The Construction Methods Presentator
A Multi Media Presentation Tool for Construction Methods

by
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Abstract

This thesis discusses the ideas behind the development of a multi media based presentation program for construction methods. The problem domain for construction methods is analysed and presented. A discussion of various ways to implement a multi media based presentation program is included as well as a description of an implemented prototype. The prototype is implemented in HyperCard and features voice input/output, animated sequences, video. The presented data reside in a prolog based database residing on a Sun Sparc station. HyperCard communicates with the prolog application via Ether Net.
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1 Preface

This thesis describes the ideas behind the developing of a multi media based presentation program for construction methods. The existing knowledge about construction methods is analysed and presented. A discussion considering different ways to implement a multi media application in general is included as well as a discussion of possible implementations for this specific problem domain. Finally an implemented prototype is described.

This is also a thesis towards a M. Sc. degree in Computer Science and Engineering at the School of Computer Science and Engineering, Royal Institute of Technology, Stockholm, Sweden.

The work has been completed at the Knowledge Based Systems Laboratory, Swedish Institute of Computer Science, Kista, Sweden during the autumn-winter 1990-91.
2 Background

The MDA research program
The MDA research program* is a multi-disciplinary research program supported by the Swedish National Board for Technical Development (STU) and the Swedish Work Environment Fund (AMFO). The MDA-program focuses on constructing and analyzing computer based solutions to industry related problems. The prototypes that implement the various solutions are constructed using some of the latest computer based techniques and theories. The goal is to obtain a technically advanced solution which is also constructed to realize a good, mentally rewarding work environment for the persons who handle it.

There are several projects in the MDA research programme, each one associated with a different branch of industry. One project, which is called "Computer based supports for the planning and administration on the construction site", deals with aspects of computer support in the construction industry, especially on the construction site. The project is called the MDA-project below.

The MDA project
The planning and administration activities on the construction site have previously not been computer supported to a great extent. Computer supported tools have mainly been used in the designing and calculation phases of the construction project and in the economic summaries. The MDA-project was formed in order to investigate how and when computer supported planning and administration tools could be used on the construction site.

The MDA-project is run in cooperation by the Knowledge Based Systems Laboratory at the Swedish Institute of Computer Science (SICS), the Royal Institute of Technology (KTH) and the Stockholm School of Economics. The participants represent different disciplines of knowledge such as computer

* MDA stands for "Människa-Datateknik-Arbetsliv" which means "Man, Computer Technology and Working Life"
science and engineering, construction know how, work organisations/planning and project management.

The objectives of the MDA project is to construct and partly implement a number of prototypes which together offer a demonstration of an integrated computer aided support system for the various activities that take place on the construction site.

This thesis describes the ideas behind, the implementation of and the further use of a presentation tool for construction methods. The presentation program is called the Construction Methods Presentator (CMP). Its aim is to help the users to choose the right construction methods for different construction parts and to serve as a reference when the methods are to be performed.
3 The Problem

The MDA projects [1] first objective was to analyze the planning process that takes place on the construction site. The analysis and a complementary discussion regarding possible computer supported tools which could support the planning process were presented [2] [3], and a preliminary report [4] summarizes the discussion. The report states that the need for computer supported tools for facilitating the planning process exists in all phases of a construction project. That is from the stage when offers are calculated until the construction is completed.

Since most of the planning on a low level is performed by the site manager, his work was further analysed, and the planning process was simulated [5] and a prototype for an interactive planning tool to be used by the site manager was presented [6]. The work of the architects, of the construction enterprises calculators and of the group leaders on the construction site were also studied and the need of an integrated computer aided support system soon became evident. This system should be able to support the information requirements of all participants in the construction process. This includes a support for the constructions plans, calculations, planning and following up. The applications that together constitute the integrated computer aided support system were specified and during that process the need for a presentation tool for construction methods became evident.

A presentation tool for construction methods is to be used primarily by the site manager but also by the calculators, the group leaders and the architect. It should thus be able to support each category of users with a presentation of for them relevant information about construction methods.

Consequently the prime goal for the work presented in this thesis is to analyse and implement a tool, which uses multimedia technique to present construction methods.

The presentation tool shall help the users to choose the right construction method for different construction parts and serve as a reference when the methods is to be performed. The users will also use the information in their own time schedules and plans. The presentation tool should thus be able to
support the different information needs of the persons that participate in different capacities during the lifetime of a construction project.

Another goal of this work is to demonstrate multi media implementation and discuss the resulting advantages and disadvantages. The presentation tool also demonstrates a connection between a multi media interface and a Prolog database application, which resides on different hardware.

Since a understanding of the problem domain is necessary for an appreciation of the discussion regarding the implementations information structure and contents, the next chapter "Domain knowledge for construction methods" describes the problem domain quite throughly.
4 Domain knowledge for construction methods

This chapter defines the concept "Construction method", describes how the choice of construction method is done and presents the existing sources of information.

4.1 Definition

In this thesis a construction method is defined as "a series of activities that produce a construction part". This definition differs from the one normally used in the construction industry in so much as "method" is here used regardless of the detail level whereas in the industry the term is often used for the most detailed level used by calculators.

A construction part is a part of a building e.g. a wall, a window with window-sill and window-pane etc. To realize the desired construction part one applies a construction method. This is an object oriented approach.

Traditionally one uses a couple of construction methods in order to build for instance a wall. One of the methods deals with putting up and down the mould, another one with the reinforcement and the third one with the casting of concrete.

The reason for remodelling the concept of construction methods is the need to treat them as units, which is due to the need to facilitate the comparision of their respective time-, cost-, resources- and personnel-requirements.

4.2 The process of choosing construction method

A building is first constructed by the architect and other technicians on one or several plans. At this stage the architects main concern is the design of the building and not how it should be constructed. However, the architect also describes how a certain part is to be constructed when the construction method plays a role for the quality or the visible appearance of the parts.
The next stage of the construction process occurs when a construction enterprise is preparing to submit an offer. In order to do this they must choose the construction methods for the different construction parts. The construction enterprise keeps records with specifications of the required resources; material, tools, personnel, time and cost to construct a given part with a certain construction method. These records are primarily kept as a help to calculate offers but they also serve as a remembrance of construction methods not often used. The resulting offer specifies how the building will be constructed in further detail.

The final choice of construction method occurs at the construction site. The site manager has the final responsibility to choose the appropriate construction method. He has to survey all construction methods that are suited for a particular purpose and compare them accordingly to their time, cost-, resources- and personnel-requirements in order to make the best choice. He can for instance choose a construction method with a lot of pre-manufactured parts if he is behind schedule (and still has some extra money) or he can choose a construction method which includes more manual work if he has some personnel to spare. His choice of method can also depend on the weather or on some event that occurs on the construction site.

The group leader organizes the carrying out of the chosen construction method. He is thus often consulted by the site manager considering the choice and he is the one who informs, guides and supervises the construction workers.

