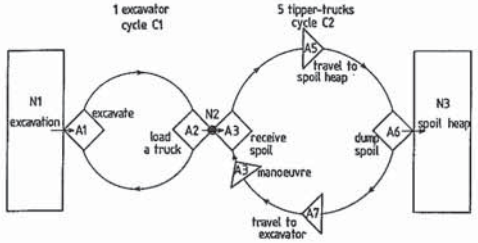

Figure 2 ICONS diagram of an excavation system

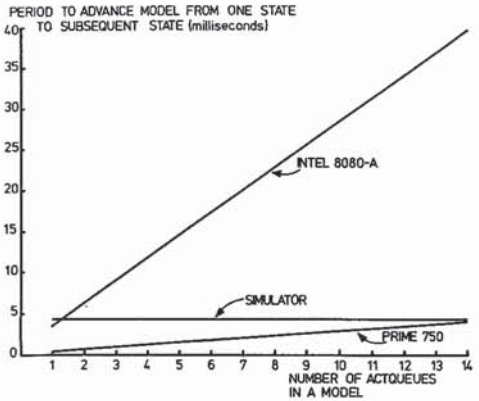

Figure 3 Performance results for models with one to fourteen actqueues, each actqueue being performed by one productive resource.

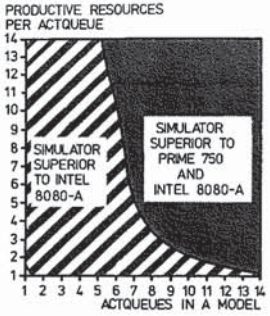

Figure 4 Modelling situation where the simulator's performance is superior to the two serial impelementations.

Computers and Construction Control

Axel Gaarslev

Technical University of Denmark
Department of Construction Management
Building 115
2800 Lyngby, Denmark

KEYWORDS

Construction Management, Construction Control, Computers, Site Management, Site Control.

ABSTRACT

Profound project control is often crucial to project success. The paper discusses how computers successfully are being used by contractors in this field and what the future probably will bring. Two different types of data are identified: Local data sets for a specific site in question and aggregated data sets for the division or company in question. Information is needed on both types of data on the different sites as well as at the main office, but the focus on site is probably on local data and in main office on aggregated data. This information structure is very complicated and will probably in the future technologically be solved by using intelligent terminals on sites tied to a main computer at the head office. Implementing such a system and making it work is a very complicated effort which most contractors probably can't accomplice in one step. Based on Danish experience two different implementation strategies are discussed, one based on a Top Down Strategy starting at main office and one based on a Bottom Up Strategy starting on site. Each strategy reflects it's own intermediate focus point, a top down strategy a central need for aggregated data, a bottom up strategy a local need for local data. Danish experience on these strategies are reported and recommendations on selecting implementation strategy are offered.

Les Ordinateurs et le Contrôle des Constructions

M. Axel Gaarslev

Ecole des Hautes Etudes Techniques du Danemark
Département de Gestion des Constructions
Bâtiment 115
2800 Lyngby, Danemark

MOTS-CLES

Gestion des Constructions, Contrôle des Constructions, Ordinateurs, Gestion des Chantiers, Contrôle des Chantiers.

RESUME

Le contrôle complet d'un projet est souvent crucial pour son succès. L'article traite de la manière dont les ordinateurs sont utilisés avec succès par les entrepreneurs dans ce domaine et de ce que l'avenir nous apportera probablement. Deux différentes sortes de données sont identifiées: les données locales particulières au chantier en question et les données globales au niveau du service ou de l'entreprise en question. Des informations sont nécessaires sur ces deux sortes de données, et ceci sur les différents chantiers aussi bien qu'au bureau principal. Mais le chantier se concentre probablement sur les données locales alors que le bureau principal se concentre sur les données globales. Cette structure de l'information est très compliquée et sera probablement technologiquement résolue dans l'avenir par l'utilisation sur les chantiers de terminaux intelligents reliés à un ordinateur central installé au siège social. L'installation et la mise en oeuvre d'un tel système est une tâche extrêmement compliquée que la plupart des entrepreneurs ne sont probablement pas à même de réaliser d'un seul coup. Basées sur l'expérience acquise au Danmark, deux différentes stratégies d'installation sont traitées, l'une basée sur une stratégie orientée du haut vers le bas en partant du siège social, et l'autre orientée du bas vers le haut en partant du chantier. Chaque stratégie reflète son propre point intermédiaire de concentration: un besoin central de données globales pour la stratégie orientée du haut vers le bas, et un besoin local de données locales pour la stratégie orientée du bas vers le haut. L'expérience danoise sur ces stratégies est relatée et des recommandations sont faites quant à la sélection d'une stratégie d'installation.

