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Short Term Management on Building Sites

Gestion journalière sur un chantier de construction

Kurzfristige Produktionssteuerung auf Baustellen

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SUMMARY

The presented system deals with a day-by-day production management on building sites. It is not a new invention but accentuates following aspects: formalized set of information, human aspects and motivation, allocation of responsibilities. The system has been functioning more than a year in a manual version on a middle size building site, at present it is programmed for a micro-computer.

RÉSUMÉ

Le système proposé traite de l'organisation de chantiers et plus particulièrement de la gestion journalière de la construction. L'article ne présente pas une nouvelle théorie mais insiste sur les aspects suivants: ensemble d'informations-types, aspects humains et motivation, répartition des responsabilités. Le système décrit est appliqué – de façon manuelle – depuis plus d'une année sur un chantier d'importance moyenne; un programme pour mini-ordinateur est en cours d'élaboration.

ZUSAMMENFASSUNG

Das vorgestellte System behandelt die tägliche Produktionssteuerung auf Baustellen. Es ist keine neue Erfindung, stellt jedoch folgende Aspekte in den Vordergrund: formalisierte Informationen, menschliche Aspekte und Motivation, Zuteilung von Verantwortlichkeit. Das System wird seit über einem Jahr auf einer mittleren Baustelle im Handbetrieb angewendet. Zur Zeit wird es für einen Kleincomputer programmiert.



1. PRINCIPLES OF FIELD MANAGEMENT

The actual management of construction on building sites uses in the most cases the information of cost accounting which is usually well established, in many firms in a computerized form. However the results are available for the day-by-day field management too late and as a result they can be used for planning, scheduling and management only for longer periods of two or more months. Therefore the site manager is obliged to establish his own day-by-day management. However the lack of a system in such field management appears not only at the level of the site manager but also prevents sufficient delegation of responsibility and of activity to foremen, supervisors, suppliers of materials and machines. A monthly cost statement is usually available at the end of the next month, therefore it is useless for the day-by-day management.

The purpose of day-by-day management is to show daily the crew a figure of its output, of meeting of dead-lines and expenditure of resources, to indicate the efficiency of construction in weekly periods, to delegate responsibilities and authorizations to participants, to consider and respect the human aspects during construction and to show the deviations against the plan which need immediate action.

The elements of information must have the following properties:

- to be intelligible for the worker and foreman so they can make possible discussions about operating instructions and about the results
- to serve the site management and management of site services (machines and material supplies)
- to make possible the imposition of schedules and budgets evaluate the efficiency for short periods
- to make possible the self control of each participant because each understands the information.

The elements of information are: worker- and machine-hours (effective, payed and unpaid absence hours), output in physical values (m, m², m³ etc.), dead-lines and milestones. They appear as

- budgeted (planned) values = planned amount x planned unit value (price/unit, consumption/unit)
- rated values = actual amount x planned unit value
- actual values = actual total price (costs) or total consumption (theoretically actual amount x actual unit value)

The bearers of the information elements are the individual participants in the construction process (workers, machines, suppliers etc.) and the individual cost centers i.e. building components, in our system labelled as work items.

The Delegation and its Formalization

The formalization of the follow up and of the field management is necessary because its activities are strongly repetitive and ought to be delegated. The formalization is done through definitions of items and through a set of forms with the appoint-

ment of persons responsible for their processing. The processing of forms by foremen and site managers is restricted to a minimum. Further processing of the original information should be done in the actual state by the site staff, in the near future by a computer, in our opinion by a micro-computer installed on the site. The delegation of responsibilities makes possible not only the relief of management but also compels the regular discussion of the tasks and the outputs and the immediate actions with the participants.

The Essence of our Management Proposal

Our proposal corresponds to the "management by exception" in which the task is formulated in budgeted values and planned milestones for short periods (weekly, exceptionally daily) and the outputs are immediately compared so that the deviations and actions for their removal can be executed without delays. A motivation hence follows from the discussion during the work introduction and from the discussion about outputs. The discussions take place regularly: site manager with foremen weekly, foreman with crews daily and weekly, site manager with suppliers, subcontractors and firm services weekly if a change of the schedule is necessary.