To summarize; the process of choosing the construction method is a step by step process. The construction method is more and more specified in each step. However, it is quite common that the site manager has to change the construction method on very short notice due to various unforeseen events.
4.3 Available sources of information about construction methods

The main sources of information about construction methods are the Methods and Data reference sheets [7] [8] [8], the AMA reference documents [10] [11], internal documents produced and used by different construction enterprises and most important: the human memory and experience.

As no complete, general available, up to date source of information about construction methods exists, it is necessary that the site manager has a vast experience. He has to survey all construction methods suited for a particular purpose, to compare them accordingly to their various requirements and to make the best choice.

4.3.1 The Methods and Data reference sheets

In order to provide a support for the calculation and planning processes and to familiarize the construction workers with different construction methods, the Swedish Building Centre has produced the Methods and Data reference sheets [7]. Every sheet describes a construction method (defined the traditional way) regarding one of the aspects Production Data, Time Data and Work Instruction. Consequently a construction method can be described in one up to three sheets. The information of the different sheets will be described below. See Appendix F for an example of the Methods and Data reference sheets.

Unfortunately the Method and Data reference sheets are quite old fashioned nowadays. They present the construction methods of the 60-70'ies and although the basic methods are the same, new techniques and new materials together provide a vide range of modified methods. Neither are the reference sheets available as computer based information. Thus they are not often explicitly consulted but they can be regarded as the foundation for the working knowledge of the people in the construction industry.

Below follows a description of the terms used in the Methods and Data reference sheets.
The Production Data Sheet
The Production Data sheet is the main one for every construction method. It includes the following headlines.

- Method
The construction method is described and illustrated with a simple picture.

- Activity diagram
This diagram illustrates the internal order of the construction methods activities and also their respective relationships to activities that belong to other construction methods.

- Material
Specification of the required raw and premanufactured material and its dimensions.

- Equipment
Specification of the required pieces of equipment which are not part of a construction workers toolbox.

- Group size
The total number of men, with different specialities, that are required during the performance of the methods activities.

- Method time
The time required to perform all the activities of the method is called the method time. This concept also includes method dependent delay time.

The method time is presented by a diagram which shows how the method time depends on the quantity. The diagram also indicates the quantity of the overhead time.

All special cases for the participating activities requiring additional time are also specified with their respective time values.

- Running time
The actual time it takes to complete the construction method is denoted the running time. It is usually computed by multiplying the method time by a running time coefficient.
- Component description
All the components that are parts of any of the construction methods activities are described in detail.

- Conditions of the participating construction sites
The conditions of the construction sites for which the time requirements were analysed are also listed.

- Calculation example
A simple calculation is performed step by step in order to demonstrate how to use the Production Data sheet.

The Time Data Sheet
The Time Data sheet for a specific construction method contains time values for all the different subactivities of each of the activities, which together constitute the construction method. An estimated average of the facts presented in the Time Data sheet is presented in the Production Data sheet under the headline "Method time". The level of dissolvemt of an activity into various sub-activities is very high in the Time Data sheet.

The Work Instruction Sheet
The Work Instruction sheet mainly consists of a number of pictures, each with an adjoining text. Together these pictures aim at providing a schematic overview on how the construction method with its activities and sub-activities should be performed. The level of detail is adjusted depending on how unusual the activity/subactivity is and to what extent its way of performance affects the entire method. Consequently there are pictures that go into great detail in presenting the different components of and how to perform a small part of the operation and pictures that mainly indicates what should be done but which leaves the decision on "how" to the user.
4.3.2 The AMA reference documents

The AMA reference documents* [10] [11] are used in the processes of stating specifications and performing previous agreed on construction and installation activities. AMA references are thus used by architects and others in their descriptions of the project.

The AMA-reference documents are divided into separate books; one for each construction discipline. The books are called the Ground-, House-, Plumbing-, Heat-, Electricity-, and Advice-AMA. The AMA reference documents are used to facilitate the process of stating the quality specifications for a product and its parts. The resulting quality specifications will consist of quotations from the AMA reference documents plus the additional specifications that are considered necessary. Advice-AMA contains additional advice upon how to use House-AMA in different situations.

House-AMA [10] and Advice-AMA [11] have almost the same disposition regarding headlines. This makes it easy to check whether there exists any further information in Advice-AMA once the appropriate headline in House-AMA has been found.

4.3.3 Additional information concerning construction methods

Some aspects considering the performance of construction methods are not explicitly stated anywhere, for example the safety instructions.

The safety instructions primarily states how the security shall be handled at the construction site during the performance of the construction method in order to avoid accidents. It also advises how to carry out the tasks associated with a construction method in order to avoid work related injuries in the

* AMA stands for "Allmän Material- och Arbets-beskrivning" which means "General Material Description and Work Instruction"
long run. The safety instruction are stated in pamphlets compiled by the National Board of Occupational Safety and Health*.

4.4 The BSAB nomenclature

The BSAB code is an nomenclature used in the construction industry. It is constructed and maintained by the Swedish Building Centre. The BSAB code was constructed in order to facilitate the organisation of the technical and financial information about a construction. In the BSAB code, the same construction part is numbered in two ways; one number specifies how the construction part shall be produced and the other number specifies where the construction part is situated in the construction.

The "how" way of numbering

The "how" way of numbering specifies how to construct different parts of a construction. The construction parts are here mainly classified according to the material they consist of. Product Table 1, of which a small part is shown below, is used for the classification of construction parts, installed devices etc. The estimated work effort needed for realising the parts are also stated in this table.

- E = Locally casted concrete constructions
- E.1 = Moulds
- E2 = Reinforcement etc.
- E3 = Casted concrete constructions
- E3.3 = Frame work of locally casted concrete
- E3.32 = Concrete walls
- E4 = Casted concrete constructions, realised with the use of sliding forms

A locally casted concrete wall will thus be numbered E3.32 in accordance with Product Table 1's notation.

* Arbetarskyddsstyrelsen
The "where" way of numbering
The "where" way of numbering specifies where a construction part is situated in the construction. Product Table 2, of which a small part is shown below, is used in the classification process. Product Table 2 is made according to the technical function and the realisation of construction parts. The table is material anonymous, as the classification concepts are not associated with specific materials.

<table>
<thead>
<tr>
<th>3</th>
<th>= House</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>= Frame work</td>
</tr>
<tr>
<td>33.1</td>
<td>= Frame walls</td>
</tr>
<tr>
<td>36</td>
<td>= Room formation</td>
</tr>
<tr>
<td>36.3</td>
<td>= Interior walls</td>
</tr>
</tbody>
</table>

This numbering corresponds with the one used in building drawings. An interior wall situated on the third floor will thus be numbered 36.32X in accordance with Product Table 2's notation.
5 Multi media technique and theories

This chapter will present a selection of existing multi media techniques and discuss their advantages/disadvantages regarding how they are suited to present different kinds of information. A discussion on designing applications for users with different information requirements and domain knowledge is also included.

