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ABSTRACT

Computer-aided facilities management (CAFM) refers to a collection of software used with increasing frequency by facilities managers. The six major CAFM components are discussed with respect to their usefulness and popularity in facilities management applications: (1) computer-aided design; (2) computer-aided engineering; (3) decision support systems; (4) management information systems; (5) project management systems; and (6) word processing. The facilities planning process is briefly reviewed, followed by a discussion of the relative benefits of the six major components. (SI)

COMPUTER-AIDED FACILITIES MANAGEMENT SYSTEMS (CAFM)

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Introduction

Computer-aided facilities management (CAFM) is a term that is being used more frequently by facilities managers today. CAFM refers to a collection of facilities management (FM) software and its use. The acceptance of these software tools is shown by the wide recognition of their acronyms: CAD, CAE, DSS, MIS, PMS, and WP. However, two of the potentially most important tools, Decision Support Systems (DSS) and Computer-Aided Engineering (CAE), do not have as wide a use as they merit.

Computer-Aided Facilities Planning *, a text on the history and the technical applications of CAFM, is both a primer and a technical reference book. This paper refers frequently to it since the text develops and applies links between computers and facilities management.

Major CAFM Components

Understanding CAFM requires knowledge of the six major components, or applications software, that are most commonly used. In alphabetical order, they are:

1. Computer-Aided Design (CAD)
2. Computer-Aided Engineering (CAE)
3. Decision Support Systems (DSS)
4. Management Information Systems (MIS)
5. Project Management Systems (PMS)
6. Word Processing (WP)

These software applications comprise the facilities manager's "electronic tool box" usually envisioned when using the term CAFM. Like tools in the carpenter's kit, each has a correct application. Incorrect use can lead to results like those obtained by trying to shape a board to a precise length with a hammer instead of a saw. Successful use of these software technologies is based on understanding their general nature and their appropriate application to the facilities manager's analyzing, planning, and construction tasks. Each of the systems is described briefly here, followed by comments on their use.

* H. Lee Hales, Marcel Dekker, Inc., 1984.

Computer-Aided Design (CAD)
Graphics for Plans

CAD software packages utilize interactive graphics on a computer terminal to develop facilities plans and designs in two-dimensional and three-dimensional formats. Generally employing most architectural symbols, along with drafting standards, the finished plans can automatically produce design drawings and bills of materials. When first introduced into the architectural and engineering workplace during the late 60's and early 70's, CAD systems required allocating more than a quarter of a million dollars for a minicomputer-based CAD workstation. Today's powerful microcomputers, however, have brought CAD capability into the reach of the smallest of professional offices. CAD systems may also be linked to CAE systems for structural analysis or other engineering calculations.

A well-developed technology, CAD has been employed by many facilities managers, architects, and engineers. The rule of *caveat emptor* applies. CAD comes in all sizes, price ranges, levels of sophistication, and capabilities. Large stand-alone systems including both the hardware and software can be purchased; the software can be purchased separately to run on a large choice of microcomputers. Alternatively, one can turn to service bureaus that will charge only for the period of use required, thereby alleviating infrequent users' high initial cost. Whether purchased, leased, or time-shared, a successful implementation of CAD requires a serious commitment of time and energy for the necessary training to implement this software tool efficiently and effectively.

Computer-Aided Engineering (CAE)
Analysis of Structures

This software technology uses extensive calculation routines to design and analyze intended structures. This is done by modeling a structure for two essential purposes: first, to compare the performance with alternative designs; and second, to assure compliance with professional standards and codes. CAE is also often used as a simulation model to show the probable response of a design to such physical forces as earthquakes, extreme winds, and other potentially disastrous physical forces. CAE allows the engineer, after the design has been accepted and approved, to calculate the proper sizes and quantities of structural members, components, and materials. The latter include those items to be installed by all of the building trades such as heating, ventilating, air-conditioning, plumbing, piping, insulation, lighting and electrical services.

