Computer Program of Construction Management: a useful Construction Supervision Tool for any Building Engineering Student and Young Professional

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Abstract

Construction supervision is a complex and demanding task. The task of a supervising engineer requires specialized knowledge on building construction and legislation as well as organizational and planning skills. The supervising engineer confronts particular ways of exchanging information, limited time corresponding to each construction and management procedure, particular characteristics of the people involved, and various unpredictable situations. The planning and organization of the technical projects as well as the development of administrative capacity are factors dependent on the practical experience gained in the construction site. Therefore, the organization and management of a building site is a challenging and heavy-going task for all young professionals with no previous construction supervision experience. Construction industry presents several computer programs and tools designed to serve the needs of construction site organization and management. However, these tools do not necessarily provide their users with the possibility of continuously monitoring and reviewing the construction and management processes, as a whole, and their operation requires a minimum relevant specialization. In an attempt to simplify the work of young professionals intended for construction supervision, this study refers to a new method of organizing the sequences of construction site's and office's workloads which are necessary for completing a simple construction project. In particular, this paper presents the structure and content of an educational computer program which guides young professionals to track down and keep the aforementioned sequences under surveillance so that the building project can be completed on schedule and in the best possible way, in terms of construction accuracy. This program is a product of both scientific - practical importance, since it will contribute to the optimization of building site planning, and educational importance, given that it can claim an important and essential role in secondary and higher building engineering education.

Keywords: construction management; model educational computer program; learning environment.

1 Introduction

Construction management or construction project management (CPM) is the overall planning, coordination, and control of a project, from beginning to completion. CPM is aimed at meeting a client's requirement in order to produce a functionally and financially viable project. It is, thus, a process that takes time and requires the existence of specialized knowledge and an appropriate professional experience of the responsible engineer. Even at the early stages of a project, a construction manager should be able to mark out the general conditions for realizing the project, using existing development plants provided by the municipal or local authorities. Other departments may become involved in the process, according to the scale and demands of the permissions sought. These may include the land registry and surveying department, the land holding office, the town planning department, the monument preservation authorities, the environmental department, the civil engineering department, the city parks authority and many others. A construction manager should also be able to deal with the various contractors, the tradespeople and the building firms involved in each project. Therefore, the profession of a construction manager requires the knowledge of Construction and Building, Technology, Public Safety, Costumer Service, Human Recourses and Mathematics as well as time management, negotiation, decision making and problem solving skills and abilities. In fact, the supervising engineer should be familiar with the basic concepts of structural economy, understand the characteristics that differentiate the latter from other sectors of the economy (classical industry) and the basic economic concepts and know the most popular programming methods. Such knowledge enable him to understand how critical and essential are the planning and rationalization of construction of civil engineering works on the completion of a structure at the desired time, the desired quality and the desired cost. The supervising engineer

should also be able to deal with simple problems of calculating financial data relating to the construction of technical projects (financing, loans, etc.) and organize the construction of a project by using GANTT diagrams and networks.

Construction Management education comes in a variety of formats: formal degree programs (one-year associate degree; four-year baccalaureate degree, masters degree, project management, operations management engineer degree, doctor of philosophy degree, postdoctoral researcher); on-the-job-training; and continuing education and professional development. The academic field of construction management encompasses a wide range of topics. These range from general management skills, through management skills specifically related to construction, to technical knowledge of construction methods and practices. There are many schools offering Construction Management programs, including some offering a Masters degree. However, the mainly theoretical background provided to a potential construction manager/supervising engineer does not necessarily guarantee a thorough knowledge of the subject. The latter presupposes and requires the practical involvement of the supervising engineer not only with the particular cognitive subject, as a whole, but also with its individual parts. This practical experience is partly gained within a relevant curriculum; it is only after graduation, when starting working as a professional (with no or relatively little experience) that a young supervising engineer may fully realize the practical challenges, virtually experiment with the potential solutions of construction management problems and implement all the above in order to organize and run a worksite.

In an attempt to facilitate the new supervising engineers and to optimize the conduction of the course "Construction Management", this paper presents a model educational computer program of construction management of a conventional house and the preliminary research findings of its use by engineering students. Aiming to balance student and industry desires and faculty domain expertise, while leveraging industry support and guidance, this program is intended to train, in a practical way, and guide each trainee/new engineer in his first steps in a real worksite, acting as a partner "construction site experienced engineer." The friendliness of the program, its -at any time- willingness, its constant awareness and its ability to anticipate and warn, its adaptability to specific conditions as well as its equipment in special tools-libraries are the elements that differentiate it from other similar programs on the market and make it a useful educational tool.

2 Users of the program

This program addresses to teachers and students of Building Science (secondary or higher education) as well as to young building engineers-potential construction managers/supervising engineers who seek to become familiar with the instruments and procedures of preliminary construction management.