5.1 Information presentation techniques

This section will present a selection of general information presentation techniques: two dimensional visual presentation, three dimensional visual presentation and audio presentation. A brief overview of some interaction devices is also included.

5.1.1 Two dimensional visual presentation techniques

Textual representation
Textual representation has served to mediate information for a couple of thousands years and it should thus not be overlooked. It is unsurpassed for the presentation of exact facts and figures.

Pictures
There are several advantages of the picture representation concept. A picture could either be a drawing or a photograph. This enables the designer to show either a simplified or "real" picture of the object. A drawn picture can be designed to focus on the relevant details. It can also show "below surface information" for the object e.g. via cross section drawings.

Animated sequences
An extension of the drawn picture - textual concept is the animated sequence. An animated sequence presents information by using moving pictures. An animated sequence can also feature sound and/or text. In the extreme case the designer can thus choose either to present the same information with the use of several media or to present different aspects of
the information by using different media. An animated sequence is usually
designed as a mix of these two presentation strategies.

An animated sequence can also support interaction from the user. The user
is able to click on objects/buttons and can thus navigate between different
sections of the animated sequence. This enables the user to, in a way,
choose presentation level of the information.

**Video, with and without interaction**
A video sequence has the advantage that it gives the user a realistic
conception of the presented information. As a video tape also includes
sounds it is a perfect medium for demonstrations, descriptions of physical
objects etc. However, it can be tricky to include textual information and
drawings. The main drawback is that the user cannot interact with the
presentation (except by searching the tape).

Interactive video on the other hand supports user interaction. Interactive
video can be regarded as "objectified" video. The user is able to click on some
objects and is thus able to navigate between sections of the video.

Video used in a multi media application of some extent is mostly stored
on optical disc instead of tape. Optical disc has advantages over tape: it
supports direct access, has shorter seek time etc.

### 5.1.2 Three dimensional visual presentation techniques

Three dimensional pictures provides a much more complex view of an
object than two dimensional ones. Thus a three dimensional picture gives
more information than a two dimensional one.

**Three dimensional interactive pictures**
In a three dimensional interactive picture a user is able to experience that
he can "grasp" and "handle" an object. This enables the user to e.g. view
the object from an arbitrary angel. The user can also be able to decompose
an object into it's components.

**Virtual reality**
In a virtual reality the user is given the perception of being in a world
created by a computer. In the virtual world he can see and handle objects. The objects will respond to his actions and he can thus e.g. move, walk around and decompose them. There is still much work to do on the virtual reality concept but it is already used to some extent in for instance flight simulators.

A couple of techniques that can be used to accomplish a three dimensional presentation will be described.

**Projection**
The easiest way to accomplish a three dimensional perception is to project a three dimensional object on a two dimensional surface. This technique uses removal of hidden lines/surfaces, depth queueing, lightning, shadowing.

**Red-blue glasses**
A three dimensional perception can be accomplished by letting the user look at two pictures, which are shown simultaneously on the screen, wearing glasses with one red and one blue glass. The pictures on the screen consists of two pictures from different angles of the same object, one red and one blue. The user sees the two pictures simultaneously, each through one eye, and his brain composes them into a three dimensional object.

**Shutter glasses**
In this case two pictures of the same object, viewed from angles approximately 15 degrees from each other are shown on the screen interleavingly. The user wears special glasses where shutters open and close with the same frequency as the pictures change. One eye sees a picture while the other one has a "blind" in front of it. Since the brain remembers the received picture from one eye for a moment, the brain will be able to compose the pictures from both eyes in order to perceive a three-dimensional picture.

**Head mounted stereoscopic display**
A head mounted stereoscopic display is a "thing" that entirely covers the eyes. Two displays, one for each eye, resides on its inside. Two pictures of the same object, from different angles, are showed simultaneously on the two interior displays. The main point is that the head mounted stereoscopic display is provided with sensors which indicates how the user holds his
head. Thus if he turns his head the displayed picture will shift in accordance with his motion. He can also walk around an object and in this way see its different sides.

5.1.3 Audio interaction and presentation

Audio interaction and presentation is so far the only commercially available interaction technique that uses other human "devices" than eyes and hands.

Voice interaction
Voice input has the advantage that the user doesn't have to interrupt what he is doing with his hands when he wants to communicate with the computer. This concept enables the user e.g. to handle an object and at the same time issue commands. The main drawback is that natural language interfaces and voice recognition devices still are research areas. There are commercially available voice recognition devices but some of them tend to be a bit too sensitive for changing nuances in the users voice to be completely reliable.

Sound presentation
Sound presentation is a summary name for various kinds of beeps and tunes. Sound presentation can be used to indicate that the state of the "system" has changed. The use of different sounds in different situations makes it possible to also indicate what has happened.

Voice presentation
Voice presentation of information enables the user to receive and perceive another aspect of the information he is presented visually at the same time. The user could also be briefly informed upon another subject e.g. a remembrance to do something or a short instruction how to accomplish a certain task in the application he is working with.

5.1.4 Interaction devices

Pointing devices
Mouse, trackball and various sorts of joysticks represent the same
interaction paradigm. They are devices that enable the user to point two dimensionally. The user moves the interaction device on a table or likewise but has to look at the screen for feedback. This only seems natural when the user is clicking on menus, moving objects and so on but could be a bit confusing for the beginner e.g. when he is using a drawing program. That is because using a drawing program the user has to respond to a different kind of feedback than he is used to in performing an already familiar action (drawing). Pen and tablet also represents the same interaction technique. Although one could argue that a pen offers a more familiar physical interaction technique, since one already knows how to handle a pen there is no great difference due to the feedback media.

**Touch screen**

A touch screen is a screen where the user can locate a point two dimensionally by pointing at it. One could be tempted to regard a touch screen as the perfect combination of a pointing device and a screen but there are several drawbacks. The touch screen doesn't provide the same precision for the pointing process as e.g. a mouse does. The screen also tends to be smeared and the work position of the user is straining in the long run.

**Data glove**

A data glove is a glove which is provided with sensors, which locate the gloves position in the room and how the fingers are positioned to one another. Thus a data glove offers a "hands on" interaction perception for the user. The user is able to point at and handle objects. Moreover if the data glove is used with some kind of 3D-glasses and an application that supports 3D, the user is really able to "experience" the handling of objects. Data gloves can also support tactile feedback e.g. by using vibrations when the user "grasps" something.

### 5.2 Choice of presentation media for different kinds of information

An important task in designing a multi media application is to decide not only which information is to be included but also by which media it should be presented. Which media to use depends on the kind of the information, the complexity and amount of it and on how, when and by whom the
application is intended to be used. The choice is also influenced by the available financial resources.

Though the information itself in an application is case dependent the various kinds that exist of information are not. Therefore a discussion on how to present some different kinds of information follows below.