Our proposal for the field management is compatible with other systems and their versions in building firms i.e. with cost accounting (monthly cost statement, monthly billing), administration of construction machines (daily, weekly, monthly follow up and redispense), pay roll (daily followed-up hours are recorded for the pay roll and for the construction work items).

The Man in the Field Management

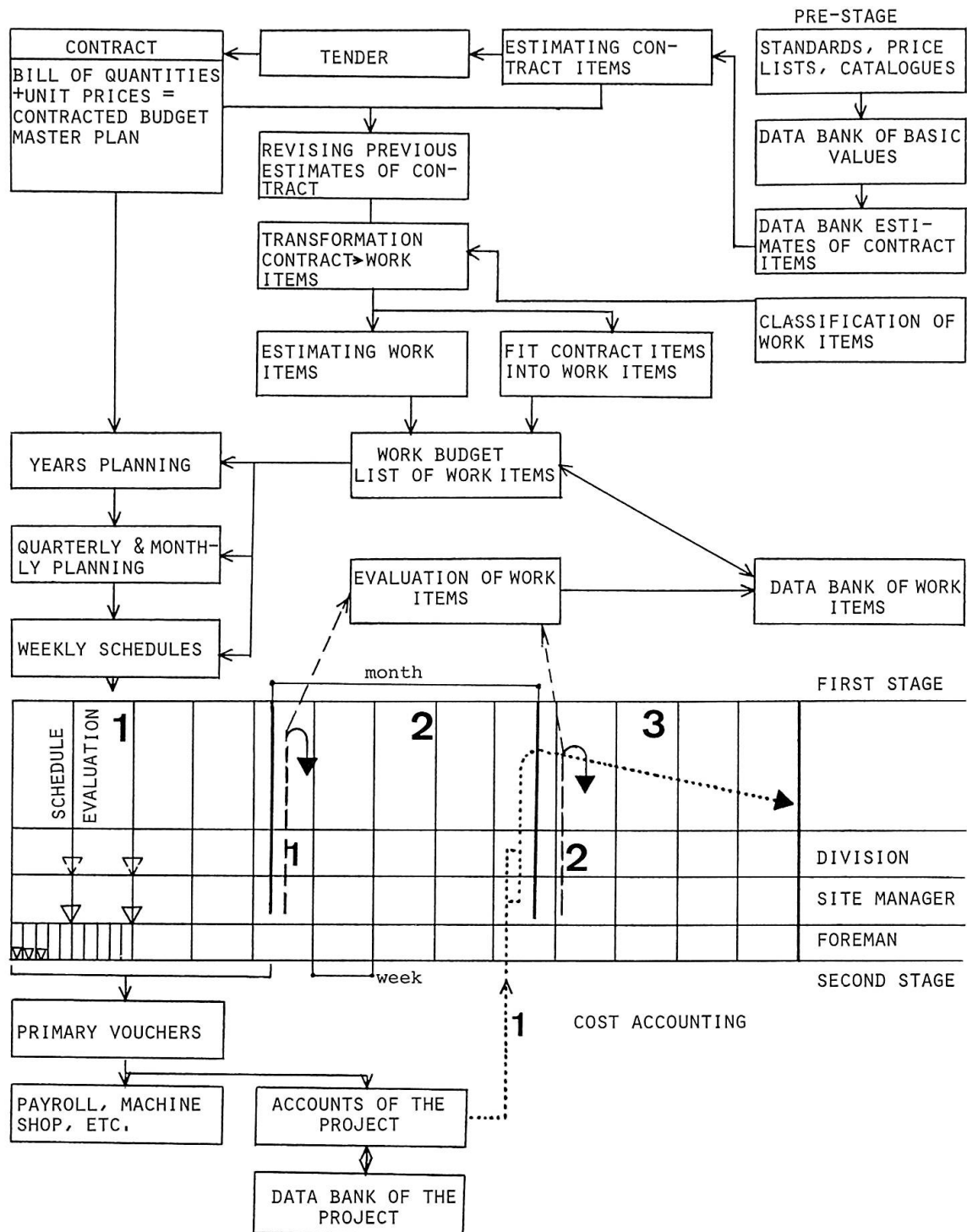
The field management serves as an aid to the participants and is not a rigid control system:

- The worker is informed during the work introduction what will be produced, in which amounts, hours and dead-lines; he can discuss the workability and the necessary requirement and make improvement proposals.
- The foreman discusses with the site manager the construction. Budgeted (planned) values can be changed after conscious analysis. After the editing of the weekly plan the budgeted values become standards to which the outputs will be compared.
- Because of the mutual discussions the follow up process is more of a self-control device at each level and less of a disciplinary control.
- Management forms and documents ought to be in practicable form, with links to the forms of existing systems (payroll, machine shop, cost accounting). The forms should be used for longer time without changes. Site managers and foremen have to record and fill in a minimum amount of information; further processing of derived information is the task of site staff, further of a micro-computer.

