VTT TIEDOTTEITA – MEDDELANDEN – RESEARCH NOTES 1845

Construction process model

Generic present-state systematisation by $IDEF_0$

Vesa Karhu, Matti Keitilä & Pertti Lahdenperä
VTT Building Technology

TECHNICAL RESEARCH CENTRE OF FINLAND
ESPOO 1997

ISBN 951-38-5131-1 (soft back ed.)
ISSN 1235-0605 (soft back ed.)

ISBN 951-38-5132-X (URL: http://www.inf.vtt.fi/pdf/)
ISSN 1455-0865 (URL: http://www.inf.vtt.fi/pdf/)

JULKAISIJA – UTGIVARE – PUBLISHER

Valtion teknillinen tutkimuskeskus (VTT), Vuorimiehentie 5, PL 2000, 02044 VTT
puh. vaihde (09) 4561, faksi (09) 456 4374

Statens tekniska forskningscentral (VTT), Bergsmansvägen 5, PB 2000, 02044 VTT
tel. växel (09) 4561, fax (09) 456 4374

Technical Research Centre of Finland (VTT), Vuorimiehentie 5, P.O.Box 2000, FIN–02044 VTT, Finland
phone internat. + 358 9 4561, fax + 358 9 456 4374

VTT Rakennustekniikka, Rakentaminen ja kiinteistönhallinta, Tekniikankatu 1, PL 1802, 33101 TAMPERE
puh. vaihde (03) 316 3111, faksi (03) 316 3497

VTT Byggnadsteknik, Byggande och fastighetsförvaltning, Tekniikankatu 1, PB 1802, 33101 TAMMERFORS
tel. växel (03) 316 3111, fax (03) 316 3497

VTT Building Technology, Construction and Facility Management, Tekniikankatu 1, P.O.Box 1802,
FIN-33101 TAMPERE, Finland
phone internat. + 358 3 316 3111, fax + 358 3 316 3497

VTT Rakennustekniikka, Rakentaminen ja kiinteistönhallinta, Kivimiehentie 4, PL 1801, 02044 VTT
puh. vaihde (09) 4561, faksi (09) 456 6251

VTT Byggnadsteknik, Byggande och fastighetsförvaltning, Stenkarlsvägen 4, PB 1801, 02044 VTT
tel. växel (09) 4561, fax (09) 456 6251

VTT Building Technology, Construction and Facility Management, Kivimiehentie 4, P.O.Box 1801,
FIN-02044 VTT, Finland
phone internat. + 358 9 4561, fax + 358 9 456 6251

Technical editing Leena Ukskoski

VTT OFFSETPAINO, ESPOO 1997

Karhu, Vesa, Keitilä, Matti & Lahdenperä, Pertti. Construction process model. Generic present-state systematisation by $IDEF_0$. Espoo 1997. Technical Research Centre of Finland, VTT Tiedotteita – Meddelanden – Research Notes 1845. 190 p.

UDC 69:69.008
Keywords construction management, construction process, project management, process models

ABSTRACT

There is a need for improved co-ordination and performance of the building process. Means to analyse, plan and manage the building process have to be developed. The construction process involves many parties and, thus, special focus should be on the interrelated tasks of the numerous parties, i.e. communication and interfaces. Presently, the parties' processes are usually considered separate each discipline having its own tasks and limits. Also, concepts and their interpretation vary according to the party and, in general, the used unsystematic and mainly verbal examination is not unambiguous even from the viewpoint of a single party.

Thus, this study has modelled the overall construction process systematically creating a generic state-of-the-art model that covers the design and construction of a building project from the conception of the project in a client's mind to its completion for handover and use. The main focus has been on the functions and flows of the process since it was found that such an aspect might be the most critical in the development of the building procedures.

Correspondingly, the $IDEF_0$ method was employed. In this method, activities are described by boxes while arrows connect the boxes and represent interfaces or interconnections between the boxes. The method also distinguishes the various flow-types as control, input and mechanism on the one hand, and output on the other hand. Natural language is combined with graphic presentation.

The resulting process model covers the activities done by the client, various design professionals and the general contractor. The model includes more than 300 activities and considerably more flows. Definitions are also offered for flows whenever the contents may be open to interpretation and, moreover, an English - Finnish glossary is built for all flows and activities included.

Naturally, the model has also been reviewed and the needed further development and utilisation is suggested in the report. The reference model can be subjected to various view-dependent examinations and functions as a platform for more specific models — it is not intended to be taken as the definitive solution. The model supports communication and helps in attaining a common understanding of process related issues. Generally, the modelling approach also supports process re-engineering and improvement efforts as well as new means of building process management, especially when combined with modern computer-aided applications.

FOREWORD

In 1994, the Technical Research Centre of Finland (VTT) launched the three-year STAR research programme which was implemented by VTT Building Technology with assistance from VTT Automation. The acronym STAR stands for Finnish words that could be translated as "***Systems Engineering in Construction***".

The programme consists of four research project entities: "*Construction process models*", "*Customer-oriented design*", "*Design for construction*" and "*Integrated information management*". The common aim is to develop a theoretical foundation, systematic methodology, tools and knowledge for continuous improvement of the construction process.

The work reported here is part of the "***Construction process models***" project. The entire project had as its aim to develop:

- conceptual metamodels of the construction process
- computerised modelling and browsing tools
- reference models on practical construction processes, and
- means to accelerate and improve construction processes

of which the last two were supported by

- a detailed pilot project data capture.

This report named "***Construction process model. Generic present-state systematisation by IDEF$_0$***" is the main deliverable responding to the challenge to reference models.

The work systematises the prevailing industrial practise by describing the numerous activities and flows that belong to the construction process. Mr. Vesa Karhu developed the design process submodels and the client's work process submodel (sections A - E / Part II). Mr. Matti Keitilä developed the production process submodel (section F / Part II). Dr. Pertti Lahdenperä has participated to the work as a project manager and is the author of Part I of this report. All authors work for VTT Building Technology.

Many others have also commented and added important information to the models. They include Messrs Markku Jokela (Insinööritoimisto Granlund Oy), Matti Kärnä (SRV-Viitoset Oy), Juha Sarakorpi (Tavoitesuunnittelu Oy), Markku Kiviniemi (VTT Building Technology) and Matti Hannus (VTT Building Technology, STAR programme manager). Mr. Jorma Tiainen has checked the language of this report.

The authors thank all named persons and parties as well as other VTT colleagues and contributors for their support and constructive comments.

Tampere, December 1996

Pertti Lahdenperä

CONTENTS

PART II:

PART I:

IMPLEMENTATION-RELATED CONCERNS IN PROCESS MODELLING

1 INTRODUCTION

1.1 BACKGROUND

The construction process consists of many stages and is a joint effort of many parties. The large number of participating companies is the result of the wide range of expertise needed. In addition, construction is generally implemented in the form of one-off projects, which makes it difficult to co-ordinate the process for successful completion. The situation is further complicated by the fact that the various stages and tasks of building are highly interdependent which creates a vicious circle. Any disturbances are widely reflected on the activities of other parties causing compound effects.

These problems have resulted in high costs of construction and buildings as well as in end-product quality that does not match the client's needs. As a result of the observed problems on the one hand, and the compulsive strive for competitiveness on the other, each of the parties to the building process has developed the process, but only for his part, while none of the parties has been interested in the comprehensive development of the building process.

Due to the need for improved co-ordination of the interrelated tasks of numerous parties to the process, the means to focus on communication and interfaces and to manage the overall building process level have to be developed. All in all, it is perfectly clear that long-term, determined development and control of the building process requires common and systematic concepts and interpretation of the various tasks of building processes as well as their goals and interdependencies and efficient tools for their analysis and organisation.

1.2 OBJECTIVE AND SCOPE

Generally, the challenge is to understand, develop and evaluate alternate implementation solutions for the construction project and, moreover, to plan and manage various more efficient project- and company-specific processes. This requires that many kinds of capabilities and tools as well as reference models are developed. It is also a challenge to the larger R&D entity of which this specific project is a part.

While the new processes, evaluation and management methods and tools, etc. are to be developed in other parts of the overall research entity, this study focuses on what takes place in the building process. In other words:

- **the aim in the long-term is to compile systematic and generic reference descriptions of the overall construction process covering the design and construction of a building project from the need survey and briefing to completion for handover and use**.

Since this goal is quite far-reaching:

- **the objective of this study is to work out a present-state model with the above-defined scope. This means systematising and integrating the prevailing understanding on the building process, establishing a foundation for more specific modelling and redevelopment efforts as suggested above**.

1.3 IMPLEMENTATION

The main focus in modelling has been on activities and their interconnections and the information flows between them. Therefore, the $IDEF_0$ method was employed since it is most often used for that purpose. In this method activities are represented by boxes which are connected by arrows representing interfaces or interconnections between the boxes. Natural language, verbs and nouns, is used to define the contents of each activity and flow.

The most important sources have been the client's and designers' task lists and the general contractors' quality management system model which have been found to provide the best description of the prevailing industrial practise. The main division of the overall model follows that of the source documents so that each of the latter corresponds to one party-based section in the model. In addition, an effort has been made to integrate them. The completed $IDEF_0$ model is presented in Part II of this report.

Part I presents the motive underlying the model and defines modelling as an appropriate strategy for construction process development. It also presents some fundamentals needed to understand the context and syntax of the construction process model. Part I also reviews the model and the need for its further development and its utilisation.

2 CONSTRUCTION PROCESS REVIEW

2.1 PROBLEMS OF THE PROCESS

The construction process involves designing and implementing a building project from the conception of the project in a client's mind to its completion for commissioning and use (CIB W65 1985). The process consists of many stages and is a joint effort of many parties. The large number of participating companies is the result of the wide range of expertise needed. The various parties are experts in their field and are essentially less knowledgeable about other fields. As this applies to all parties, it is natural that problems arise at interfaces. Problems and differences of opinion are more the rule than an exception.

Moreover, construction is generally implemented in the form of one-off projects, while both the buildings and the project organisations are unique. This places major additional demands on project co-ordination as the parties used to different operating procedures work together quite intuitively and randomly.

The situation is further complicated by the fact that the various stages and tasks of building are highly interdependent which creates a vicious circle. Thus, any disturbances are widely reflected on the activities of other parties which causes compound effects. Due to the synchronisation problems created by rigid professional divisions of labour and the one-time nature of construction projects, such disturbances are quite likely, which causes idling in the process and lower productivity of construction in general.

2.2 CHALLENGE OF DEVELOPMENT

Due to the need for improved co-ordination of the interrelated tasks of numerous parties to the process, the means to focus on communication and interfaces and to manage the overall building process level have to be developed. Especially, since most of the development work done so far focuses on just parts of the process and is made for and from the viewpoint of individual parties.

Moreover, the problems associated with traditional modes of operation have also been recognised, which along with increasing competition, is forcing companies to develop new products and forms of service. These developments will increase the multiplicity of construction processes. The consequence will be delivery entities and responsibilities that vary from one project to another, and thus, management of building procurement and the integration of different parties will become even more important. We will not know which of the many interrelations will form the interfaces between the parties, and therefore we should know the entire process to a certain degree.

Similar conclusions were also drawn, for instance, by Ndekugri and McCaffer (1988) who said that total integration is a gargantuan task that requires concerted effort at an industry-wide level and even with the industry’s best efforts it can be

achieved only in stages and over a long period. They also point out that these features of the task demand the use of a structured analysis, design and development methodology. It is not enough simply to mimic currently practised procedures.

Chung (1989), again, remarks that due to the fragmented nature of the industry, the co-ordination among project members is ineffective and results in the loss and duplication of information. He continues that there is an evident need for the definition of the information flow required to support the building construction process, and for the clarification of tasks and responsibilities in information generation and transfer among the project participants.

As if the presented need for a systematic approach to tasks, responsibilities and data transfer were not enough, it also seems to us that in the future greater emphasis on individuality and technical systems requiring different kinds of specialisation will lead to increasingly demanding projects. The resulting increased number of involved parties and the significant interdependence of the work stages that they perform will further complicate the process. The transfer towards computer-integrated construction also presupposes the systematisation of operations.

2.3 ALTERNATIVE PROCESSES

The construction process is a multifaceted mess of many concepts. In fact, there are many possible implementation strategies for a project, not just one, although such simplification is usually needed to be able to deal with the subject. Mohsini (1984), for instance, has criticised the general simplified interpretation of the process since there are actually numerous different processes and it is critical to understand the details of each when identifying and then changing those particular determinants of the organisation which may be dysfunctional.

Mohsini illustrates a related problem by presenting an analysis where, at first, the main determinants of project-organisation forms were identified as well as their various alternatives. Although the study was restricted to the main alternatives, and the irrelevant combinations were excluded, 185 alternate building processes were generated. Therefore, it would be of primary interest to form a viewpoint from which all construction processes, or at least as many as possible, are alike because it is not possible or even purposeful to study them all separately.

On the other hand, it should be accepted that hardly any model can — especially in its early stages — describe all the variations perfectly. Genericness and practical utilisability are quite often, at least partially, exclusive properties.

2.4 DEFINING THE CRITICAL ISSUES

As regards the building process, Bakens (1997) states that it involves all activities, tasks and roles of its participants, starting with the first initiative for realising a

building, encompassing programming, design and construction of the building and ending with maintenance. The phases correspond to the definition we used earlier (sec. 2.1). What is relevant is the emphasis on activities, tasks and roles of this latter definition, since most of the variations are results of the different roles the parties have in each alternative process.

In other words, there are many alternative procurement and delivery systems and other modes of operation which define the responsibilities and, moreover, the contents and chronological order of and constraints on various tasks in the building process. For instance, the contract for implementation may be signed before, during or after technical design and, moreover, its content and meaning changes accordingly.

However, on the general level, the construction of a building presupposes that certain activities are implemented and become scheduled tasks of the practical process. Thus, it is of primary importance here to study the generic activities and their interrelations. It should be pointed out that here the word 'activity' refers more to the functional nature of doing something instead of its concrete occurrence in relation to the building system, i.e. tasks. This way, more alternative processes can be covered by a description.

Other important aspects to focus on in the study, besides activities, can be searched by surveying studies that examine the factors most critical from the viewpoint of the success of the project (e.g. Hughes 1989, Mohsini 1984, Sidwell 1982, Sanvido et al. 1992). Probably the single most important demand on the building project is (managerial) integration, the ability to co-ordinate the needed differentiation. It was already mentioned as a starting point for this research.

Another more concrete conclusion made by Sanvido et al. (1992) is that the optimisation of information between the parties is also critical. In fact, according to another study, the availability of and access to information is the most important factor affecting the level of performance (Mohsini 1984, Mohsini & Davidson 1992) in the traditional building process. This is also supported by statements according to which the fragmentation of functions and barriers to the effective flow of information between participants has been a major obstacle to productivity and quality in the industry (McGeorge et al. 1994, Aboud-Zeid & Russell 1993).

All in all, this survey gives us reason to give the concepts of "activity" and their interconnections and information "flows" a critical position in the development of the construction process. On the other hand, the question of where to start and how to proceed is also linked to the tools and methods available as well as to the availability of information on practical building processes.

3 MODELLING CONVENTIONS

3.1 OUTLINING THE RESEARCH APPROACH

Above, the complicated nature of the building process was emphasised as it involves many participating organisations and persons. On the other hand, experience, especially from large-scale information-technology development projects, has shown that mere verbal communication cannot create an understanding between various parties and define issues unambiguously. This is due to the fact that, for instance, people with different experiences assign different meanings to the same concepts. Moreover, it is difficult to understand the context to which the described matters belong. (Björk et al. 1991)

Thus, in order to be able to describe construction in a way that is clear to all parties and enables communication between them on the subject, systematic description methods are required (Björk et al. 1991). Redesign of processes also calls for a more systematic approach to understand the weaknesses of present procedures as well as to identify new processes which allows definitive comparison (e.g. Davenport 1993). This, after all, leads to the use of modelling techniques when responding to the above challenges.

Generally, a model is an abstract representation of reality that excludes much of the infinite detail. The purpose of a model is to reduce the complexity of understanding or interacting with a phenomenon by eliminating the detail that does not influence its relevant behaviour. (Curtis et al. 1992) A more detailed study on the meaning and possibilities of modelling in the case of a construction process was made in a sister project of the same research entity by Heinonen et al. (1996).

3.2 INTRODUCTION OF THE 'IDEF$_0$' SEMANTICS

Chapter 2 concluded that activities and their interconnections and information flows are of primary importance in the selected development strategy. A method similar to the IDEF$_0$ method (ICAM 1981, Pelkonen & Pulkkinen 1987) is used mostly (Mertins & Süssenguth 1991, Busby & Williams 1993) in the examination and description of these issues. IDEF$_0$ is based on the Structured Analysis and Design Technique, SADT (see Marca & McGowan 1986, Ross 1977). On the other hand, the IDEF family consists of a few modelling methods and the 'zero' stands for the one used to produce 'function models'.

Chung (1989) also found the method best for this purpose (cf. sec. 2.2). Software is also available for convenient model construction while it is also most advantageous to use a well-established method.

IDEF$_0$ employs both natural and graphic languages to convey the meaning of a particular process. Activities are described by boxes which are connected by arrows that represent interfaces or interconnections between the boxes: more information is given in Figure 1.

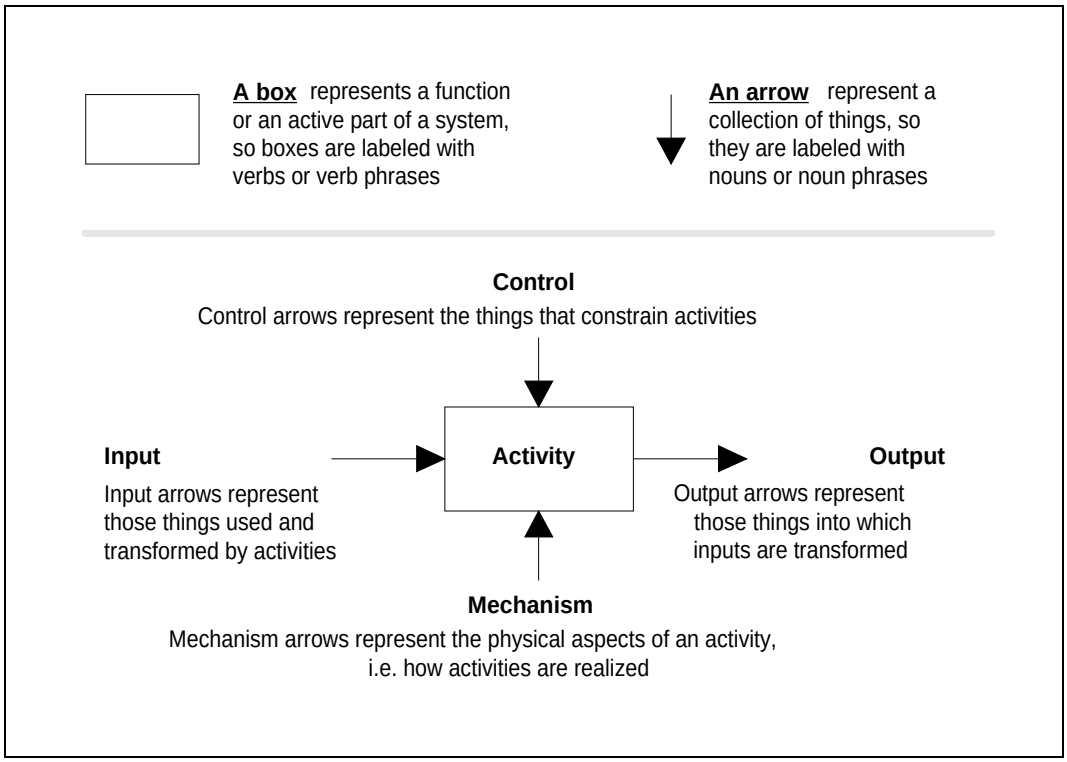


Figure 1. The basic concepts of the IDEF$_0$ method. The type and meaning of arrows is tied to their relative position to a box; the side of the box has a specific meaning.

IDEF$_0$ models are co-ordinated sets of diagrams. Models bring together and organise diagrams into a hierarchic structure where the diagrams at the top of the model are less detailed than those at the bottom. Thus, an IDEF$_0$ model can be thought of as a tree-shaped collection of diagrams. This is illustrated by the diagram-linking system of the decomposed model in Figure 2.

3.3 RELATED RESEARCH AND ITS RELEVANCY

The selected methodology has been used also for construction process modelling. One of the most famous models was composed by Sanvido et al. (1990) to provide an open information architecture to support the provision of a facility. (Compared to the work presented in this report, Sanvido's model covers a wider scope of functions of facility management and operation.) The model is used to support computer-integrated construction and to define the critical success factors for construction projects.

The model of Zhong et al. (1994) covers also the overall building process although is quite rough compared to the former. The model by van Merendonk & van Dissel (1989), again, is thorough and includes many schemes, functional and conceptual ones. The ATLAS model (van Nederveen 1995, Bakkeren 1995), for

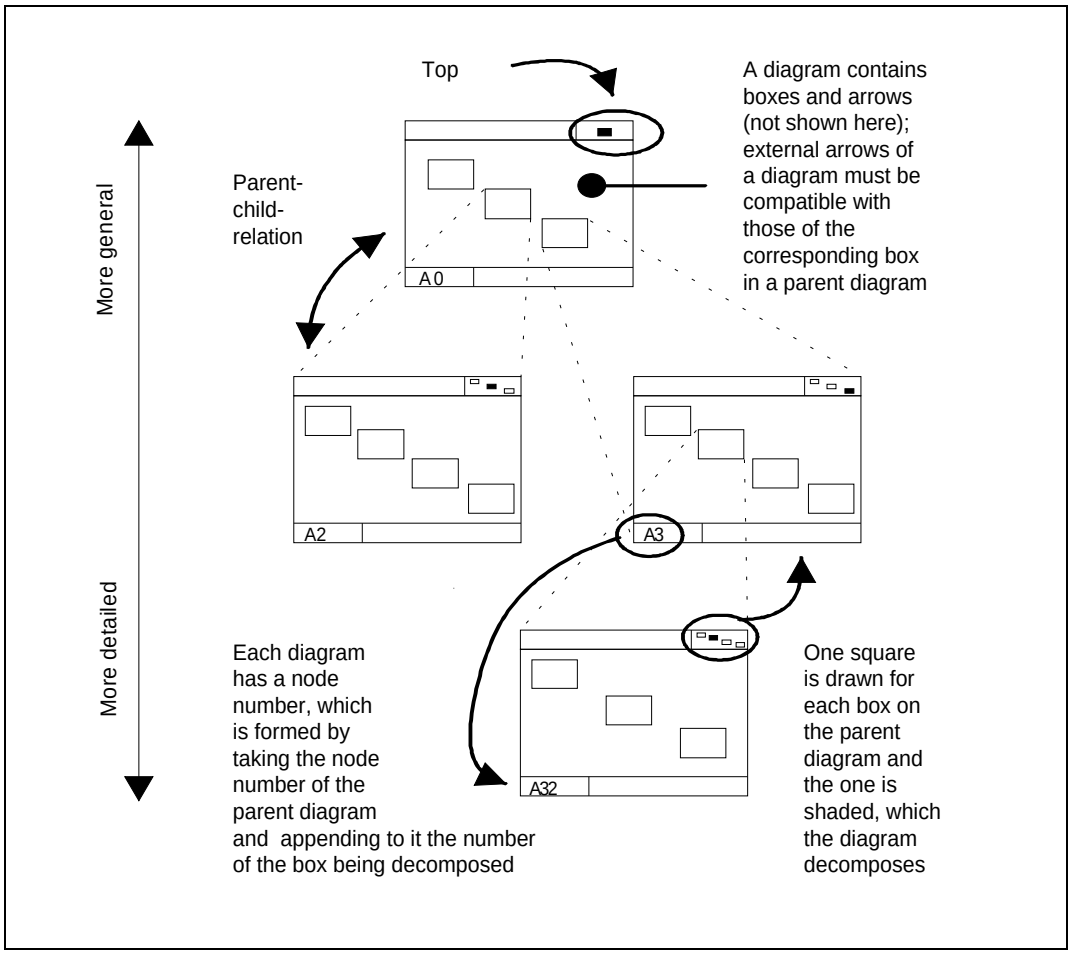


Figure 2. The hierarchical structure and reference systematic of the IDEF$_0$ modelling system (e.g. Marca & McGowan 1986).

its part, describes architectural and structural design processes from specific actor-based points of view. Thus, these submodels are called view-type models and the data content has also been specified.

Corresponding models have also been compiled for understanding and developing new procedures when a specific information system is generated. These models mainly focus on just a part of the building process. Laurikka (1994), for instance, has used IDEF$_0$, in addition to conceptual models, to present the principles of scheduling information systems while the objective of his research was to describe how CAD-based building product model information can be integrated into the production scheduling system.

Karhu's model (Karhu et al. 1994) specifies the design of a prefabricated concrete facade from the architectural point of view. A product model of a facade was also developed but the integration with the activity model was done mainly using check lists.

We present here just a few examples — there are many others. The need for a new one may have to be reconsidered.

Huru (1991) has concluded that various breakdown models give a very incoherent picture of the construction process. The names, contents and number of functions alternate according to the author and his definitions; the different language backgrounds cause further confusion.

This is understandable due to at least two reasons. Firstly, process descriptions, models, task lists and the like are usually compiled for a specific purpose, which means that they have been organised from a given viewpoint and vary from case to case. The other reason is that the procedures of the construction process and especially the roles of the parties alternate from country to country and we cannot avoid the culture-specificity of construction especially when modelling details.

On the other hand, the adjustment of scope, viewpoint and purpose is also emphasised as part of the used methodology. Since our primary aim is to model the construction process to support the Finnish national building industry practise and concepts from the viewpoint of overall process co-ordination, the task sets its own constraints and, moreover, produces a unique solution.

4 CONSTRUCTION PROCESS MODEL

4.1 STARTING POINT

An $IDEF_0$ model always has a clear subject, purpose and viewpoint (cf. Marca & McGowan 1986). The ***subject***, firstly, defines the boundary of a system. In section 2.2 the building process was defined as involving all activities, tasks and roles of the participants, starting with the first initiative for realising a building, encompassing programming, design and construction of the building and ending with maintenance. This definition is relevant also here although the last phase is included only as far as it is strictly related to the construction of a new building and its handover. As regards various roles, only the construction professionals proper are included while customers, authorities, manufacturers, etc. are not.