**Textual data**

Textual data which have to be presented literally are normally presented by use of textual representation in some media. The actual text can also be presented by use of voice output. The latter has the disadvantage that if the text is not very short the user tends to lose concentration.

Textual data that are not literally important but which describes something, indicates dependencies etc. can be presented in several ways depending on their contents and amount. A description can be transformed into an interactive video, an animated sequence or an audible presentation. On the other hand a set of dependencies are perhaps transformed into a picture.

**Figures**

Figures that have to be shown separately can be presented by use of textual representation or by voice output. Voice output is though not very suitable if there are a lot of figures and/or complicated ones that is to be presented. Very simple quantities such as one, two etc can also be represented by use of icons.

Large quantities of figures are almost always shown in some kind of graph. How the graph is constructed is strongly dependent on the circumstances it will be used in. The graph can be shown as a mere picture or be part of an animated sequence or a video.

**Pictures**

Pictures can be used as they are, transformed into an animated sequence or form part of a video. If a picture is transformed into an animated sequence, the picture is sometimes decomposed and the adjoining picture text split up. In this way it is possible to construct an animated sequence which visualises how something develops over time instead of showing a static picture. An animated sequence can also support grouping of information by allowing
some pieces of information not to be presented until they are explicitly asked for by a user action. In the same way a picture can form part of a video or be substituted by one. If interactive video is used the above mentioned information grouping can also be achieved.

Sounds
Sounds can be represented by onomatopoeic expressions, fonetic expressions or by music notes if they are suited for any of these representations. However sounds are mostly best and most accurately presented by a recording.

5.3 How to implement a multi purpose application

A multi purpose application is an application which is designed to provide users on different levels with different background knowledge with the appropriate parts of the entire available information, presented on a detail level and in a way that corresponds to their needs and demands.

There are many interaction paradigms that can be used in implementing a multi purpose application. Some of them will be described briefly below.

Modes - Levels
An application is said to support different modes or levels if the content of the information as well as its extensity and presentation depends on in which mode the user is working when he issues a command. An application which supports different levels is often implemented to support beginners up to advanced users doing approximately the same things, while an application which supports different modes is implemented so that the different modes support different views of the available information.

Views - Windows
Views are used to present different aspects of the same information. Different views can be presented simultaneously in separate windows or on different occasions.

Different media
One of the advantages a multi media environment provides is the ability not only to use many media in the same information presentation but also to
choose the media that are most suitable in a presentation for a specific kind of user. This enables the designer to use the facilities of a multi media environment to design applications that are tailored to fulfill the requirements and demands of many kinds of users.
6 The Construction Methods Presentator

The Construction Methods Presentator (CMP) is a prototype of a presentation tool for construction methods, which is implemented using multimedia technique. The CMP is developed to guide users in choosing the right construction methods for different construction parts and to serve as a reference when the methods is to be performed. The CMP is also developed in order to demonstrate how multimedia can be used in a multi purpose application.

The CMP is based on HyperCard, which is a Macintosh software for developing applications with the "Macintosh" interaction paradigm. That is applications that includes buttons, fields, menues, multiple windows etc. HyperCard also permits the designer to include various multimedia facilities.

Since most of the presented data reside in a separate database (see "The use of the Construction Methods Presentator in a larger context" for further information) the application is data independent. But as it is only a demonstration program the three dimensional interactive picture, the animated sequence work instruction and the video taped work instruction are only available for one method: the construction method considering how to make an on site moulded, reinforced concrete wall.

The CMP consists of several views, each one designed to present a specific aspect of the information for a specified construction method. The views are called the Main Presentation (including the overview facility and a three dimensional interactive picture), the Resource Presentation, the Time Presentation and the Work Instruction.
6.1 Summary and Detail mode

The CMP can be run in two different modes. These modes correspond to the two different ways there exist to look at a construction method. A construction method could either be regarded as a unit or as something consisting of several activities. The modes in the program are consequently called Summary-mode and Detail-mode. The Summary-mode permits the user to look at e.g. the entire methods resource demands while the Detail-mode presents the resource demands of a single activity. The Resource Presentation, the Time Presentation and the Work Instruction views supports the two modes.

6.2 Main Presentation view

The Main Presentation view is designed to provide an overview of the currently selected construction method. The intention is that it should be easy to survey the main characteristics of the method. This view also controls all the other ones. They can thus be regarded as subviews. The choice between Summary-mode and Detail-mode buttons is done in this view.
The Main Presentation view includes the following features: a method overview facility, a three dimensional interactive picture and a help facility. They are described in detail below. Appendix A shows a complete presentation of the view.

6.2.1 Method overview facility

A construction method consists, in accordance with its definition, of a number of activities which are to be performed sequentially. These are shown as consecutive arrows with corresponding names. For each activity the number of men needed, the estimated time requirements and the possibly need for limited resources are listed.

![Method overview graph]

**Activities**
The activities are normally performed consecutively and are thus represented by consecutive arrows. A small overlap can be permitted; it can be possible to start an activity although the previous one is not yet completed. The exact amount of the overlap is difficult to show because it
varies with the conditions on the construction site. Yet, an alternative could be to indicate where overlap is possible and where it isn't.

**Personnel requirement**
The estimated number of persons needed is based on an average for the number of persons needed in each work operation of the activity. It is thus a rough figure to give the user an help to estimate.

**Time requirement**
The estimated time per m² constructed area or equivalent is shown. The time values shown are more detailly presented in the Time Presentation view for the corresponding activities. The initially presented time is the "basic" one since no adjustments for extra operations have been done automatically. Thus if the user wants to see how much e.g. a curved wall affects the moulding time, he has to explicitly state that he wants the calculations to consider this fact in the Time Presentation view.

**Limited resources requirement**
Limited resources, for example cranes, are indicated by stylized symbols which reside under the activities where they are used. This feature was included in order to help the user to quickly recognise if a method uses some unusual piece of equipment or a one that the user knows is often an limiting factor.

6.2.2 **Three dimensional interactive picture**

A three dimensional interactive picture of the construction part, which is the result if you apply the currently presented construction method, is showed. The three dimensional view is included because a mere two-dimensional picture doesn't contain enough information. The view shows a projected picture.

In the main example which concerns a concrete wall, the user can manipulate the wall by mouse movements. The wall can be made to spin right or left and to "explode" into its different parts; namely two moulds, two pieces of concrete and the reinforcement that resides in the middle.
The three dimensional picture was realised by a MacroMind Director movie combined with tracking of the users mouse movement. Appendix G shows two snapshots of the picture.

6.2.3 Help facility

An extensive yet easy to use help facility, to be accessed on line, should be a part of every program that is developed for professional use. One drawback though is that the user often has to interrupt what he is doing in order to change to the help facility.