INTRODUCTION

This paper deals with control in a construction company. This has become a crucial issue and lots of effort is invested to obtain the best possible control with the often very heterogeneous and widespread activities of the company in question.

The growing interest in this topic is possibly due to the growing competition, the margins are narrow and all actions have to be as good as ever possible to obtain a reasonable profit and to stay in business.

This problem has normally primarily been defined as an information problem, and an additional use of computer power often recommended. This approach is probably very reasonable - although other diagnoses might be just as good - but Danish experience shows however that introduction of more computational power is not a guarantee for success. Many busy Danish contractors have in panic invested in edp lured by the promises of smart sales people. The result has often been an investment without pay off. And the reason often that the introduction was not carefully considered. This paper will introduce two different implementation strategies observed in Denmark. Both strategies are stepping stones towards a future integrated system, but as a starting point only put focus on a part of the total information need of the company, and in this way try to facilitate the implementation. The paper will report on the consequences observed in practice and offer recommendations on selecting implementation strategy.

INFORMATION NEEDS

Two types of information needs are identified in a construction company, local data on each site and aggregated data comprising all activities of the company.

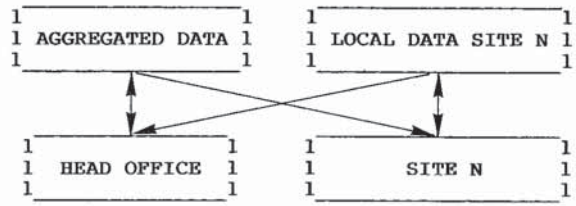

Figure 1: Information flow in a construction company

Figure 1 shows schematically the total data flow. Local data are collected at all sites. Local data from all sites are united at head office and become aggregated data for the company/division in question.

The sites have mainly a need for local data as a means to control the site but also a need for some aggregated data to ensure coordination and best possible use of company experience.

The main office has mainly a need for aggregated data to ensure the total well being of the company, but also a need in some cases to collect detailed local data from some sites to ensure proper control.

THE INTEGRATED SYSTEM

The optimum solution to this complex information need is probably an integrated system. Local data are collected on site - to ensure local data for control use. Local data from all sites are united at head office. These data are integrated with other company data and placed in a central data base. This gives head office a means to control the total behavior of the company and a possibility of detailed control with individual sites. On the other hand the central data base gives the individual sites a possibility to share important information.

An integrated edp system is an obvious solution to this information problem with terminals on sites hooked up to a main computer at head office and for the last 20 years experiments with implementation of such systems have been conducted in a number of countries. In very few instances they have really succeeded. This might have many causes but we have most often observed that they fail due to the fact that the company - i. e. it's human resources - has not been able to adapt to this drastic change.

To ensure success it's therefor in our experience essential to consider the introduction of such a system carefully and to choose a strategy which implies a phased implementation and to choose that phased strategy which has the biggest chance of success for the company in question.

STEPPING STONES ON THE WAY

In Denmark two such strategies have been observed in practice.Both strategies agree on the point that the total integration in one step is impossible today and as a starting point they therefor both only put focus on a part of the total information need of the company but both with the intention of - at a later point in time - if possible to establish a real integrated system. The two strategies will here be termed: The Top Down Strategy and The Bottom Up Strategy, the first one putting main focus at the start on aggregated data and the second one putting main focus at the start on local data.

