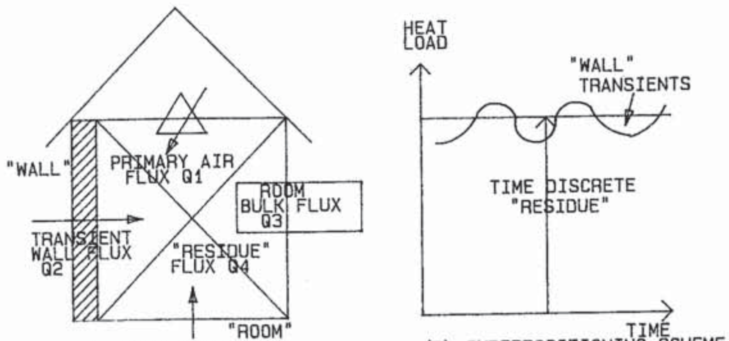
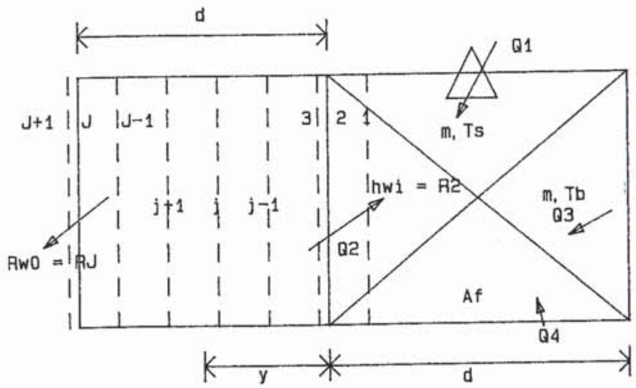


(A) ROOM MODEL (B) SUPERPOSITIONING SCHEME

$$Q1 = mCpa\ Af\ (Tb-Ts)$$
$$Q2 = h2\ Aw\ (Tb-Ts)$$
$$Q3 = -(\Delta Tb/\Delta t)\ m\ Cpa\ Af$$
$$Q4 = Af\ qi$$
$$Q1 = Q2+Q3+Q4$$



(C) NODAL SYSTEM

FIG 2. HVAC MODEL SYSTEM

TRANSFER OF INFORMATION VIA DRAWINGS

J. A. Kooren

Stichting Bouwresearch
Weena 740
Postbus 20740
3001 JA Rotterdam
The Netherlands

ABSTRACT

The increasing complexity of construction works and the developments taking place in the area of computer aided design and construction make a uniform method for the compilation and transfer of graphical information absolutely essential. The whole process of construction preparation can be seen as an information-processor operation. In this operation drawings only form a part of the communication between the various partners involved in the building-process.
Drawings in general, contain information which cannot be transferred in any other form. Effective communication can only be achieved when the information contained correspond to the information required.
Investigations are in progress at SBR directed towards the development of a system for information-processing on drawings which will offer a uniform basis for the introduction and use of computerized information systems.

Computerized dataprocessing requires information which is in such a form that it can be readily processed by the computer. Characteristic of modern CAD/CAM systems is the processing of information in layers of levels and its compilation into elements and element-groups. In these systems elements are introduced or 'drawn' by forms (line, circle, triangle, right angle, etc). Compilation into elements takes place at each level of the building components. A level-distinction function makes its possible to link together information and also for partners in the building process to exchange information at any particular level.
The objective and content of the information can be determined from the construction preparation process. Information required can be established from the project objectives deduced per phase.

TRANSMISSION DES CONNAISSANCES AU MOYEN DE DESSINS

J. A. Kooren

Stichting Bouwresearch
Weena 740
Postbus 20740
3001 JA Rotterdam
The Netherlands

SOMMAIRE

La complexité croissante du procès de construction, outre les développements dans le domaine des plans et de la construction à l'aide d'ordinateurs, soulignent le besoin d'une méthode au sujet de l'édification et de la transmission d'informations graphiques.
Tout le procès de préparation de construction peutêtre défini comme un procès traitant de l'information.
Dans ce procès, les dessins ne sont qu'une partie de la communication entre les différents partenaires de construction. En général, ils contiennent les informations qui, en rapport avec d'autres supports, ne peuvent pas être transmises d'une autre façon.
La communication ne peut s'effectuer d'une manière optimale que si le contenu des informations correspond au besoin d'informations.

