers and teams of workers for building site. Flows of information between these various actors are thus significant in terms of volume and complexity.

These multiple exchanges are prone to dysfunctioning :
• the transfers of data are unilateral. There is no information feedback towards the first links of the chain of production. A bad decision will be raised and corrected only in the course of process whereas it should be announced upstream of this one in order to avoid the reproduction of the error;
• the information supports are of varied forms and do not allow a univocal definition of the necessary data. That induces interpretations and inaccuracies which inevitably lead to repetitions of procedures inducing wastes of time and money, as well as an inadequacy between the needs emitted by the customer and the end product provided to him;
• a house contains a huge volume of different elements which has to be defined with precision. Those are generally available in catalogues which the commercial delegate submits to his customer in order to help him to make his choices. As the market is evolving quickly, it is difficult to keep these numerous data up to date. One can thus find errors and inconsistencies

between the information presented to the customer and the corresponding elements available in the company;
• the management of the whole of the building sites in progress and to come is a particularly significant task and is delicate to control for this type of company. Indeed, on the one hand it is essential to prevent as much as possible « holes » in the general planning of the company in order to make the work of the various teams uninterrupted; in addition, from this general planning depend the start and finishing dates of the building site which are communicated to the customer. This one expects from the company that it provides him with precise and reliable dates as soon as possible.

So, the management's aims, which are closely interrelated, are mainly those listed below :
• to reduce losses to a minimum;
• to raise the quality of services and delivered products;
• to improve and to maintain the public image of the company (the actual costumer satisfaction rate is about 95%);
• to increase the company's share of the market.

More accurately, the proposed system had to meet the companie's specific needs and problems. It had to make it possible for partners to co-ordinate their respective jobs while facilitating the day-by-day management of the building process as a whole in all its stages, from the drawing up of a draft project and the designing of the building to its actual realisation (including the necessary co-ordination) which will take a strict control of costs into account.

Its several modules had to meet the following aims :
• univocal definition and formalisation of client's needs;
• a planning system that makes it possible to easily co-ordinate the several mapping of resources in the traditional sense of the word;
• a logistic follow-up of the development and realisation of the building (whether in terms of finances, equipment or staff).

Expected results should be :
• a better adequation between built houses and client's needs and wishes, including their specific expectations in terms of building materials and architectural options;
• a shortening of delays involving higher productivity;
• an improvement in quality.

The amount of data processed by building companies is impressive. Involved agents should thus be in a position not just to manage these data but to use them as a constantly available data base through which they can rely on past experience (whether fortunate or not) as a starting point for future decision. This system should improve current practice through preventing the repetition of past mistakes and/or pointing to more efficient procedures.

The building production process

The problems of the concerned company are induced from specific characteristics related to the building sector as a whole. This one is organised upon a strongly nuclearized and split up structure because of the significant number of actors intervening on a single object. Hereafter, we succinctly mention some essential points inherent in the sector :
• each building is unique and has its own characteristics (architectural options, organisation of the work, etc.);

• building operations call for a complex integration due to the number of trades and crafts involved in the process;
• several kinds of data have to be integrated. Each stages of the process generate their own set of information;
• the building process is prone to dysfunctioning. The preceding features account for building sites being subjected to serious disturbances which lead to dysfunctioning, and so to poor quality in the building process and in the general organisation in the building industry, and which entail costs and delays.

3. METHODOLOGY

In order to bring a concrete answer to these problems and dysfunctioning, LEMA-ULg applied the methodology outlined hereafter.

Analysis of the existing situation

Through many interviews with the various departments, persons in charge and commercial delegates, a detailed study of the operation of the company and procedural chain of data processing was established. This study led to the synthesis of the totality of the process in the form of a functional diagram. Helped with this diagram, we located the problems raised or announced which burden knowledge circulation with abnormal operations, losses and distortions of information, by weakening the performances of the process and, by there, the image of the company.