2.1 The student

The model computer program of construction management is an easy-to-use educational tool which serves the process of transmitting specialized knowledge and skills to each Building Engineering student, enabling him to become familiar with the terms, the concepts and the various processes of construction management. The student can experiment and examine in depth the stages of different construction procedures, view the design, construction, time and financial challenges from the supervising engineer's perspective and thus, start developing critical thinking and, in the future, take advantage of this knowledge either as a professional supervising engineer or as a Building Science educator.

2.2 The teacher

The teacher, whether involved in secondary or higher education, is able to provide the student a higher level of communication and cooperation, as far as it concerns the subject of construction management and, in particular, the various construction and management procedures. The model computer program of construction management enables the tutor to indicate the possible construction management mistakes and risks in a more practical, pleasant and friendly way and thus, to expand his teaching methods, while educating, guiding as well as inspiring the students and encouraging their interest and personal effort.

2.3 The young professional

The supervising engineer who is just starting his professional career has not any structural or managerial experience but only theoretical knowledge. It is very likely for him to ignore certain practical procedures, related both to construction and legal or/and financial matters, and may face difficulties to overcome various obstacles that arise during the construction project supervision. The program will play the role of a loyal ally, of an experienced

supervising engineer consultant, since it can help the young engineer to organize all the data related to each specific project, inform him both at a theoretical level (see program library) and a practical level (e.g. warning of potential error in data entry) and guide him properly according to the developments of the worksite procedures.

3 The model educational computer program of construction management

It is obvious that the "noise", meaning the loss or/and misinterpretation of information, which is being developed during the processing and transmission of the information related to construction management issues, leads mathematically to construction management failure. In order to reduce the chances of such a risk, both in construction industry and in Construction Management Education, this paper presents the structure and function of a software product which could help simplify the various time-consuming and not-always-so-simple procedures which are related to the construction management of a conventional small house's construction site.

Nowadays, there are many computer programs concerning the construction project management that are intended for professional engineers and other professionals specialized in Construction Management. Many of these programs are intricately formed, often specialized in only certain parts of construction project management, while some are even unknown or provide limited access to the Engineering Education community (i.e. the educators, the students and of course the young inexperienced supervising engineers). The present program's aim, therefore, is to change the above facts and to offer the aforementioned potential users the opportunity to overcome, as much as possible, the anxiety and the lack of practical background when studying or dealing with the various terms, concepts, procedures and risks relating to construction project management. The primary objective for the model educational computer program of construction management is to enhance educational communication effectiveness by employing visual and interactive teaching techniques to illuminate core concepts while, simultaneously motivating and exposing students/young professionals to new construction management working processes and industry opportunities. This educational computer program is a software application, used as a construction management educational tool, carefully crafted to explore and clarify information inputs and outputs in order to enable critical analyses and decisions.

In terms of functionality, this computer program of construction management-educational version follows the philosophy of many successful professional programs of construction project management. However, its structure is unique. The various applications, features and settings that this program has to offer a user are formed in such a way as to serve the needs and demands related to a course properly "designed" to upgrade the level of Construction Management Education. Its templates and graphics are simple, in order to enable the trainee engineer as well as the young supervising engineer use the various settings, yet the options provided are specific enough to meet the demands of any professional supervising engineer.

In the present work, the computer program of construction management examines and organizes the various individual stages of the design and construction process of a conventional small house. The program includes settings and applications related to construction site procedures conducted both before starting the construction work and during the latter. In the first case, these settings and applications refer to application study, choice of materials-suppliers, subcontractor selection, budgeting, scheduling, task scheduling and security measures. In the second case, they refer to proper installation factory benefits, health and safety measures, proper placement of the building construction, detail drawings (if and where they are necessary), control of materials-invoices, observation-revision of programming, monitoring of cleaning procedures, contacts-interact with synergy. The aforementioned are all recorded in this computer program in suitable libraries. Depending on the type of each library and the purpose of its existence, the user can either visit the corresponding library to update/monitor the work or to intervene in the data, inserting new constants and variable, depending on the existed conditions, the requirements and needs of each construction site.

3.1 The main settings of the model educational program of construction management

The model educational computer program of construction management is a software which examines and organizes the various individual stages and actions related to the design and construction process of a conventional small house. The main settings of the computer program of construction management-educational version include tabs referring to the index project, the project details, the calendar, the library work, the alerts and reminders, the contacts, the personal data of the trainee engineer/young supervising engineer and the standard official documents required for planning permission, construction, legislation etc. (Figure1). For example, the index project sheet may include data related to the name of the project, the location of the project, the authorities responsible for executing, sponsoring,

operation and maintenance and the concerned ministry etc, while the project details sheet may include information related to the plan provision, the project objectives and its relationship with sector objectives etc.