Audible help
In order to demonstrate and investigate the capacities of help through a different medium, audible help was included in the CMP. Audible help was chosen since the main information in the CMP is perceived visually. Some of the buttons in the demonstration program; the "Detail"-mode and "Summary"-mode buttons, were provided with the shift-click option. If a user shift-clicks on one of these buttons he will hear a short, concise description of what clicking on one of the four buttons "Resources", "Time", "Work Instruction" or "Video" will result in, in that mode.

Audible help proved to be a good way to provide short help on a specific subject. Though the designer must be careful so that the recorded help instructions are not too long. If the user wants more extensive help the best thing for him is to have some kind of special "Help" window resident on the screen.

The MacRecorder was used to record and install the Help-sounds.

Visual help
Since the CMP is a demonstration program, the normally required extensive visual help facility was not implemented.

6.3 Time Presentation view

The Time Presentation facility is activated when the user clicks on the "Time"-button. This facility is only available in "Detail"-mode because the
overview information is already presented in the Main Presentation view. The Time Presentation view is designed to give the user a thorough understanding of the different factors that affect the estimated time requirement for a specific method.

The time requirements for the presented activity, for a certain quantity of the construction part, with the specified extra operations is presented in this view. This value is also shown in the Main Presentation view in connection to the activity arrow. Furthermore the estimated running time for the activity is also shown in the Time Presentation view. The running time is the total time requirement value multiplied by a running coefficient.

**The extra operations influence on the total time requirement**

As previously mentioned, an activity can contain a number of extra operations that are only invoked if there is need for them. To provide the user with a tool for estimating the proportions between the time requirements of the simple activity and the time requirements of the composite activity, which includes a number of extra operations, a graphical display has been constructed.

<table>
<thead>
<tr>
<th>Description of an extra operation</th>
<th>Person timmar/m² totalt (ungefär)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uppsplitting och förekommande nedtegning av smygformar</td>
<td>0.03</td>
</tr>
<tr>
<td>Vid vägshöjd över 3.25 m</td>
<td>0.04</td>
</tr>
<tr>
<td>Vid 1 side form (stöttad form)</td>
<td>0.22</td>
</tr>
<tr>
<td>Vid svängd form</td>
<td>0.10</td>
</tr>
</tbody>
</table>

\[ \sum: \quad 4.1 \text{ timmar/m}^2 \]

The "x"-marked extra operations are included and the total time requirement for this activity is 4.1 hours per square metre (since 4.0 hours per square metre is the "basic" time).
The user can click on/off the different extra operations, note how much time they require and directly see how the presence of them affect the total time requirements for the activity.

**The influence of the initialization time on the total time requirement**
The initialization time for an activity affects the total time requirements less and less when the quantity rises. The curve that specifies the time requirements for the simple activity is shown. Thus the user is able to estimate the proportions of the initialisation time for different quantities. The curve has also been transformed into a mathematical expression which is used when the system computes time requirements.

The graph shows the initialisation time requirement proportion of the total time requirement.

**Quantity**
The quantity that is shown in the Time Presentation view is supposed to be the quantity of the actual part that the method will realise in a specific construction. The user can change the quantity by entering a value in the "Quantity"-box. This feature enables the user to test interactively whether, e.g. larger construction parts would be more time effective due to their lesser percentage of initialization time. The user forces a new quantity to be included in the calculations by clicking the "Calculator"-button. This is the only time in the Time Presentation view a calculation has to be explicitly
ordered, because changes due to a different set of extra operations are shown immediately.

The user can enter a new quantity and perform the calculations.

**Computation model**
The computation model for the calculations has been extracted from the more extensive calculation basis that is found in the Time Data Sheet. The user can see this basis by clicking the "Sheet"-button. The computational basis will then be presented.

### 6.4 Resource Presentation view

The Resource Presentation facility is activated when the user clicks on the "Resource"-button. All required resources needed to carry out the construction method are listed in connection to their respective activity. The required resources are divided into three categories; materials, machinery and personnel. The Resource Presentation facility is available in both the "Detail" and the "Summary" mode. The difference between the presentations is that the "Detail" mode presents the, for the activity, corresponding subset of the presentation in the "Summary mode".

The Resource Presentation also includes the possibility for the user to print the resource requirements. Appendix C shows a complete presentation of the view.

<table>
<thead>
<tr>
<th>Activity name</th>
<th>Materials requirement</th>
<th>Machinery requirement</th>
<th>Personnel requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport av</td>
<td>Formyta av laster 1&quot;0.4−0.5 m x 1.0−2.0 m</td>
<td>Kran</td>
<td>1−2 man</td>
</tr>
<tr>
<td>fenomaterial,</td>
<td>Kryssfandiskiver 12.5 mm, 0.60−1.52 m x 1.52−3.15 m</td>
<td>Håkning maskina</td>
<td></td>
</tr>
<tr>
<td>uppställning av</td>
<td>Glue inbörden 1&quot; x 4&quot;, d 0.25 m</td>
<td>Maskinborden</td>
<td></td>
</tr>
<tr>
<td>första</td>
<td>Ljusmar 1&quot; 0.40−0.60 m x 0.75−3.80 m</td>
<td>Maskinborden</td>
<td></td>
</tr>
<tr>
<td>formåldan</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An activity and its corresponding resource requirements.
The materials field
The materials list includes an enumeration of all the required materials though without corresponding quantities. The reason for the lack of quantification is that the CMP is primary a tool for presenting construction methods. There exists a certain amount of interactivity regarding the time calculations but this interactivity is implemented only to help the user to choose the most suitable construction method for every occasion. The quantification of materials is not necessary for this choice.

The machinery field
The machinery requirements include every piece of equipment, not normally included in a construction workers toolbox, that is necessary for carrying out the activity. The major pieces of equipment or those which are known to often be a limiting factor are presented with icons in the Main Presentation view in connection to the activity.

The personnel field
The personnel requirements for an activity specifies the approximated number of construction workers needed to perform the activity in accordance with the time requirements. This number is also shown in the Main presentation view. This specification also states if some of the workers need to have some special skills, such as for instance crane driver.

6.5 Work instruction
There are a number of participants on different levels in the construction process for whom a work instruction might be useful.

The project manager and the site manager are usually familiar with the construction method in general but can occasionally need to refresh their memory on some minor detail. Since they make the time schedules for the construction, their main reason for consulting a work instruction is to check if some activity needs special consideration. Consequently a work instruction has to be brief and easy to survey to suit their needs.

The group leader has the responsibility for instructing his group how to carry out the construction method. He will thus need a work instruction
that is suitable for both his personal use and for the use of the construction
workers, both the experienced ones and those recently employed. This calls
for a work description that is designed to provide each user with a
complexity level suitable to his needs.

The perfect choice for a work instruction that is designed to suit the needs of
different users is an interactive video. The interactive video concept enables
the designer to select the most appropriate media or media for all the
presented information. He can choose among and be able to utilize all the
advantages of video, animation, text and sound.