Specifications and development of an integrated platform

The partners of the project wished to work out an information management system made up of easy access computerised modules answering precise requests :
• fast and easy integration in the daily practice of the company;
• coherence and total integrity of the whole.

The specifications and computer developments were thus carried out in close collaboration with the company-partner. LEMA-ULg, under the technical coordination of the CSTC (Belgian Building Research Institute), played a significant role in the technical specification of the modules developed by the various partners of the CABMaS project.

Tests and implementation in the company

Once the modules have been sufficiently developed, they were set up in the company in order to subject them to tests in real situation. Thus, new modifications have been made in order to obtain a final product answering the raised problems.

4. COMPUTERISED PLATFORM STRUCTURE

We present hereafter the principles which guided the development of the computerised platform. We will stick mainly to the principles of operation and the specifications which underlay our step rather than to the technical and strictly data processing features of the product.

Tasks integration

Dedicated modules

As already outlined before, several tasks, or groups of actions, are the subject of a specific computerised module :
• acquisition and formalisation of the customer requirements by the commercial delegate of the company;
• detailed specification of the architectural project;
• planning of resource requirements for the building site;
• planning and organisation of the whole of the building sites dealt by the company.

The combination of these modules with the infrastructure concerning communication and data storage constitutes a platform allowing the management of the treated information. These modules can however be used separately in order to allow a better adapted partial use to certain professional contexts. It was the case for some of the Portuguese and Belgian partners, more interested by a partial use, targeted on more specific and restricted needs.

Connection and integration

The problems previously exposed raised the lack of coherence and integration of the construction process, inherent information in this process and, consequently, of the tools used to process these data. We thus developed an organisation around a central system in charge of the data storage and redistribution towards the modules susceptible to use them.

For example, the data coming from the module dedicated to the architectural project specification define the associated planning of the building site and this last one influences the general organisation of the company's teams of workers. The transfers of information are thus permanent and non-unilateral. So we see the necessity to endeavour to the formats of data, their presentation and formalism as well as their storage for a later use.

The client approach

In the precise context of a « ready for immediate occupation » houses building company, the step towards the customer is an essential stage. It is dealt by commercial delegates who meet the potential customer, present the philosophy of the company to him and start the process of specification of its project.

The complexity of this task is related to several factors :
• the formalisation of the needs and of the specifications which result from it must be as precise as possible so that the architect can be in possession of all the needed information for the development of the project without multiplying the constraints related to repeated visits at the customer intended to supply the missing, vague or erroneous data;
• in order to assist the customer in the expression of his needs, the delegate must be able to present past realisations to him which correspond to it and thus to progress, starting from a concrete base, towards a personalisation of the project satisfying the customer. Photographs, catalogues and various references support the dialogue between the delegate and his customer which is in search for concrete elements enabling him to affirm its decision with full knowledge of the facts;
• each customer being different, he apprehends the approach of its project in a different and personal way. One will wish to start the discussion on the basis of a plan, another one will

start from a particular typology, a third one will stick to some details related to colors or materials. Of course, the delegate must be able to allow these various « entry points » and to conclude the total step; i.e. to end the dialogue in possession of the totality of the needed information to the continuation of the process. The computerised module gives the possibility of starting the dialogue from these various entry points and of following the discussion to the liking of the personal desires of each one, in a non-linear way. A graphical management report makes it possible to the delegate to know instantaneously and constantly the level of complétude of the input data and the quality of those and thus, to reconsider the incomplete or still not specified points;

• in order to facilitate the task of the commercial delegate during his discussion with the customer, we equipped the module with a case base made up of projects already carried out by the company.