Production Management

Three stages of production management on sites are shown in Figure 1 as follows:

Pre-stage: tendering, tender estimates, job contract, job cost estimates, master- and years plans, schedules and budgets inclusive of data banks. These documents are prepared at the level of top or division management partly in collaboration with the site manager. The Pre-stage ends with valid obligatory Quarterly plan.



- ▽ daily follow-up by foreman
- ▽ evaluation & actions weekly (site manager)
- ▽ optional actions (division)
- ▼ evaluation & actions monthly (site manager)
- monthly resource & output statement
- monthly cost & output statement (cost accounting)

Figure 1: Scheme of production management on building sites

First Stage: Operative Field Management

Based on the Quarterly plan the weekly plans are developed and followed up daily by foremen. Weekly outputs will be analyzed, then actions for improvement follow. Simultaneously two sets of information are developed: hours of workers and machines from daily follow up needed for payroll and for billing the machine rents and cost documents as acknowledged bills, receipts etc. for cost accounting.

The field management is subdivided in four periods which will be dealt with further.

Second Stage: Two Month Management by Costs

Monthly statement of costs prepared by cost accounting is usually available at the end of the next month. Therefore management actions can be implemented only for the further (third) month and very often only for a longer period in the future.

2. PRE-STAGE BUDGETS AND SCHEDULES (FIGURE 1)

Budgets

The budget estimates, together with all documents defining the scope of the work and approved in a signed contract with a client will be the control document for a specific project. The basis for developing estimates for cost control in construction management is the classification of accounts to cover the items of work included in a particular project. This classification should be connected to

- a) contract documents especially to the approved budget estimate, aside from the contract form (lump sum, guaranteed upset price, cost plus fixed fee, unit price contract)
- b) scheduling items, to accounts in cost accounting and to the classification used in field day-by-day management. Thus this classification has the goal of decomposing complex items or to aggregate over-detailed items of a unit-price-budget. The result is a list of work items for the planning, scheduling and controlling of the realization of the project (= work budget).

The classification has two stages:

- master classification corresponding to the master schedule and to preliminary estimates
- detailed classification of work items corresponding to the detailed schedule, to cost accounting, to bills of quantities and to the items of control forms such as quantity and hours reports of workers and equipment, cost report etc.

The bills of quantities describe the project in items with physical values and are a valuable basis for bidding and after the contract is approved for elaboration of estimates of work items. Contracted budgets based on bills of quantities use very often classification systems, which are published e.g. in USA CSI, UCI, in England Sfb etc. The classification of work items is mainly done for individual needs by the contractor himself.



The Master Schedule

The master schedule is a part of a contract. It uses bundles of activities mainly aggregated from the bill of quantities which includes also the contracted prices. The scheduling technique is at present mostly bar charts, in "linear" building works (tunnels, bridges, tall buildings etc.) time space diagrams, and in intensive relationships networks.

Yearly and Quarterly Schedules

These schedules should be based on the work budget. The activities should correspond to the work items, they may be still slightly aggregated but with a possibility of disaggregation. If these schedules are constructed in a network form then it is usual to calculate them using a central computer. Quarterly schedules are usually updated for a quarter, monthly schedules are included in a quarterly schedule and are updated only when significant deviations appear.

Learning Effects in Quarterly Plan

The necessary pre-requisites for achievement of learning effects should be secured not later than in the quarterly plan i.e. uninterrupted flows of repetitive work in principal work items both of workers and machine activities. Such arrangements may cause sometimes an insertion of floats between partial flow lines. If the flow line is possible an estimate of a learning effect in hours must follow (90-75%).