Secondly, the model itself must be able to answer the set questions with a predetermined level of accuracy. The ***purpose*** of the model crystallises the substance of these questions into a compact form. In this case, the purpose is to identify the various tasks of the major parties to the process, and understand how the tasks area interrelated so that the co-ordination of the overall building process can be studied and improved. This also serves as a managerial, or should we say, outside observer's ***viewpoint*** of the entire process. In practise, the viewpoint represents the position from which the system in operation is modelled.

4.2 COMPILATION OF THE MODEL

There are a couple of decomposition strategies for model compilation of which the actor-tied strategy seems more interesting at the top level. This is only natural since it enables fluent utilisation of the present industry-oriented process descriptions and keeps the model in touch with the professional practise. The strategy leads to submodels for each major party while they are also integrated into one model to some extent. The implementation neglects some of the finer aspects of modelling but is a friendly gesture to practitioners/readers.

The integrated process model covers all major design disciplines: architectural, structural, building services and geotechnical. The model also incorporates all the production as well as client's works. The design process submodels and client's works are based on general scope definitions, i.e. "task lists" (RT 10-10575, RT 10-10576, RT 10-10577, RT 10-10579, RT 10-10580), that are recognised as industrial standards, more or less, and various check lists for design disciplines. (The term "client's work" is used here in keeping with the source document although, the client may employ a consultant to manage the project or the tasks may be carried out by the contractor as is the case in speculative building, etc.)

The production process model is mainly based on the general contractors' quality management system model (Rakentamisen... 1994), which seems to be the most comprehensive source on production activities. Some other relevant sources have also been utilised where appropriate. For instance, the nomenclatures of building

works and elements, etc. (Talo 90-ryhmä 1993) also have formed the basis for the classification of physical site works. After all, the references are intended to describe the practical building process and are generally thought to do so.

The task lists and the quality system model have overlapping parts. The resulting process model covers completely the designers' and client's task lists but, in principle, nothing else as far as those works are concerned. Therefore, the corresponding tasks presented in the quality management system model (e.g. design management) are not included and the model adheres to the traditional design-bid-build process.

On the other hand, the general contractors' quality management system model covers the activities of a building company very thoroughly and the non-project-specific functions have also been excluded from the process model. Thus, such functions as company management and marketing, for instance, have been left out of the model as they are considered more company-level activities. Collection of tasks and activities has also been partly changed to better serve the aim while the work breakdown structure of the design and client's work submodels corresponds to that of the source documents, i.e. task lists.

4.3 STRUCTURE AND COVERAGE OF THE MODEL

The resulting construction process model covers the activities needed to carry out a building project by various major parties and integrates these activities as illustrated in Figure 3. The figure's only purpose is to shed light on the main division of the overall model and, thus, the flows and feedbacks are also only schematic. Detailed submodels are presented below in Part II of this report. They are:

- Section A Client's work process model
- Section B Architectural design process model
- Section C Structural design process model
- Section D Building services design process model
- Section E Geotechnical design process model, and
- Section F Production process model.

As far as the design disciplines and client's works are concerned, stage-based decomposition is applied mostly. The client and all the design professionals are, in principle, involved in every stage. The share and significance of the work by various parties alternates, however, strongly in different stages. Table 1 tries to shed light on this question and gives a general introduction of various stages.

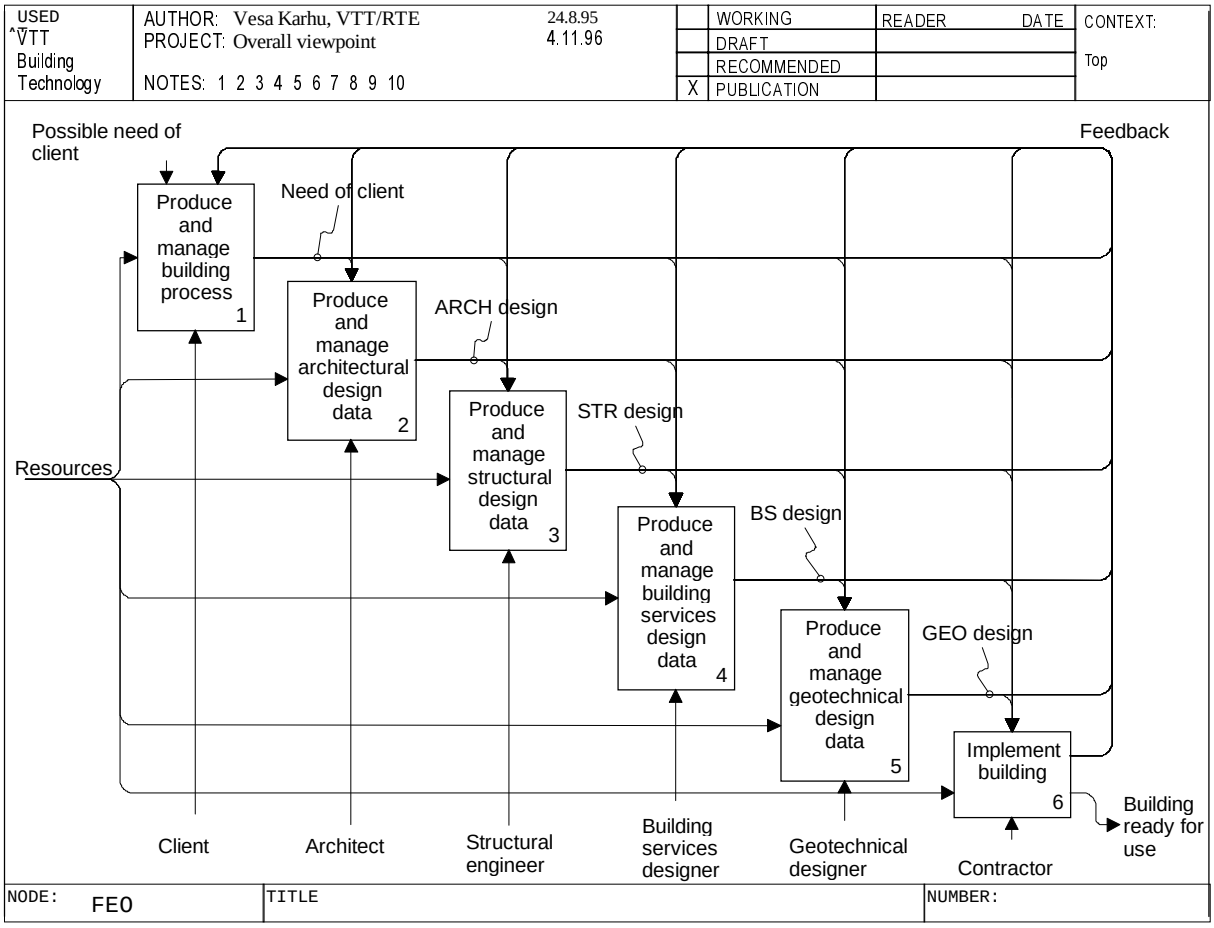


Figure 3. A schematic diagram of the overall construction process model presenting its main divisions and, moreover, its various subprocess models. Output from each discipline is only shown schematically as, for instance, design although the submodels focus on stage-based interaction in detail.

The client's works play an important role in the whole process, of course. In this context also the early stages of a building project, before briefing, are of importance. The main factor that leads to briefing is the strategic decision of a company. However, these matters are not included in the model as they are considered more company-level than project-specific activities; this corresponds to what has been said about the scope of the production submodel above (sec. 4.2). On the other hand, the contractor’s works begin quite late in the model when an invitation to tender is sent to him according to the traditional process, i.e. the production process submodel. Stage-based decomposition is not as prevailing in this submodel as in all the others.

Table 1. The interfaces and essential points of the process submodels. The stages are traditional although, for instance, the 'detail design' phase is also called the 'construction preparation' phase. In the compiled model, 'construction-related' matters are mainly included in the 'production process model' while all the other submodels touch on all the stages. In practise, the stages are also at least partially parallel in many cases.

Process stage	**Essential points**
Briefing	Briefing is mainly part of the client's works and can be done by the developer/client himself or by his representative, i.e. a professional consultant. Contributions may be received from various design disciplines and the result is a brief which deals with the necessity and possibilities of undertaking the project. The decision to launch the project is based on the brief.
Programming	Programming is part of the client's work. A programme includes all essential parts concerning individual design disciplines. The result is a programme that in addition to scope and quality-level data, also sets the cost level and schedule. The investment decision is based on the programme.
Global design	In the global design phase all the designers get into full speed. More data exchange occurs and co-operation is needed when design solutions from each discipline are worked up and checked for compatibility. Also, design solutions often require solutions by others before design can continue.
Detail design	Detail design of various disciplines is done simultaneously as design solutions need to be compatible. In case of a design-bid-build process the contractor is chosen during this stage which means the decision to build. The contractor's involvement also means that the construction preparatory stage and erection are parallel to detail design.
Construction	The major part of construction activities are implemented by the general contractor and his numerous subcontractors. The phase is at least partly parallel with the design phases and, thus, exchange of information increases, although the physical construction of various systems is not treated in detail in the model. The stage ends in the decision to accept.
Take-over	The construction phase is followed by the taking-into-use phase. Then, the activity intended for the building is launched and the readiness for use is monitored. Thus, all the major parties are involved, although now to a very small extent. The project ends with a guarantee inspection, possible guarantee repairs and termination of guarantees.

4.4 READING THE MODEL

The model follows the $IDEF_0$ syntax and guidelines outlined in section 3.2. This makes it easy to use and understand and ensures an unambiguous interpretation. However, since the model holds to the division of labour of today's industry, more detailed instructions for reading the process model diagrams are needed. In other words, the integration of various submodels is based on an adhoc solution.

Figure 4. shows how a control or an input that comes from outside the specific subprocess model in question, can be traced quite easily, just by identifying the

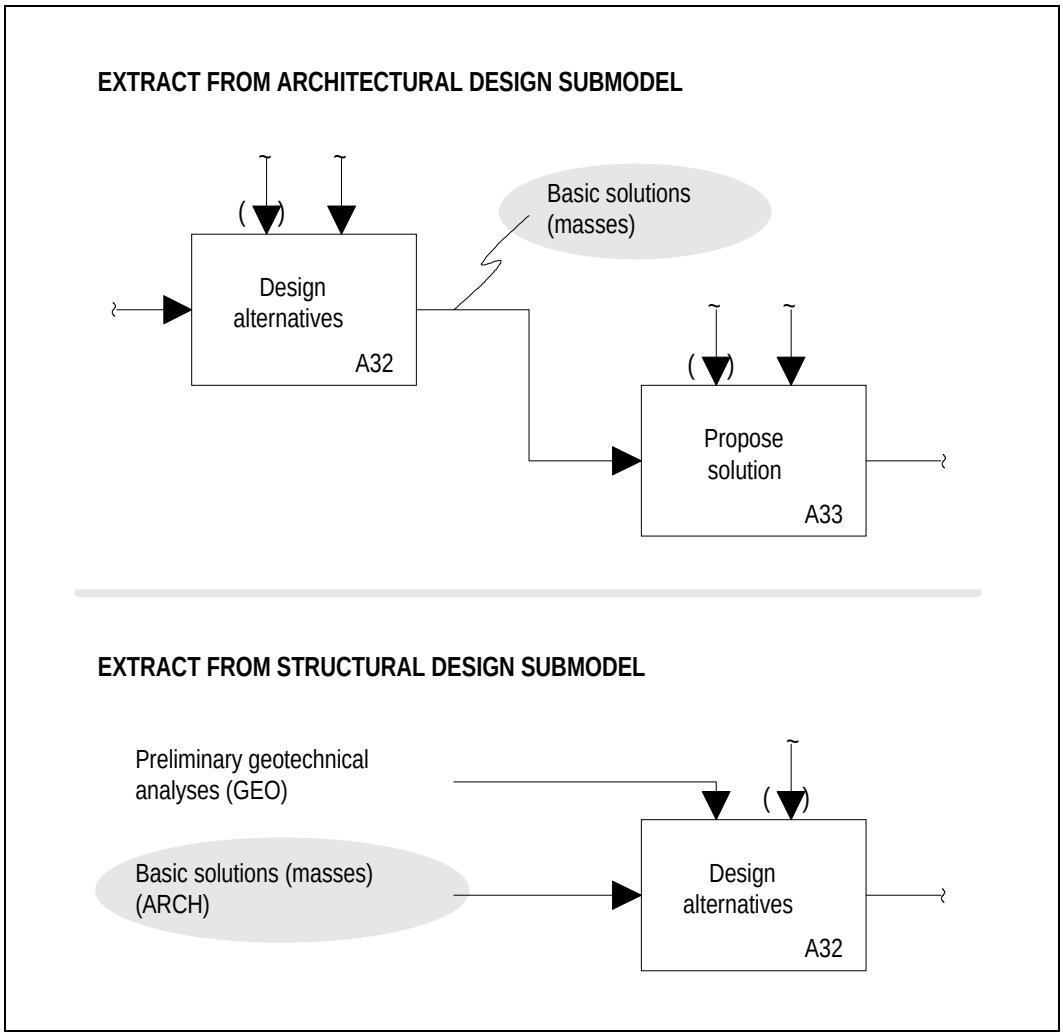


Figure 4. The upper part of the figure shows an extract from the architectural process model where "Basic solutions" are designed and constitute the output of the "Design alternatives" activity. The lower part of the figure shows the input that is needed for structural design (model). The input my be traced on the basis of the abbreviation "ARCH" which refers to the architectural process submodel.

flows. For instance, basic solutions are produced in architectural design and used later also in structural design.

When modelling flows into the processes, the basic idea has been that the use of an output from one activity is mainly relevant only within a single process. If the output from one activity is needed also in another submodel, the corresponding branch is not shown in the source model but only in the receiving one.

For instance, if HVAC design needs an input from structural design, there is no trace of this in structural design model but only in the HVAC design model. In other words, it is not relevant from the structural design point of view. On the other hand, the corresponding receiving activity (e.g. in HVAC) should obtain knowledge about where the information or data is produced which enables it to request the needed information.

The selected approach is similar to that of the design task lists which functioned as source documents for the model. This approach has also been followed in the ATLAS model (Bakkeren 1995, van Nederveen 1995), called a "view-type model" which is aimed to serve the selected party.

In the model, the following abbreviations and hierarchy are used to describe the different design disciplines and the works of the other parties:

- CLI = client's works
- DES = design works
    - ARCH = architectural design
    - STR = structural design
    - GEO = geotechnical design
    - BSE = building services design
        - HVAC = heating, ventilation and air conditioning design
        - AUT = automation design
        - TEL = telecommunications design
        - ELE = electricity design
    - INT = interior design
- CON = contractor's works and
- AUTH = authorities' works.

Building services design is an "umbrella term" that covers the more specific design disciplines of automation, electricity, etc. Thus, "BSE" is used as a collective term at the upper levels of the model while the different disciplines are distinguished at the lower levels that require a detailed approach. Another collective abbreviation is "DES" which refers to all designers but has been used only in the "production submodel".

Abbreviations not only refer to a certain party as an actor of an activity, but are also used to refer to documents and information flows originating with the party. Document names are formed by connecting the abbreviation of the

author/profession and the descriptive part focusing on the document contents. For instance, the ARCH programme refers to the programme contribution from the architectural design process.

As regards the flows in general, a fundamental idea of the $IDEF_0$ is that arrows are collections of things. This means that all the flows are not expressed in detail in every context where they exist. The decomposition also alternates. This can be seen, especially, in the "production submodel" which imports all the design (flows) to the top level and decomposes the clustered data based on the needs of detailed activities. This is different from the design phase decomposition.

The "production submodel" neither imports nor exports anything below the top level (A0) and thus, the mode differs from that of the designers' and client's works. (Tunnelling is, however, used also at the decomposed levels of the "production submodel".)

Thus, the model includes more information than would appear and arrow joints and branches are a means of managing the deluge of information. An arrow is always labelled before its branch and after its joint in order to indicate the collection. Branches which are not labelled are assumed to contain either all or some of the thing indicated by the aggregate label before the branch or after the joint. (Marca & McGowan 1986)

5 RESTRICTIONS AND FURTHER DEVELOPMENT

5.1 REVIEW OF THE MODEL STRUCTURE

The decomposition strategy followed at the top level of the overall process model was based on the prevailing division of labour between the parties to the building process (as was explained in section 4.2). Thus, the client, various design professionals and the general contractor were identified. Then, the strategy adhered mainly to phase-based thinking at the lower levels although the activities which have the primary function of controlling other activities are exceptions in this respect.

The deviation from the main line in the case of control and management activities should be logical since it is impossible to describe or predefine the existence of these activities in the context of the sequential approach. Usually these tasks exist either "continuously" to ensure the desired outcome, or whenever they are needed as a result of mistakes or confusion. Such control may be an aim towards a common understanding, some sort of change or a proposed change in plans, etc. which would result in recursion.

In the model, management stands out especially in the site production phase which adheres more to the function-type model. After all, detailed modelling is not needed since, in practise, the project-specific task schedules serve the detailed needs and it is more important to understand the general functioning of the management.

As a main principle, however, phase-based thinking and emphasis on sequentiality were deemed useful. This was also largely a result of the source material used. Especially the task lists adhered strictly to this principle. The reason behind the sequential approach in both cases is practical utilisability. Such an approach is needed to understand "what we should do next" since, obviously, it is easier to follow a model where interrelated activities are organised together instead of on the basis of conceptual similarity.

Thus, it was deemed that a theoretically correct model, that emphasises "activity nature" and recursion instead of "task nature" and sequentiality would lead to an abstract model of little practical use. At least it would have been extremely difficult and risky as a first trial and it would have required highly developed computerised tools to exploit. This led to the present practise which was not considered the final solution.

In addition, the selected decomposition strategy emphasising sequentiality is in line with the wishes of the sister project that focuses on the utilisation of this kind of reference models (Hannus et al. 1996, see sec. 6.2). On the other hand, the management activities that are not modelled according to the sequentiality principle are broken down into decisions and meetings, etc. in case-specific

applications. Besides, the consideration of the decomposition strategy results in suggestions for future studies, both small step (sec. 5.2) and more fundamental improvements (sec. 5.3).

5.2 TOWARDS IMPROVED MODEL VALIDITY

The model presented here is state-of-art as it is the first one trying to draft a systematised description of the prevailing building practise. For instance, design process submodels consist almost exclusively of general task lists (see sec. 4.2); they show advantages and disadvantages as they are. The model doesn't cover the entire overall process and all the activities of various parties as accurately. Thus, it is clear that this kind of initial model should still be improved to serve various interests and should be considered as a platform for more advanced and specific models.

The entire process model may be developed at least in the following areas:

- the architectural submodel and its activities could be modelled from two viewpoints, one emphasising the main designer's tasks and the other the architectural design tasks proper,
- effects of alternative procurement and delivery methods and various modes of operation should be taken into account, and
- the activities of subcontractors and suppliers should be added to the model and their co-operation with the existing parties should be considered as well.

The main designer's tasks are part of architectural design tasks in the task list and in the corresponding submodel. In practice, few architects do all these tasks. Also, the distinction between the tasks of the client and other disciplines in briefing and programming is not clear which applies not only to the compiled process model but also to the task lists.

Further, the division of labour in the model follows that of the source documents. This is not appropriate from the general viewpoint since modelling according to the traditional roles of the parties does not support the alternative modes of operation. Especially, since the building practise is changing drastically (e.g. Lahdenperä 1995). For instance, the tender by the general contractor may be given earlier or the process may follow some kind of partnering procedures. Thus, the functioning and validity of the model should be studied in relation to various alternative construction processes (cf. sec. 2.3).

It is also obvious, that genericness and complete integration of the subprocesses would require that the overall process is modelled from the information point of view. This means that any data or information that is needed in a certain activity and is a result of another activity, is modelled and produced regardless of who the producer and user of the data are. This was, indeed, recognised when the modelling strategy was decided but such a generic approach was deemed too difficult and risky to implement without using this kind of model as an intermediate version.

Anyway, future work should focus also on the integration of the various submodels for which support is available from the sister project which analysed the detailed information flows between the parties in one realised building project (Tanhuanpää & Lahdenperä 1996). The report by Lakka & Nykänen (1991) is another relevant source as concerns design interfaces.

The term “intermediate version” is used and considered appropriate since, to be really useful in practise, the model should be adaptable to various case-specific solutions without any bigger compromises. Use should also become much easier, which, again, is linked to the development of the modelling methods and computerised browsers, etc. which require deep-going and laborious development.

5.3 TOWARDS AN IMPROVED MODELLING APPROACH

The decomposition strategy led to some selections and simplifications from the viewpoint of alternative processes as was explained above. In practise, the model adheres to something that can be called the traditional building process. Thus, it makes sense to return to the question whether the process model applies to all variations of constructing a building (cf. sec. 2.3).

Figure 5 sheds light on these variations by introducing a few interchangeable ways to carry through some parts of the process. Firstly, we have to notice that the figure represents only cases where the division of labour and organisational relations between the parties are alike (while a more thorough explanation of those processes is skipped here). If more leeway is allowed in alternative contractual and operational relations, the division of labour remaining the same, a few additional reasonable processes can be found as shown in the source document by Lahdenperä (1994). The alternative processes involve, in principle, the same activities but their order is different.

Next, we can deliberate what happens if the division of labour between the parties is also changed. It does not only influence the assignment of activities but changes their nature in many cases. For instance, if we compare the system unit procurement of the above example and the traditional process where the technical design is done by the client’s designer, it is obvious that the activities become different. While in the traditional design process the detailed solution is a result of “straightforward” design that, stage by stage, becomes more accurate, the other process concentrates initially on defining the clear functional requirements, pet ideas of designers and unambiguous selection criteria for the comparison of tendered solutions. Thus, the activities differ so much that it is practicable to use separate concepts to refer to them in order to be able to describe the used practise best.

However, the solution is not that clear. In the case of similar kinds of processes, the different order of activities (cf. Figure 5) is likely to cause some differences in “similar” activities. On the other hand, also the activities of extremely different processes should have many common components since the aim to “build a

building" is the same. This raises a question about the modelling approach and the level of abstraction; how to combine top-down and bottom-up approaches?

Let's return to the role of reference models: they describe typical, but not actual, processes and make it possible to reuse the existing construction knowledge (Hannus & Pietiläinen 1995). They are only suggestive examples and have to be adapted to each separate case anyway. Therefore, modular thinking is suggested for compiling reference models so that by combining various library modules and standard procedures any building project and/or process could be described. Modularity offers, at least in theory, a means to cover a wide field of processes with a reasonable amount of alternative components. This could become relevant as information technology and its applications develop (cf. Hannus et al. 1996).

At the lower levels, another reason supporting the strive for modularity is feedback and iteration which are part of all function-type models but make it difficult to understand and define the activity occurrences in the process. For instance, an activity may improve the exactness of information for each iteration. For this reason, an activity may occur several times in a process which could make use of the modular approach sensible.

An example could be an activity like *"Present results"* in stagewise development of building designs. The same activity is done several times during a design process but different data is handled, i.e. input could be *"a basic solution"*, *"a proposed solution"*, etc. Of course, in practise, the activity may have to be changed to get the desired output which leads to controversy since the activity is not the same anymore. Thus, the success of this approach is not self-evident or unproblematic but at an appropriate level of abstraction it seems to be worth further consideration.

This example, dealing with design development, is again connected to the relation between the activity models and the data models. Thus, a modelling approach and tool that enable combining a data model with an activity model should also be considered. In fact, a few tools have been developed and they are based on the $IDEF_0$ and EXPRESS or $IDEF_{1X}$ methodologies (Maritime 1995, Meta Software 1996). There, the data is connected with the flows, e.g. the shape of a facade is depicted using the corresponding EXPRESS definition, whereas the flow corresponds to an output or input of the $IDEF_0$ methodology.

In summary, we suggest that alternative processes be given more attention in future work to provide guidelines for module composition. It is also suggested that internalisation of the above concepts of division of labour, contractual and operational relations and sequentiality could pave the way for modular thinking. Thus, it is hoped that this tentative discussion helps devise strategies for future work. However, since the model is not an end in itself, its application should be developed and tested at the same time which brings us to the subject matter of Chapter 6.

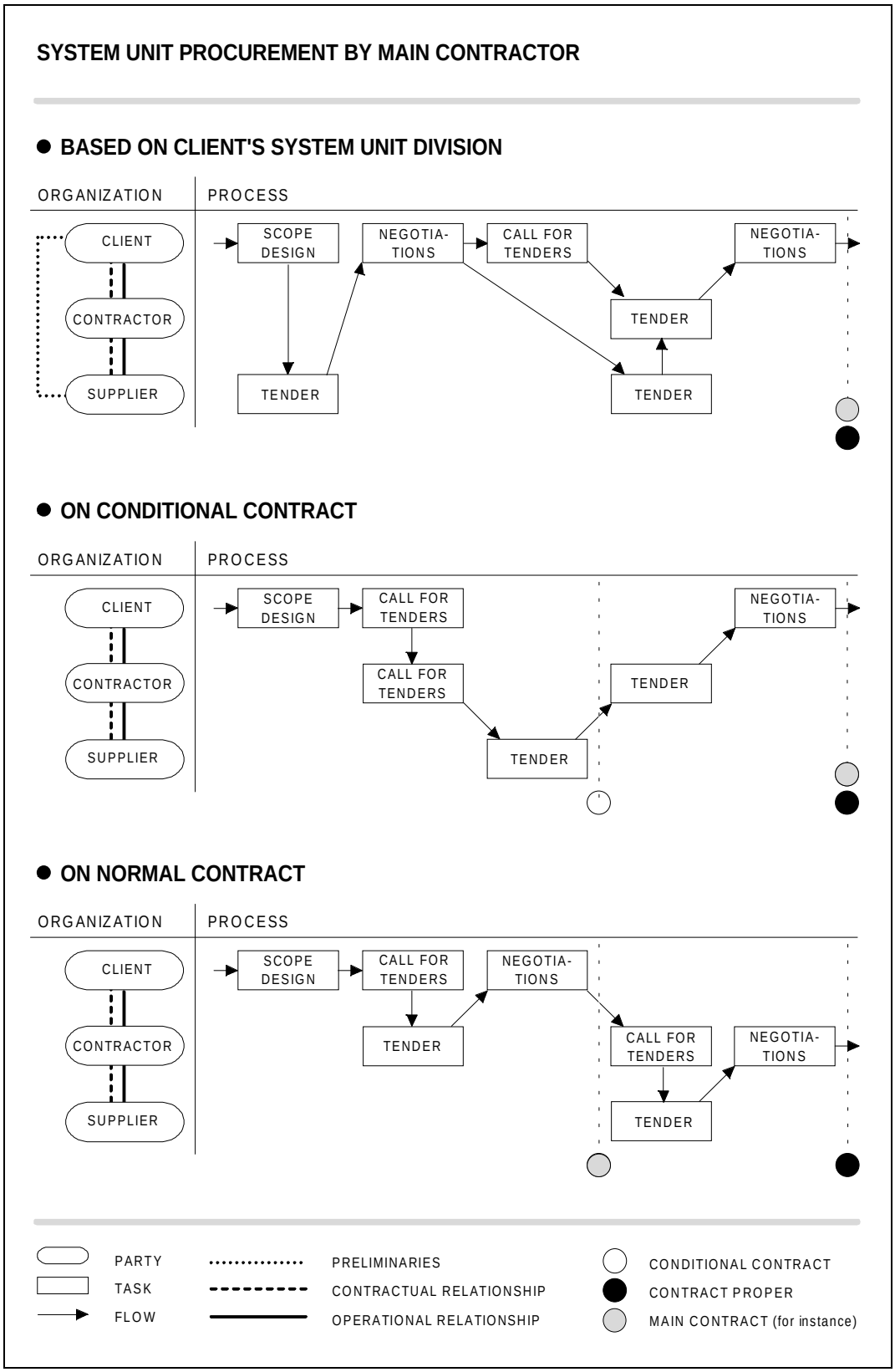


Figure 5. Alternative processes for system unit procurement by the main contractor; i.e. one supplier is liable for technical design and assembly of a system of a building, etc. (Lahdenperä 1994).