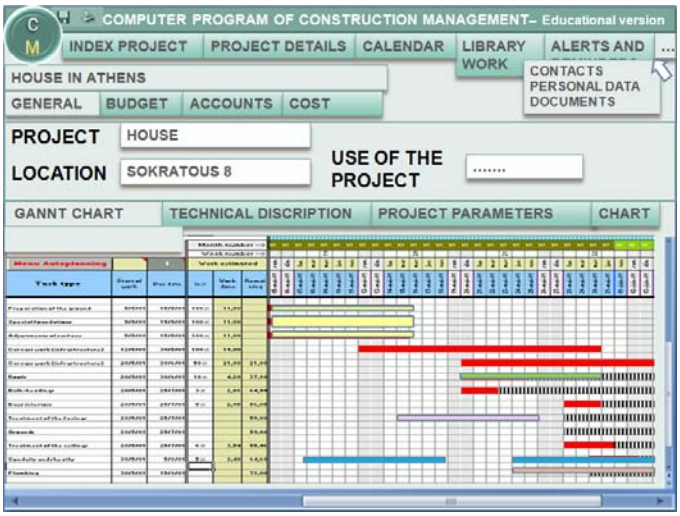

Figure 1: The main settings of the computer program of construction management-educational version

The user (student/ young engineer) may visit, at any time the calendar in order to monitor the construction site procedures (Figure 2).

Figure 2: The calendar

Moreover, the user may visit the library work tab in order to find theoretical information concerning the construction project management terms and concepts (e.g. definitions of construction terms, machinery related to individual construction work etc.). In terms of Construction Management Education, the library work tab is a very useful educational tool, given that it provides the student access to an electronic engineering and construction management encyclopedia; the student (or/and young professional) avoids the trouble of seeking for specific specialized knowledge in relevant books, notebooks or even on the internet, where the risk of misunderstanding or misinterpreting the various information may negatively affect the quality of his study/work. In addition, the teacher may use the library work tab as an electronic presentation tool in order to optimize the quality of the teaching process. At this point it should be mentioned that when running the program, the student/young engineer must respect the necessary restrictive limits, which are set by the program for construction and operational reasons. These limits apply to all stages of the program and if the student or even the teacher, sometimes, does not run the program accordingly, the program will display an error notice (Figure 3). This function also provides the teacher with the chance to properly guide the student and demonstrate the potential risks or challenges related to the construction management actions.

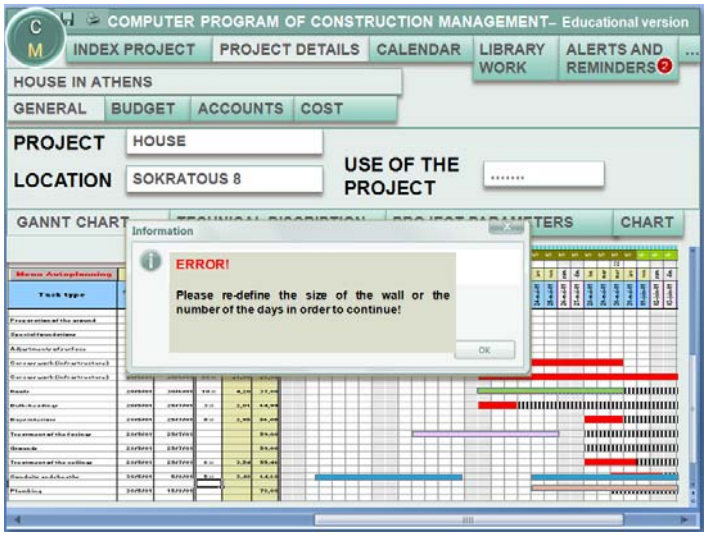

Figure 3: Alerts and reminders

Furthermore, the program provides the user with the possibility of inserting data related to the type of the construction, the initial budget, the relative accounts, the cost of the construction project and the measurement. It shows the complete GANNT diagram with all the required procedures and the relevant information. Whenever the user desires to add a new type of construction work, he may go to the library work tab, define the required material and measurement and then the program automatically adds and presents the above construction work on the GANNT diagram. Depending on the progress of work, the program presents a tab concerning the actual cost of work completed up to that time (Figure 4).