Data Banks for Estimating of Contract and Work-Items

For estimating in bidding and in calculation of contract, and work items three data banks are used:

- a) Data bank of basic values containing physical standards of consumption, price lists of materials, wages, machine rents etc.
- b) Data bank of estimates of contract items made for bidding and then revised and completed for estimating of work items.
- c) Data bank of standards (hours, material consumption, costs) of actual performed work items.

3. FIELD MANAGEMENT

The four periods of field management mentioned above are as follows:

Period A: Review and Updating of the Quarterly Plan

Let us presume that the following documents are available at least two weeks before the start of the quarter: contracted bill of quantities with contracted prices, estimating sheets for contract and work items with estimates for cost and hours of workers and machines, master schedule for the whole project, list of work items with volumes, costs, prices, hours (work budget), estimates of outputs of the actual quarter according to the real situation on sites, records (accounts) of work items, where the changes in standards (hours, cost, volumes etc.) during the processing are stated.

The site manager investigates the original quarterly plan, or develops a new one, according to actual situation on site, discusses its necessary changes and redistribution of resources with the top management. The updated quarterly plan should be available at least one week before the start of the quarter with the following characteristics:

- The activities correspond to work items, they can be subdivided into sections (working places) in weekly plans. Each work item has its estimating sheet and record of changes in standards. There is a unique assignment between the contract and work items.
- The dead-lines and milestones of the master plan must be met. Worker and machine capacity will be assigned to months. A sequence of activities according to their importance and dead-lines is considered.
- The supplies are checked for the reliability of procurement. Possible risks in the quarterly plan and their consequences are considered. Relations of the project to other project are revised (interface events) in regard to the actual state.

Period B: Weekly Planning, Daily Follow-up, Weekly Evaluation and Management

Elaboration of Weekly Plans

The site manager determines for each crew and important machine respectively for each foreman at the latest on Friday morning the tasks for the next week; dead-lines, outputs, hours of workers and of machines for each work item (= activity). These values can be established for more weeks and on Friday changed if necessary. The proposal will be investigated by the foreman and discussed when necessary on Friday in order that the site manager would be able to arrange the changes in supplies of materials or machines with suppliers. After the discussion (if necessary) each foreman develops weekly plans for each crew and important machine. Figure 2 is showing the information flow in the system. The orders of the site manager for the week can be made also for several weeks with changes for a particular week in brief written form.

Daily and Weekly Follow-up

The foreman follows up daily each of his groups and machines in daily reports with hours of each worker in the classification needed for payroll, hours of each machine classified for machine shop, hours (worker, machine) spent effectively on each work. Daily reporting of a machine will be done usually by the operator. The outputs are assessed for each work item weekly, exceptionally daily by the foreman.

There are in a weekly schedule: planned (budgeted) values (planned outputs x planned standards), rated values (actual outputs x planned standards), actual values (observed and recorded). They are compared for the evaluation of effectiveness: actual outputs are compared with planned outputs, of efficiency: actual values are compared with rated values.

Weekly Discussions about Results

Weekly results of each crew and each machine will be discussed by the site manager and foreman very soon after the end of the week e.g. Monday afternoon as follows: deviations in effectiveness and efficiency, actions for removing the deviations, removing of unexcused absence of workers, removing of idle machine hours, delays in dead-lines and milestones. Weekly discussions are based on weekly schedules completed with actual and rated values (hours, outputs, dead-lines), narrative reports of fore-

men according to a fixed agenda. After the discussion the weekly sums will be successively added and summarized for a month.

Period C: Monthly Evaluation Immediately after the End of Month (Figure 3)

Monthly evaluation will take place at the latest in the first week of the next month (i.e. after monthly billing) based on following data: workers hours, machine hours and outputs of work items, outputs in physical values and prices of work items, the same for contract items according to billing. The evaluation takes place shortly on the building site (site manager with foremen) but above all at the higher levels (division, top management).

There are two forms of importance:

- monthly review of work items (= accomplished physical outputs according to the weekly schedules x unit price from estimating sheets)
- monthly review of contract items (= accomplished physical outputs according to the measurement of outputs for billing x contracted unit price).

Both reviews are compared, however with some provisos: (i) the accomplished outputs are in the first case assessed, in the second case measured, (ii) the unit price of work item is combined from prices of included contract items.

Total contracted prices of included contract items will be added and divided by the output which is selected for work item for follow-up.