6 UTILISATION OF THE MODEL

6.1 GENERIC MODELLING INCENTIVES

In general, this reference model offers the opportunity to conduct various view-dependent surveys and classifications while also serving as a platform for more specific models. Thus, it and its derivatives can be utilised in many ways in the development and control of the building process due to the following reasons:

- **Common concepts and interpretation.** Models help define issues and contexts clearly and create mutual understanding between people and parties with different experiences. The standardisation of certain interfaces and the support to the classification of information and development of information and control systems is also significant.

- **Development of processes.** The analysis of models can yield new and more efficient operational procedures for construction. Models and computerised tools facilitate the design, construction and testing of various means of improving efficiency and new types of operational processes without real risks. They also allow rating alternative implementation solutions against each other.

- **Process control.** Models can be used to plan and control construction, to match and synchronise the work of various parties and to set intermediate goals. Models can be used, for instance, to define the information needs and material flows of a process and to fix the corresponding timewise goals with respect to various activities and the various parties.

These aims are quite general and, in fact, gave the motivation to launch this study. For that reason, section 6.2 focuses more on the specific usage-related findings of a sister project of the same research entity. Here, the diverse possibilities are only mentioned. They are also examined in Table 2.

A generic modelling approach is dealt with in more detail in another sister project by Heinonen et al. (1996) which also aims to extend the mentioned concepts related to the building process to cover more than just “an activity” and “a flow” (and “an actor”) as is the case with this model.

6.2 SPECIFIED NOVEL APPLICATIONS

The effort to build a reference process model is described in this report. The work is, however, just part of the research entity focusing on the development of construction process modelling methods and capabilities. One of the sister projects, by Hannus et al. (1996), has been developing computerised modelling capabilities and drafting application possibilities for reference models.

Table 2. Why model ? The table suggests a possible use for a model and, correspondingly, incentives to inspire modelling efforts. The lists have been modified from the one presented by Curtis et al. (1992).

FACILITATE HUMAN UNDERSTANDING AND COMMUNICATION
• Represent process in a form understandable to humans • Enable communication about and agreement on construction processes • Formalise the process so that people can work together more effectively • Provide sufficient information to allow an individual or team to perform the intended process • Form a basis for teaching the intended process
SUPPORT PROCESS IMPROVEMENT
• Identify all the necessary components of high-yield construction development • Reuse well-defined and effective construction processes in future projects • Compare alternative construction processes • Estimate the impacts of potential changes to a construction process without putting them into actual practice • Assist in the selection and incorporation of technology into a process • Facilitate organisational learning regarding effective construction processes • Support managed evolution of a process
SUPPORT PROCESS MANAGEMENT
• Develop a project-specific process to accommodate the attributes of a particular project, such as its product or organisational environment • Support development of plans for the project and forecasting the progress • Monitor, manage, and co-ordinate the process • Provide a basis for process measurement, such as definition of measurement points within the context of a specific process

The developed modelling tool is prototype software for browsing, sorting and analysing the construction processes. The tool itself is programmed by using Paradox software (Borland International 1996) while Microsoft Project software (Microsoft 1996) is utilised for scheduling as shown in Figure 6. The tool requires that the models imported and used as reference data are completed by using $IDEF_0$ while the specific software used and required so far is Design/IDEF (Meta Software 1996). Correspondingly, the process model introduced in this report is compiled by using this particular software while other software also exists.

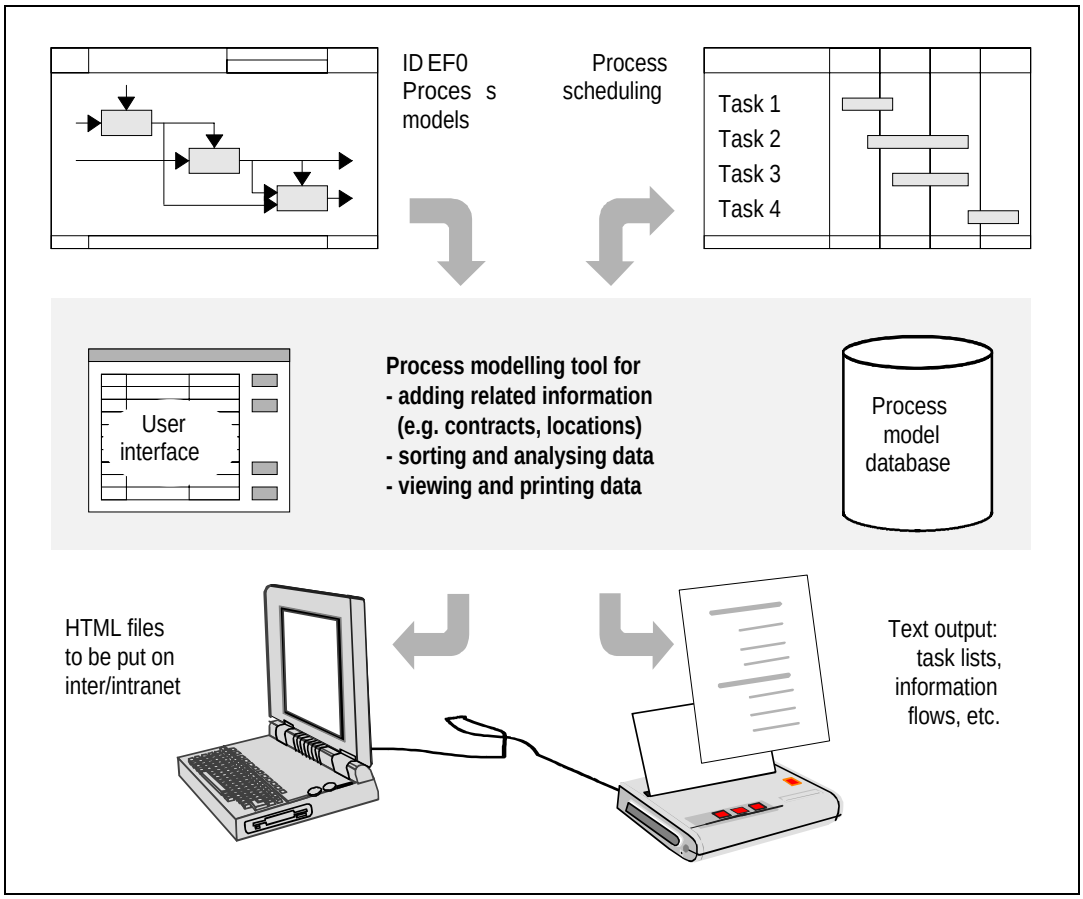


Figure 6. PROMO process modelling prototype makes use of the process modelling approach in the development and management of construction processes (Hannus et al. 1996).

Many useful applications are available when using reference process models and the tool is meant to be a big help in this respect. In summary, the presented application areas are the following:

- **Quality systems of companies**. Developing, maintaining, documenting and distributing quality systems of a construction company (using internal WWW).
- **Project-specific quality plans**. Developing project-specific quality plans to describe the tasks and scopes of liabilities of the parties, etc.
- **Co-ordination of construction projects**. Integration of the processes of the participants in a construction project, compilation of plans and schedules.
- **Contract management**. Setting intermediate goals for a project and drawing up the related contracts by sorting the appropriate flows and interrelations.
- **Evaluation of alternative processes**. Evaluation of alternative implementation solutions for a construction project based on duration, complexity, etc.
- **Process knowledge reuse**. Development of reusable project- and company-specific processes to be integrated for planning purposes (library subprocesses).

7 CONCLUSIONS

One fundamental reason for writing this paper was the idea that development efforts should be focused more on the entire building process instead of suboptimisation and view-dependent studies that neglect many of the relevant items that have an influence on the performance of the construction process. The complicated mess of construction-related items and problems cannot, however, be fully understood by the limited human mind. The modelling approach is an effort to understand the issues and problems of construction. Thus, the orientation has been more development-driven than explorative.

Moreover, the main focus of the study has been on the functions and flows of the overall building process since it was found that they are very critical for the development of the building procedures. The study was conducted in a systematic way based on the well-established $IDEF_0$ method. The client's and designers' task lists and the general contractor's quality management system model have formed the basis of this work. These documents are believed to describe the industrial practise best and were selected to tie the study to practise.

Thus, the resulting building construction process model covers the functions of the client, various design professionals and the general contractor. The model includes more than 300 activities (from all levels) and significantly more flows to define the interrelations. In addition, definitions are offered for flows whenever the contents may be open to interpretation and, moreover, an English - Finnish glossary is prepared for all flows and activities of the model.

As to the composed model, it adheres to the so-called traditional building process and a sequential decomposition strategy after the main division into the main parties has been done at the top level. Therefore, we suggest that alternative building processes and their compatibility with the model have to be studied and developed further. Also, subcontractors' and suppliers' work should be given more attention in further development while the integration of the existing activities by separate parties should also be examined more carefully. In fact, the information point of view should be emphasised more in model building to really integrate the involved activities.

On the other hand, the study points out the corresponding necessities in the development of the source material for which the model development could offer a good starting point. Consideration of newer types of building processes and the division of architectural task list into main designer's tasks and architectural design proper are among the needed improvements.

The possibility of managing all the variation in the building process through the modular approach should be examined, so that by combining various library modules and standard procedures, any building project or process may be described. This will be increasingly possible as information technology and its applications develop, which, on the other hand, is a precondition for the effective utilisation of process models. Another challenge is the integration of process model flows which

define the information exchange in building design, and product model data. These challenges are, however, incorporated into the development of modelling concepts and syntax, besides being determinants of practical building.

Generally, the resulting reference model offers possibilities for its various view-dependent examinations and functions as a platform for more specific models. Models support communication and help in attaining a common understanding of process- related issues. Further, the modelling approach also supports process re-engineering and improvement efforts as well as offers new means for (the improvement of) the building process management.

In practice, when integrated with modern computer technology, the compiled construction process model and its future versions allow the evaluation of alternate implementation solutions for the construction project, the planning of various project- and company-specific processes and assist in the development and documentation of quality management systems. At the same time, the model and its scopes of liabilities, to be selected, form the key tools for setting intermediate goals for the construction project, the co-ordination of various parties' work, etc.

After all, the study concludes that continued use of the modelling approach in the development of building process performance is worthy of future work which will repay the costs before long. This statement is based not only on this research but also on some ongoing applications. The construction process is, however, such a mess that a lot of work still remains to be done. What has been done here is only the first step.

REFERENCES

Abou-Zeid, A. & Russell, J. 1993. Using data flow diagrams to study communication process between construction project participants. Proceedings of the 5th International Conference on Computing in Civil and Building Engineering, Anaheim, CA, USA. New York, US: ASCE. Pp. 245 - 254.

Bakens, W. (ed.) 1997. Future organisation of the building process. Final report. Rotterdam, NL: International Council for Building Research Studies and Documentation CIB. 270 p. CIB Publication 172. (to be published)

Bakkeren, W. 1995. View type Model for the Structural Engineer for RC Detailing. Delft, NL: TNO Building and Construction Research. (unpublished)

Björk, B.-C., Hannus, M., Karstila, K., Koskela, L., Leppänen, P. & Sarja, A. 1991. Tietokoneyhdennetty rakentaminen [Computer integrated construction]. Espoo, FI: Technical Research Centre of Finland (VTT). 119 p. + app. 20 p. VTT Research Notes 1319. (in Finnish)

Borland International. 1996. Paradox. World Wide Web document at URL: http://www.borland.com/paradox/. Scotts Valley, CA, US: Borland International Incorporation.

Busby, J. & Williams, G. 1993. The value and limitations of using process models to describe the manufacturing organizations. International journal of production research, vol 31, no 9, pp. 2179 - 2194.

Chung, E.K. 1989. A survey of process modeling tools. University Park, PA, US: The Pennsylvania State University, Department of Architectural Engineering. Technical Report no 7, CIC Research Program.

CIB W65. 1985. Glossary of terminology in organization and management of construction. Rotterdam, NL: International Council for Building Research Studies and Documentation CIB. Working Commission W65: Organization and Management of Construction. 16 p. CIB Report, Publication 83.

Curtis, B., Kellner, M. & Over, J. 1992. Process modeling. Communications of the ACM, vol. 35, no. 9, pp. 75 - 90.

Davenport, T. 1993. Process innovation. Reengineering work through information technology. Boston, US: Harvard Business School Press. 337 p.

Hannus, M., Lahdenperä, P. & Vahala, P. 1996. Computerised process modelling as a basis for improved project management. 15 p. (manuscript for a prereviewed journal article)

Hannus, M. & Pietiläinen, K. 1995. Implementation concerns of process modelling tools. In: Proceedings of CIB W78 Workshop on Computers and Information in Construction, Stanford, CA, USA. CIB Proceedings / Publication 180. Pp. 449 - 458.

Heinonen, R., Lahdenperä, P. & Pietiläinen, K. 1996. Construction process modelling — A conceptual approach. Espoo, FI: Technical Research Centre of Finland (VTT). 60 p. VTT Research Notes 1807. (to be published)

Hughes, W. 1989. Organizational analysis of building projects. Liverpool, UK: School of Built Environment, Liverpool Polytechnic. PhD Thesis. 202 p. + app. 44 p.

Huru, H. 1991. Talonrakentamisprosessin osapuolet ja toteutusmuodot. Kohdemaat Iso-Britannia, Saksa ja Ranska. [Building procurement methods and parties to the building process. Target countries Great-Britain, Germany and France.] Academic dissertation. Tampere, FI: Tampere University of technology, Institute of Construction Economics. 324 p. (in Finnish)

ICAM. 1981. Integrated computer-aided manufacturing (ICAM), Architecture Part II. Volume IV - Function modelling manual ($IDEF_0$). Waltham, MA, US: SofTech. 165 p.

Karhu, V., Hannus, M. & Pellosniemi, J. 1994. Elementtirakennuksen tuotemallipohjainen arkkitehtisuunnittelu [Product model based architectural design of prefabricated construction]. Espoo, FI: Technical Research Centre of Finland (VTT). 97 p. + app. 86 p. VTT Research Notes 1568.

Lahdenperä, P. 1994. Increasing use of the product conception and its incorporation into various procurement systems. In: Rowlinson, S. (ed.). East Meets West. Proceedings of the CIB W92 Procurement Systems Symposium, Hong Kong, December 4 - 7, 1994. HK: The Department of Surveying, Hong Kong University. Pp. 149 - 158. CIB Publication 175.

Lahdenperä, P. 1995. Reorganizing the building process. The holistic approach. Espoo, FI: Technical Research Centre of Finland (VTT). 210 p. + app. 7 p. VTT Publications 258.

Lakka, A. & Nykänen, V. 1991. Rakennussuunnitteluprosessin kehittäminen tuotannon näkökulmasta [Building planning process from the viewpoint of production]. Espoo, FI: Technical Research Centre of Finland (VTT). 72 p. + app. 7 p. VTT Research Reports 723. (in Finnish)

Laurikka, P. 1994. Tuotemallin käyttö sisävalmistustöiden aikataulusuunnittelussa [The use of a product model in the scheduling of finishing works]. Espoo, FI: Technical Research Centre of Finland (VTT). 90 p. + app. 11 p. VTT Research Notes 1553. (in Finnish)

Marca, D. & McGowan, L. 1986. SADT, Structured analysis and design technique. New York, US: McGraw-Hill Publishing Company. 392 s.

Maritime. 1995. AP factory overview. World Wide Web document at URL: http://www.metis.no/solutions/ap-factory/APF/overview.htm. Horten, NO: NCR Metis Solutions.

McGeorge, W., Chen, S. & Ostwald, M. 1994. A dynamic framework for project decision support - developing “soft” interfaces for the management of construction projects. In: CIB W78 workshop on computer integrated construction, Helsinki, Finland, August 22 - 24, 1994. Espoo, FI: VTT Building Technology & International Council for Building Research Studies and Documentation CIB. 10 p.

Merendonk, P. van & Dissel, D. van. (eds.). 1989. Bouw informatie model; versie 3.1. Rotterdam: IOP-Bouw. App. 1000 p.

Mertins, K. & Süssenguth, W. 1991. Integrated information modelling for CIM. Computer-Integrated Manufacturing Systems, vol. 4, no. 3, pp. 123 - 131.

Meta Software. 1996. Design/IDEF. Easy to use business process modeling and analysis tool. World Wide Web document at URL: http://www.metasoftware.com/prodidef.html. Cambridge, MA, US: Meta Software Corporation.

Microsoft. 1996. Microsoft Project. World Wide Web document at URL: http://www.microsoft.com/project/. Redmond, WA, US: Microsoft Corporation.

Mohsini, R. 1984. Building procurement process: A study of temporary multi-organizations. Montreal, CA: Université de Montréal, Faculté l'Aménagement. PhD Thesis. 150 p.

Mohsini, R. & Davidson, C. 1992. Determinants of performance in the traditional building process. Construction Management and Economics, vol. 10, no. 4, pp. 343 - 359.

Ndekugri, I. & McCaffer, R. 1988. Management information flow in construction companies. Construction management and economics, vol. 6, no. 4, pp. 273 - 294.

Nederveen, S. van 1995. View type model for the architect in the global design stage. Delft, NL: TNO Building and Construction Research. (unpublished)

Pelkonen, A.-M. & Pulkkinen, T. 1987. Suunnittelumenetelmien kartoitus [Survey of planning methods]. Helsinki: Atk-instituutti. 504 p. (in Finnish)

Rakentamisen laatu. Rakennusyrityksen laatujärjestelmämalli. [Quality of construction. Quality management system model for contractors]. 1994. Helsinki, FI: Rakennusteollisuuden Keskusliitto (RTK) [The Confederation of Finnish Construction Industries]. Osa 2. Toimintokansio: Menettelyt ja toimintaohjeet. Ab. 300 p. (in Finnish)

Ross, D. 1977. Structured analysis (SA): A language for communicating ideas. IEEE Transactions on Software Engineering, vol 3, no 1, pp. 16 - 34.

RT 10-10575. 1995. Rakennuttamisen tehtäväluettelo [Scope of client's work in building construction]. Helsinki, FI: Rakennustieto Oy. 14 p. (in Finnish)

RT 10-10576. 1995. Arkkitehtisuunnittelun tehtäväluettelo [Scope of work in architectural design]. Helsinki, FI: Rakennustieto Oy. 12 p. (in Finnish)

RT 10-10577. 1995. Rakennesuunnittelun tehtäväluettelo [Scope of work in structural design]. Helsinki, FI: Rakennustieto Oy. 12 p. (in Finnish)

RT 10-10579. 1995. Talotekniikan suunnittelun tehtäväluettelo [Scope of work in building services design]. Helsinki, FI: Rakennustieto Oy. 12 p. (in Finnish)

RT 10-10580. 1995. Geosuunnittelun tehtäväluettelo [Scope of work in geotechnical design]. Helsinki, FI: Rakennustieto Oy. 8 p. (in Finnish)

Sanvido, V., Grobler, F., Parfitt, K., Guvenis, M. & Coyle, M. 1992. Critical success factors for construction projects. Journal of Construction Engineering and Management, vol. 118, no. 1, pp. 94 - 111.

Sanvido, V., Khayyal, S., Guvenis, M., Norton, K., Hetrick, M., Al-Muallem, M., Chung, E., Medeiros, D., Kumara, S. & Ham, I. 1990. An integrated building process model. University Park, PA, US: The Pennsylvania State University. Technical Report no 1, CIC Research Program. 144 p.

Sidwell, A. 1982. A critical study of project team organizational forms within the construction industry. Birmingham, UK: University of Aston. PhD Thesis. 145 p.

Talo 90-ryhmä. 1993. Talo 90: Nimikkeistö. Yleiseloste. [Building 90: Nomenclatures. General survey.] Helsinki, FI: Rakennustieto. 48 p. + app. 62 p.

Tanhuanpää, V.-P. & Lahdenperä, P. 1996. Rakentamisprosessin malli. Toteutumatiedot toimistorakennushankkeesta. [Construction-process model. Actualized data of an office project.] Espoo, FI: Technical Research Centre of Finland (VTT). 294 p. + app. 7 p. VTT Research Notes 1768. (in Finnish)

Zhong, Q., Mathur, K. & Tham, K. 1994. A construction process model by using Design/Idef. In: CIB W78 workshop on computer integrated construction, Helsinki, Finland, August 22 - 24, 1994. Helsinki: VTT Building Technology & International Council for Building Research Studies and Documentation CIB. 17 p.

PART II:

THE COMPLETE CONSTRUCTION PROCESS MODEL

SECTION A:
CLIENT'S WORK PROCESS MODEL

Table of contents

ACTIVITY MODEL

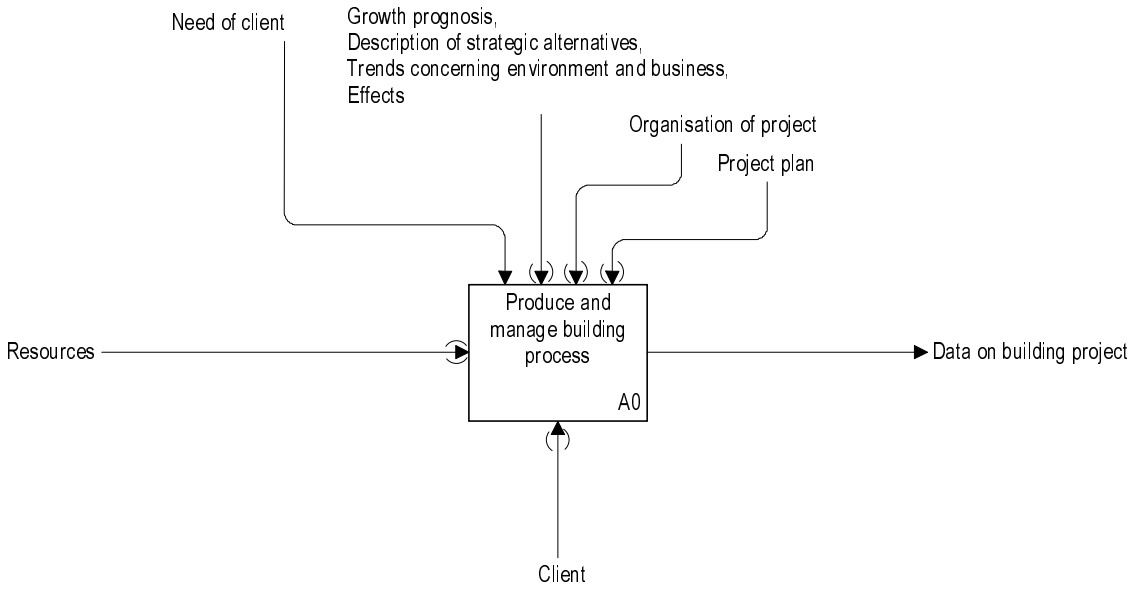
A-0 MODEL SCOPE

Client's work during the building process involves overall supervision of design work and managing official opinions and decisions concerning design solutions at different stages.

The client's work process model is divided into six different stages that are briefing, programming, prepare design, supervise design, prepare construction, supervise construction and, finally, use and maintenance stages.

The presented process model is based on a task list (RT 10-10575). The A-0 diagram is shown in Figure 1.

USED AT:	AUTHOR: Vesa Karhu, VTT/RTE 24.8.95		WORKING	READER DATE	CONTEXT:
VTT Building Technology	PROJECT: Client's work (RT 10-10575) 4.11.96		DRAFT		
			RECOMMENDED		Top
	NOTES: 1 2 3 4 5 6 7 8 9 10	X	PUBLICATION		



NODE: A-0	TITLE: Produce and manage building process	NUMBER:

Figure 1. Model scope.

A0 PRODUCE AND MANAGE BUILDING PROCESS

The client's work begins with briefing for which assistance is received from different design disciplines (Figure 2). These disciplines are architectural design, structural design, building services design and geotechnical design. This guarantees sufficient expertise in all design disciplines.

It should be noted that client's work does not necessarily lead to a project. It is considered part of a company's strategy. The strategy includes a description of for instance the economic situation.