Les recherches, au sein du SBR, s'efforcent de développer un système sous la forme de traitement d'informations sur dessins qui offre une base uniforme pour l'apport et l'utilisation de systèmes d'information automatisés.

Un traitement automatisé des données requiert centaines exigences pour l'édification d'informations permettant un rendement efficace de l'ordinateur.
Ce qui caractérise les systèmes CAD/CAM, actuellement bien connus, est le fait de travailler constamment en étapes ou niveaux et la création de fichiers en éléments ou groupes d'éléments. A cet égard, les éléments sont présentés ou 'dessinés' par des formes (ligne, cercle, triangle, rectangle etc.).
Cette création en éléments se pratique à n'importe quel niveau des parties de la construction. La différence de niveaux permet la jonction d'informations, ainsi que l'échange d'informations entre partenaires sur un niveau précis.
C'est à partir du procès de préparation de construction que sont déterminés le but et le contenu des informations.
Le besoin d'information peutêtre défini à l'aide des objectifs qui découlent du projet par phase.

Information transfer via drawings

1. Introduction

The increasing complexity of the construction process next to the developments taking place in the area of computeraided design, underline the need for uniformity in the composition and transfer of graphic information.
The whole process of construction preparation can be seen as an information-processing procedure (1).
In this procedure drawings form only a part of the communication between the various partners in the building proces. The drawings, generally, contain the information which in relation to other data-carriers, cannot be given in any other form. Communications flow most efficiently when the content of the information conforms to the purpose for which it will be used.
Investigations at SBR are directed at the development of a systematic way of information-processing in graphics which offers a uniform base for the introduction and use of automized information systems (2).
To achieve this,first an impression has to be obtained about the processes which interact in the completion of a building. Existing models of the construction preparationprocess appear, to date, to be inadequate, with the result that leisurely a multitude of different systems has developed.
In a recent SBR-publication (3) the construction process has been described as an information-processing procedure based on system-theory principles.
The system-theory was originally applied succesfully to achieve complex construction projects. In the SBR investigations, however, these principles have been applied for the first time directly to the construction process itself.

2. The construction process as a system

A system can most generally, be defined best as a collection of elements which have an underlying relationship.
A system involves a part of reality and therefore it is to some extent limited by its surroundings. The elements and the limits to the system can be selected in relation to the objective for which the system denardering has been selected.
For an open system one also speaks of relationships between the system and its surroundings in addition to the relationships between adjacent elements. All the elements and their properties and relationships are referred to as the state of the system and the variation of the state with time is referred to as the performance of the system.
In the general form:

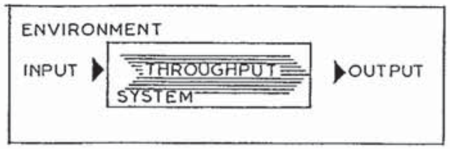


FIGURE 1

The construction project can be shown as an analogue system as follows:

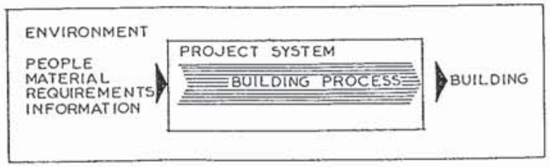


FIGURE 2

Specific for each construction project is the temporary interrelationship of the participants which must be organized afresh for each project.
The participants of the project are here considered as elements of the system, which develop in objective interactive activities. In this process is made use of knowledge information, material and other aids. These items are regarded as inputs from the surroundings. In the project system these inputs are transformed into a complete construction, the output from the system, which fulfils a function in relation to its surroundings. With the completion of the construction, the aim of the system is achieved and it can be dismantled.
The 'social' sphere in which the project will function forms part of the surroundings in sofar as it has external influence on the project. These external influences, however, do not govern the project or only have a limited effect. Typically the surroundings, when viewed from outside the project, have little or no ruling effects.