Period D: Evaluation of Work Item (Figure 3)

Actual values of important work items such as workers and machine hours, consumption of main materials will be collected on an evaluation sheet for each important item with description of circumstances and conditions during the construction. If a time or work study was performed the result will also be recorded. The results of evaluations will be stored in a data bank of work items. If a work item occurs very often it is recommended that an evaluation sheet will be developed for the corresponding standard contract items in order to shorten the preparation of bids in the future.

CONCLUDING REMARKS

The principle of the system of field management on building sites mentioned here is not a new invention. It has been used with success on some building sites. In respect to the experience collected by us we should like to mention some new aspects in our conception:

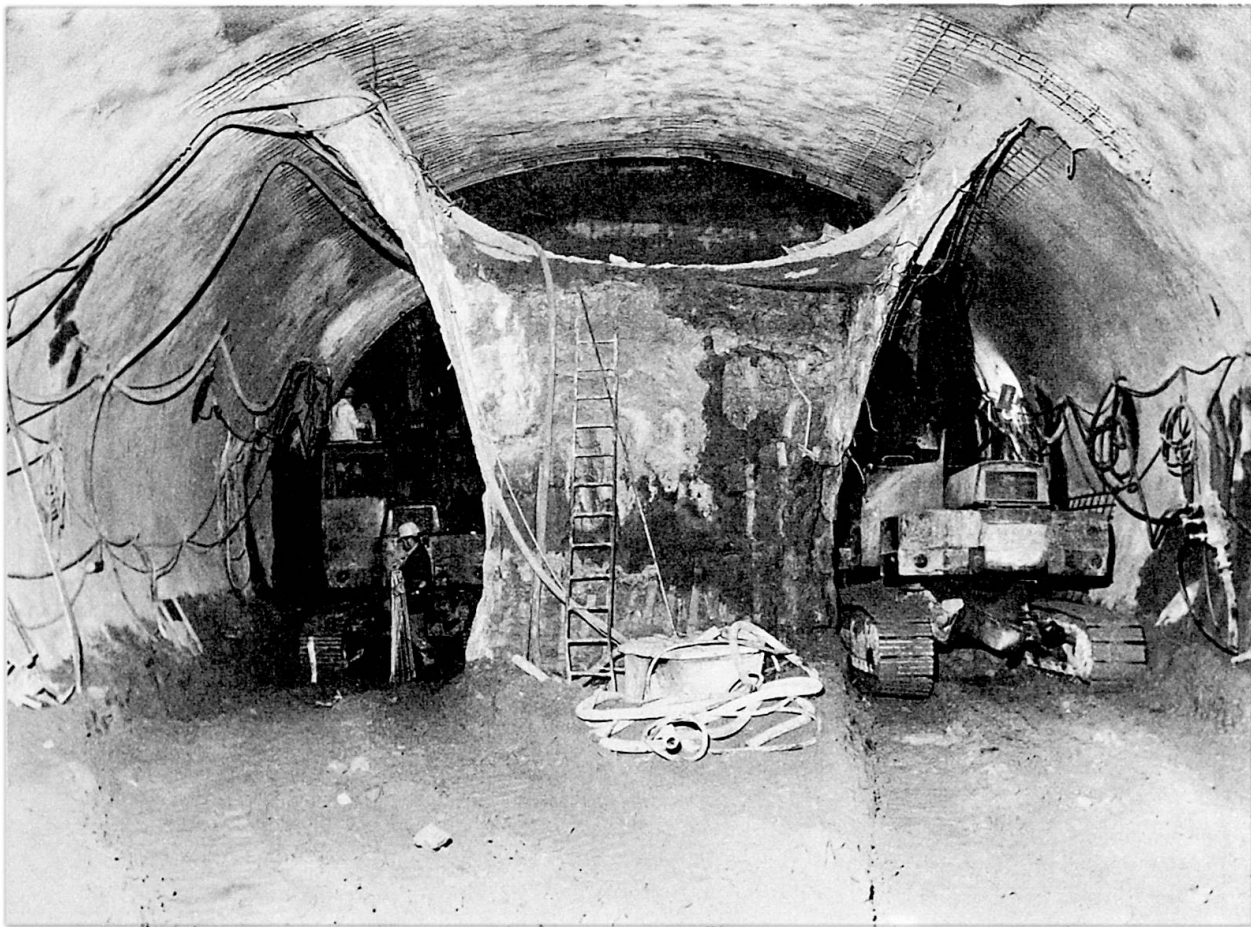
Through the publication we should like to focus the attention of building firms which do not use such formalized system on its advantages in improving the effectiveness and productivity. The system is completely developed with the sharing of authority and duty, and above all with respect to the human aspects at all levels. This contributes highly to motivation. The system is flexible; if some parts are already built up in the firm e.g. follow up for payroll they can be absorbed by the system. The system preserves other management systems in the building firm especially cost accounting while it arranges the links with these systems. The forms of the system are conceived in such a way that the whole administrative work with further processing of data from the site manager and foreman can be done by computer. The system is based on a realistic quarterly and monthly plans.