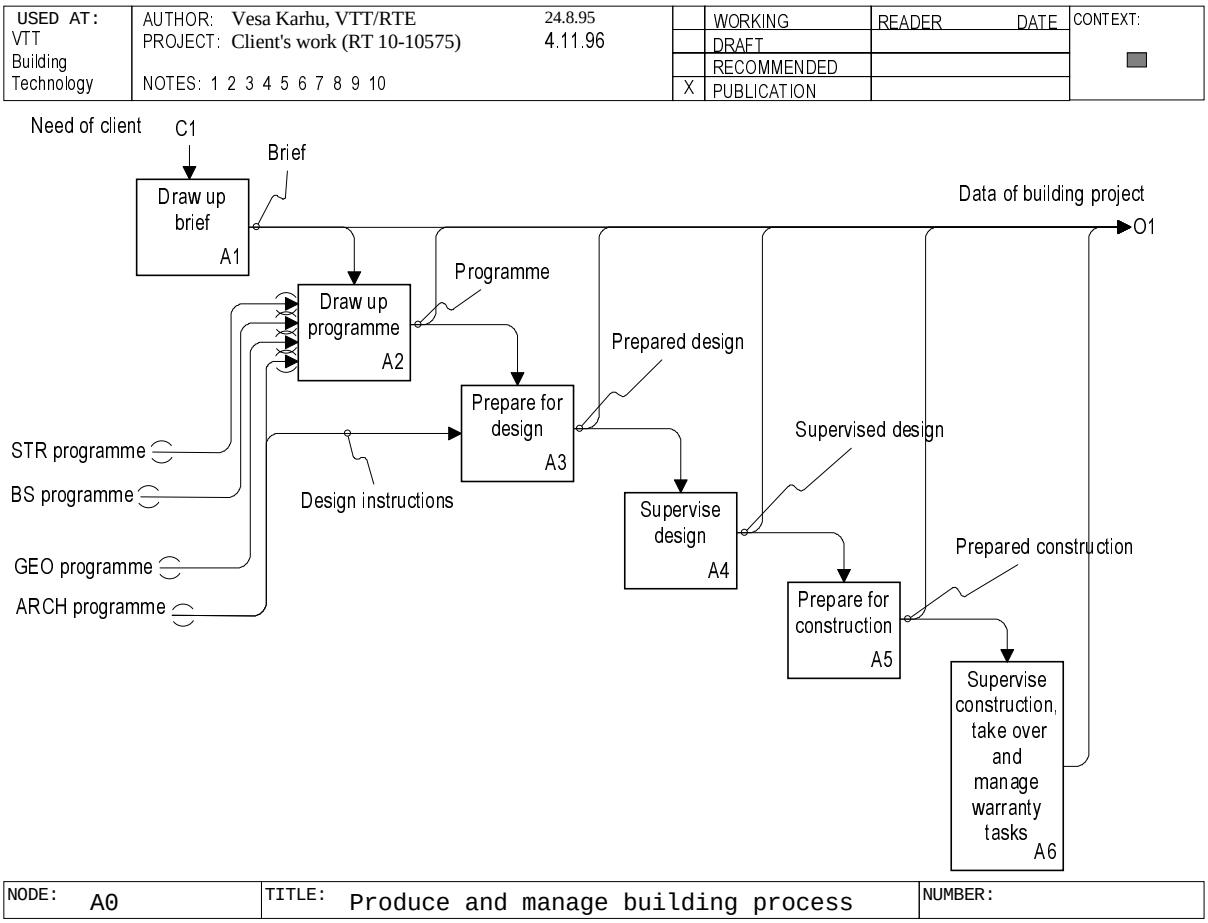


Figure 2. Produce and manage building process.

A1 DRAW UP BRIEF

Briefing is used to identify changes in activities of the client (Figure 3). These changes may require more space, for instance, a precast element manufacturer may need more space for the production. The operational alternatives to satisfy the needs may be a new building or renovation of existing buildings.

Briefing gathers information from different design disciplines into a common project brief which includes the corresponding parts from:

- architectural design,
- structural design,
- building services design, i.e., HVAC, electric, building automation design, telecommunications design,
- geotechnical design, and
- interior design.

It should be noted that project briefs from other disciplines serve merely as additional information, that is, they represent opinions and comments concerning the specified discipline.

The requirements are defined in the first activity, e.g., the manufacturing of a larger number of products requires additional space. In *A13 Prepare decision for programme*, analyses of environmental effects are carried out and the requirements for building permit are established.

At this stage, a negative decision may be made which means that no changes are necessary. Thus, the project brief does not lead to a programme. The project brief is a basis for programming.

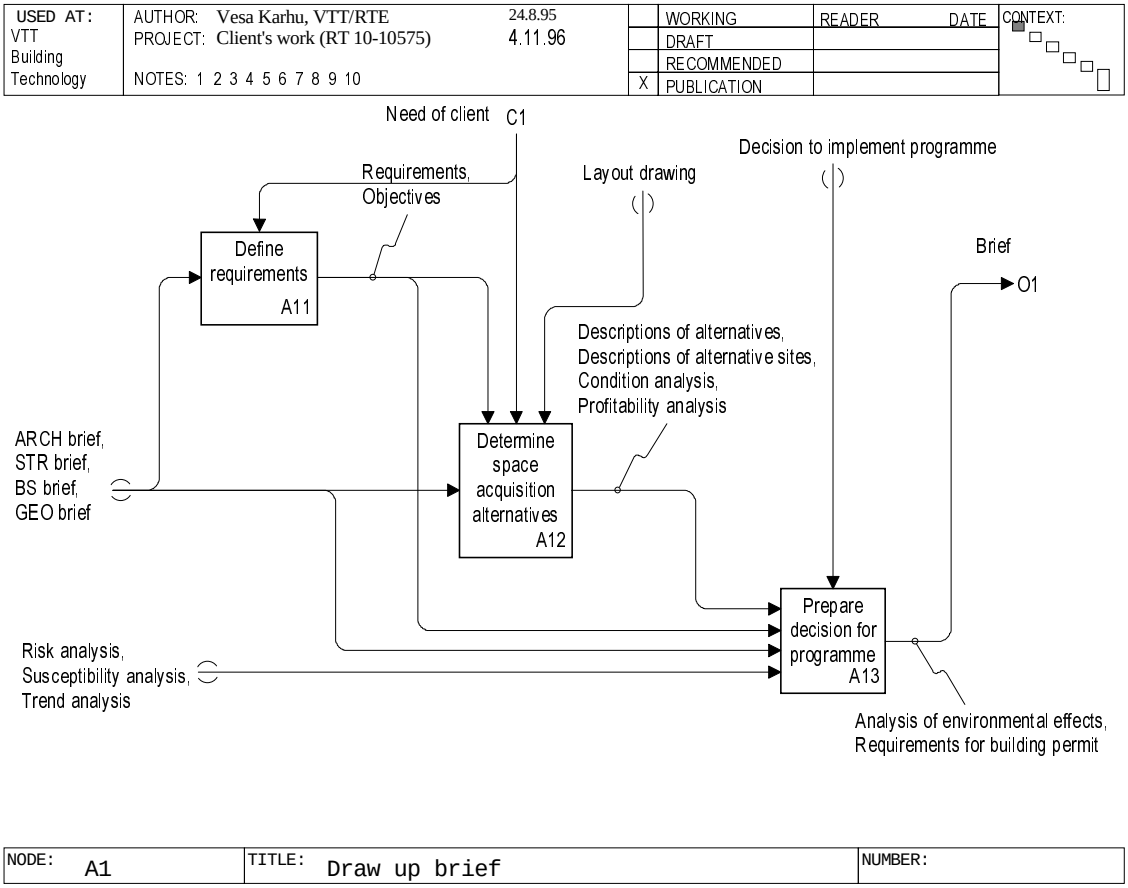


Figure 3. Draw up brief.

A2 DRAW UP PROGRAMME

The purpose of programming (Figure 4) is to lay a foundation for the investment decision. Requirements set during programming concern functional aspects, cost, profitability, schedule, mode of operation, maintenance and building permit. The programme is assembled in A26 including the investment decision which is a control.

Main designer's work plays an important role as all tasks presented here are also parts of architectural tasks (see the architectural model).

For instance, the establishment of a space programme is the main designer's task. Client's work needs assistance from other disciplines.

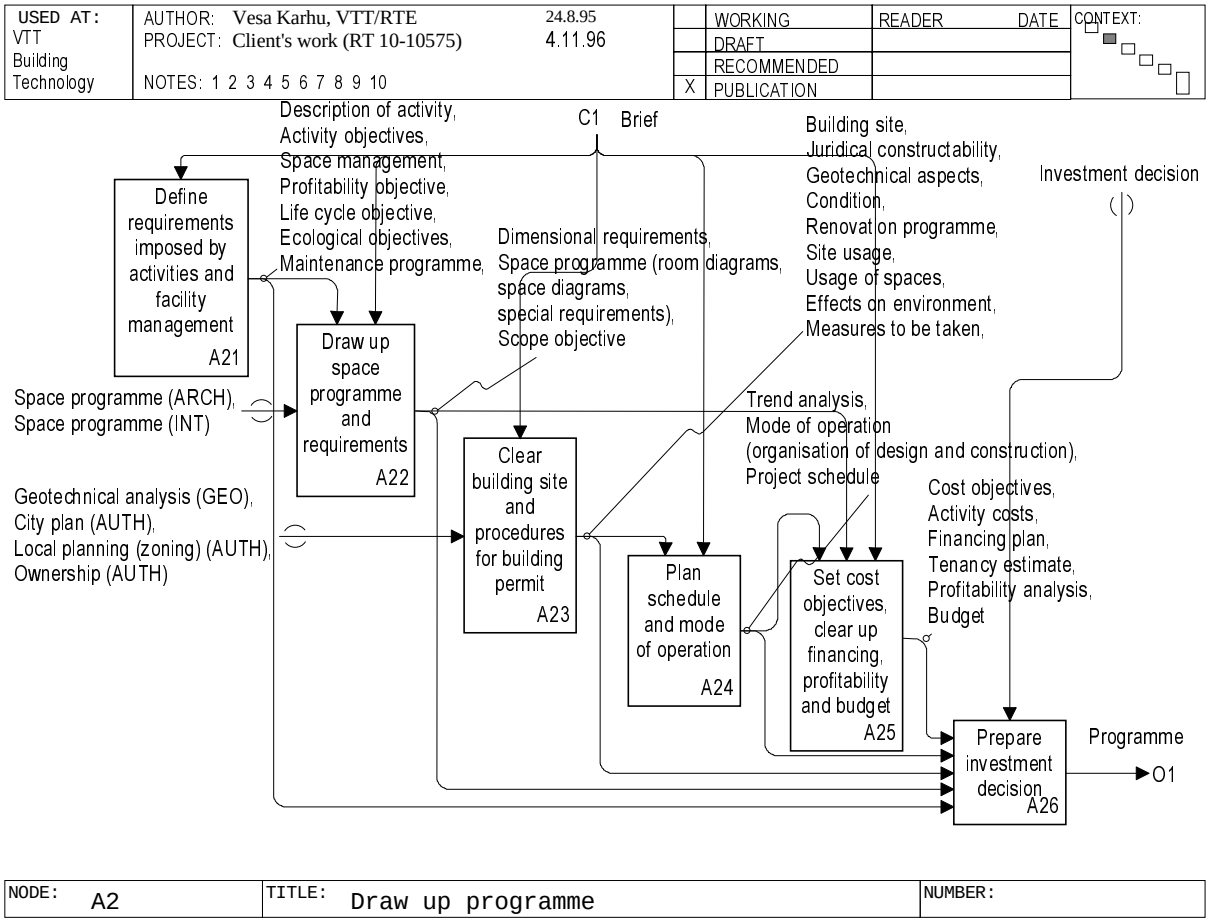


Figure 4. Draw up programme.

A3 PREPARE FOR DESIGN

Preparation of design includes organizing design, choosing designers and concluding design contracts (Figure 5). Design schedule and design instructions are assembled. Design instructions include also CAD-instructions. Contracts are

made sfter choosing designers. Design instruction is given during programming stages by the main designer.

Selection of designers (Figure 6) may be made in several different ways:

- direct selection, i.e., designers are invited directly,
- negotiation, i.e., several candidates are negotiated with,
- selection based tender, i.e., designers submit tenders based on invitation to tender,
- design competition, i.e., usually the design of valuable buildings for which design competition are arranged.

Selected designers will then start the design work.

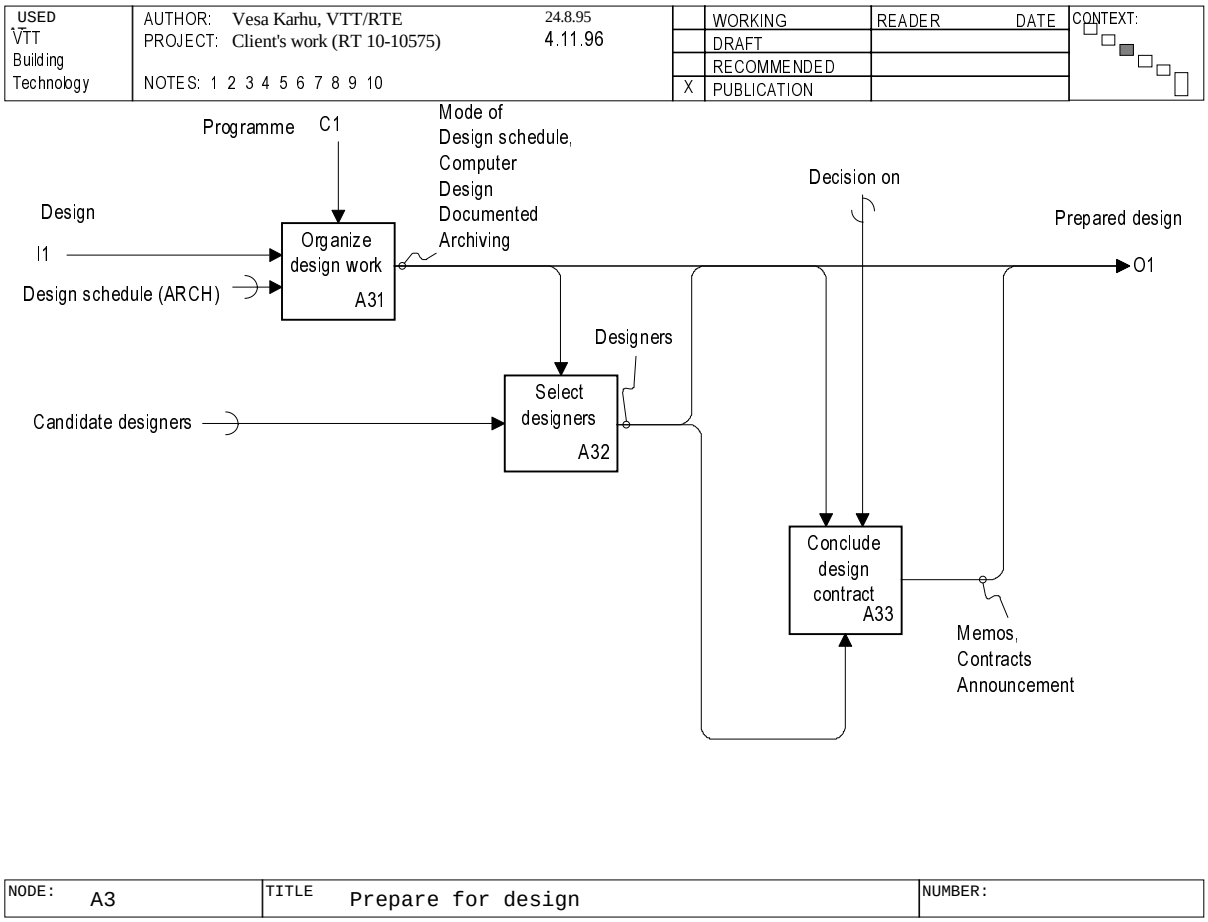


Figure 5. Prepare for design.

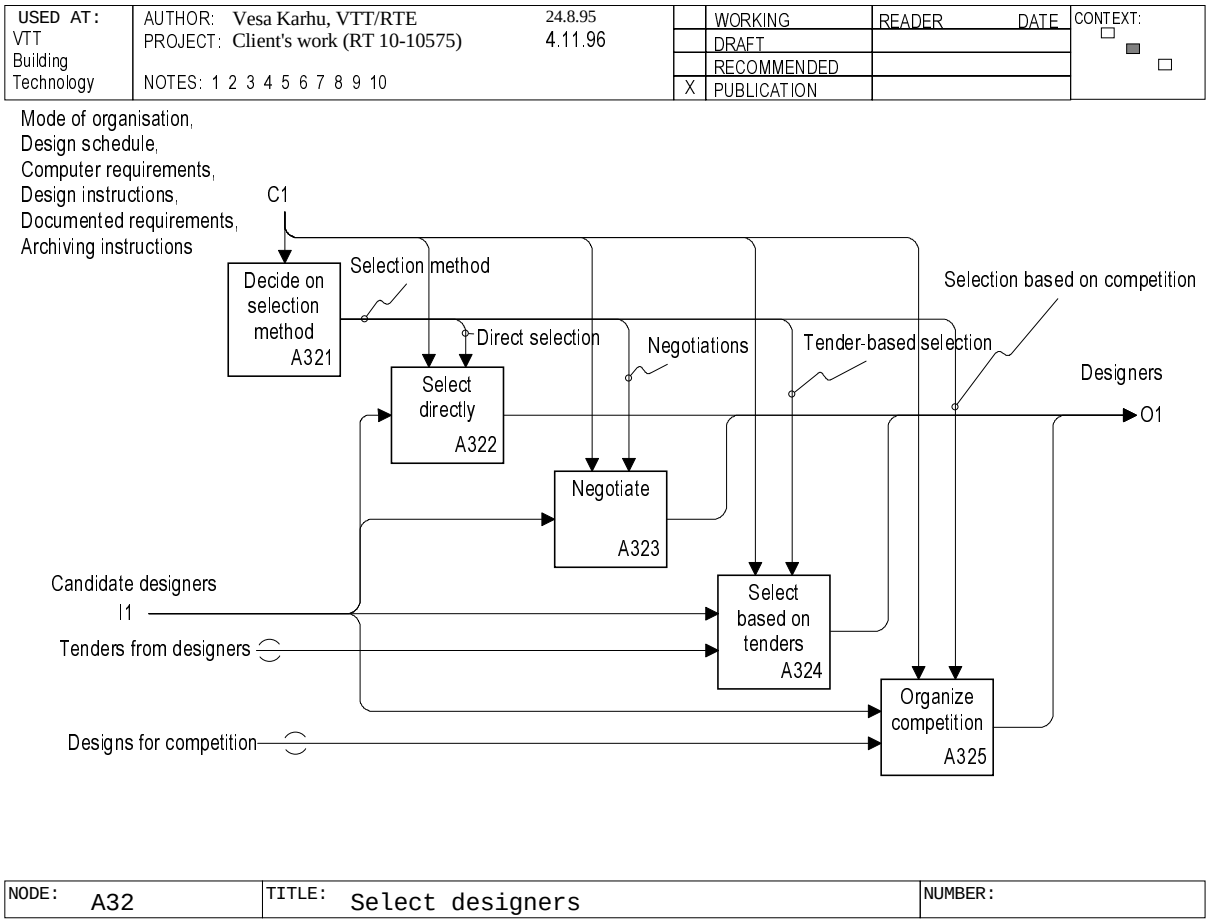


Figure 6. Select designers.

A4 SUPERVISE DESIGN

Controlling and supervising design includes several tasks (Figure 7). Design solutions at different design stages are compared, checked and approved. The decisions are of importance for both the client and the designers since they function as guarantees for obtaining the desired results and yield acceptable designs concerning functional, economical, esthetical, technical as well as environmental aspects.

The decisions are made by the client. A contract is usually signed before.

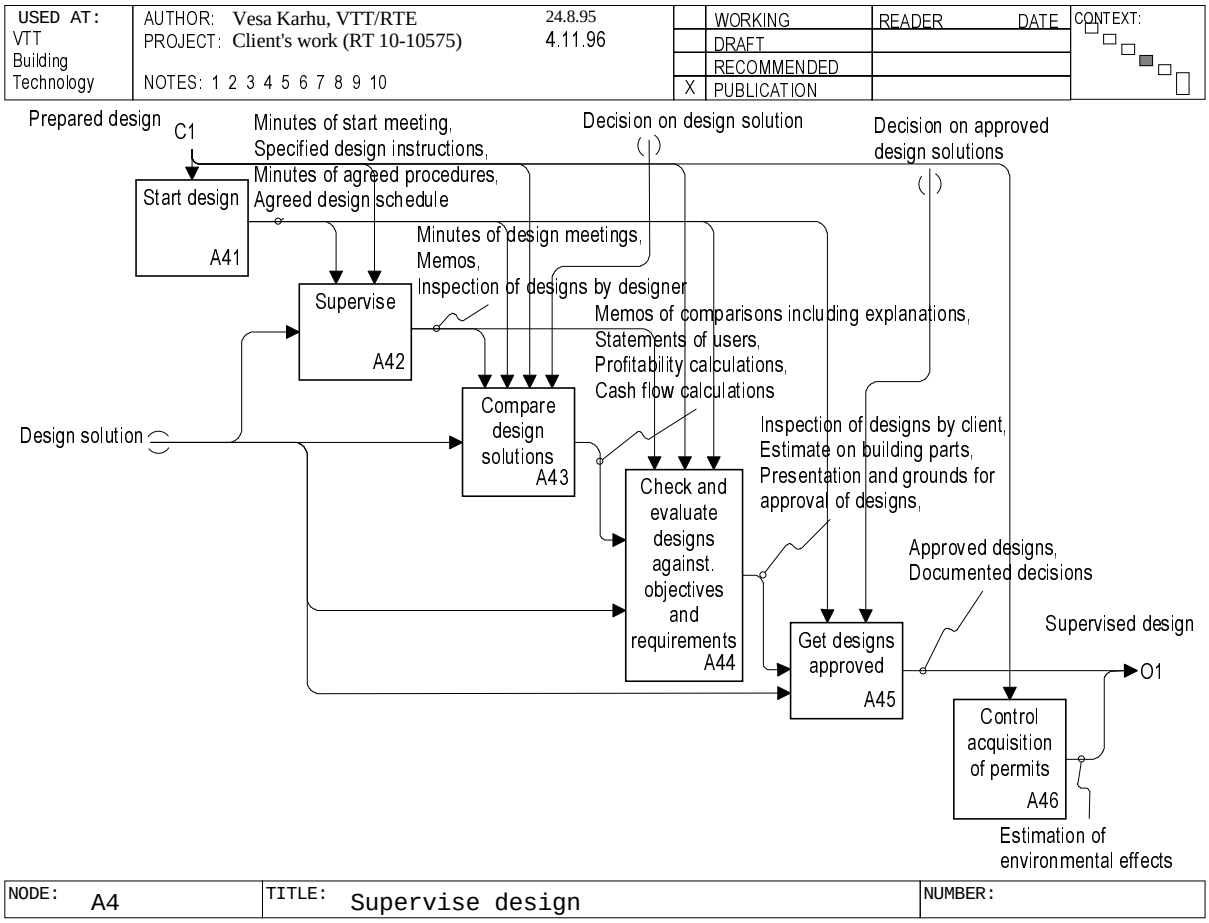


Figure 7. Supervise design.

A5 PREPARE FOR CONSTRUCTION

The purpose of this activity is to prepare and process invitations to tender (Figure 8). The mode of operation is also decided. The selection of contractors is based on tenders. After the selection, contracts are concluded.

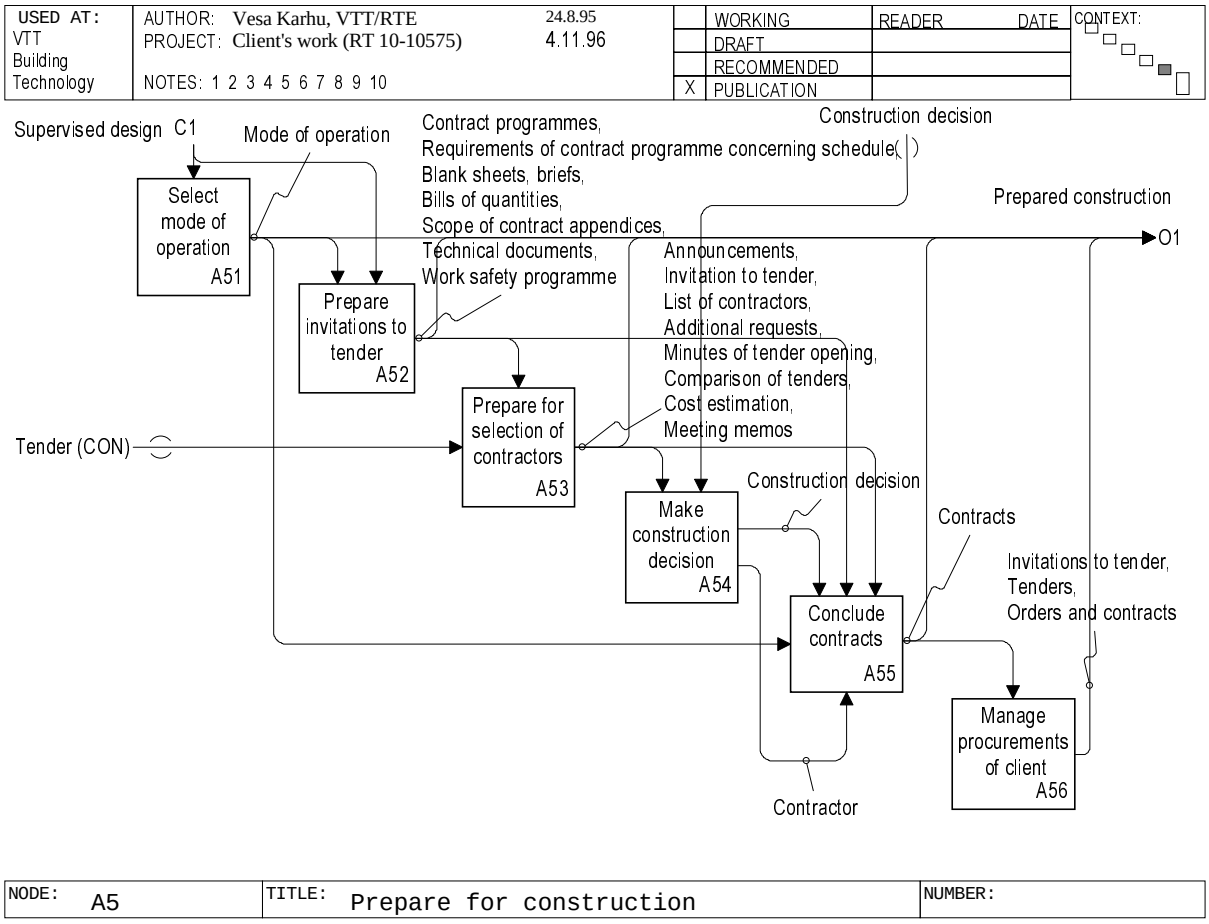


Figure 8. Prepare for construction.