The CMP offers two kinds of work instruction, an animated sequence and a
video taped one. They are activated by clicking on the "Work Instruction"
and the "Video" button respectively, both residing in the Main Presentation
view. Together the implemented work instructions aim on demonstrating
how the components of an interactive video could function.

6.5.1 Animated sequence

The animated sequence consists of a main menu and five scenes. See
Appendix D for a survey of the scenes. The scenes use movement, sound,
twinkling etc. in different ways and combinations in order to mediate the
information. An investigation of the most effective way to mediate different
kinds of information lies beyond the scope of this thesis.

The main reason for developing the animated sequence was to provide an
example where the possibilities of the technique was demonstrated, not to
implement a realistic work instruction. The Methods Data sheets are used
as the basis for the animated sequence.

Main menu
The main menu offers an overview of the five scenes and the user can
choose which one he wants to see. This enables a more experienced user to
scan the work description quickly.
The main menu for the animated sequence that describes how to mount the mould of a concrete wall.

Choice of preferred media
One of the features a multimedia environment offers is the ability to present information by using the most appropriate one/ones of the available media. The user should both be notified when the information exist on several media and be able to choose by which media it should be presented.

Sound is incorporated in some of the scenes. The sounds are mostly an audible version of the presented texts which are thus presented simultaneously by two different media. In order to demonstrate the user's possibility to choose presentation media a loud-speaker icon is present whenever the presented text also exists in an audible version. The user can turn the sound on/off by clicking on the icon. Since it is not possible to turn off the textual presentation and only keep the audible one the textual representation is here considered to be the main one.

Macromind Director and MacRecorder was used to create the animated sequence and sound.
6.5.2 Video

The CMP supports the feature of showing video directly in a HyperCard window. Please see the "Physical environment and equipment" paragraph for technical specification.

The video tape resides on a video-tape recorder that accepts remote control. Since it is possible to mark a video tape with tags, HyperCard can control the video recorder entirely. The interface in the CMP visually resembles the remote control device of a video recorder. This has the advantage that it is possible to operate the video recorder explicitly but all the commands, that are now explicitly operated, could naturally be included in the internal code of the application.

The video tape used in the demonstration program shows some of the operations that are used to mount a mould.

6.6 The House- and Advice-AMA views

The paragraphs from House-Ama and Advice-Ama that are relevant for the presented construction method are included. The view that contains House-AMA is reached by clicking the House-AMA icon in the Main view. Appendix E shows a complete presentation of both views.

The House-AMA texts are presented basically in the same form as in the book. Due to the fact that the House- and the Advice-AMA are organised with mostly the same headlines, every headline in the House-Ama which is also present in Advice-AMA is underlined with grey in the former. The user double-clicks on a grey head-line to make the view that contains the corresponding Advice-AMA information appear.
7 The use of the Construction Methods Presentator in a larger context

As stated in the paragraph regarding the MDA-project, the Construction Methods Presentator is one of several parts that together form a continuous computer aided support system to the various activities, especially the planning oriented ones, that take place on a construction site. The different parts are not yet fully implemented but their basic behaviour and their respective communication interfaces are specified.

The presentation environment consists of four basic parts. These are the Visualisation Facility, the Construction Methods Presentator, the Planning Presentation and the Diary Facility. The Constructions Methods Presentator, The Planning Presentation and the Diary Facility are all implemented using HyperCard.

![Diagram showing the MDA-project's applications internal configuration.]

The presentation environment communicates via Ethernet with a SUN Sparc Station on which corresponding prolog applications are running. These are the Construction Parts Database (CPD), the Construction Methods Database (CMD) and the Construction Site Planning Application.
The Construction Methods Presentator
- a multi media presentation tool for construction methods

(CSPA). The Construction Methods Presentation and the CSPA uses the same prolog database. CSPA will also use the CPD in the future.

**The Construction Methods Database**
The Construction Methods Database (CMD) is a database for construction methods which is implemented in prolog. The CMD is divided according to the BSAB-nomenclature. It contains the information of the Construction Methods Data sheets, planning dependent information, construction structure related information etc. Appendix H shows the content of the CMD for one construction method.

```
Methodid and method specific information +
pointers to all the construction methods
participating activities

Activityid and
activity specific
information

Activityid and
activity specific
information

```

The Construction Methods Databases structure.

**Communication Construction Methods Presentator - Construction Methods Database via Ethernet**
Since the CMP is a presentation program all data presented by the CMP are extracted from the Construction Methods Database; that is numerical data, textual descriptions, names of animated sequences etc. This demonstrates the technique of distributing the presentation application for a central database. There are several advantages of the distribution of data and the CMP-program on different hardware. The distribution enables the designer to use the most suitable hardware for both the database and the presentation application. It also distributes the processor requirements of the application among several computers.

The CMP communicates with the CMD via Ethernet. The CMP sends prolog predicates to the CMD and receives corresponding unifications from the CMD which are interpreted. Thus a prolog predicate can e.g. ask for all
data that are to be shown in the Resource Presentation view for the currently selected activity of a construction method.

Example of session:

The methodid is known before in this example

CMP -> CMD : send_all_activities_for_method(methodid);
CMD -> CMP : [activity1,activity2,activity3]
   The CMP then interprets the received list and sees that the currently
   selected construction method consists of three activities.
   The activities are named activity1 etc.

CMP -> CMD : send_the_specified_resource_information_
   for_this_activity(activity1,[personnel,machinery])
   The CMP asks for the personnel requirement list and
   the machinery requirement list for the specified activity: activity1.

CMD -> CMP : ["1-2 Men","Crane,Concretemixer"]
   The CMP receives two lists,
   the one regarding personnel requirement contains "1-2 men" and
   the one regarding machinery requirement contains
   "Crane,Concretemixer".
   The received lists are then presented in the Resource Presentation
   View under the corresponding headlines.

The use of the Visualisation Facility and the Construction Methods
Presenter concurrently

The Construction Methods Presenter is presently used to present the CMD's data straight off. That is all time values for a specific construction method is presented per m² or likewise and no adjustments for extra operations are done automatically. Thus if the user wants to see how much e.g. a curved wall affects the moulding time, he has to explicitly state that he wants the calculations to consider this fact in the Time Presentation view.