Our Conception for Computer Use

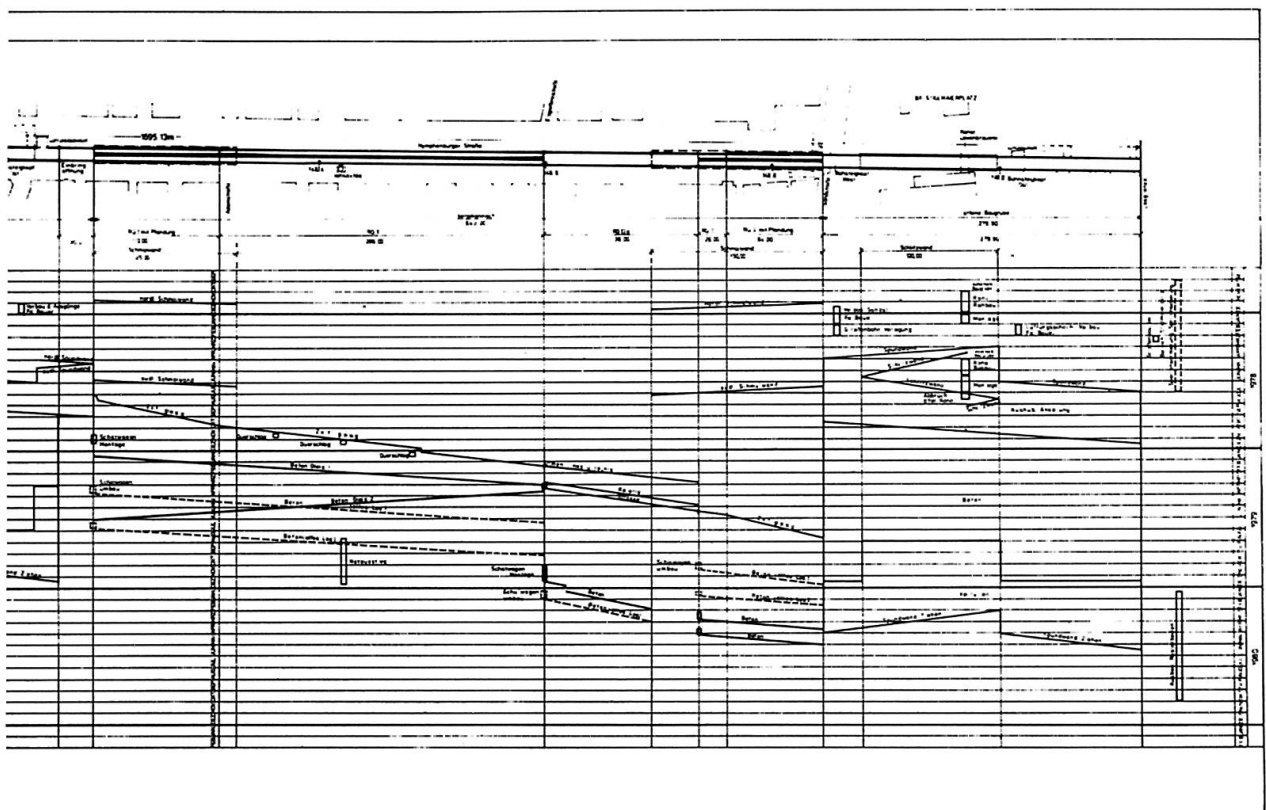
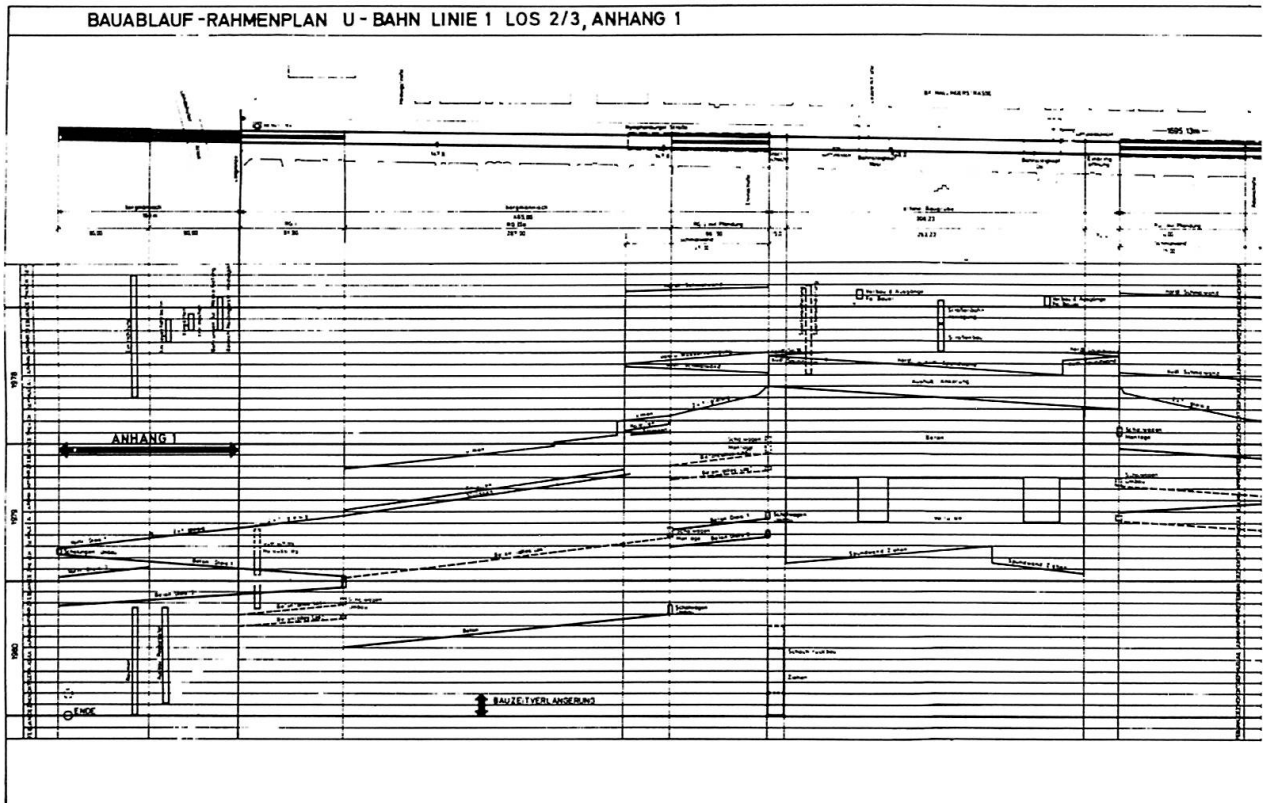
We are convinced that a workable solution of computerized field management for middle and large building sites is a micro-computer on the building site which can but need not have a connection with a central computer of the firm. We have arrived at this conclusion for the following reasons:

- A central computer can certainly manage our system but because of its time occupancy the results are delayed so that they inhibit the taking of management actions. For the same reason the system with a micro-computer is flexible with respect to removing the mistakes in the input and to additional questions
- micro-computers are evolving quickly with rapid price decreases; we expect their intensive use in the very near future
- last but not least there are psychological reasons if the micro-computer is in the full responsibility of the site manager and his staff.

We have already introduced and co-managed for several months the system described in a manual version on a medium sized site of an underground railway section with two stations. We are working now on a computerized version for a micro-computer installed on building site which should remove the need for all derived administrative manual activities. The system is described in detail in further publications of the Institute of Construction Planning and Management (Swiss Federal Institute of Technology Zürich)



Two-rail elliptical profile of the section
(excavated in two sections, austrian method with reinforced shotcrete)



Tube Railway Munich - Master Plan of the Section