Sophisticated CAE models use interactive graphics, such as those produced by CAD systems, as an input medium. The appropriate characteristics of the final design are fed into the CAE routines so that results may be analyzed, summarized, and even graphically displayed. In structural analysis, deflection of a structure under various stresses can be displayed on a graphics terminal or plotted on a drawing. Such use of a computer can

save many hours of manual labor, and simultaneously provide higher accuracy and broader perspective. While computer-aided engineering software can be run on hardware devices ranging from mainframes to microcomputers, the complexity of some engineering calculations may require the use of minicomputers rather than micros. CAE is a well-developed field with many programs commercially available for a wide range of specific tasks.

Decision Support Systems (DSS)
Explaining Alternatives

Decision Support Systems consist of mathematical algorithms, BOOLEAN logic, and statistics to setup mathematical models of a situation to assist the user in deriving a solution, or a set of alternative solutions, to a series of complex decisions DSS are most frequently used in interactive financial planning models. For facilities managers, DSS can be applied to such questions as: build or lease, build or renovate, and how much space should be provided. Also included in Decision Support Systems are those algorithms that determine the best arrangement of equipment, spaces, and organizations. These are commonly referred to as layout and process plans for equipment and materials, and block layouts for spaces. Each of these decisions can be reached with analytical approaches that, while not necessarily providing the "right answer", can provide good, if not optimal solutions or estimates. A well-known decision support system in economics is Industrial Dynamics developed by MIT Professor Jay W. Forrester. This is an analytical model that calculates and displays the interactions of different business or economic scenarios and various strategic plans.

A wide variety of DSS programs is available to the facilities manager, usually with appropriate vendor warnings - "This system may need custom tailoring to fit your specific situation." In many corporate situations, simulation models such as decision support systems must be built and not purchased off the shelf in order to reflect adequately the corporate need for internal, decision-making support. Alternatively, DSS capabilities such as curve-fitting and statistical routines are available as off-the-shelf packages that can be effective without further customization. DSS can be run on mainframes, minicomputers, or microcomputers. Again, the correct selection of hardware depends on the scope of the specific application.

Management Information Systems (MIS)
Database Computations

Computers were initially developed to provide computational capabilities at high speed and accuracy. Information storage and retrieval was the subsequent use for these devices. Over the years, the design of files and the input, update, security, and reporting of data from those files has come to be labeled MIS. This technology usually incorporates a number of calculation routines to aid in the statistical analysis and summarization of stored information.

Most facilities managers employ some form of MIS. Lists of corporate assets such as buildings and equipment, and rolling assets such as company trucks and leased railroad cars, are the most common first uses of MIS. Answers to the questions, "What do I have and where is it?" provide the basic level of management's need for MIS. After fulfilling these primary concerns, management soon focused upon the utilization of those assets. Specifically, MIS is often used to answer the query, "How well am I using those assets that I have?". Utilization studies, or ratio analysis, often allow management to know the effectiveness of their investment in, and use of facilities in the production and sale of goods or services, which is what provides the means of purchasing those facilities!

A good management information system permits the user to ask for unanticipated information. As the student of MIS is often reminded, a manager needs to receive an answer to a first question before posing the next, and so on. This refers to the decision-making tree that models most major corporate decision making.

All types of hardware can be used for MIS from microcomputers to mainframes. The key factor is, of course, the size of the database. The amount of data to be stored is determined both by estimating the initial data to be collected, and the storage capacity required to accommodate the buildup of historical data that will become available over time once the MIS is in place.

Project Management Systems (PMS)
Charting the Progress

Project Management Systems, an important tool in the facilities manager's tool box, had its origin in military programs. Initially referred to as Program Evaluation and Review Techniques (PERT), it was developed in the late 50's and early 60's by the U.S. Navy to predict potential bottlenecks in the tight scheduling of the production of POLARIS submarines. PERT provided the capability to model activities and milestone events that sequentially depend upon one another in order to predict expected completion dates of key events and expected cumulative costs.