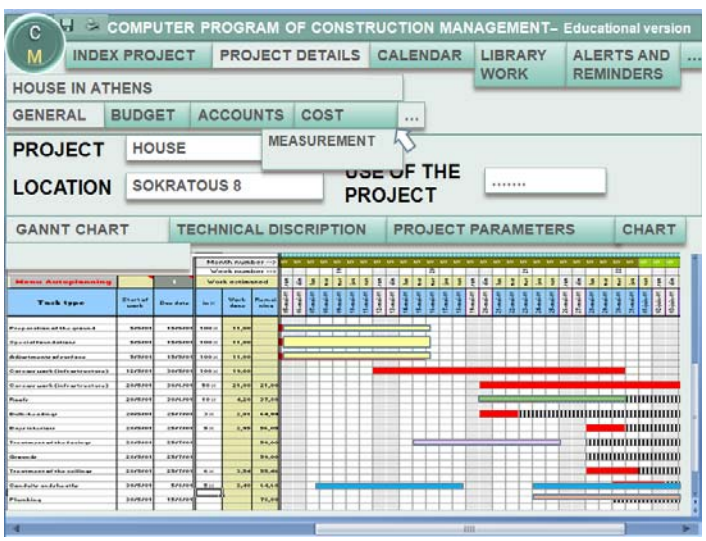

Figure 4: General information and GANNT diagram

3 Possible expanding of the model educational computer program of construction management

It must be highlighted that the program, now in an experimental phase, is the subject of an investigation, whose potential extensions are numerous and varied. These extensions are presented by name in the following lines. Since this program serves the construction needs of a conventional small house, in a next phase of evolution could examine the design of:

- residences of a greater range of square meters (m^2),
- residences with special architectural requirements,
- other structures such as bridges etc.

This computer program could also include:

- complete and constantly updated list of building and electrical materials
- a complete and constantly updated list of standard official documents required for planning permission, construction, legislation etc.

Regarding the utilization of this computer program and the aforementioned extensions, should be noted that the added features will be an individual development of this research and, possibly, will require compatibility with other specialized electronic programs. The computer program of construction project management will be updated constantly, in order to respond properly to the developments relating to the construction process (Eurocodes, bioclimatic design, paragraphs of the General Building Regulations etc.), the legislation and the economic reality.

4 The usefulness and the evaluation of the model educational computer program of construction management

The similarities and differences - particularities which are presented to all similar construction sites as well as to each of them, the transferred amount of information, the various means of transferring information (drawings, plans, charts, formal documents, , technical texts, mails, spoken word, etc.), the limited time which does not forgive the lack of experience, the disorganization because of the stress, the volume of existing legislation, the unpredictable element in construction site procedures, the many and varied persons involved, their consistency and inconsistency (society, the State, engineers, employers, contractors, buying building products), the sanitation and security, the reversible over irreversible events are all essential and cannot-be-ignored factors, the solution of which generally requires the existence of experience in the relevant field. Given the aforementioned, the difficulties in the organization and management of an ordinary construction site are considered to be a normal challenge for any engineer, let alone the trainee engineer or the new-inexperienced supervisor engineer. The first one, acquires, within the curriculum of the university/technical school, a remarkable relevant theoretical background, yet is lacking in practical experience, since the predefined credit hours do not allow extensive laboratory exercise. Consequently, the second one has to initially work in a construction site with almost none experience and, in the majority of cases, with inadequate guidance.

As mentioned before, the loss or/and misinterpretation of information, which is being developed during the processing and transmission of the aforementioned information, and the inadequate guidance of an experienced engineer lead mathematically to construction failure. Such risks should be known to both the student, from the earliest stages of training, and to the young supervising engineer, who is intended for working in a construction site for the first time. The program aims to point out knowledge and enhance experiences that will assist in the successful management of technical projects and the organization of construction sites according to the most contemporary views and practices of Management. Operating the program, the student/young supervising engineer faces the construction process through an experienced supervising engineer's perspective, while becoming familiar with the subject of Construction Management and developing construction management skills. Similarly, the educator, taking advantage of the maieutic nature of the program, acquires the opportunity to improve the transmission mode of the related to Construction Management knowledge (theoretical and practical). The program's continuous feedback enables the teacher to indicate, in a practical way, the possible construction mistakes and risks. Moreover, the teacher can propose appropriate solutions, which will be presented electronically to the student, in a direct and analytical way. Finally, turning the theoretical course into a "game" of construction experimentation, the teacher manages to reinforce the communication and cooperation with the student. At this point it should be highlighted once more that the model educational computer program of construction management is in experimental stage and its development continues at the present time. However, it has already been used, as an educational tool, by a group of civil and structural engineering students of ASPETE, within the "Construction Management and Machinery" course and at the presence of two teachers/evaluators. According to the evaluation results, the students displayed a stronger interest in the course, when they had the chance to use the program. Indicatively, some comments of the students who have filled out evaluation forms are the following: "the use of the program keeps me awake. Not only I pay attention to what the teachers says, but also actively participate in the course", "It seems very helpful to me as well as fun that I can directly use the theoretical knowledge in practice, experiment and not just take notes during the lesson.". According to the teachers' / evaluators' comments, students participated in lessons with more confidence. The evaluation of the indicative tests that students sat at end of the lessons showed they had understood well the general and specific content of the teaching module. Finally, the teachers noted an obvious improvement on the quality of the teaching process as well as on their communication and collaboration with the students.

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