A6 SUPERVISE AND CONTROL CONSTRUCTION

This activity guarantees that the construction stage is executed according to contract (Figure 9). The project schedule is also followed in its implementation.

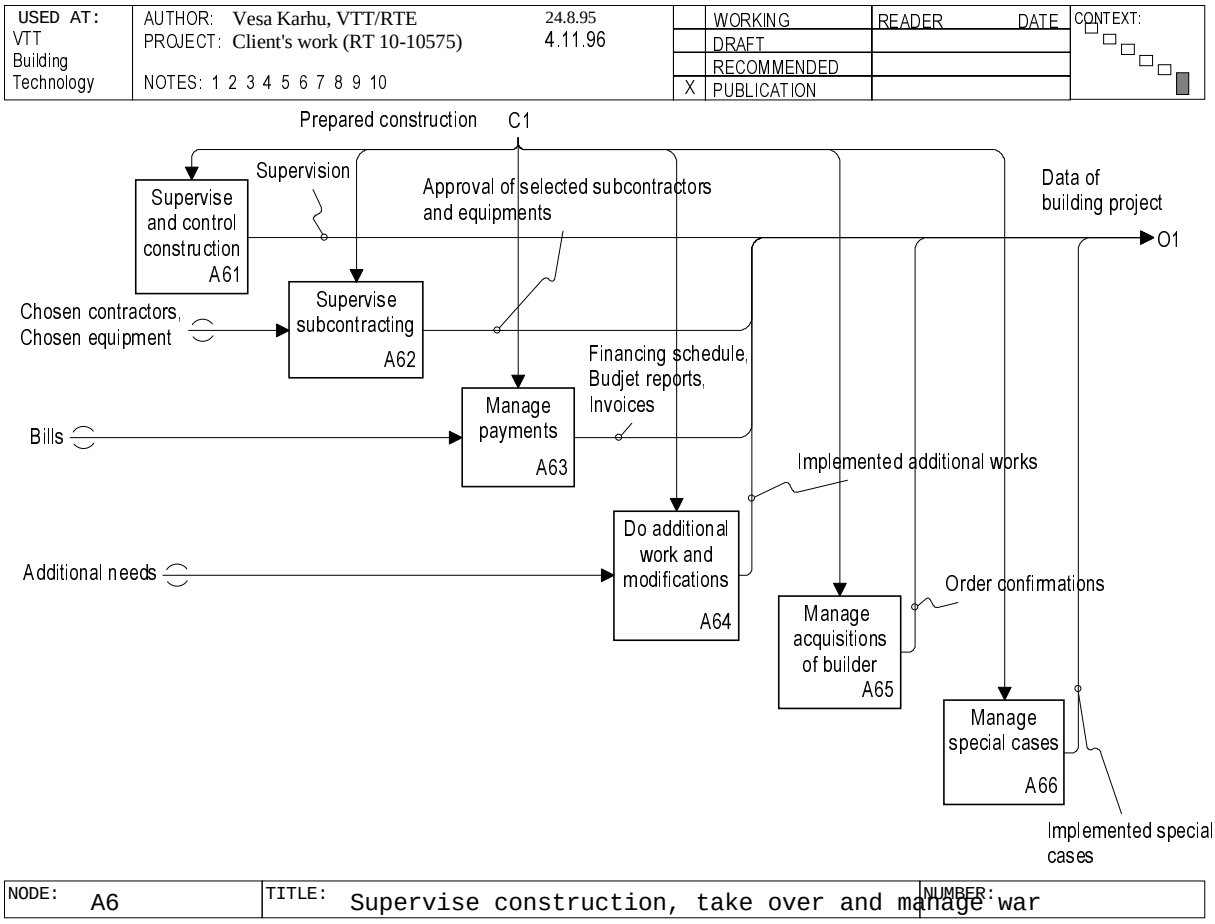


Figure 9. Supervise construction, take over and manage warranty tasks.

LIST OF ACTIVITIES

English

[A0] Produce and manage building process

[A1] Draw up brief
[A11] Define requirements
[A12] Clear space acquisition alternatives
[A13] Prepare decision for programme

[A2] Make programme
[A21] Define requirements imposed by activities and facility management
[A22] Draw up space programme and requirements
[A23] Clear building site and procedures for building permit
[A24] Plan schedule and mode of operation
[A25] Set cost objectives, clear up financing, profitability and budget
[A26] Prepare investment decision

[A3] Prepare design
[A31] Organize design work
[A32] Select designers
[A321] Decide on selection method
[A322] Select directly
[A323] Negotiate
[A324] Select based on tenders
[A325] Organize competition
[A33] Conclude design contract

[A4] Supervise design
[A41] Start design
[A42] Supervise
[A43] Compare design solutions
[A44] Check and evaluate designs against objectives and requirements
[A45] Get designs approved
[A46] Control acquisition of permits

[A5] Prepare for construction
[A51] Select mode of operation
[A52] Prepare invitations to tender

Finnish

[A0] Tee hankkeen rakennuttamistehtävät

[A1] Tee tarveselvitys
[A11] Määrittele tavoitteet
[A12] Selvitä tilanhankintavaihtoehdot
[A13] Valmistele hankepäätös

[A2] Tee hankesuunnittelu
[A21] Tarkista ja määritä toiminnan ja kiinteistönpidon asettamat tavoitteet
[A22] Laadi tilaohjelma selvitä tilojen vaatimukset
[A23] Selvitä rakennuspaikka ja lupamenettelyt
[A24] Suunnittele hankkeen ajoitus ja toteutustapa
[A25] Aseta kustannustavoitteet, selvitä rahoitus, kannattavuus ja budjetti
[A26] Valmistele investointipäätös

[A3] Valmistele suunnittelu
[A31] Organisoi suunnittelu
[A32] Valitse suunnittelijat
[A321] Päätä valintamenettely
[A322] Tee suora valinta
[A323] Tee neuvotteluvalinta
[A324] Tee tarjousvalinta
[A325] Järjestä kilpailu
[A33] Tee suunnittelusopimus

[A4] Ohjaa suunnittelua
[A41] Käynnistä suunnittelu
[A42] Valvo suunnittelua
[A43] Vertaile ratkaisuvaihtoehtoja
[A44] Tarkasta ja arvioi suunnitelmien tavoitteenmukaisuus
[A45] Hyväksytä suunnitelmat
[A46] Valvo viranomaislupien hankkimista

[A5] Valmistele rakentaminen
[A51] Valitse toteutusmuoto
[A52] Laadi tarjouspyyntöasiakirjat

[A53] Prepare selection of contractors	[A53] Valmistele urakoitsijavalinnat
[A54] Make construction decision	[A54] Tee rakentamispäätös
[A55] Conclude contracts	[A55] Tee urakkasopimukset
[A56] Manage procurements of client	[A56] Hoida rakennuttajan hankinnat
[A6] Supervise construction, take over and manage warranty tasks	**[A6] Ohjaa rakentamista, tee vastaan- ja käyttöönotto sekä hoida takuuaika**
[A61] Supervise and control construction	[A61] Valvo ja ohjaa rakentamista
[A62] Supervise subcontracting	[A62] Valvo alihankintoja
[A63] Manage payments	[A63] Maksuliikenne
[A64] Do additional work and modifications	[A64] Lisä- ja muutostyöt
[A65] Manage acquisitions of builder	[A65] Rakennuttajan hankinnat
[A66] Manage special cases	[A66] Erikoistapaukset

LIST OF FLOWS

English	Finnish
Additional needs • Additional needs are fulfilled. Modifications are also cleared up.	Lisätarpeet • Lisä- ja muutostyöt. Lisätarpeet täytetään. Muutokset selvitetään.
Analysis of environmental effects, Requirements for building permit	Ympäristövaikutusanalyysi, Lupaedellytykset
Announcements, Invitation to tender, List of contractors, Additional requests, Minutes of tender opening, Comparison of tenders, Cost estimation, Meeting memos	Ilmoitukset, Tarjouspyynnöt, Urakoitsijaluettelot, Lisäkirjeet, Tarjousten avauspöytäkirja, Urakkatarjousten vertailutaulukko, Kustannusarvio, Neuvottelumuistiot
Approval of selected subcontractors and equipments	Hyväksytyt alihankkijat ja laitehankinnat
Approved designs, Documented decisions	Hyväksytyt suunnitelmat, Päätösdokumentit (päätös suunnitteluratkaisusta)
ARCH brief, STR brief, BS brief, GEO brief	ARK-tarveselvitys, STR-tarveselvitys, TATE-tarveselvitys, GEO-tarveselvitys.
ARCH brief, STR brief, BS brief, GEO brief	Arkkitehti-, rakenne-, talotekniikka- ja geosuunnittelun tarveselvitykset.
ARCH design	Arkkitehtisuunnittelu
ARCH programme • The programme of architectural design contains parts of programmes of other design disciplines if the architect is the main designer.	ARK-hankesuunnitelma • Hankesuunnitelma sisältää myös muiden suunnittelualojen hankesuunnitelmat mikäli arkkitehti toimii myös pääsuunnittelijana.
Bills • Bills are checked.	Laskut. • Laskut tarkistetaan.
Brief • Brief contains requirements by the client. See also briefs for other design disciplines.	Tarveselvitys • Tarveselvitys sisältää asiakkaan tarpeet. Katso myös muiden suunnittelualojen tarveselvitykset.
BS design	TATE-suunnittelu
BS programme • The building services design	TATE-hankesuunnitelma. • Sisältää talotekniikan osalta hanke-

programme contains only parts related to building services design issues.	suunnitelman.
Building ready for use	Käyttövalmis rakennus
Building site, Juridical constructability, Geotechnical aspects, Condition, Renovation programme, Site usage, Usage of spaces, Effects on environment, Measures to be taken,	Rakennuspaikkaselvitys, Juridinen rakentamiskelpoisuus, Geotekninen selvitys, Kuntokartoitukset, Korjausohjelma, Tontinkäyttäselvitys, Tilankäyttöselvitykset ja kaaviot, Ympäristöpaikkaselvitykset (YVA), Toimenpideohjelma.
Candidate designers • Possible designers.	Suunnittelijakandidaatit. • Mahdolliset suunnittelijat.
Checked and approved selections of subcontractors and equipments	Hyväksytetään alihankkijat ja laitevalinnat
Chosen contractors Chosen equipment	Valitut urakoitsijat, Valitut laitteet
Client	Rakennuttaja
Construction decision	Rakentamispäätös
Contract programmes, Requirements of contract programme concerning schedule, Blank sheets, briefs, Bills of quantities, Scope of contract appendices, Technical documents, Work safety programme	Urakkaohjelmat, Urakkaohjelman aikatauluvaatimukset, Lomakkeet, luettelot, Määräluettelot, Urakkarajaliitteet, tekniset asiakirjat, Työturvallisuusohjelma
Contractor	Urakoitsija.
Contracts	Sopimukset
Cost objectives, Activity costs, Financing plan, Tenancy estimate, Profitability analysis, Budget	Kustannustavoitteet, Toimintakustannusselvitys, Rahoitussuunnitelma, Vuokralaskelma, Kannattavuuslaskelma.
Data of building project	Rakennushankkeen tiedot.
Data on building project	Rakennushankkeen tiedot
Decision on approved design solutions	Päätös hyväksytyistä suunnitteluratkaisuista
Decision on design solution	Päätös suunnitteluratkaisusta
Decision on selection	Valintapäätös
Decision to implement programme	Hankepäätös

- Decision is needed for further elaboration.

Description of activity, Activity objectives, Space management, Profitability objective, Life cycle objective, Ecological objectives, Maintenance programme,

Descriptions of alternatives, Descriptions of alternative sites, Condition analysis, Profitability analysis

Design instructions
- Design instructions consist of general and specific guidelines and instruction for design.

Design schedule (ARCH)
- Design schedule contains detailed information on schedules.

Design solution

Designers
- Designers are the chosen designers.

Designs for competition

Dimensional requirements, Space programme (room diagrams, space diagrams, special requirements), Scope objective

Direct selection

Estimation of environmental effects

Feedback

Financing schedule, Budjet reports, Invoices

GEO design

GEO programme
- The geotechical design programme is only concerned with geotechical design issues.

- Päätöstä tarvitaan jotta hanke voi jatkua.

Toiminnan kuvaus, Toiminnalliset tavoitteet, Tilahallintoselvitys, Tuottotavoite, Elinkaaritavoite, Ekologiset tavoitteet, Ylläpito-ohjelma.

Vaihtoehtojen kuvaukset, Rakennuspaikkavaihtoehtojen kuvaukset, Kuntoselvitys, Tuottoanalyysi

Suunnitteluohjeet.
- Suunnitteluohjeet sisältävät yleiset ohjeet sekä hankekohtaiset ohjeet.

Suunnitteluaikataulu (ARK)
- Suunnitteluaikataulu sisältää detaljit (tämä tulee pääsuunnittelijalta).

Suunnitteluratkaisu

Suunnittelijat
- Valitut suunnittelijat.

Kilpailusuunnitelmat.

Tilojen mitoitusperusteet, Tilaohjelma (huonekortit,tilakaaviot, tilojen erityisvaatimukset), Laajuustavoite

Suora valinta.

Ympäristövaikutusten analyysi

Palaute

Rahoitussuunnitelma, Budjettiraportit, Laskut

Geotekninen suunnittelu

GEO-hankesuunnitelma
- Geotekniikan hankesuunnitelma sisältää geotekniset näkökohdat.

Geotechnical analysis (GEO), City plan (AUTH), Local planning (zoning) (AUTH), Ownership (AUTH)	Alustava geotekninen analyysi (GEO), Asemakaava (VIR), Kaavoitustilanne (VIR), Omistusoikeus (VIR)
Growth prognosis, Description of strategic alternatives, Trends concerning environment and business, Effects	Kasvuennuste, Strategiset vaihtoehdot, Suhdanteet, Vaikutukset
Implemented additional works	Hoidetut lisätyöt
Implemented special cases	Hoidetut erikoistapaukset
Inspection of designs by client, Estimate on building parts, Presentation and grounds for approval of designs,	Rakennuttajan suunnittelukatselmuspöytäkirja, Rakennusosa-arvio, Esitys ja perustelut suunnitelmien hyväksymiseksi
Investment decision	Investointipäätös.
Invitations to tender, Tenders, Orders and contracts	Tarjouspyynnöt, Tarjoukset, Tilaukset ja sopimukset
Layout drawing	Asemapiirustus
Managed additional works	Hoidetut lisätyöt
Managed special cases	Hoidetut erikoistapaukset

SECTION B:
ARCHITECTURAL DESIGN PROCESS MODEL

Table of contents

ACTIVITY MODEL

A-0 MODEL SCOPE

The presented architectural design process model is based on a task list (RT 10-10576 ARK 95). The basic model does not separate the main designer's tasks and normal architectural design work. The main designer's function is to coordinate and supervise the design work of all other design disciplines (structural, HVAC, etc.). It should be noted that the main designer may be a group consisting of representatives of various design disciplines.

The process is divided into six different stages. These are briefing, programming, global design, detail design and design during construction and the tasks during the handover. It should be noted that the main architectural design work concerns global and detail designs, presented here as activities A3 and A4. Briefing and programming usually belong to the main designer's tasks. These tasks are mainly accomplished in activities A1 and A2. See also Section A for the client's work.

The A-0 diagram is shown in Figure 10.

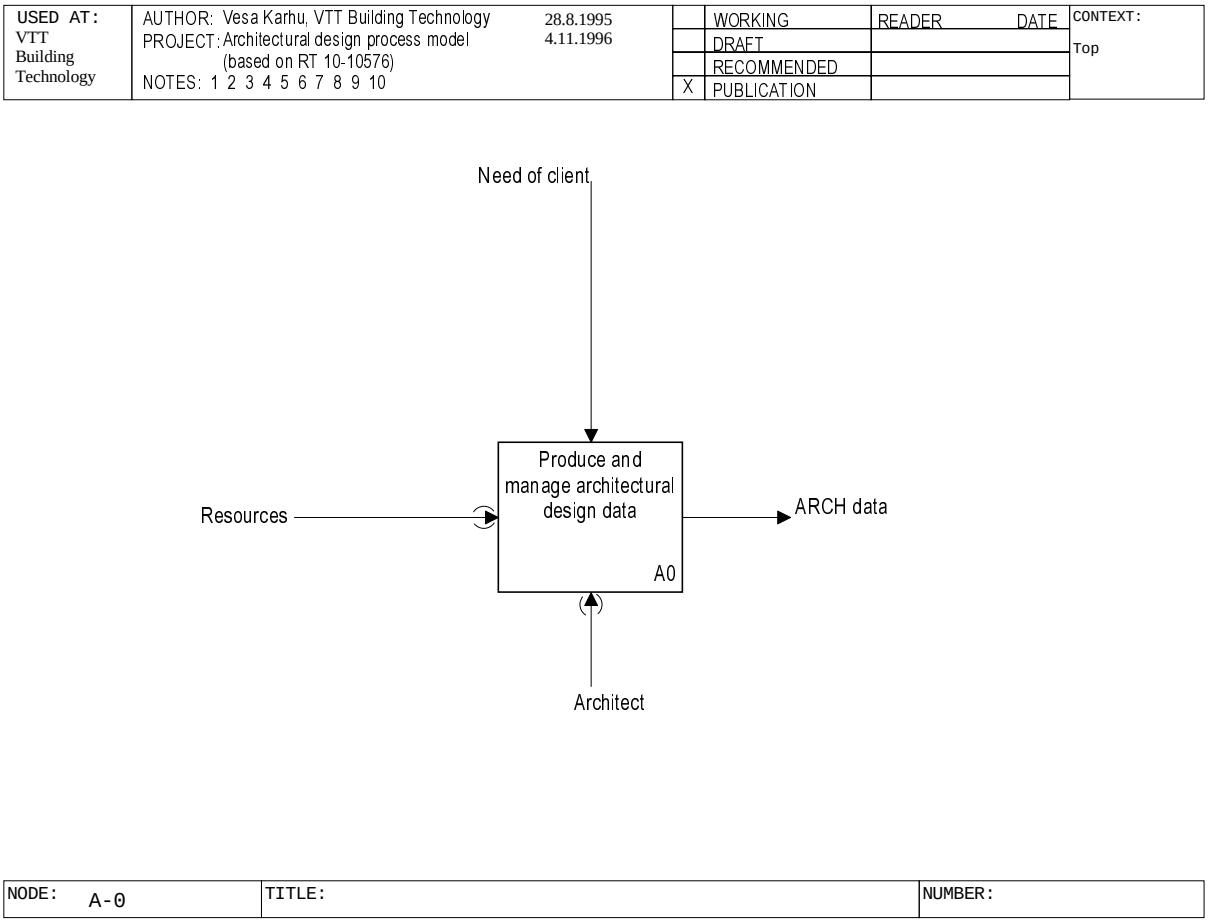


Figure 10. Model scope.

A0 PRODUCE AND MANAGE ARCHITECTURAL DESIGN DATA

The activity (Figure 11) is divided into briefing, programming, global design and detail design. Activities during the construction stage and during the use and maintenance stage are not of importance here. Anyhow, delivery contracts are needed during the construction stage.

Briefing and programming get input from the client's work (see Section A). The project brief and programme are complemented with architectural points of view. The purpose is to assist in defining the client's need for more space. The output, the project brief is incorporated into the project brief of client's work.

Most of the data are used as controls during the earlier stages. The design instructions, however, are checked in the activity A3 *Make global design*. Thus, they are shown as input to the activity.

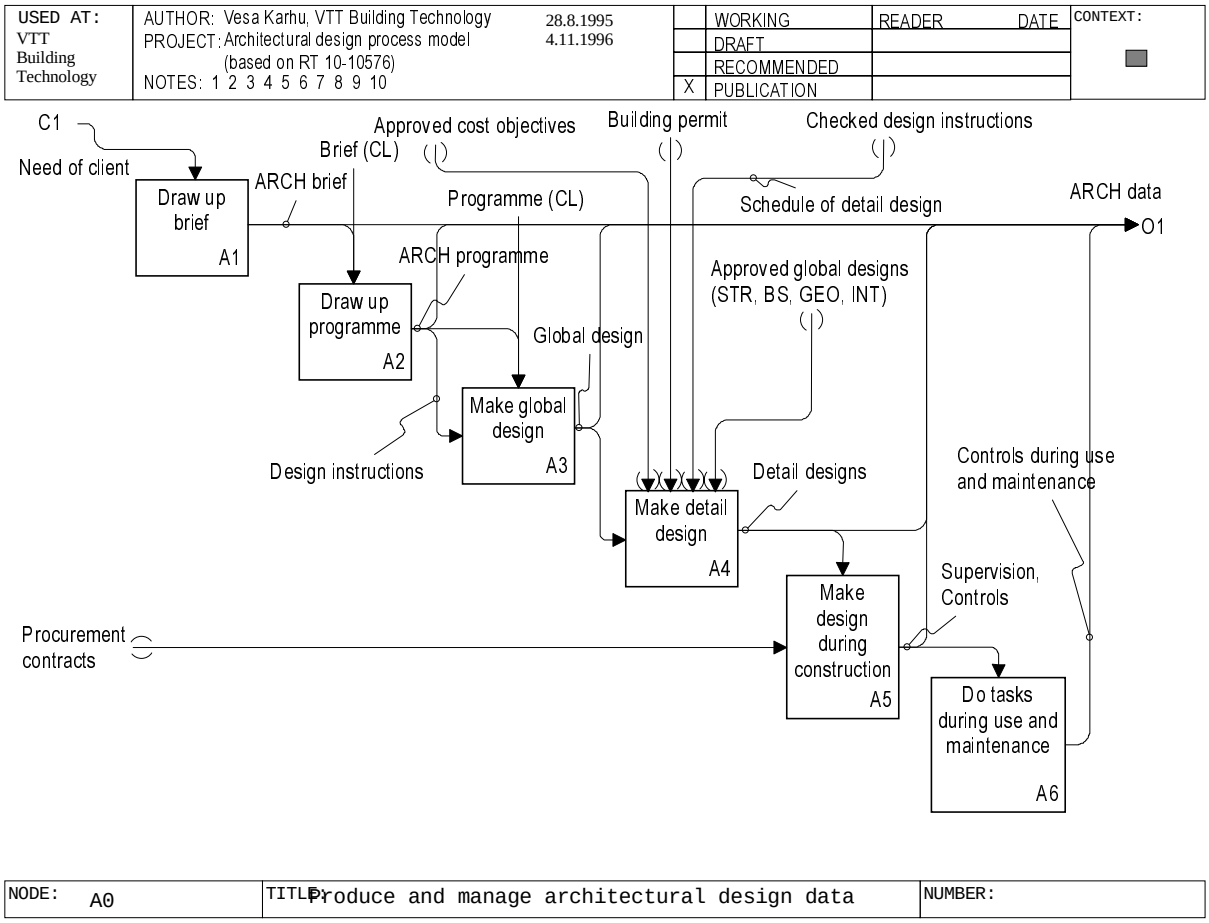


Figure 11. Produce and manage architectural design data.

A1 DRAW UP BRIEF

The project brief (Figure 12) is a collection of basic information provided by the client concerning space requirements. The information consists of needs, requirements and possibilities. The subactivities are:

- analyse present situation,
- define requirements,
- study alternatives for space acquisition, and
- prepare programme decision.

The project brief may lead to drawing up of a programme if the brief indicates a need for more or less space.

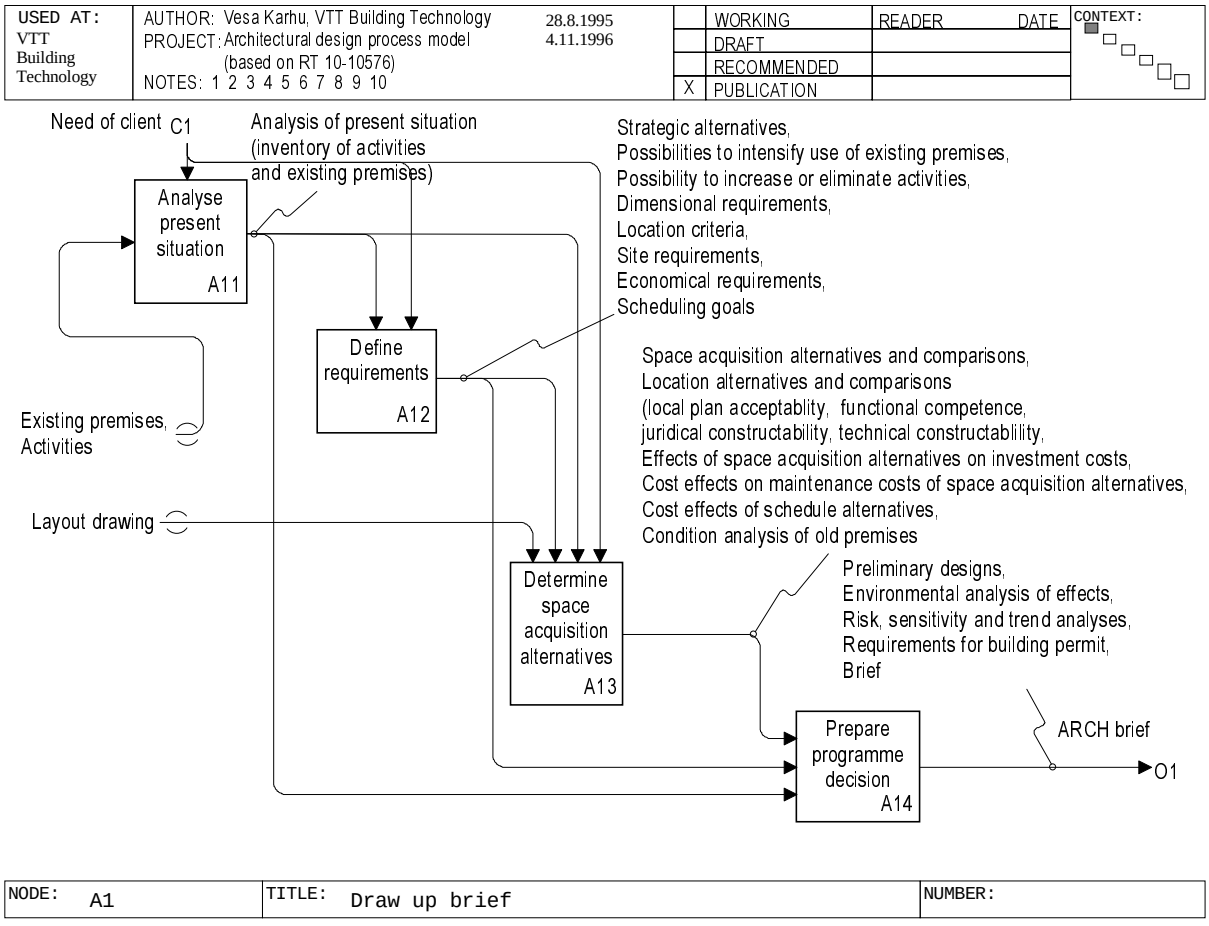


Figure 12. Draw up brief.