These techniques quickly found their way into the construction industry. With slightly changed algorithms and scheduling terminology, PERT's application to the management of construction projects became known as CPM, or the Critical Path Method. The application of CPM by most large and small construction firms today attests to the effectiveness and value of PMS. The techniques, as one might guess, apply equally well to other non-construction projects, such as the production of Broadway plays and the tracking of bills through the U.S. House of Representatives and Senate.

Project management systems are available for use on mainframes, minicomputers, and microcomputers alike. The selection of a proper hardware host to run the several best-known PERT and CPM software packages depends upon two basic criteria. They are the size of the activity network to be stored and manipulated by the system, and the speed with which the cumbersome time algorithms for the schedules need to be calculated.

Word Processing (WP)
Many Low-cost Packages

While word processing software became available for use on mainframe computers soon after Management Information Systems began to appear, it was the advent of microcomputers that made possible the proliferation of many WP packages. These packages come with a multitude of capabilities at reasonably low cost. WP is an invaluable aid to the facilities management team for documentation, specifications, reports, and other areas in which the written word is essential.

In addition to providing electronic typing with large memory, WP includes features such as electronic spelling checking, thesauruses, and others. Each year seems to bring another capability made available to those who use WP packages. The current bonanza in the WP field is, of course, electronic publishing, which provides the user with the ability to prepare camera-ready documents that look as if they were done by a graphic designer.

WP's use is already widespread and is probably the most well-known of all the software technologies described here. Any reader not yet introduced to word processing should quickly become familiar with its capabilities and applications. Word processing software can be purchased for use on almost any existing hardware.

Six Major Phases in the Facilities Planning Process

Before we begin to look at the relative benefits of the six major components or applications software that we collectively refer to as CAFM, let us briefly review the facilities planning process. As detailed in Table 1, the process of planning describes the six activity phases of facilities projects. The analysis activities typically required to compile and evaluate the basic facilities needs of a corporation are detailed in the table as Phases 0 and I: Preplanning and Orientation, respectively. The more traditional planning activities of the facilities manager are represented by Phases II through IV: Overall Plan, Detailed Plans, and Implementation, respectively. These activities focus on the conversion of physical requirements to overall facilities plans, the detailing activities for those plans, and the conversion of the plan into an active program. The Construction or Renovation task of the facilities manager is described as Phase V.

If one accepts this outline of the planning process, one can relate the economic consequences of various events to the required invested resources, over the entire span of the six planning phases. This is well done in the Hales' text* and presented here as Figure 1.

*Ibid.

Clearly facilities decisions do have a direct and long-term effect on corporate financial resources and building operating efficiencies. Often changes in plans or designs are reviewed and critiqued on the basis of the added costs incurred during construction. However, an inefficient plan often leads to an inefficient design that will ultimately consume extra funds over the entire life of a facility. Therefore, Figure 1 reflects what we know of the consequences of our planning processes, and the requirements for investing resources. Our preplanning activities clearly have the greatest influence on profit and thus should be very high on our list of items to receive as much attention as required. Referring back to Table 1, we can see that in the preplanning phase, a compilation of basic needs, the evaluation of existing facilities forecasting plans for future requirements, and the development of project plans are activities that strongly affect operating efficiency of our new facilities, and of course, the final profit. Location decisions, derived in the orientation phase, are the next most important activities upon which facilities managers should also focus their attention in order to influence the outcome.

A review of Figure 1 reminds us that resources are being invested at increasing rates during the detailed planning, implementation and construction of a project. At these stages, planning actions have little impact on profit, yet our invested resources are being committed extremely rapidly. There are few, if any, opportunities for changing our minds, plans, or facilities; nor can we readily turn off the flow of capital and other resources committed to the construction of the facility.

The Impact of CAFM Components

Each of the six software applications as the major components of CAFM, CAD, CAE, DSS, MIS, PMS, and WP offers economic benefits as well as intangible benefits, but to different phases of a facilities project. Figure 2, Project Benefits of Computer Technology, provides a view of which CAFM component beneficially influences what phases of the planning process.