PART OF ORGANIZATION / STRATEGY	HEAD OFFICE	SITE
TOP DOWN	FOCUS HERE AT START	TO BE IMPROVED LATER
BOTTOM UP	TO BE IMPROVED LATER	FOCUS HERE AT START

Figure 2: Implementation strategies

Top Down Strategy

This strategy puts focus on aggregated data. It sees the most urgent need of the company as the need to establish tools for a total data base of present information and experience of the company as a way to optimum utilization of shared resources and knowledge. The daily control on site is more or less handled by traditional methods.

The systems are generally based on a main frame computer at head office with terminals placed in it's different departments. For the time being all entries to the system are made at head office and the accounting department is the key to the system. Invoices, bills, man hour reports, etc. concerning all activities of the company are in this way entered centrally into the system.

Experiments in Denmark with terminals on sites hooked up to the system by phones have normally failed due to slow communication. As a consequence of this, communication between sites and head office is normally handled manually awaiting that cable communication or other kinds of faster communication support are being established.

Bottom Up Strategy

This strategy puts focus on site control. It sees the most urgent need of the company as the need to obtain fast and accurate control on site and to establish tools for an environment being characterized by personal involvement, innovation and creativity on site. The head office activities are handled in a more traditional manner and establishment of an up to date data base is regarded of a more secondary importance. In the long run an integration is intended but this is considered a much too complicated step at the moment.

This strategy is normally based on micro computers on sites gathering all site information. Communication site - main office is normally established at certain intervals say by mailing disks with information. Data processing at head office is handled traditionally by an in house computer or on an edp service bureau.

CONSEQUENCES AND STRATEGY SELECTION

In this section we will try to discuss the probable consequences of selecting strategy. For each of the strategies described above we will now try to draw up both the likely advantages and disadvantages.

Using a Top Down Strategy you will observe a number of obvious advantages mostly to head office. You have established an excellent tool for central control and coordination of activities. You have all the odds to obtain optimum behavior of the company as a whole. You can store and share experience and make the most of the similarities between jobs.

On the other hand you will also observe a number of disadvantages mostly on the sites. Project management has now more or less been a byproduct of the company wide accounting functions on centralized computer equipment, and in fact project management do not demand such a substantial computing power. The site manager is isolated from the computer and has only occasional and second - hand contact with it. Computer specialists and complicated input/output procedures stand as a barrier between the computer and project management. Sheets of input are necessary, many errors occur and often it takes days to produce a meaningful output. Furthermore communication is slow and in using the system project managers almost loose contact with his job. The information received from the system is out of date and to ensure an up to date control the project manager produces - in spite of the nice system - his own hand drawn barcharts and uses his old manual cost control system. On top of this, the system does not offer a possibility of storing private data so he creates his own manual data base. He has no trust in the computer and feels that the entire hierarchically system of information handling is not adapted to the actual decentralized organizational form centered around profit centers.

The Bottom Up Strategy offers on the other hand a number of advantages to site. The project manager can again run his own job, make his experiments - also the foolish ones - on his own small computer, and when things are ready he can communicate with main office. This is an entirely different, but much more motivating and responsible situation. The main obstacle - human factors - to meaningful and successful use of computers has been removed.The set up adapts well to the scattered nature of company activities

and fits well into a decentralized organizational form. The user can store his own private data, get fast answers and mistakes are seldom as he has actually imputed the data himself. Information from head office is difficult and slow to obtain but he probably don't feel this as a big problem.

Contrary to this the Bottom Up Strategy also do not ease any of the information problems at head office and have in this respect a number of disadvantages. Head office feels that it's hard to survey and control the entire company. They feel themselves on "the rear edge" of things. Important experience is hard to find and often irretrievably lost when key people leave the organization.

WHICH STRATEGY TO CHOOSE

This question is of course impossible to answer unequivocally. Both strategies have a number of advantages and disadvantages and individual companies might have diverging priorities.

Companies with well developed in house computing facilities will likely utilize these and are likely to choose a Top Down Strategy[1].The company without computing power[2] has a better chance of starting from scratch and might choose a Bottom Up Strategy.