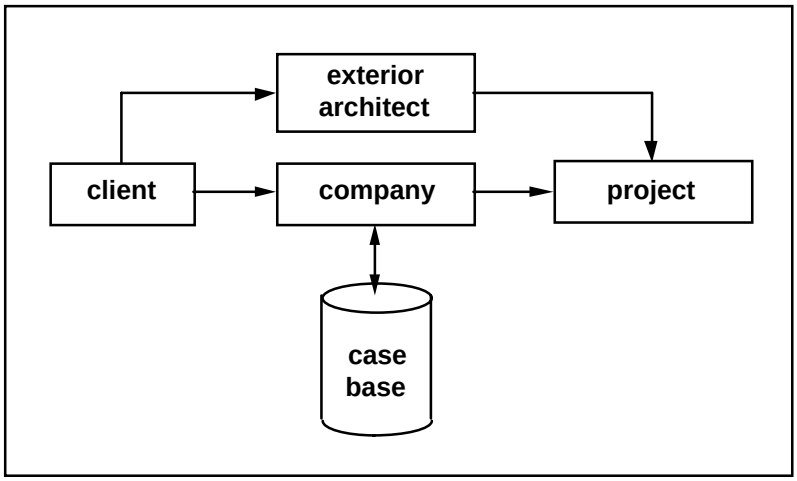

Figure 1 : Integration of the case base in the design process.

This case base is a catalogue of buildings already achieved by the company containing descriptive information relating to each one of it : photographs, plans, options, etc. The idea underlain by this case base is to allow, starting from a series of basic specifications emitted by the customer, to provide a series of projects corresponding to these specifications (as illustred in figure 2).

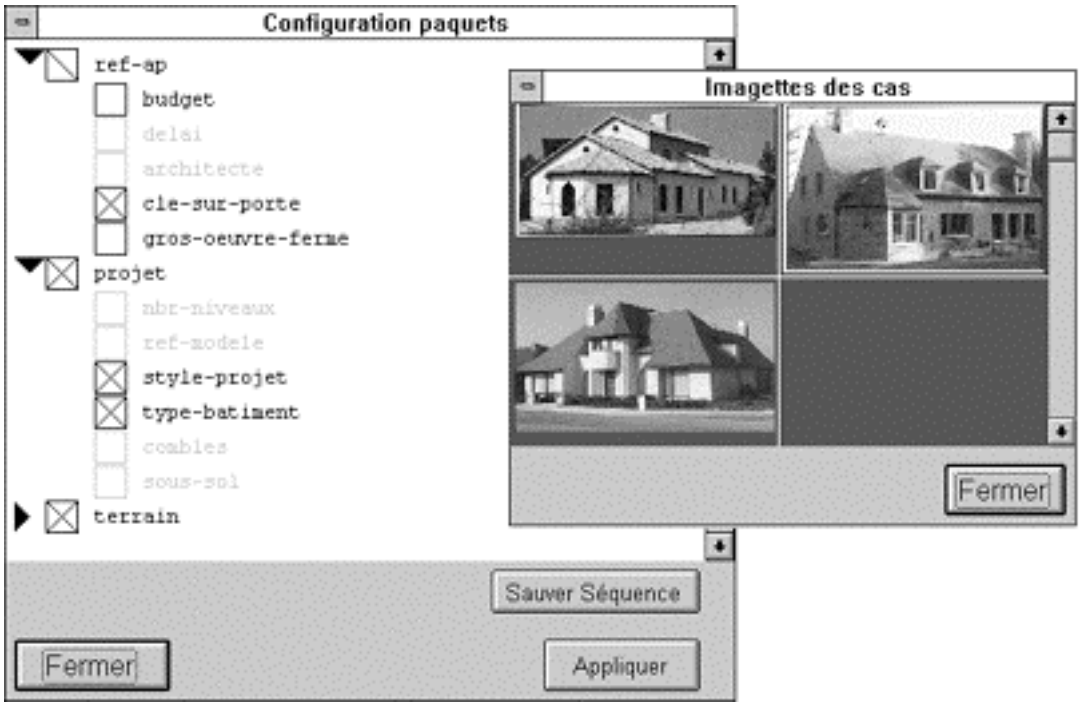

Figure 2 : Case base access and results.

The customer can then concretise the expression of his desires and carry out his choice in agreement with the possibilities provided by the company.

This case base constitutes an effective support for the commercial deleguate work which can quickly reorientate the dialogue with the customer in the directions which are best appropriate for the two parts.