Figure 3, derived by Hales* from the previous two figures, summarizes the influence on profit and operating efficiency of a facility by each computer technology, during each planning phase. The collective experiences I've had from meeting and observing many facilities managers, both in the classroom and out, substantiate this figure. Specifically, the influence on profit and efficiency of each CAFM tool, when applied optimally to the appropriate phases, wane as the planned facility emerges as a real entity.

DSS and CAE Offer The Greatest Benefits

With Figure 3 in mind, we see that the specific CAFM software applications providing the greatest potential influence on our overall project is the Decision Support System. Next in importance is Computer-Aided Engineering. These facts may be surprising to many, for we are greatly influenced, I believe, by the marketplace. And what does the marketplace say about these tools? From the most highly touted to the least mentioned, the list includes: CAD, WP, MIS, PMS, CAE, and DSS.

*Ibid.

While CAD and WP are widely advertised, MIS and PMS receive medium coverage; CAE and DSS, little or none. Unfortunately, the systems research and development budgets for each of these computer technologies is also far from representative of what one might expect. Specifically, the systems with less influence on profit and efficiency generally have higher R&D budgets that have allowed them to enjoy newer capabilities and more user-friendly interfaces, but do not significantly increase their effect on the planning process. On the other hand, the systems with the greatest potential influence on planning have little or no corporate or university R&D focus. Computer-Aided Engineering systems are not far behind DSS on this score, unfortunately.

In summary, Decision Support Systems have the following characteristics:

1. Highest influence on facilities planning outcomes; lowest profiles in the marketplace.
2. Little, if any, research and development funds committed to enhancing the existing technology which consists largely of late 1960's or early 1970's algorithms.
3. Generally operate well on microcomputers.

These systems can have great influence in facilities management - a positive effect for those who have discovered their potential; a negative one for those not able to take advantage of their capabilities. DSS provides the greatest influence on the most complex facilities plans and projects, for a minimum investment in hardware and software alike! That makes economic sense in the world of facilities management...but are we ready to share some of our attention, heretofore spent fervently on our CAD and WP systems, with DSS and CAE? That, as I see it, is a challenge for facilities managers.

Phase 0 - Preplanning

- Compile Basic Needs (company policy, business plans, and general goals) and forecast non-physical requirements (what do we want?)
- Evaluate Existing Facilities (what do we have now?)
- Forecast Plan for Capacity Requirements - sizing, dimensioning, conceptual plans (what do we need?)
- Check for Feasibility (is it economical to go after the need?)
- Develop a Project Plan - breakdown of phases, steps, responsibilities, and schedule (how will we plan to go after the need?)

Phase I - Orientation

- Convert the non-facility objectives and existing conditions to physical facility requirements.
- Locate the site, the facility(ies) on the site, or the department in the plant, and identify its external opportunities and constraints.

Phase II - Overall Plan

- Convert the physical requirements into overall plan of physical facilities - that is, plan the overall facility.
- Establish a solution in principle.

Phase III - Detail Plans

- Convert the physical requirements and physical constraints for subdivided areas or components of the overall plan into more detailed facilities.
- Establish solutions in detail - details of major features.

Phase IV - Implementation

- Convert the plans of physical facilities into a program of action; planning the "Do".
- Plan the construction, renovation, and/or installation.

Phase V - Construction, Renovation, and/or Installation

- Follow-up or carrying out of the planning.

Table 1 The Process of Planning

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Abstract

Computer-aided facilities management (CAFM) refers to a collection of software used with increasing frequency by facilities managers. The six major CAFM components are discussed with respect to their usefulness and popularity in facilities management applications. Taken collectively, these software applications are considered as the facilities manager's "electronic tool box"; successful use of this technology is based on understanding their general nature and their appropriate application to the facilities manager's analyzing, planning, and construction tasks.

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