3. System and model

The construction project, when considered as a system, is in fact no more than a way of seeing the reality, which makes it easier to handle and more manageable. A simplified representation, a model, which only contains those elements and relationships relevant to the aim of the system, is made for the information transfer.
Various models of the same system can be considered, depending on the particular aim.

4. The project model

As shown in figure 2 the basic model is somewhat abstract and far removed from the actual construction project. The model has, on the one hand, limited content, but, on the other hand, it has general applicability. By making specific modifications to the basic model the level of abstraction can be lowered and the content increased. This is possible because each component of the basic model can be split up independently as a subsystem of the main system.
Three aspects, important for information transfer, are elaborated below.

4.1 Objectives

The establishment of a new building, as a rule, is not itself an objective; it is a means of housing an organization. The need for the building arises from the growth or extension of the activities of the organization. For the principal the project aim is primarily to improve the functioning of his organization. This objective contains more than simply a new building; layout, fittings, personnel organization, etcetera, all contribute. Thus, the construction project is in fact a subproject within a larger project formed by the principal's organization as a whole.

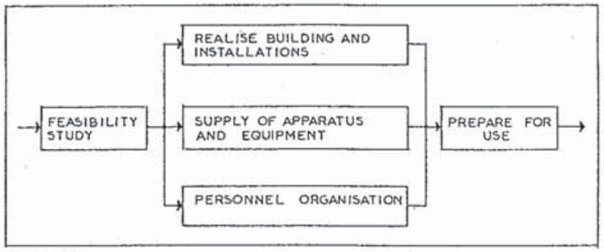


FIGURE 3

In the beginning the objectives of a construction project can only be defined in the form of the requirements and wishes which the design must satisfy. These initial objectives are set by the principal. Other factors, however, still have to be taken into account and the ultimate users and the authorities concerned also state their requirements from their point of view.
In addition the technical experts involved will see the building as an object which must be according to architectural and technological specifications. As a consequence, at the start of the process, the project system has no obvious content but is a complex of diverging requirements, demands and specifications.
From this initially inconsistent whole, a programme of requirements has to be developed to serve as a basis for objective building preparation. Traditionally the building process is often presented as a linear succession of programming, design and execution.
With more complicated projects this succession is incorrect and building preparation must rather be seen as a process in which a complete plan for the work is developed from the interaction between programming and design.

4.2 Phasing

One consequence of interaction between programming and design is that the form of the preparation process changes from linear to cyclic. To be efficient the application of this cycle should not contain unlimited repetitions and to achieve this, the whole process is divided into phases.

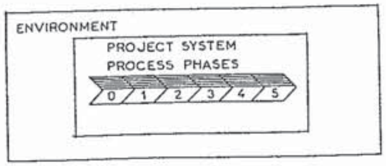


FIGURE 4

The zero phase is, in practice, the start of the project, while Phases 1, 2 and 3 form project preparation, in sequence:
Phase 1 - development of design alternatives
Phase 2 - elaboration of selected design(s)
Phase 3 - preparation of the construction
Phase 4 - the construction
Phase 5 - preparation for use.
The preparation process flow pattern, within which the cycle of programming and design can function, can now be seen as follows:

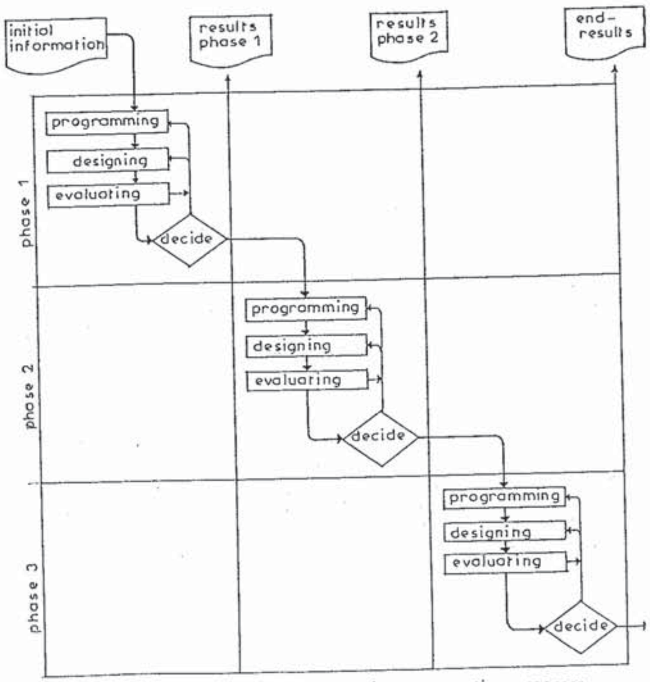


FIGURE 5 flow-chart of the building preparation process

Phasing is a means of directing the project and it improves process manageability. Objectives are firmed up progressively and, as a result, can be adapted without disturbing the process.
Interim phase results give the Principal and the other (external) authorities concerned simple information on plan developments and project progress. To promote information-transfer it is important at this stage to know who the partners in the construction process are and how information processing fits into this process.

5.3 Project structure

Project structure concerns the interrelationships between the different participants in the construction process.
While process phasing is based on time the functional structure is based on the division of the process in terms of project content. The functions within this process concern the specific contributions made by the various participants. Together the main functions in their interrelationship form the functional structure of the project system.

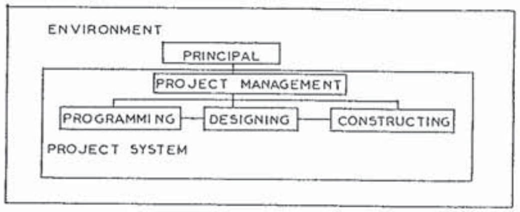


FIGURE 6

Each main function is seen as a subprocess. A further subdivision of the main functions is based on the specific tasks allocated to the various participants. This way a task structure can be developed which, is basically, derived from the main objectives of the project. The information requirements are deduced per phase from the main objectives and are determined by the level of elaboration required at any particular moment.
The preparation process flow pattern shown in Figure 6 is still very general in terms of in phase information-processing. Within each phase, however, the main functions of the construction project appear with greater differentiation.

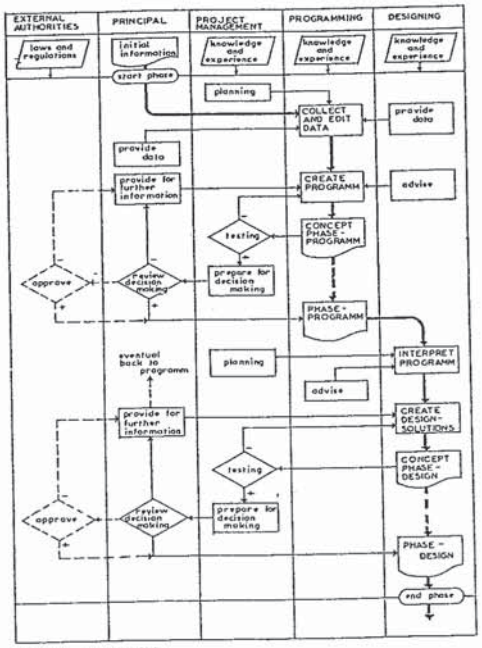


FIGURE 7 PHASE MODEL

Now this phase model has general applicability and is basically simular for each phase of building preparation. The model forms a basis for a uniform method of information-transfer within the construction process. However it offers, no ready-made answers and before use it must be adapted to project-related information provided by the participants.

5. The application of the phase model to information transfer via drawings

Further investigations at SBR have been directed at making the model more easy to apply practically. An elaboration of the programming function has already been published (5).
For information transfer via drawings it is important that the model furnishes a view at information processing in the designing process, per phase. This principle is outlined above and needs to be elaborated for practical applications, on the basis of the objectives of an actual project (6). The model should also enable data to be processed automatically. The requirements for the composition of graphic and alpha-numeral information and the extent to which it can be transferred are basically set by this point of view.