The aims are :
• on the one hand, to allow a fluid, user-friendly and intuitive unfolding of the dialogue in itself by minimisations of directing constraints;
• to ensure the final satisfaction of the customer by providing him with a final product which corresponds to the needs and desires expressed in accordance to concrete elements;
• to ensure a control on the delegate's work to avoid multiple visits at the customer.

Means used are :
• a graphic-supported module allowing a flexible and non-linear dialogue (see the main window on figure 3);
• a univocal and complete encoding of the specifications emitted by the customer, thus removing the later mistakes in interpretation of the actors of the process;
• a concrete reference index coming to support the decisions taken at any time of the dialogue.

However we insist on the fact that there is no question of substituting an autonomous data-processing tool for the commercial delegate. The human aspect being here particularly significant.

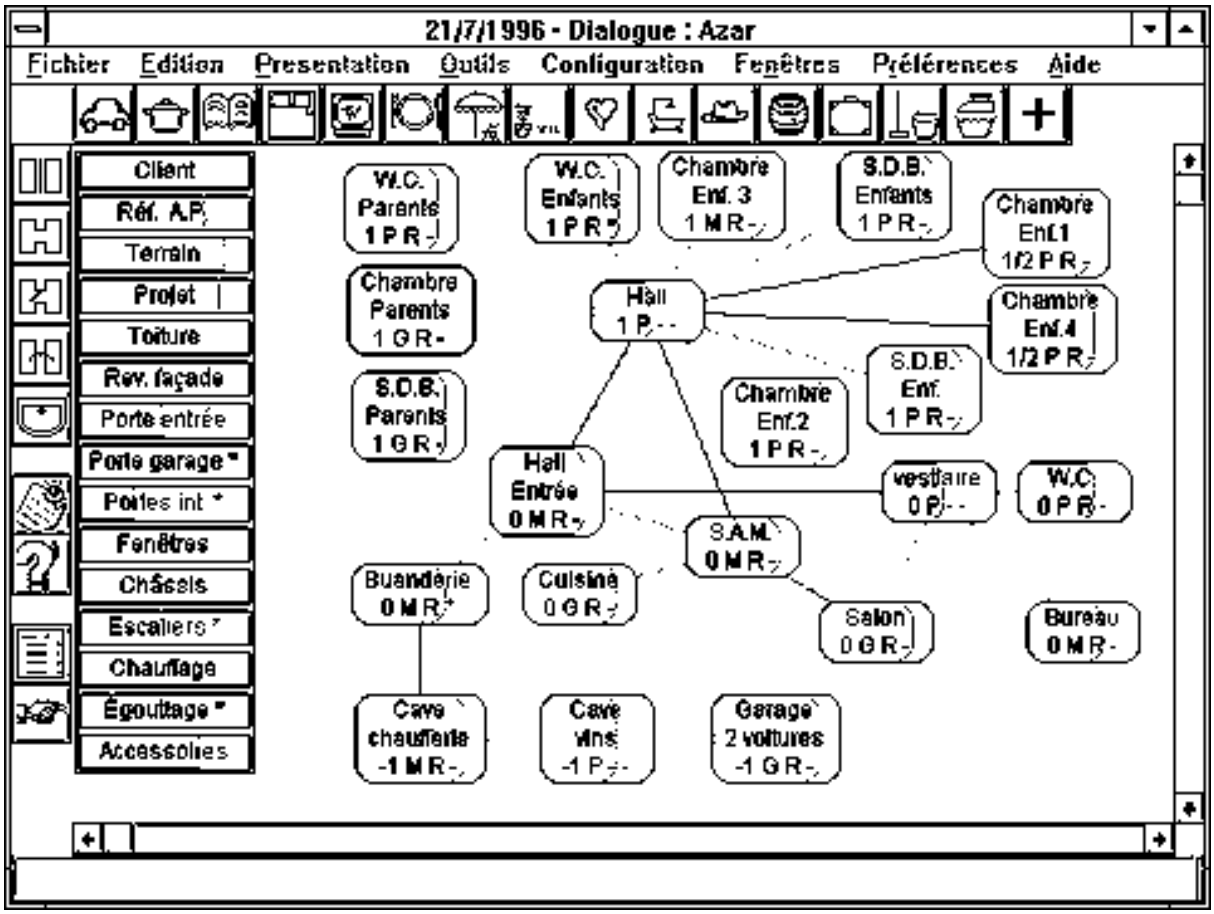

Figure 3 : Main window of the « acquisition of the client's needs » module.