The Visualisation Facility and the Construction Methods Presenter will later be allowed to be used concurrently. This will make the Time Presentation related information as well as the method overview facility more sophisticated. The user will be able to select a specific part of a construction, which is viewed with aid of the Visualization Facility, and concurrently look at and choose one of all the construction methods that can realise the indicated part. When the user looks at the different construction methods in order to compare them, he will see time values that include all
the extra operations the system is able to detect automatically. Such operations are for example, extra requirements for a curved wall.
8 Physical environment and equipment

The CMP was implemented using the hardware and software listed below:

- Macintosh IIx with system 6.0.7, 8 MByte primary memory and virtual memory, by Virtual 2.0.3.
- HyperCard 2.0 [16] [17]
- Macromind Director 2.0 [18] [19]
- Swivel 3D™ 1.1L [20]
- Remoted control video recorder + special hardware
- Wacom tablet model SD42x
- MacRecorder [21]
- Voice navigator [22]
- Sun Sparc Station with Sicstus Prolog

![Diagram of CMP hardware configuration](image)

Physical drawbacks
The Macintosh and HyperCard provide a good experimental environment. It is easy to connect various applications and tools to realise a multi media environment. One drawback is that animated sequences, sounds etc require quite a lot of memory. This and the fact that the supporting applications like
Voice Navigator, Hyper Card etc also require some memory make the overall primary memory demands rather large. Consequently quite a lot of memory is needed if realistic animated sequences with sounds are to be used.
9 Future work

To provide a more flexible use of the Construction Methods Presentator and the Construction Methods Database, the user should be able to enter both new construction methods and new, personal, sets of time data for a specific construction method into the CMD. This would enable the user to create a personal database, regarding time data, upon which to base his future calculations.

The three dimensional interactive presentation of the construction part, which the currently presented construction method realises, can be made more sophisticated. That is, the CMP should also be able to provide interactive presentations of complex construction parts e.g. a complete kitchen.
10 Acknowledgements

I would like to thank Anna-Lena Ereback, Knowledge Based Systems Laboratory SICS and Lennart E. Fahlén, Distributed Systems Laboratory SICS which initiated this work and guided me during its performance.

I would also like to thank all the members of the MDA project group, especially their chairman Adina Jägbeck ADARK, who have taken time to comment on and discuss the Construction Methods Presentator during the different stages of its development.
11 References


[8] : Svensk Byggtjänst, BSAB-systemet Tabeller och tillämpningar

[9] : Svensk Byggtjänst, Koder och rubriker enligt BSAB-systemet


[15] : Hayes & Ball & Ready, Breaking the man-machine communication bar

Manuals


[17] : Weiskamp & Shammas, Mastering Hypertalk

[18] : Macromind, Macromind Director Interactivity Manual


Aktiviteter:

Transport av formmatrikla, uppsättning av första formsidan

Armering

Uppsättning av väggformens andra sida

Gjutning

Formrivning, nedtagning och smörjning

Two men are required to perform this activity

The time requirements for this activity is two hours per square metre

The Resource button

Resurser

Arbetsbeskrivning

Tider

Video

The work instruction buttons:
Video- and Animated sequence-button

A limited resource

The Detail-mode and Summary-mode buttons

Method name

Main Presentation

Platsjuten (via kran) armerad betongvägg med formytor av luckor

House-AMA icon

HUS-AMA
**Time Presentation**

**Activity name:**

**The graph that shows the initialisation time influence on the time requirement**

**Aktivitet: Transport av formmaterial, uppsättning av första formsidan**

**Tid för grundoperation**

**Tilläggsoperationer:**

- Uppsettning och förekommande nedtagning av småformer: 0.03
- Vid veggbjörd över 3.25 m: 0.04
- Vid 1 sida form (stöttad form): 0.22
- Vid svängd form: 0.10

The x-marked extra operations are included and the total time requirement for this activity is 4.1 hours per square metre.

\[ \sum : 4.1 \text{ timmar/m}^2 \]

**Mängd:** 100 m²

The user can enter a quantity in the box and press the Calculator button to compute the time requirements for the new quantity.

**Drifttid = 1.55 * tid**

**Tid:** 417 timmar

**Drifttid:** 646 timmar

The time requirement for this activity is 417 hours and the time requirements including method dependent delay time is 646 hours.

The computational model is presented when the user presses the Sheet-button.
**Resource Presentation**

**Activity names**

**Method name**

**Print resources**

**Skriv ut resurser**

**Resursöversikt för metoden:** Platagjuten (via kran) armerad betongvägg med formytor av luckor

<table>
<thead>
<tr>
<th>Aktivitet:</th>
<th>Material:</th>
<th>Maskiner:</th>
<th>Personal:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport av formmatial, uppsättning av första formsidan</td>
<td>Formyta av luckor 1&quot; 0.4 - 0.5 m x 1.0 - 2.0 m</td>
<td>Kran</td>
<td>1-2 man</td>
</tr>
<tr>
<td></td>
<td>Kryssfanésskivar 12,5 mm, 0.60 - 1.52 m x 1.52 - 3.15 m</td>
<td>Maskinell kap- och klyv-säg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gles inbrödning 1&quot; x 4&quot;, c 0.20 m</td>
<td>Et-handssäg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lömmar 1&quot; 0.40 - 0.60 m x 0.75 - 3.80 m</td>
<td>Et-borrmaskin</td>
<td></td>
</tr>
<tr>
<td>Armering</td>
<td>Armeringsstål klöpt eller bookat av kamstång Ks 40, Ks60</td>
<td>Fast eller spörbunden krina</td>
<td>1-4 man</td>
</tr>
<tr>
<td></td>
<td>Självstång diameter 8-16 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Njåtråd</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>distansklossar av olika typ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uppsättning av väggformens andra sida</td>
<td>Formyta av luckor 1&quot; 0.4 - 0.5 m x 1.0 - 2.0 m</td>
<td>Kran</td>
<td>1-2 man</td>
</tr>
<tr>
<td></td>
<td>Kryssfanésskivar 12,5 mm, 0.60 - 1.52 m x 1.52 - 3.15 m</td>
<td>Maskinell kap- och klyv-säg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gles inbrödning 1&quot; x 4&quot;, c 0.20 m</td>
<td>Et-handssäg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lömmar 1&quot; 0.40 - 0.60 m x 0.75 - 3.80 m</td>
<td>Et-borrmaskin</td>
<td></td>
</tr>
<tr>
<td>Glutning</td>
<td>Betongmassa med medelstift eller plastisk konsistens</td>
<td>Fast eller spörbunden tornkran</td>
<td>3 man</td>
</tr>
<tr>
<td></td>
<td>Bask, stavvibrator och skyffel</td>
<td>Bask, stavvibrator och skyffel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Betongficka (ej tipprar eller flärmankavring)</td>
<td>Betongficka (ej tipprar eller flärmankavring)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bookar att placera formyta på</td>
<td>Bookar att placera formyta på</td>
<td></td>
</tr>
</tbody>
</table>

**MDA-projektet**

**Materials requirement**

**Machinery requirement**

**Personnel requirement**
The main menu and the five scenes that constitutes an animated sequence

FORMSÄTTNING FÖR VÅGGFORM AV TRADITIONELL TYP

- Formytans komponenter
- Transport av formmaterial
- Montering av botten- och bind-reglar
- Montering av spikreglar
- Montering av avstångare etc

The user can click on the icons for the animated sequences scenes and can thus navigate through the sequence. It is also possible to choose to see the entire sequence, but the corresponding button is not showed here.