5.1 Information aims and content

The conditions for the aim and content of information can only be determined when the purpose of the information has been established. If the realization of a building or structure is considered to be the main goal of a project, it is possible to establish the purpose of the information, per phase, from the derived objectives of the project. The objectives derived lead to phase results within which subobjectives can be defined for each phase, which in turn lead to part results. These part results concern the production of information by the various partners. The prior setting of objectives, per phase, must ensure that the production of information is devided due to the project, and within the project according to the purpose of the information.

5.2 Information composition

Automized data processing requires the information to be composed in such a way that it can be fed into the computer efficiently. This requirement has lead directly to the development of CAD/CAM systems. Characteristics of these systems are that they work in layers or levels, and the composition of existing items in the form of elements and element groups. Elements are here predesignated or 'drawn' as forms (lines, circles, triangles, rectangles, etc.) This composition into elements takes place at each level of the structural component. In this system a window frame is an element of the facade element group and the facade is an element of the space element group. This devision is comparable with the LACS (Location, Assembly, Component drawings and Schedules) method which is accepted internationally in the building world.
Composition in the form of elements and element groups is essential for automized data processing, the aim of which is to store a specific collection of data separately, thus enabling it to be recalled independently. Data-files can be allocated, for both different levels of elaboration and part results of, as well as at, the same level. However the aim of the LACS method is somewhat different. In the first place a functional division is selected which is based on the aim of the drawing. The location drawing indicates where something must be introduced, the assembly drawing how, and the component drawing what. The LACS method is in fact a process for communication within the information processing system. The method ties in well with current building practice but (still) omits the links to levels or data collections which are essential for automatic processing.

5.3 Information transfer

Information transfer takes place in two directions: horizontal, that is, between different participants at the same level of elaboration (within a phase) and vertical, that is, to a subsequent level of elaboration (between two phases).

Horizontal information-transfer

The phase model shown in Figure 7 forms the basis for the horizontal transfer of information during the designing process. The flowchart relates to the functional structure of the project. Depending on project, details and the derival objectives, the tasks can be divided per phase, amongst the various participants. In other words information production, within each phase, is tuned to the purpose for which it is required for the project.
Depending on the phase model information between partners can only take place at the same levels of elaboration. In practice the process is interrupted if participants feed each other information which is not at the same level of elaboration. Horizontal information links within a phase are essential in order to reach a coordinated result. This coordination is represented in the model by the project management function. The horizontal linkage of information places the strictest requirements on automated systems.

Vertical information-transfer

The flowchart in Figure 6 illustrates vertical information-transfer. This method of transfer concerns the transfer of phase results from one phase to the next.
It is essential for the model that the phase results are checked explicitly by the principal before they are transferred. In practice this does not always take place, just as all the phase results are not actually recorded.
Often the phase results are anticipated during external checking. One should, therefore, be thoroughly aware of this and reconsider the risks versus the advantages of possible time savings.
Characteristic to the whole preparation process is the refining which takes place, from coarse to fine, from generally to specificly. Measuring points are built into certain levels of elaboration to enable the principal to be aware of project progress (8). This is based on phase results defined by the project objectives. Names in current usage for these are structure plan, preliminary design, definitive design etc. It is important that phase results contain nothing more or less than necessary for the principal to take decisions about the particular phase.
Vertical information linkage across phases is of special practical importance to automatization since it enables data from the previous phase to be elaborated without the need for new drawings.
Naturally, modifications should be made to all the drawings concerned. Should this affect the phase results from a previous phase the initiation of a new project is, in fact, warranted.

(1) Burckhardt-Förderer: Bauen ein Prozess 1968/1972
ISBN: 37212 00217
(2) SBR - C 32 - Informatie-overdracht via tekeningen
(3) SBR nr. 127 - Van initiatief tot bouw; een systeembenadering, model en toepassing
(4) De Nederlandse Delta,Uitg.Natuur en Techniek 1982
ISBN.90.70157 25X
SBR nr. 102 - Techniek in bouw en industrie
(5) SBR nr. 128 - Het programma van eisen bij nader inzien
(6) BNA-PIM - Informatieverwerking tijdens het bouwvoorbereidingsproces
(7) Ontwerp NEN 2574 - Indeling van gegevens op tekeningen voor gebouwen
(8) Burie - Informatie en besluitvorming in de bouw
ISBN 90-71174-01.8