The building site teams management

A significant task consists in organising the work of the teams (about thirty in the T-PALM company) in charge of the realisation of the work. The mission of the planner is to ensure an optimal occupation of the teams in agreement with the start and end dates of the building promised to the customer.

The numerous commercial planning softwares available on the market did not answer this request precisely. Too much complex and too applicants in information, they could not be adapted to the assigned task.

We thus clearly defined the following needs :
• to provide a total and graphical representation of the general planning of the company's teams of workers so that this one can be assimilated as a whole by the coordinator;
• to equip this planning with « graphically active » functionalities allowing a fast, intuitive and « transparent » handling (i.e. without tiresome encodings). Indeed, this planning being unceasingly modified, it is essential to allow quick reactions and « up-to-dating » allowing all the decision-makings which depend on it. The simulation of solutions, alternatives combined with instantaneous visualisation of their results was also a determining element;
• to allow the circulation of reliable information from the coordination department towards the commercial delegate, in order to be able to quickly provide to the customer a precise end date of the building which one can be sure that it is held.

The following specifications were developed in response to these needs :
• primarily directed around a graphical data presentation, the whole planning is visible and « understandable » in a glance by its user;
• each building site is represented by a color rectangle laid out on a time scale. By modifying the position of the rectangle on the screen using the mouse, the coordinator can see the repercussions of this modification on the whole planning in real time. This handling approaches « drag-and-drop » technology;
• the positions of the building sites on the time scale are not « rigid ». Indeed, they will position themselves automatically in a time interval which is appropriate to them or right following another building site. The procedures of positioning are thus double : on the one hand, positioning can be imposed by a precise date and the number of working days necessary to its execution; on the other hand, automatic positioning according to the end of the preceding building site or the beginning of the following, or according to a sufficient time interval (a « hole » in the planning). The informational contents of the graphic objects and position are thus rich and immediately manageable.