A2 DRAW UP PROGRAMME

Programming (Figure 13) is usually carried out by the client. Thus, presentation of the programme is done either here in A26 (input to A26, dashed line) or in client's work A26.

The design instruction (in Finnish *suunnitteluohje*) contains:

- project-specific instructions,
- standards,
- instructions concerning documents,
- quality class,
- special requirements for design
- usage of quality management systems, and
- decision procedures concerning design solutions, etc.

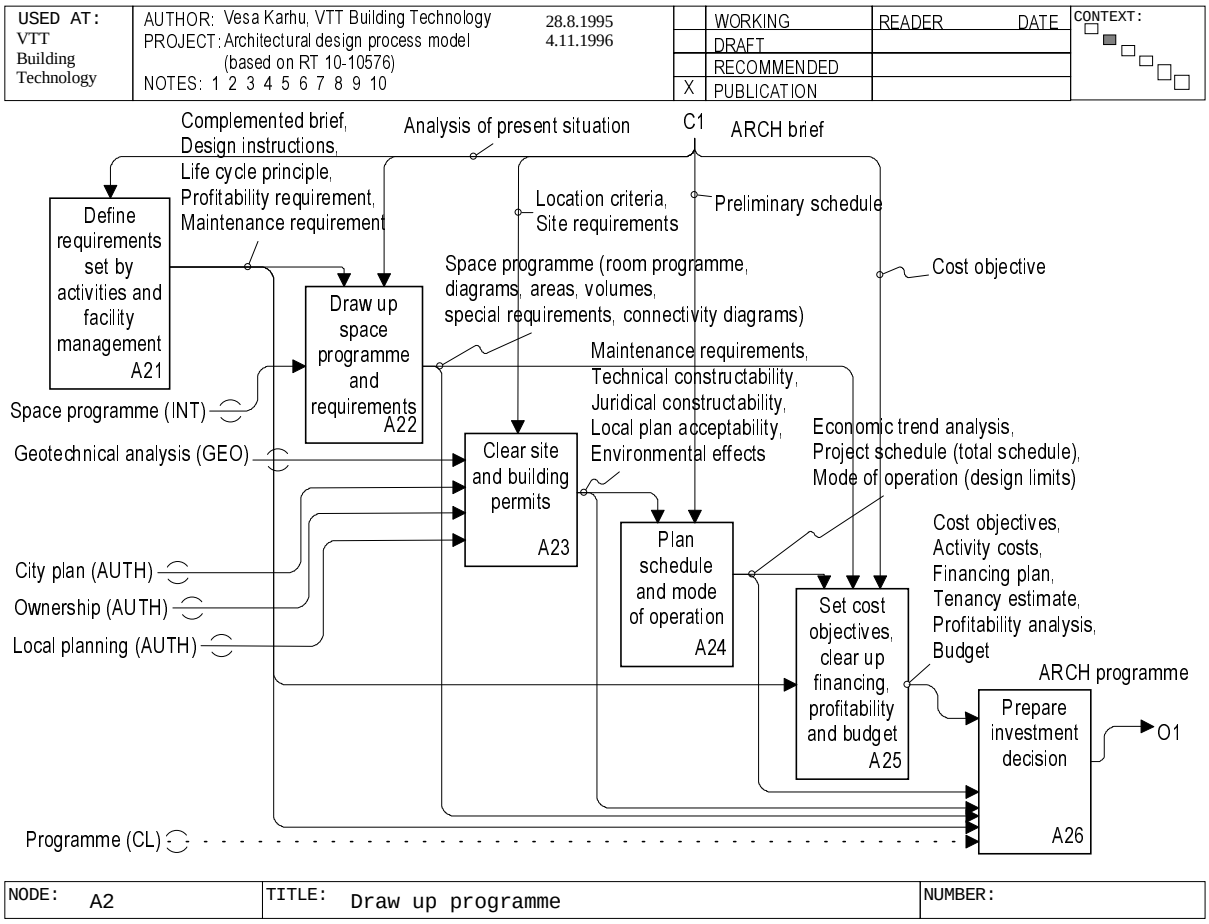


Figure 13. Draw up programme.

A3 MAKE GLOBAL DESIGN

Global design (Figure 14) produces design sufficient for a building permit. Activity A31, Start building design, belongs to the main designer's tasks. Architectural design begins in activity A32 where alternative basic solutions are designed. The proposed solution is based on a chosen basic alternative. The final scheme is elaborated in A34.

Different design solutions are approved by the client. These are shown as controls to activities.

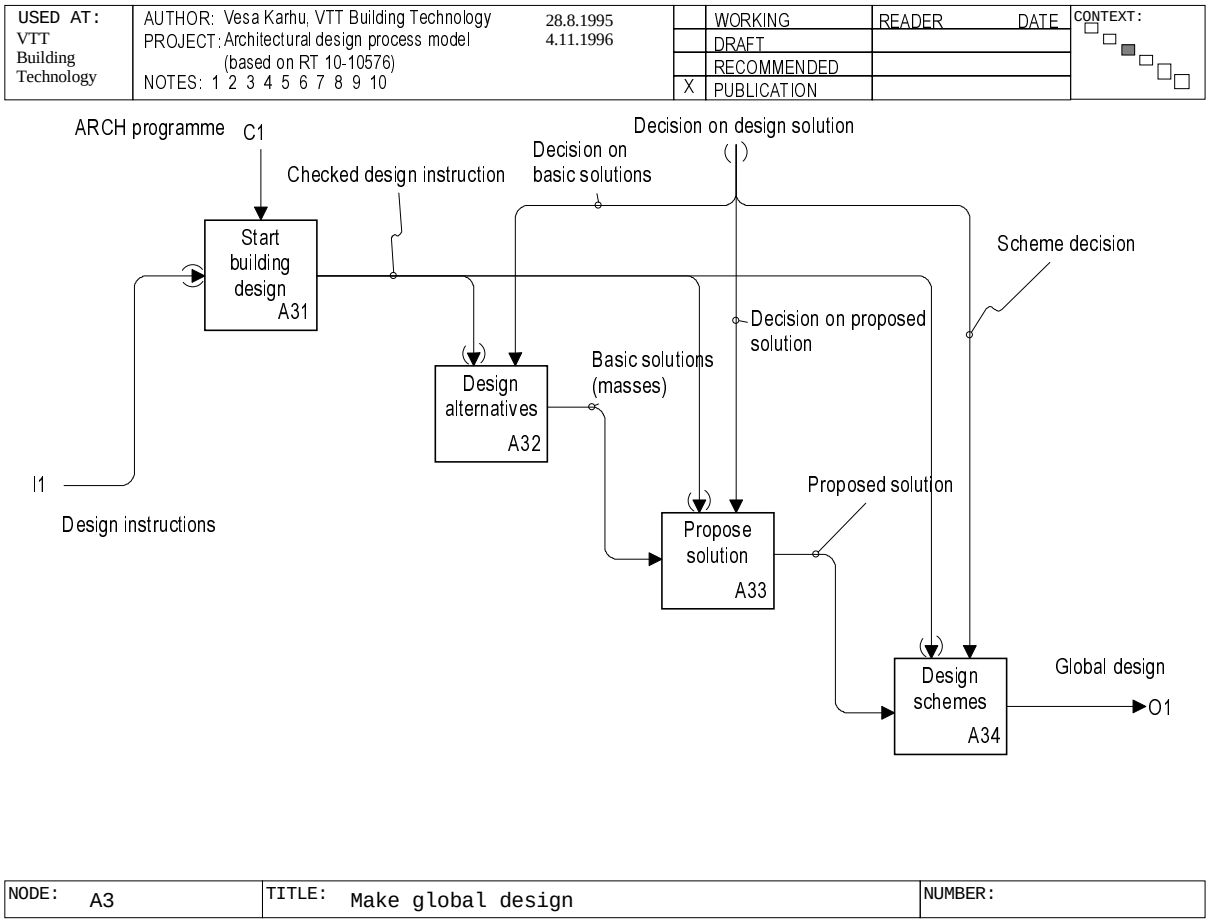


Figure 14. Make global design.

A31 Start building design

Start building design involves the main designer's tasks (Figure 15). The design schedule is usually part of the activities of the client's work. The result of the activity is a checked design instruction which is used later in other activities.

In A316, the work of the design group starts. Checked design instructions are alsoassembled.

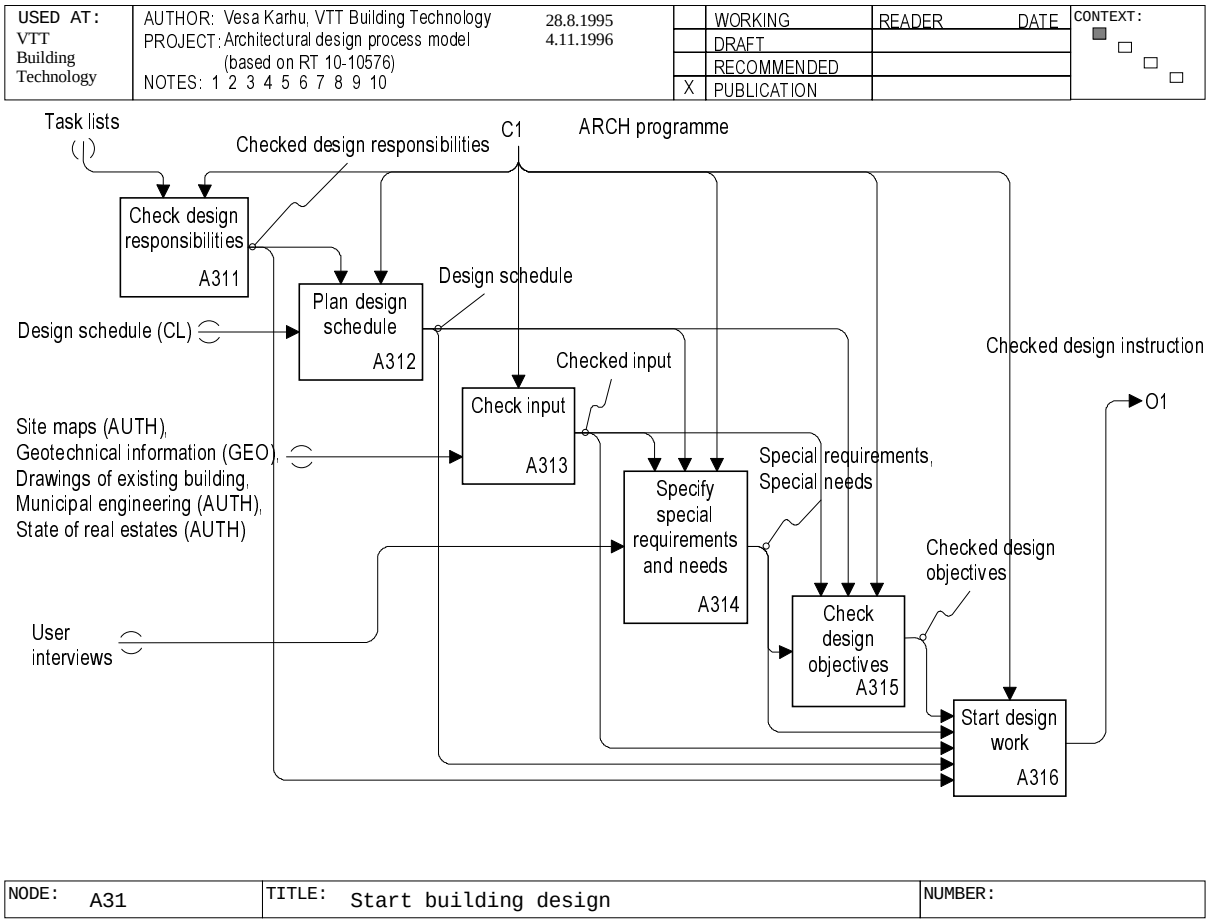


Figure 15. Start building design.

A32 Design basic alternatives

The activity starts with designing alternative designs for site usage (Figure 16). Usually 2-3 alternatives are designed. An approved site design is elaborated on further to design alternative basic solutions. These alternatives are compared and analyzed and an environmental analysis is carried out.

At the final stage, a decision is made on the alternative to be chosen for further design. The decision is made by the client (shown as a control) after presentation of the design solutions.

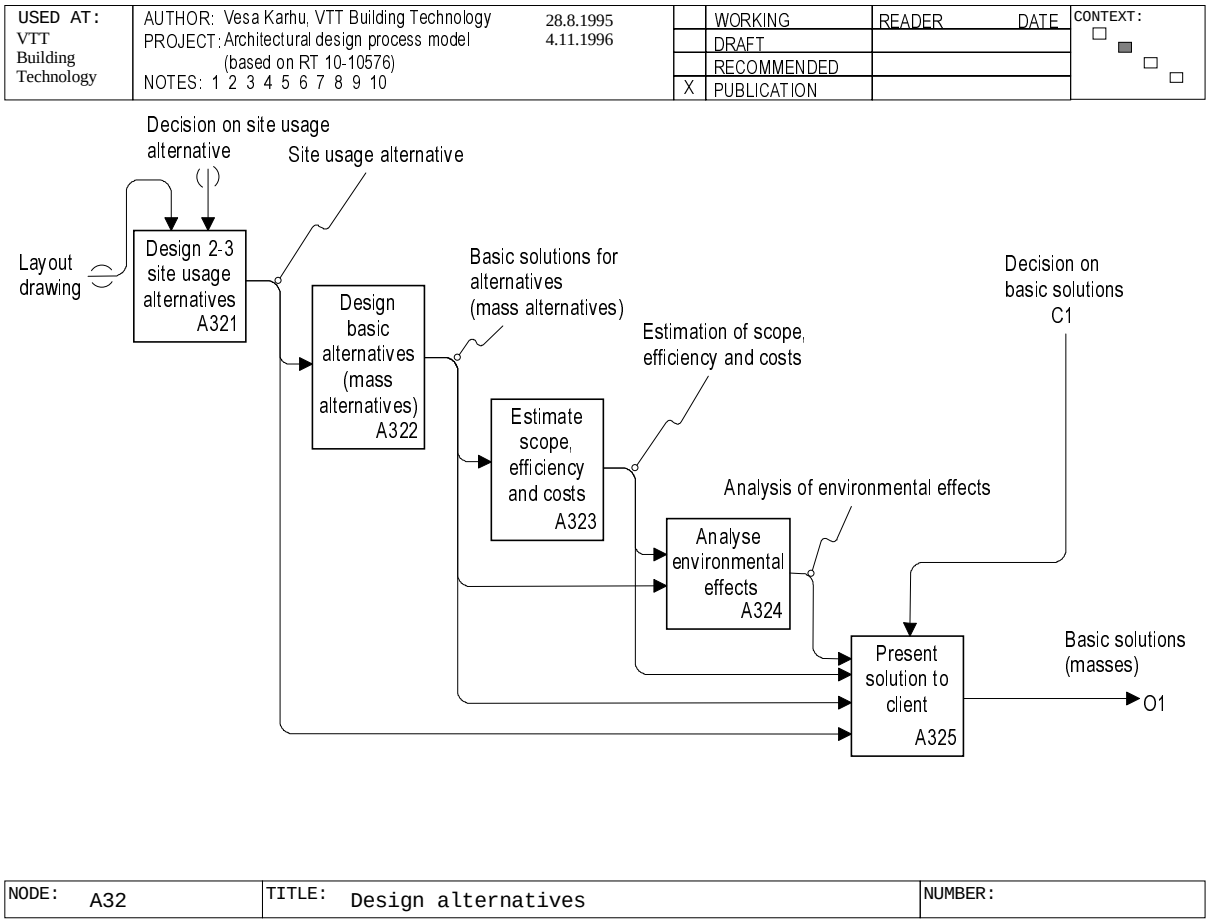


Figure 16. Design alternatives.

A33 Propose solution

The proposed solution (Figure 17) is elaborated on. Advance opinions about building permit and exceptional permits are acquired by sending an application to authorities. In practice, the layout drawing (in Finnish *asemapiirustus*) is sufficient for acquiring an advance opinion on the building permit.

The architectural and structural basic solutions are elaborated on. Input from other design disciplines is needed for comparison and compatibility checks.

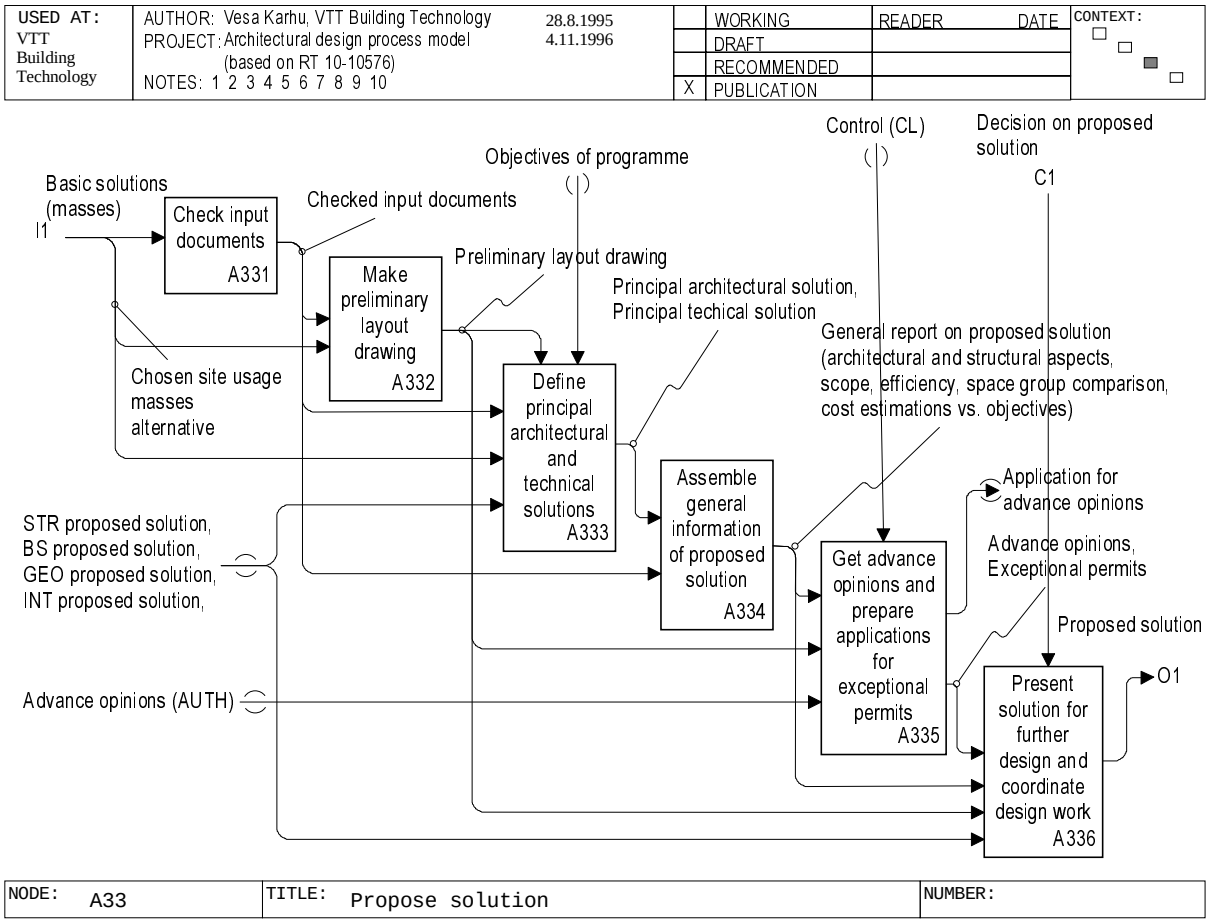


Figure 17. Propose solution.

A34 Design schemes

The design schemes involves preparing and submitting an application for a building permit (Figure 18). The supervision (control) is part of the client's work (see activity A46). A general description of building is assembled. A report on the method of construction is used in later design stages.

A345 and A344 belong to the main designer's tasks. In A345, input is received from structural design. In practice (in 1995), the building permit may be received in approximately one month in a normal case.

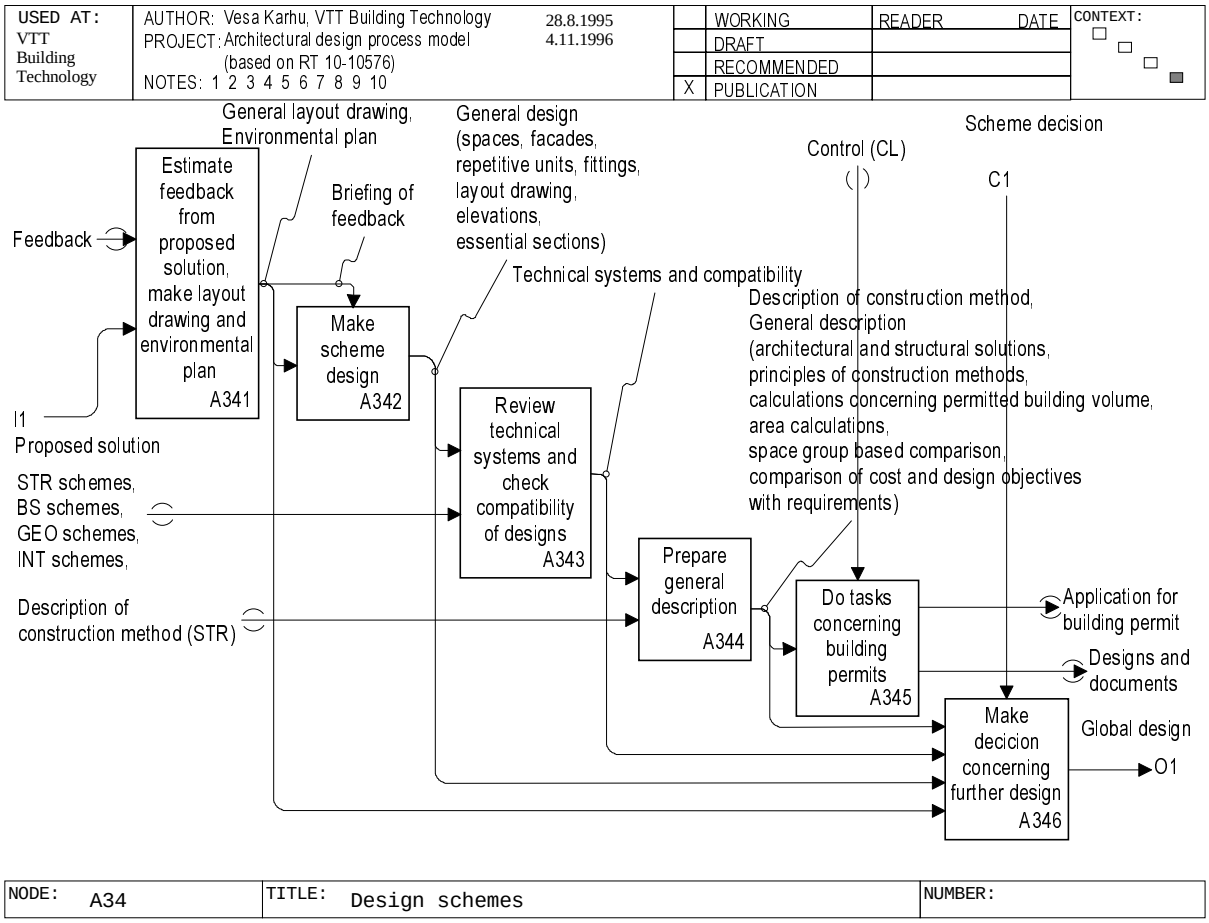


Figure 18. Design schemes.

A4 MAKE DETAIL DESIGN

Make detail design (Figure 19) starts with an evaluation of the global design solutions. This evaluation is used as control for further design. Detailed design is elaborated on until sufficient accuracy is achieved for invitation to tender (in the traditional mode of operation). Activity A43 involves checking compatibility of design solutions of all design disciplines.

The contractor may require or suggest preliminary modifications and corrections. These are shown as controls to the activities After additional tasks, the contractor is chosen and specialized detailed design may be done according to the contractor specific instructions which are usually production and work methods.

Invitations to tender are assembled during additional tasks. It should be noted that additional tasks do not belong to normal architectural design unless an agreement is made to that effect. Additionally, preparation of the invitation to tender is actually made in the client's work. The main designer may be considered a consultant.

Detailed design includes activities such as design of facades, spaces (rooms etc.), basements, roof structures (Figure 20). Complementary structures include windows and doors. The courtyard is also designed. A general report on building methods is assembled.

Additional tasks involve assistance in preparing invitations to tender as well as analyzing tenders. Additional tasks also include design of movable pieces of furniture, landscape, guidance systems and signs.