In fact it boils down to a choice whether you want to start with establishing a tool for optimum central control at head office or a dynamic, creative local environment on site. In the long run both strategies attempt to obtain both advantages, the top down people by putting intelligent terminals on sites with momentary communication to head office and with possibility of storing and handling data locally, and also at a later point in time the bottom up people attempt integration by hooking the local PC's together in a network or by binding them to a main frame at home. But where to start?

Probably the biggest obstacle to implementation and successful use of computers is people. The success is totally dependent on acceptance and favorable motivation of the people involved. Motivated people will move far, frustrated people will fight any change. Why not start attacking this problem?

In this respect the Bottom Up Strategy is far superior to the Top Down Strategy. It is always hard to get people started working with computers but by using PC's this job is normally moderate[3].Let the people as a start choose there own hardware and software[4] and let the PC be a tool with a stressing of the P not the C. Put an enthusiastic colleague together with the more conservative type and let them start using simple, standard software as word processing, spreadsheets etc. on the PC to solve well defined routine tasks. In this way the site feels the PC pays and

that they can adjust the computer use to the local "culture" and not the other way around that they have to adjust to some kind of equipment.

When such a feeling has settled they might be willing to accept or even help initialize the next step towards the integrated system. And if the company never decides to take this next step it is probably more important to the successful future of the company that creativity and fantasy have been established and retained on site than a proper information system - which the sites do not trust and can't utilize - has been installed to the benefit of head office. Anyhow, with optimum behavior on all sites the total well being of the company can't be too bad.

CONCLUSIONS

No doubt edp equipment is a valuable tool for contractors to control company activities. This fact has practice already clearly shown. But total control requires an integrated system serving both the need of head office and sites. However, Danish experience shows that implementing such a system in one step is unrealistic. To survive such a drastic chance the company has to use a strategy which implies a phased implementation. In choosing this strategy it's most important to ensure motivation and acceptance by the people involved. PS's are in this respect probably superior to any other kind of edp equipment on hand, and a strategy starting with establishing PC environments on sites seems to have a good chance of success.

FOOTNOTES

1. When the machine was purchased it was the only choice also for control purposes. Since the purchase the machine has performed well for accounting etc. and it's hard for the company to realize today that for control purposes it might be regarded as a sunk cost as other solutions today might be preferable. In this way they are in reality "stuck" with this initial solution.
2. Often these companies previously in fact did invest in computers and they might also still be present in the company performing certain tasks but the company has realized years ago the limitations of the equipment and have no intention at the moment to use it for control purposes.
3. Naturally you have to beat a few obstacles but soon the problem might even be the contrary: to control the use and to convince the user that the PC is only a tool to performe a job not a goal in itself!
4. This freedom of choise might naturally be restricted in certain areas to ensure future compatibility etc. This can be done by communicating some musts to the sites but still the freedom of choice must be substantial to ensure responsibility and motivation.

Application of Mathematical Methods While Discovering and Defining Optimal Solutions for Architectural Projects and Construction Subsystems

Milan Glisic, Mihajlo Samardzic and Milan Lazic

Faculty of Architecture
Bulevar Revolucije 73/2
11000 Beograd, Yugoslavia

KEYWORDS

Construction Subsystems, Mathematical Methods, Optimization.

ABSTRACT

While studying and defining the optimal solutions for a group of architectural projects and construction subsystems there are found appearing as a rule a large number of criteria, entering values and variables, series of limitations which are expressed by group of equations and non-equations, and also numerous undefined conditions (such as function, quality, space useful value, performances of construction subsystems, etc.). A mathematical expression profit - cost = maximum is a basic model for operative researches which is being applied to architectural projects while studying and discovering the optimal solutions.
In the work, the mathematical model is shown through the categories of fundamental, functional, architectural and productive decisions in function of time t→tk (tk - a physical lasting period of an architectural project).
By a mathematical model would also be considered a period of exploiting a project (t→tk) and entered the categories of flexibility and variability of spaces, as well as a possibility for an appropriate conjugation of user and architect. The construction subsystems deserve an important place while defining the function of aim in a proposed mathematical model.