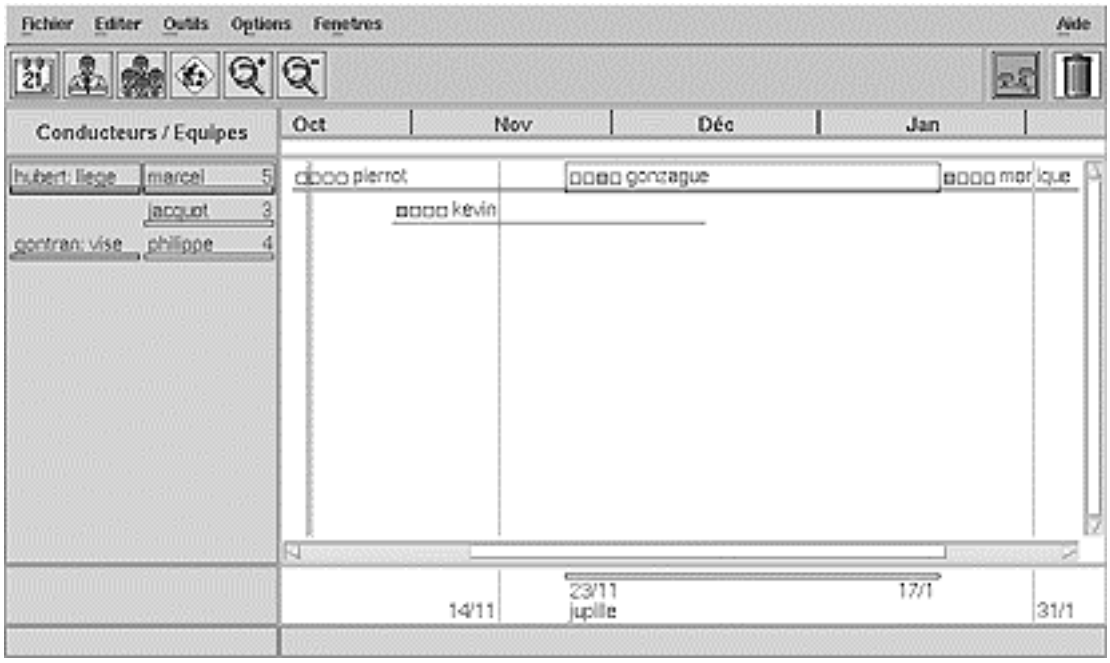

Figure 4 : Main window of the planning module.

These functionalities largely facilitate the daily practice of the coordinator who was previously constrained to carry out his handling on alphanumeric tables.

Integration of a knowledge base

Our concern was to allow a multilateral distribution of data useful for the various actors. By storing the experiments, good or bad, carried out by the company, it is possible for us to use these data rich in teaching from the first contacts with the customer. This in order to be able to direct the client towards choices which lead to a better quality project corresponding to competences and possibilities of the company (this one must hold its promises). These experiments are stored in a “knowledge base” which will grow gradually and which constitutes a collection of good practices to be reproduced and bad practices to be avoided.

The idea underlain by this knowledge base is to make the information acquired throughout production process, and in particular on building site, « go up » towards the phases of specification and design (see figure 5 below).

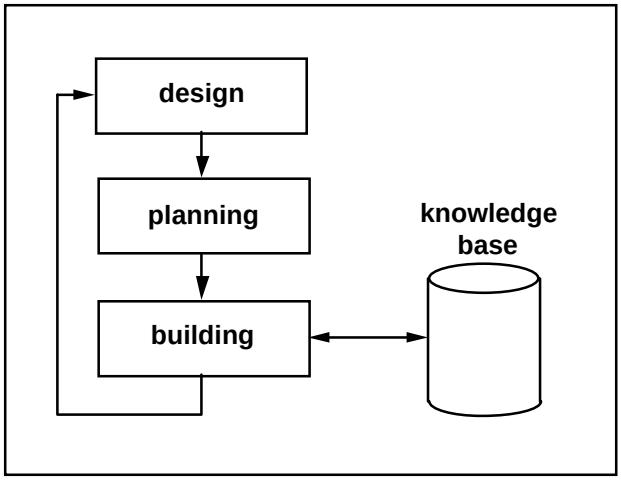

Figure 5 : Integration of the knowledge base in the process .

We think that the significant decisions (the « key decisions ») are caught during the first moments of the process; this in order to avoid later less effective corrective solutions. In this manner, one can establish a link between a decision taken by a designer and his direct consequences on site. This in order to reproduce the good decisions and to correct the bad ones.

5. IMPROVEMENT OF THE PRODUCTION PROCESS

The development and installation of the computerised platform in the company are part of a « quality step » intended to improve the production process. This process is vast and complex and it is obvious that our computerised tools do not allow to improve all the procedures taken in charge within the company (for example, tasks of accountancy).

However, all the tasks primarily centered on the « build object » were considered and are currently equipped with a dedicated support (module) and ready to be integrated in a coherent system ensuring a better information management (captures, formalisation, transfer and flow, processing and integration, storage) and so, a better quality of the product itself.

Hereafter we present the various improvements made compared to the initial situation and to the problems which emerged from it.

Capture and formalisation of data

The needs emitted by the customer during his discussion with the company’s commercial delegate are now defined in a univocal way. Interpretations due to the lack of formalisation of data are reduced, which facilitates the later work of the architect and of the administrative department in charge of introducing the new customers files and to carry out their follow-up.