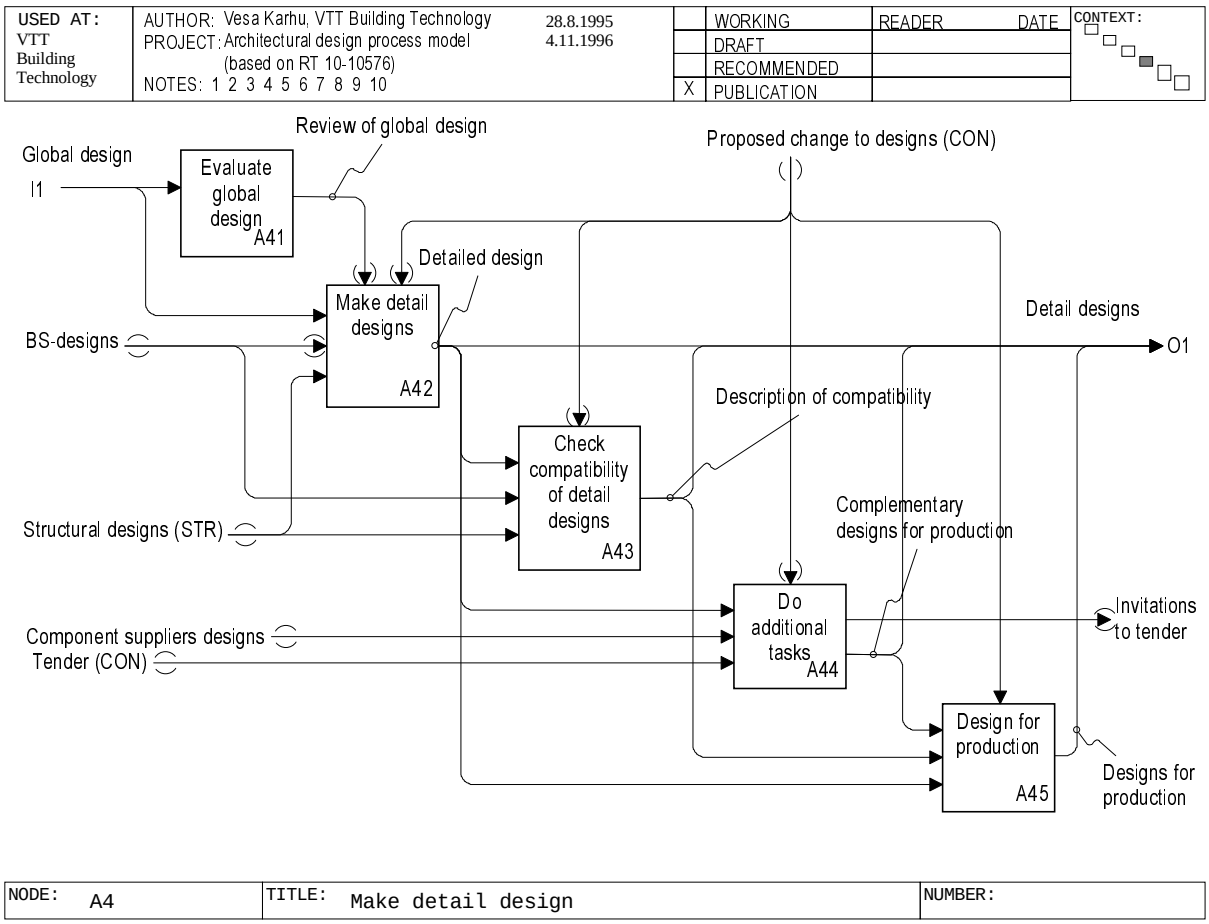


Figure 19. Make detail design.

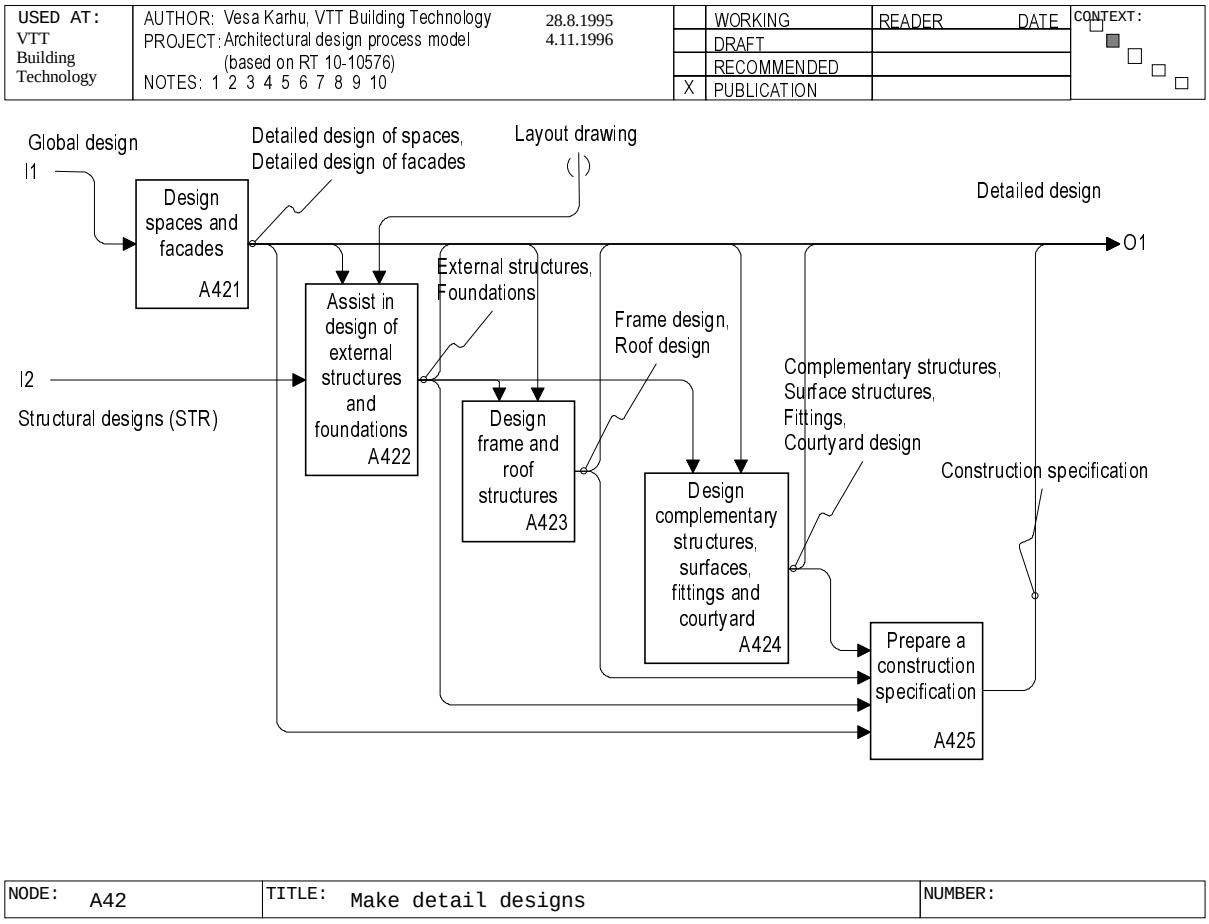


Figure 20. Make detail designs.

A5 DO DESIGN TASKS DURING CONSTRUCTION

Construction stage tasks consist mainly of supervision and inspections. The control of these activities is required by procurement contracts. At the final stage of this activity a taking over decision is made.

A6 DO TASKS DURING USE AND MAINTENANCE

Tasks during use and maintenance include warranty inspections. Checking the usage and the maintenance plan as well as planning the guidance and archiving of the design documents may also be needed. This activity ends when warranties are released.

LIST OF ACTIVITIES

English

[A0] Produce and manage architectural design data

[A1] Draw up brief
[A11] Analyse present situation
[A12] Define requirements
[A13] Determine space acquisition alternatives
[A14] Prepare programme decision

[A2] Draw up programme
[A21] Define requirements set by activities and facility management
[A22] Draw up space programme and clear up requirements
[A23] Clear site and building permits

[A24] Plan schedule and mode of operation
[A25] Set cost objectives, clear up financing, profitability and budget
[A26] Prepare investment decision

[A3] Make global design
[A31] Start building design
[A311] Check design responsibilities

[A312] Plan design schedule
[A313] Check input
[A314] Specify special requirements and needs

[A315] Check design objectives
[A316] Start design work

[A32] Design alternatives
[A321] Design 2 - 3 site usage alternatives
[A322] Design basic alternatives (mass alternatives)
[A323] Estimate scope, efficiency and costs

Finnish

[A0] Tuota ja hallitse ARK-suunnittelun tiedot

[A1] Tee tarveselvitys
[A11] Analysoi nykytila
[A12] Määrittele tavoitteet
[A13] Selvitä tilanhankintavaihtoehdot

[A14] Valmistele hankepäätös

[A2] Hankesuunnittelu
[A21] Laadi tilaohjelma ja selvitä tilojen vaatimukset
[A22] Määritä toiminnan ja kiinteistöpidon asettamat tavoitteet
[A23] Selvitä rakennus paikka ja lupamenettelyt
[A24] Suunnittele hankkeen ajoitus ja toteutustapa
[A25] Aseta kustannustavoitteet, selvitä rahoitus, kannattavuus ja budjetti
[A26] Valmistele investointipäätös

[A3] Tee luonnossuunnittelu
[A31] Käynnistä rakennussuunnittelu
[A311] Tarkista suunnittelu ja vastuurajat
[A312] Laadi suunnitteluaikataulu
[A313] Tarkista lähtötiedot
[A314] Täsmennä kohteen erityisvaatimukset seka tilaajan ja käyttäjän tarpeet
[A315] Tarkista suunnittelutavoitteet
[A316] Käynnistä suunnitteluryhmän työ
[A32] Laadi ratkaisuvaihtoehtoja
[A321] Laadi 2 - 3 tontinkäyttö-vaihtoehtoa
[A322] Laadi vaihtoehtoisia periaateratkaisuja (massoittelu)
[A323] Tee laajus, tehokkuus ja kustannus tarkastelu

[A324] Analyse environmental effects	[A324] Analysoi ympäristö vaikutukset
[A325] Present solution to client	[A325] Laadi tilaajalle esitys jatko-suunnittelusta
[A33] Propose solution	[A33] Laadi ehdotus
[A331] Check input documents	[A331] Tarkista lähtotietoasiakirjat
[A332] Make preliminary layout drawing	[A332] Laadi alustava asemapiirros
[A333] Define principal architectural and technical solutions	[A333] Määrittele arkkitehtoniset ja tekniset periaateratkaisut
[A334] Assemble general information of proposed solution	[A334] Laadi ehdotuksen yleisseloste
[A335] Get advance opinions and prepare applications for exceptional permits	[A335] Hanki ennakkolausunnot ja laadi poikkeuslupa-asiakirjat
[A336] Present solution for further design and coordinate design work	[A336] Tee esitys jatkosuunnittelusta ja koordinoi suunnitteluryhmän työ
[A34] Design schemes	[A34] Laadi luonnokset
[A341] Estimate feedback from proposed solution, make layout drawing	[A341] Arvioi ehdotuksesta saatu palaute, laadi asemapiirros ja ymparistösuunnitelma
[A342] Make scheme design	[A342] Laadi kohteen yleissuunnitelma
[A343] Review technical systems and check compatibility of designs	[A343] Selvitä tekniset järjestelmät ja tarkasta suunnitelmien yhteensopivuus
[A344] Prepare general description	[A344] Laadi kohteen yleisseloste
[A345] Do tasks concerning building permits	[A345] Tee rakennuslupatehtävät
[A346] Make decision concerning further design	[A346] Tee päätösesitys jatkosuunnittelusta
[A4] Make detail design	**[A4] Tee toteutussuunnittelu**
[A41] Evaluate global design	[A41] Arvioi luonnossuunnitelma
[A42] Make detail designs	[A42] Tee toteutus suunnitelmat
[A421] Design spaces and facades	[A421] Laadi tilojen ja julkisivujen toteutus suunnitelmat
[A422] Assist in design of external structures and foundations	[A422] Avusta perustusten ja ulkopuolisten rakenteiden suunnittelussa
[A423] Design frame and roof structures	[A423] Suunnittele runko- ja vesikatto-rakenteet
[A424] Design complementary structures, surfaces, fittings and courtyard	[A424] Suunnittele täydentävät ja pintarakenteet, sisusteet, kalusteet ja piha
[A425] Prepare a construction specification	[A425] Laadi rakennusselostus
[A43] Check compatibility of detail designs	[A43] Tarkasta toteutussuunnitelmien osien yhteensopivuus
[A44] Do additional tasks	[A44] Tee täydentävät tehtävät

[A441] Plan usage and maintenance	[A441] Suunnittele käyttö ja ylläpito
[A442] Draw up a plan for movable furniture and a guide for plants, landscaping, display of artwork, existing furniture and signs	[A442] Laadi irtokaluste ohjelma, istutus, maisema, taideteosten sijoitus-, olemassa olevien kalusteiden sekä opastesuunnitelma
[A443] Calculate bills of quantity	[A443] Tee määrälaskenta
[A444] Check designs of building parts suppliers	[A444] Tarkasta rakentamisosien toimittajien suunnitelmat
[A445] Participate in preparation of competitive bidding	[A445] Osallistu urakkakilpailun valmisteluun
[A446] Participate in processing tenders	[A446] Osallistu urakka tarjousten käsittelyyn
[A45] Design for production	[A45] Laadi tuotantosuunnitelmat
[A5] Make design during construction	**[A5] Tee rakennusaikaiset tehtävät**
[A6] Do tasks during use and maintenance	**[A6] Tee käyttöönottotehtävät**

LIST OF FLOWS

English	Finnish
Advance opinions (AUTH)	Ennakkolausunnot (VIR)
Advance opinions, Exceptional permits	Ennakkolausunnot, Poikkeusluvat
Analysis of environmental effects	Ympäristövaikutusten analyysi
Analysis of present situation	Olemassa olevan tilanteen analyysi
Analysis of present situation (inventory of activities and existing premises)	Nykytilan analyysi (toimintojen inventointi, olemassolevien tilojen inventointi)
Application for advance opinions	Ennakkolupahakemus
Application for building permit	Rakennuslupahakemus
Approved cost objectives	Hyväksytyt kustannustavoitteet
Approved global designs (STR, BS, GEO, INT) • Approved global designs form the basis for further design.	Hyväksytyt luonnossuunnitelmat (RAK, TATE, GEO, SIS). • Hyväksytyt luonnossuunnitelmat muodostavat pohjan jatkosuunnittelulle.
ARCH brief • Architectural brief covers both architectural matters and other disciplines.	Tarveselvitys • Arkkitehdin tarveselvityksessä on sekä arkkitehtoniset että muut asiat.
ARCH data	Arkkitehtisuunnittelun tiedot
ARCH programme • The programme of architectural design covers parts of other design disciplines if the architect is the main designer.	ARK-hankesuunnitelma • ARK-hankesuunnitelma sisältää arkkitehtisuunnittelun tuottamat tiedot.
Architect	Arkkitehti
Basic solutions (masses)	Periaateratkaisu (massoittelu)
Basic solutions for alternatives (mass alternatives)	Vaihtoehtojen periaateratkaisut (massoitteluvaihtoehdot)
Basic solutions of alternatives (mass alternatives)	Vaihtoehtojen periaateratkaisut.
Bills of quantities	Määrälaskelmat
Brief (CL)	Tarveselvitys (RAP)
Briefing of feedback	Selvitys palautteesta
BS-designs Building services designs.	Talotekniikan suunnitelmat.
Building permit	Rakennuslupa
Checked design instructions	Tarkistettu suunnitteluohje
Checked design objectives	Tarkistetut suunnittelutavoitteet
Checked design responsibilities	Tarkistetut suunnittelu- ja vastuurajat

Checked input	Tarkistetut lähtötiedot
Checked input documents	Tarkistetut lähtötietoasiakirjat
Chosen site usage masses alternative	Valittu tontinkäyttö ja- ja massoitteluratkaisu.
City plan (AUTH)	Asemakaava (VIR)
Complementary designs for production	Täydentävät tuotantosuunnitelmat
Complementary structures, Surface structures, Fittings, Courtyard design	Täydentävät rakenteet, Pintarakenteet, Kalusteet, Pihasuunnitelma
Complemented brief, Design instructions, Life cycle principle, Profitability requirement, Maintenance requirement	Tarkennettu tarveselvitys, Suunnitteluohje, Elinkaarianalyysin periaate, Tuottotavoite, Ylläpitotavoite
Component suppliers designs	Rakentamisosatoimittajien suunnitelmat
Construction specification	Rakennusselostus
Control (CL)	Ohjaus (RAP)
Controls during use and maintenance	Vastaanottotarkastukset
Cost objective	Kustannustavoite
Cost objectives, Activity costs, Financing plan, Tenancy estimate, Profitability analysis, Budget	Tavoiteustannukset, Toimintakustannusselvitys, Rahoitussuunnitelma, Vuokralaskelma, Kannattavuusanalyysi, Budjetti laskelmineen
Decision on basic solutions	Päätös periaateratkaisusta
Decision on design solution	Päätös suunnitteluratkaisusta.
Decision on proposed solution	Päätös ehdotuksesta
Decision on site usage alternative	Päätös valittavasta tontinkäyttöratkaisusta
Description of compatibility	Selvitys osien yhteensopivuudesta
Description of construction method (STR)	Rakennustapaselostus (RAK)
Description of construction method, General description (architectural and structural solutions, principles of construction methods, calculations concerning permitted building volume, area calculations, space group based	Rakennustapaselostus, Luonnoksen yleisseloste (ratkaisun arkkitehtoniset ja tekniset periaateratkaisut, rakennustavan pääperiaatteet, rakennusoikeus- ja pinta-alalaskelmat, vertailu tilaryhmittäin, kustannusten ja sunnittelutavoitteiden vertailu

comparison, comparison of cost and design objectives with requirements)	puitteeseen)
Design instructions	Suunnitteluohjeet
Design schedule	Suunnitteluaikataulu
Design schedule (CL)	Suunnitteluaikataulu (RAP)
Designs and documents	Asiakirjat ja suunnitelmat
Designs for production	Tuotantosuunnitelmat
Detail designs	Toteutussuunnitelmat
Detailed design	Toteutussuunnitelma.
Detailed design of spaces, Detailed design of facades	Tilojen toteutussuunnitelma, Julkisivujen toteutussuunnitelma
Economic trend analysis, Project schedule (total schedule), Mode of operation (design limits)	Suhdanneselvitys, Hankkeen ajoitus (kokonaisaikataulu), Toteutustapa (suunnittelurajaliite)
Estimated global design	Selvitys luonnossuunnitelmasta.
Estimation of scope, efficiency and costs	Laajuus-, tehokkuus- ja kustannustarkastelu
Existing premises, Activities	Olemassa olevat tilat, Toiminnot
External structures, Foundations	Olemassa olevat rakenteet, Perustukset
Feedback	Palaute
Frame design, Roof design	Runkorakenteet, Vesikattorakenteet
General design (spaces, facades, repetitive units, fittings, layout drawing, elevations, essential sections)	Yleissuunnitelma (tilat, julkisivut, toistuvat yksiköt, kalustettavuus, pohjapiirustukset, julkisivupiirustukset, oleelliset leikkaukset)
General layout drawing, Environmental plan	Asemapiirustus, Ympäristösuunnitelma.
General report on proposed solution (architectural and structural aspects, scope, efficiency, space group comparison, cost estimations vs. objectives)	Ehdotuksen yleiseloste (ratkaisun arkkitehtoniset ja tekniset periaateratkaisut, laajuus, tehokkuus, vertailu tilaryhmittäin, kustannusten ja suunnittelutavoitteiden vertailu puitteeseen)
Geotechnical analysis (GEO) • Some preliminary geotechnical information is needed and analysed.	Pohjatutkimukset (GEO) • Alustavia pohjatutkimustietoja tarvitaan ja anlysoidaan.
Global design	Luonnossuunnitelma
Invitations to tender	Tarjouspyynnöt
Layout drawing	Asemapiirustus

Local planning (AUTH)	Kaavoitustilanne (VIR)
Location criteria, Site requirements	Sijaintikriteerit, Rakennuspaikan vaatimukset
Maintenance requirements, Technical constructability, Juridical constructability, Local plan acceptability, Environmental effects	Ylläpitovaatimukset, Tekninen rakennettavuus, Juridinen rakennettavuus, Kaavallinen kelpoisuus, Ympäristövaikutukset
Need of client	Käyttäjän tarve
Objectives of programme	Hankesuunnitelman tavoitteet
Ownership (AUTH)	Omistusoikeus (VIR)
Preliminary designs, Environmental analysis of effects, Risk, sensitivity and trend analyses, Requirements for building permit, Brief	Alustavat suunnitelmat, Ympäristövaikutusanalyysi, Riski-, herkkyys- ja suhdanneanalyysi, Hankkeen lupaedellytykset, Tarveselvitys
Preliminary lay out drawing	Alustava asemapiirros.
Preliminary schedule	Alustava aikataulu
Principal architectural solution, Principal techical solution	Arkkitehtoninen periaateratkaisu, Tekninen periaateratkaisu
Procurement contracts	Hankintasopimukset
Programme (CL)	Hankesuunnitelma (RAP)
Proposed change to designs (CON)	Urakoitijan muutosehdotus (URA)
Proposed solution	Ehdotussuunnitelma
Resources	Resurssit
Review of global design	Selvitys luonnossuunnitelmasta
Schedule of detail design	Toteutussunnittelun aikataulu
Scheme decision	Päätös luonnoksesta
Site maps (AUTH), Geotechnical information (GEO), Drawings of existing building, Municipal engineering (AUTH), State of real estates (AUTH)	Rakennuspaikan kartat (VIR), Pohjatutkimusaineisto (GEO), Olemassa olevien rakennusten piirustukset, Kunnallistekniikka (VIR), Kiinteistötekninen tilanne (VIR)
Site usage alternative	Tontinkäyttövaihtoehto
Space acquisition alternatives and comparisons, Location alternatives and comparisons (local plan acceptablity, functional competence, juridical constructability, technical constructablility, Effects of space	Tilanhankintavaihtoehdot ja vertailu, Rakennuspaikkavaihtoehdot ja vertailu (kaavallinen kelpoisuus, toiminnallinen kelpoisuus, juridinen rakennettavuus, tekninen rakennettavuus), Tilanhankintatapojen investointivaikutukset, Tilanhan-

acquisition alternatives on investment costs, Cost effects on maintenance costs of space acquisition alternatives, Cost effects of schedule alternatives, Condition analysis of old premises	kintatapojen käyttökustannusvaikutukset, Aikatauluvaihtoehtojen kustannusvaikutukset, Vanhojen tilojen kuntoselvitys
Space programme (INT)	Sisustussuunnittelun tilaohjelma (SIS)
Space programme (room programme, diagrams, areas, volumes, special requirements, connectivity diagrams)	Tilaohjelma (huonetilaohjelma, tilakaaviot, pinta-alat, tilavuudet, erityisvaatimukset, yhteyskaaviot)
Special requirements, Special needs	Kohteen erityisvaatimukset, Tilaajan ja käyttäjän erityistarpeet
STR detailed designs, BS detailed designs, GEO detailed designs	STR-toteutussuunnitelmat, TATE-toteutussuunnitelmat, GEO-toteutussuunnitelmat
STR proposed solution, BS proposed solution, GEO proposed solution, INT proposed solution,	RAK-ehdotus, TATE-ehdotus, GEO-ehdotus, SIS-ehdotus
STR schemes, BS schemes, GEO schemes, INT schemes,	RAK-luonnos, TATE-luonnos, GEO-luonnos, SIS-luonnos
Strategic alternatives, Possibilities to intensify use of existing premises, Possibility to increase or eliminate activities, Dimensional requirements, Location criteria, Site requirements, Economical requirements, Scheduling goals	Strategiavaihtoehdot, Olemassa olevien tilojen tehostamismahdollisuudet, Toimintojen laajentamis- tai karsimismahdollisuudet, Mitoitusperusteet, Sijaintikriteerit, Rakennuspaikan vaatimukset, Taloudelliset tavoitteet, Aikatavoitteet
Structural designs (STR)	Rakennesuunnitelmat (RAK)
Supervision, Controls	Ohjaus, Valvonta
Task lists	Tehtävälistat
Technical systems and compatibility	Selvitys teknisistä järjestelmistä ja yhteensopivuudesta
Tender (CON)	Tarjous (URA)
Trend analysis, Project schedule (total schedule), Mode of operation (design limits)	Suhdanneanalyysi, Projektin kokonaisaikataulu, Hankemuoto (urakkarajat)
Usage plan, Maintenance plan	Käyttösuunnitelma, Ylläpitosuunnitelma
User interviews	Käyttäjähaastattelut

SECTION C:
STRUCTURAL DESIGN PROCESS MODEL

Table of contents

ACTIVITY MODEL

A-0 MODEL SCOPE

The structural design (Figure 22) process is divided into six different stages;

- briefing,
- programming,
- global design,
- detail design,
- design during construction, and
- design during takeover.

It should be noted that the main structural design work concerns global and detail design, presented as activities A3 and A4. Briefing and programming usually belong to the client's work (see Section A).

The A-0 activity diagram is shown in Figure 21.