Scene 1

Formsättningen kan utföras på olika sätt och med skiftande arbetsorganisation. Till formytan väljs olika material beroende på bl.a. de krav som ställs på den färdiga betongytan, formsättningens omfattning, hur många gånger formmaterialet skall användas och underlagets jämnhet.

Vid stående inbrändning (1) monteras spikreglarna (2) liggande och bindreglarna (3) stående.

Scene 1 describes the components of the mould.
Scene 2

Scene 2 demonstrates how the material can be transported.

Transporten av formmaterielet mellan olika etaper sker via kran.

Scene 3

Scene 3 shows how to put up the fundamental parts of the mould.

Bindreglar ställs mot bottenregeln och fästs vid denne, varefter de lodas in och strävas.

I detta skede uppsätts endast de bindreglar som behövs för att spkreglarna skall kunna fästas.

Bottenregel spikas fast mot underlaget efter utsatte markeringar.
Scene 4 shows how the construction workers shall mount the remaining parts of the mould.

I bindreglerna spikas spikregler fast.
- Antalet spikregler avpessas med hänsyn till gjuttryck och styvheten hos materialet i formytan.
- Formytan påspikas och kompletterande bindregler uppsätts.

Scene 5 shows how the last parts of the mould is to be mounted.

Avstängare, smygformar, trummor etc. spikas fast i formytan.
Hus-AMA

E PLATSBJUTNA BETONGSKONSTRUKTIONER

Betongkonstruktioner skall utföras rationell betongbeständiga.

E1 FORMAR

UTFÖRANDEFÖRESKRIFTER


Till sam manhållning av form, för vattenlit betongkonstruktion skall användas för ändamålet utformade förhållande eller formtag.

Form skall rivas. Med hänsyn till risken för mekaniska skador - tex ytavvikling och avlägsna höra - skall betonghallfastheten vid formrivning vara minst 2 MPa, vid sådana eller specialprofilerade bräder dock minst 3 MPa.

E1.1 Valfri formtyp

Material och utförande får väljas fritt.

E1.2 Formar av skivor

MDA-projektet

Råd och anvisningar till Hus-AMA

Vid betongtyper som efterbehandlas kan entreprenören ofta ger frihet att använda sitt re form än den föreskrivna och kommersier detta med en bättre efterbehandling.

Observera att kostnader för vissa råd entreprenör påverkas av val av formmaterial. Exempelvis kan kostnaden för elinstallation öka vid stifform jämfört med träform.

Om val av formtyp överlägsen till entreprenören. Anges att denne skall svara för den marknivrad som kan uppmuntra till råd entreprenörer om annat formmaterial än trävåta.

I de fall viss formtyp ska redovisas i byggnads- eller rumsbeskrivning bör det ske med klart text och skyddet skall ställas vid rätt moment. Detta för att undvika omedelbara problem som kan uppstå vid efterföljande utförande av råd entreprenörer. Exempelvis kan exempelvis formuppbyggnaden brädförst typer i vara svår att utföra.

Beträffande formtyp att styrd material dimensionering m m se Byggeskrivningens information blad 86:1977.

UTFÖRANDEFÖRESKRIFTER

Kontrollera att handlarens innehåller uppgifter om krav på vattensäkerhet.

Ange form, som skall rätta kvar. Exempel på sådana form är vissa typer av utföringsform och sparkrobben. Observera att kvarstående form inte medger efterkontroll av

MDA-projektet
Picture 1 shows a bit of the Time Data sheet. The level of detail is very high in this sheet. The fields shown in the picture specify the time for mounting various details of the mold.

Picture 2 shows a bit of the Work Instruction.
A concrete wall which consists of two moulds, two halves of concrete and reinforcement in the middle.

The concrete wall is here "exploded" into its components.
The content of the Construction Methods Database
for a construction method

The content of the Construction Methods Database for the construction method
considering how to make an on site moulded, reinforced concrete wall is here presented.

The construction method (its internal key is 1) is here described. The description
contains the construction methods full name and a list of the activities it consists of:
3134a, 323, 3134b, 343, 3834. The activities are numbered in accordance with the BSAB
nomenclature.

m(1,'Platsgjuten (via kran) armerad betong(agg med formytor av luckor,'
aktivitet('3_3','[3,3,1,V4,V5],[e,1L]),
[aktivitet('3134a','[3,3,1,V4,V5],[e,1L,R]),
aktivitet(323,[3,3,1,V4,V5],[e,2,1,1L]),
aktivitet('3134b','[3,3,1,V4,V5],[e,1L,R]),
aktivitet('343,[3,3,1,V4,V5],[e,3,3,2L]),
aktivitet('3834,[3,3,1,V4,V5],[e,1L,R])).

The first activity: 31314a is here described. The description starts with the full activity
name.

akt(aktivitet('3134a','[3,3,1,V4,V5],[e,1L,R]),
[(aktivitetsbeskrivning,'Transport av formmaterial upps(tning av första formsidan
'),
(tidsformel,
(0.67 * (sum((laengd(rit([3,3,1,V4,V5],[e,3,3,2,_,])
+ hoejd(rit([3,3,1,V4,V5],[e,3,3,2,_,]))) *
-0.00125 + 0.36 + 0.13) *
sum((laengd(rit([3,3,1,V4,V5],[e,3,3,2,_,])
+ hoejd(rit([3,3,1,V4,V5],[e,3,3,2,_,]))) * 0.6),
(matrisalbeskrivning,'Formyta av luckor 1" 0.4-0.5 m x 1.0 - 2.0 m
Kryssfanerskivor 12.5 mm; 0.60 - 1.52 m x 1.52 - 3.15 m
Gles inbr(dning 1" x 4", c 0.20 m
L(mmar 1" 0.40-0.60 m x 0.75-3.80 m
'),
(personalbeskrivning,'1-2 man
',
(maskinbeskrivning,'Kran
Maskinell kap- och klyv-sag
El-handslig
El-borrmaskin

t).
(antal_tillagg,4), - Number of extra operations

- Descriptions of all extra operations and their adjoining time requirements

(tillagg1,'Uppsättning och fl rekommande nedtagning av smygformar, avstangare, flortagningslister, trummor, ingjutningsdetaljer etc'),
(vt1,0.03), - A description and its corresponding time requirement
(tillagg2,'Vid vaghjävd över 3.25 m'),
(vt2,0.04),
(tillagg3,'Vid 1 sida form (stöttad form)'),
(vt3,0.22),
(tillagg4,'Vid svängd form'),
(vt4,0.10),

(tillaggsenheter,'Persontimmar/m2 motgjuten formyta'), - Unit-description
(driftkoefficient,1.55), - Running koefficient
(concatenheter,'timmar/m2'), - Unit-description
(enhetstid,4), - Unit time
(forenhet,'m2'), - Unit-description
(svarsenheter,'timmar'), - Approximation of the personnel requirement
(antalman,2)].

The methods other activities are described in a similar manner.