The unique formalisation of the project also makes it possible to directly introduce the « standard planning » attached to it. Indeed, within the framework of standardised houses building, the company proposes a series of basic models which it is possible to add a number

of options and alternatives. To these basic models corresponds a precise planning tested by the company. It is thus possible to introduce these data into the general planning of the company, from the very start of the process, and to provide a precise building final date and to communicate it to the customer. The general organisation of the company is thus assured longer-term.

Transfers

The computerised platform directs information flows and limit the losses, the dispersion and the mistakes inherent in data interpretation transmitted within the company. The elimination of the paper medium, not very reliable, and its replacement by a computerised support lead to a better control of exchange processes between the actors.

Integration

Each developed module is dedicated to the data processing within the framework of a precise task. The outputs of a process will then be communicated towards other users charged to handle them in their turn. So the necessity of a coherent transfer and handling management : no unfolding of information, precise knowledge about the provenance of the information, insurance about the availability of up to date data. The heterogeneity of the previously used information management system did not make it possible to guarantee this coherence. The human factor, which is essential but perfectible for the global management of a significant volume of data, combined with tools and supports unsuited or obsolete, did not ensure the necessary coherence and integration.

The development of homogeneous modules, able to transfer an information precisely defined between them, answers to this preoccupation concerning processes and data integration.

Data storage

In our context, the data storage problems are related to two important points :
• first of all, the « traditional » backup of data as the company's memory;
• then, a storage of experiments for a daily use (case base, knowledge base).

Adequacy between needs and results

We underlined the fact that the imperfections and abnormal operations resulting from the complexity of the contruction process induced a reduction in quality of the product in itself. In particular regarding the adequacy between what is promised to the customer and what is provided to him, in terms of specifications, price, delays.

To answer these problems, we treated the phases concerning the definition and the planning of the project, as well as its integration in the general planning of the company. The process is thus treated as a whole by respecting the practices previously in use within the company and while adding to it the complementary procedures (case base, knowledge base) intended to improve its result.

6. CONCLUSION AND FURTHER DEVELOPMENT

The CABMaS research relied on a close collaboration and a synergy between the various implied partners. It led to the production of a series of modules intended to be distributed and integrated in a common platform. In addition to the set of modules described in this paper, that had been developed by LEMA-ULg, the problems relating to the costs management, stock

management or quality management were also the subject of specific developments carried out in Lisbon and CSTC.

The developed platform is currently installed at various companies and is used in the daily practice. As long as T-PALM is concerned, all the tasks being not supported by this tool, the company continues its equipment policy, in particular with regard to the administrative tasks. This in order to lead to a complete and integrated organisation, entirely supported by computerised tools.

The knowledge base, whose utility has been recognised within the framework of the improvement of the process and its product, is not yet sufficiently developed to allow its use. The feedbacks of building site towards the preceding stages of the process, and in particular towards the design phases, are currently made in a manual way while waiting to be able to resort to more thorough techniques (artificial intelligence for example) able to automatically treat these transfers and their consequences.

However, the establishment of graphical modules, able to communicate between them, and coming as a reliable support for essential daily tasks tends to appreciably improve the practices in use within the company without forcing or modifying them.

Presently, the Belgian partners are gathered in a consortium in order to make the product viable and to ensure its further development.

7. BIBLIOGRAPHY

• Sleiman AZAR, « Prototype de sélection de cas en composition architecturale », ULg, 1994.
• Albert DUPAGNE, Pierre MATHUS, Sleiman AZAR, David PIROTTE, « CRAFT-CABMaS - Rapport final », LEMA-ULg, 1997.
• Albert DUPAGNE, Pierre MATHUS, Sleiman AZAR, « Système de gestion intégrée pour la reproduction industrielles de logements clé en main », Colloque INTERFACE 97, Montpellier, FRANCE, 27-05-97.
• Pierre LECLERCQ, Sleiman AZAR; « CRAFT-CABMaS - Rapport intermédiaire - Phases d'analyse 1a, 1b, 1c », LEMA-ULg, 1994.