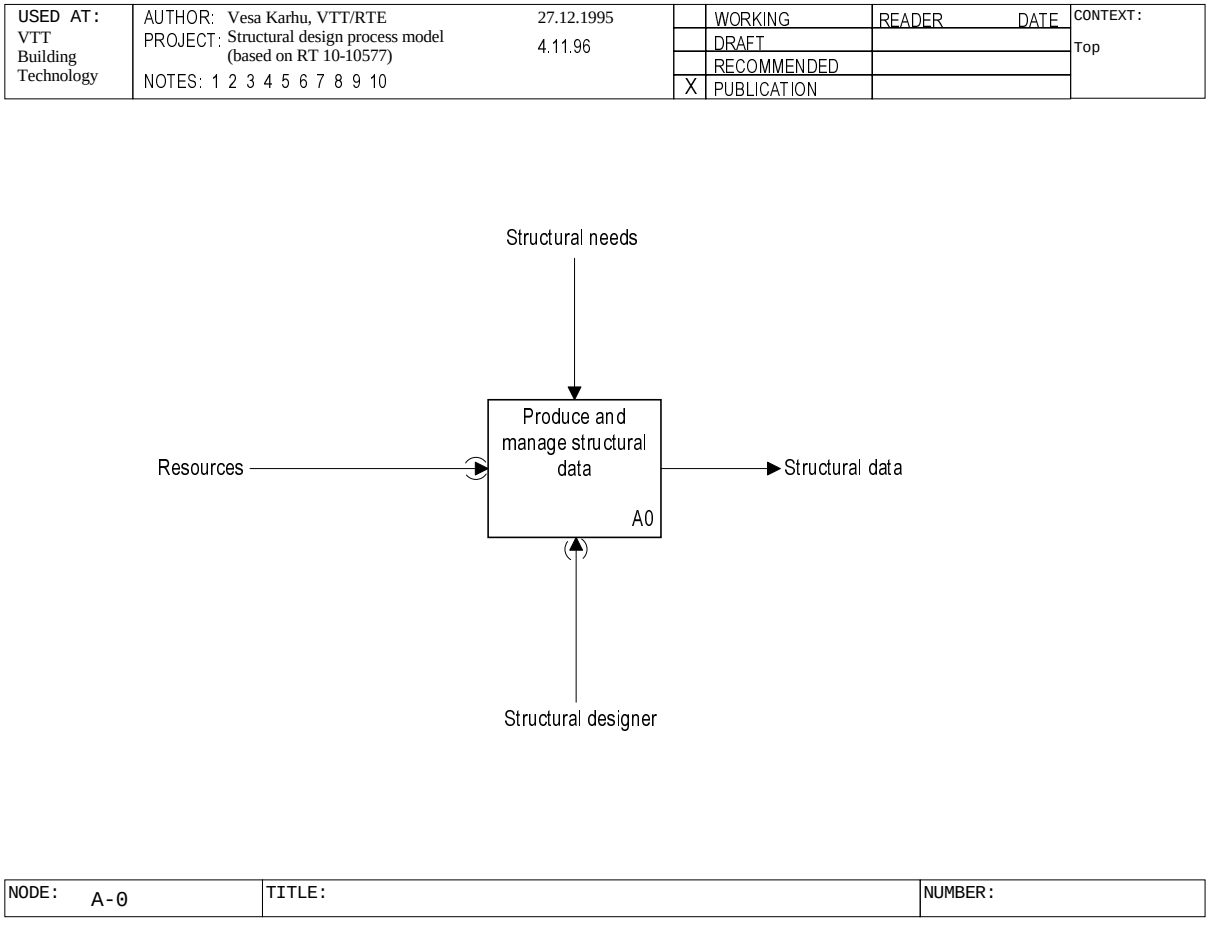


Figure 21. Model scope.

A0 PRODUCE AND MANAGE STRUCTURAL DESIGN DATA

Structural design deals with loads and material strength. Structural design requires input from other design disciplines such as architectural design. These form the foundation of structural design.

The structural design procedure follows the same principle as other design disciplines, i.e., alternative solutions are worked into a solution proposed and then schemes are developed.

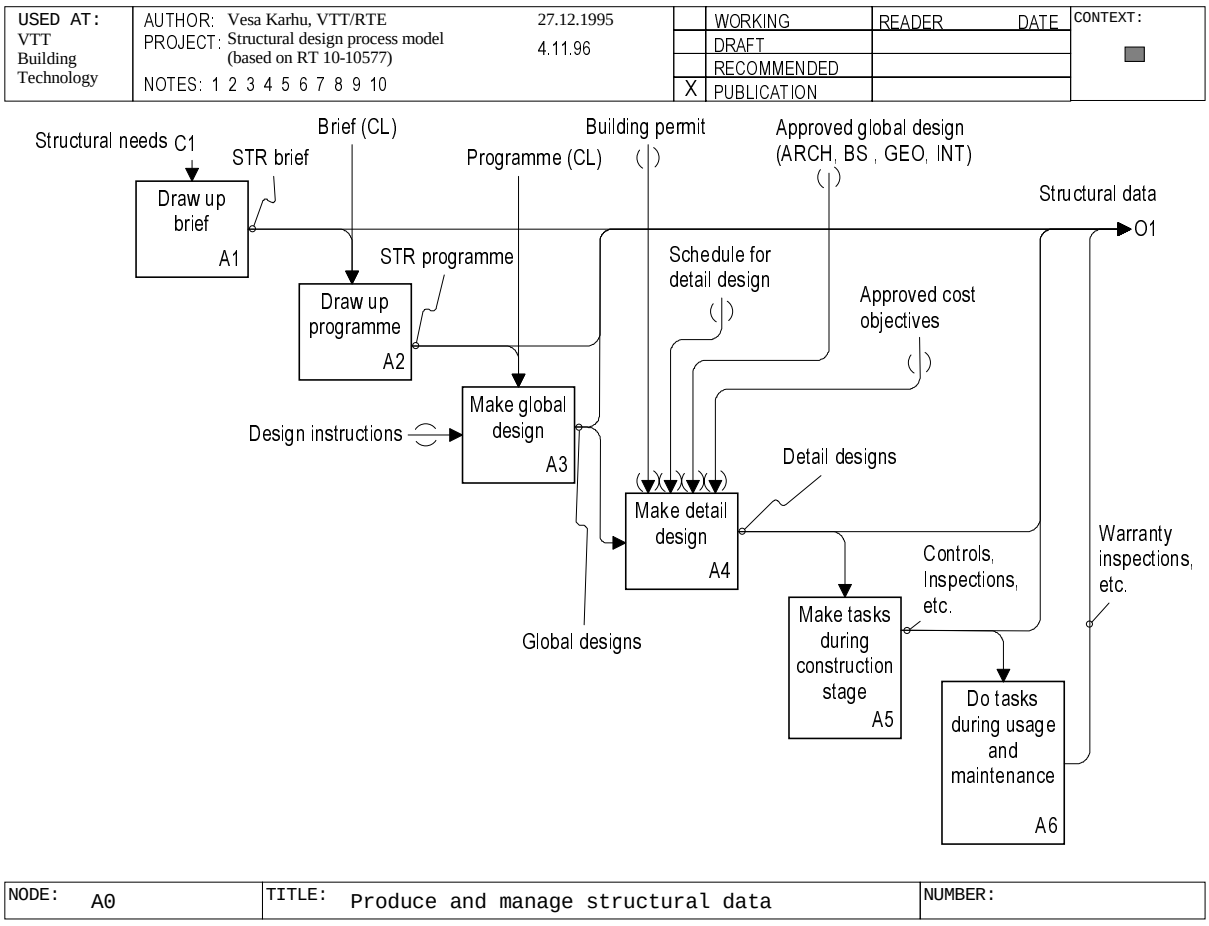


Figure 22. Produce and manage structural data.

A1 DRAW UP BRIEF

This task is usually not included in the structural engineer's design tasks (Figure 23). If needed, structural analyses of space acquisition alternatives, existing premises and spaces are carried out. Additionally, contributions to the client’s work are submitted when estimating costs of new building and renovation of old buildings. The brief is added to the brief on client's work (see Section A).

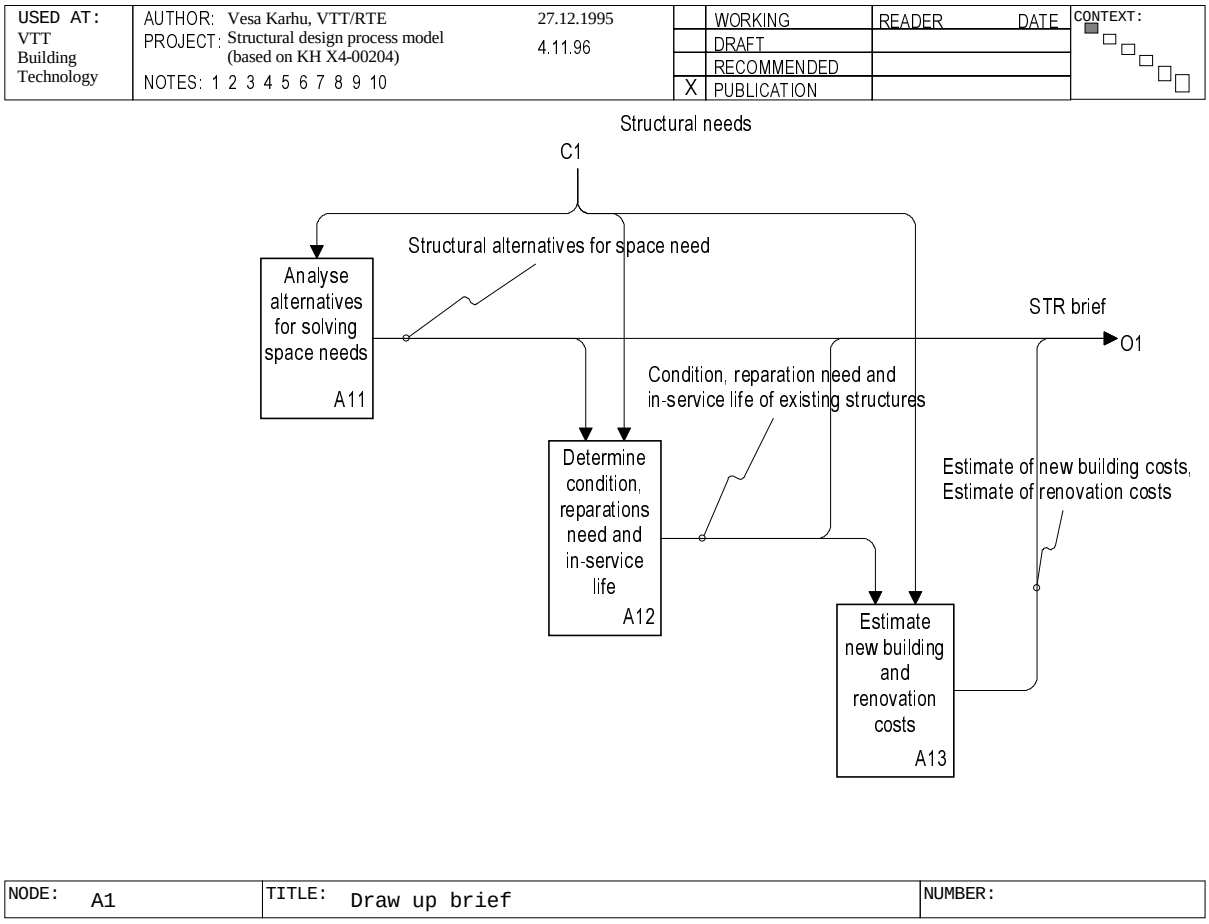


Figure 23. Draw up brief.

A2 DRAW UP PROGRAMME

This task is not usually included in the structural designer's tasks (Figure 24). If assistance is needed, the structural engineer may define some technical requirements and cost requirements. Also, site constructability may be evaluated as well as a contribution to the client’s work added to evaluations of existing premises. The programme is added to the programme of client's work (see Section A).

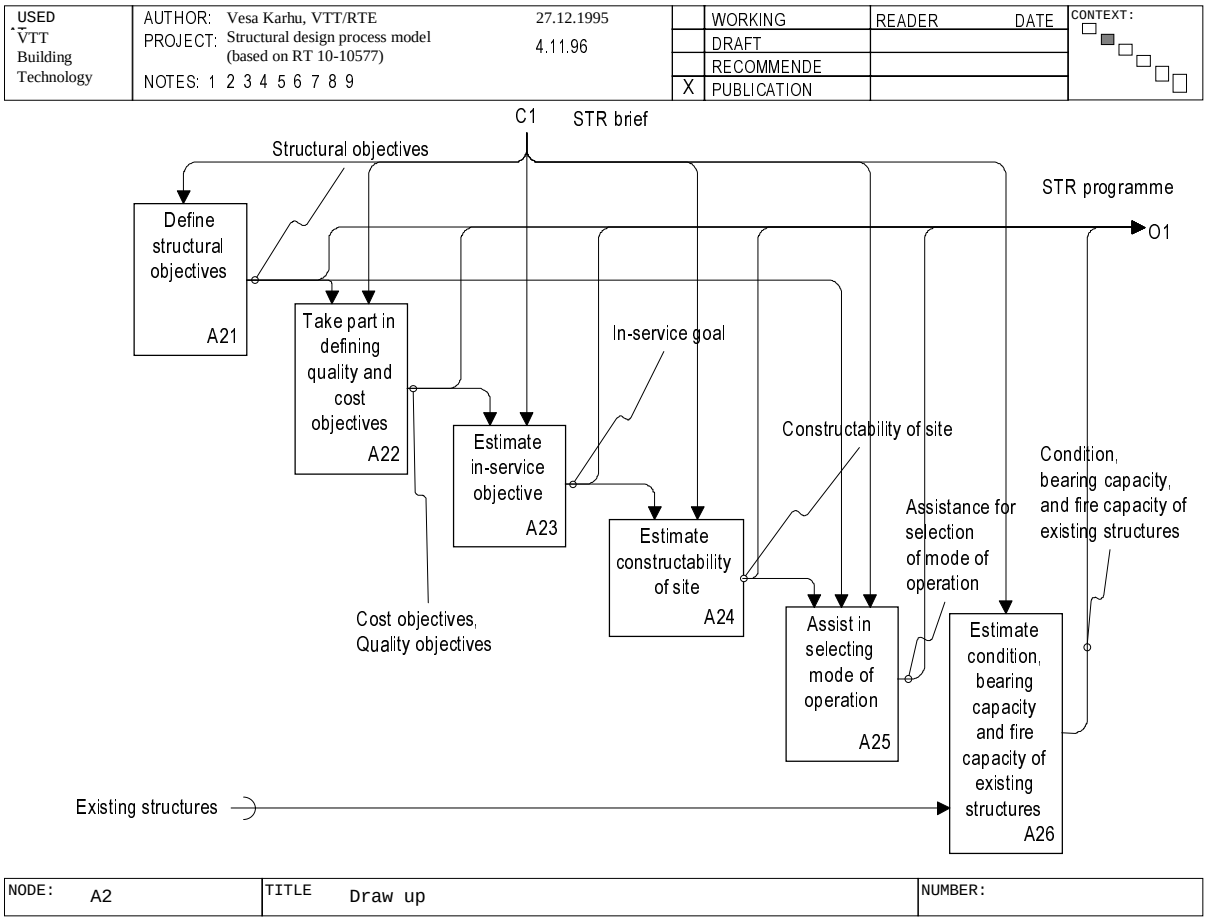


Figure 24. Draw up programme.

A3 MAKE GLOBAL DESIGN

Global design (Figure 25) is divided into four subactivities. The first subactivity innvolves checking the design instructions which is done in conjunction with client's work (see section A) and main designer's tasks (see Section B).

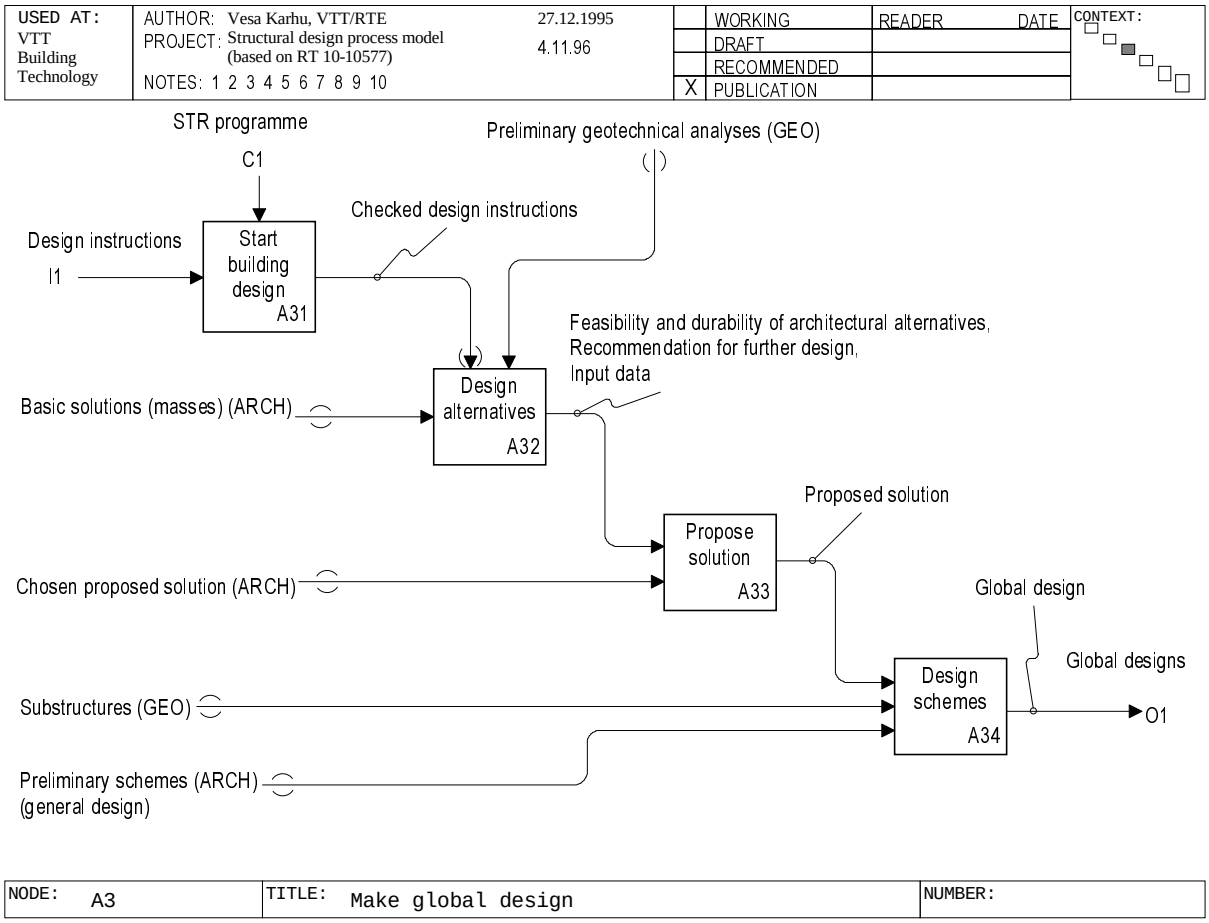


Figure 25. Make global design.

A31 Start building design

The starting of building design does not belong to the structural engineer's normal design tasks. If needed, an agreement may be made concerning this activity.

The purpose of the activity is to check the design instructions and start building design. For more details, see activity A31 in the architectural design process model.

A32 Design alternatives

The purpose of designing basic alternatives (Figure 26) is to study the feasibility of architectural solutions complemented with structural designs. The first subactivity lays the foundation for the position of the building as well as needed substructures. Structural possibilities are based on architectural solutions.

Loads, fire classes and material alternatives are studied. Finally, a recommendation for further design is presented.

Input is needed from architectural design.. It contains the alternative basic solutions.

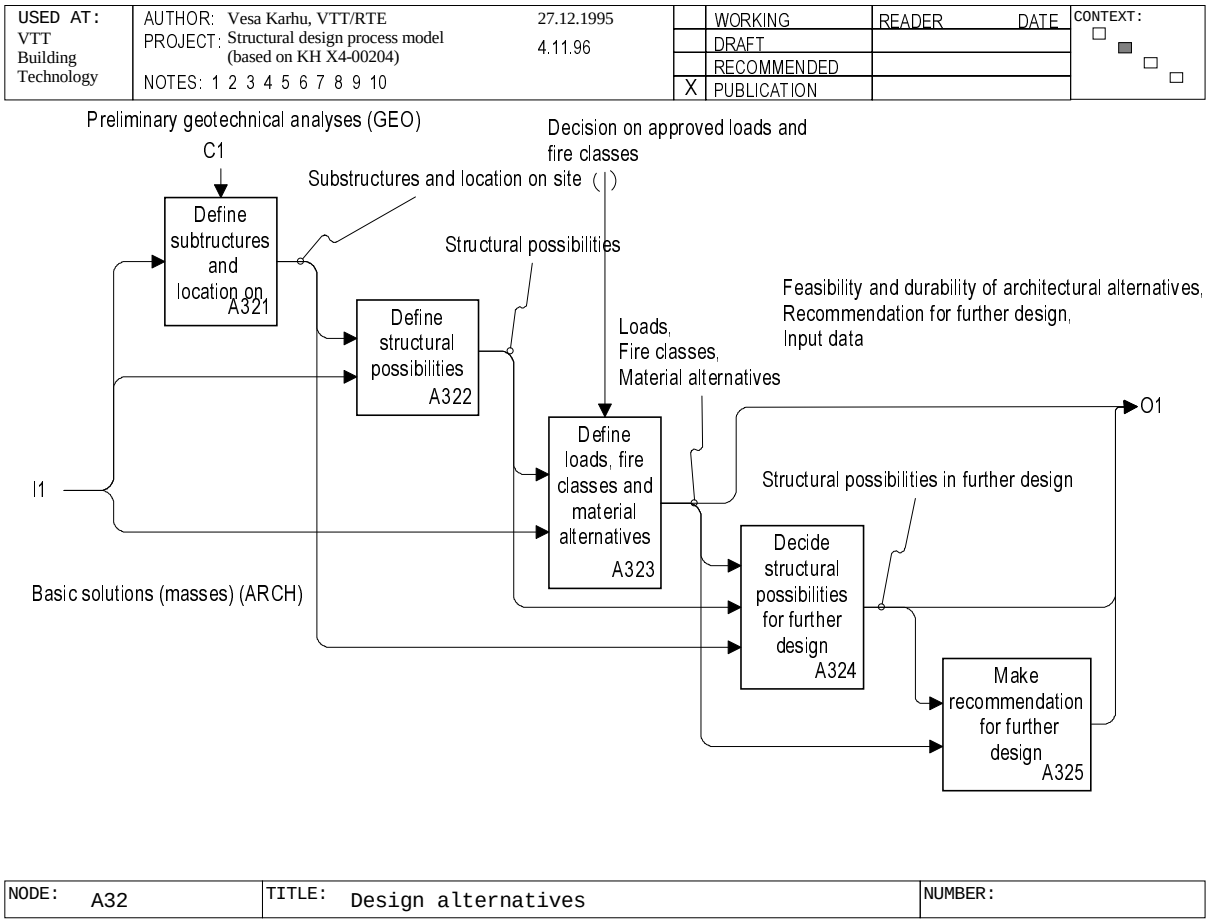


Figure 26. Design alternatives.

A33 Propose solution

A more detailed solution which is called proposed solution is worked out in this activity (Figure 27). The proposed solution is based on the chosen architectural basic solution.

Building system alternatives are studied. Also, input from other design disciplines is taken into account. An important task is to check the compatibility of all designs such as building services and bearing structures. Building services installations require space and voids that have to be taken into account.

A decision on the basic structural system is made at the final stage.

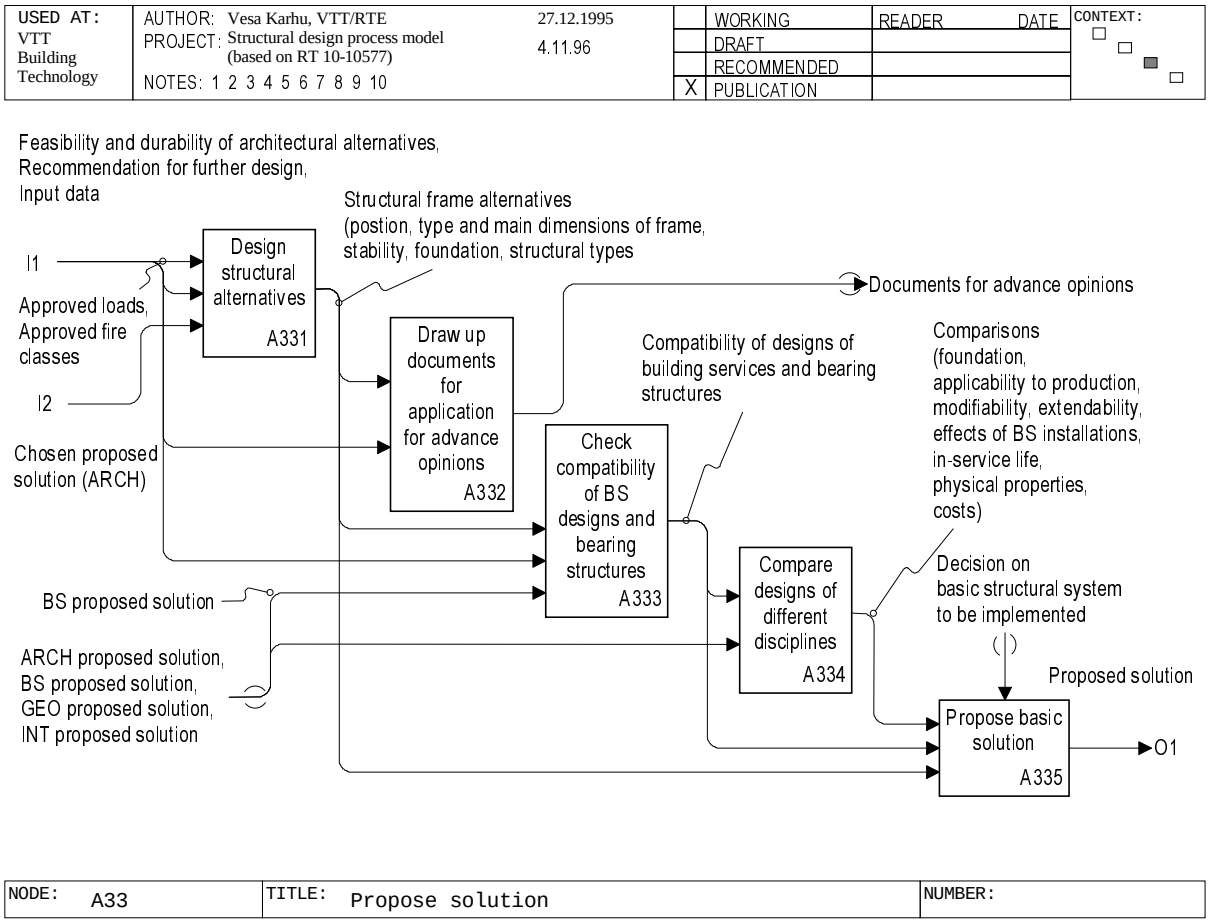


Figure 27. Propose solution.

A34 Design scheme

“Design schemes” (Figure 28) is used to provide sufficient accuracy for applying for a building permit. At this stage, designs are compared to design objectives and requirements that were set earlier, primarily as part of the client's work.

The structural solution is specified. It takes into account aspects of fire protection principles, environmental class, thermal class, water and moisture insulation. Stability analysis is carried out and main dimensions of main structural components are determined.

Compatibility with other designs is checked and seen as an input to activity A343 in the diagram. A final decision on which solution is to be further developed is made by the client.

A description of construction methods is documented. The document contains all the essential information such as site information (address, etc.), material specifications, areas, volumes, responsibilities of parties concerning design disciplines. Also, it contains information about the quality level. The document has parts that are common with the architectural design (seen as input to activity A345).

The additional tasks are not normally included in structural design activities though they may be performed according to a specific contract.

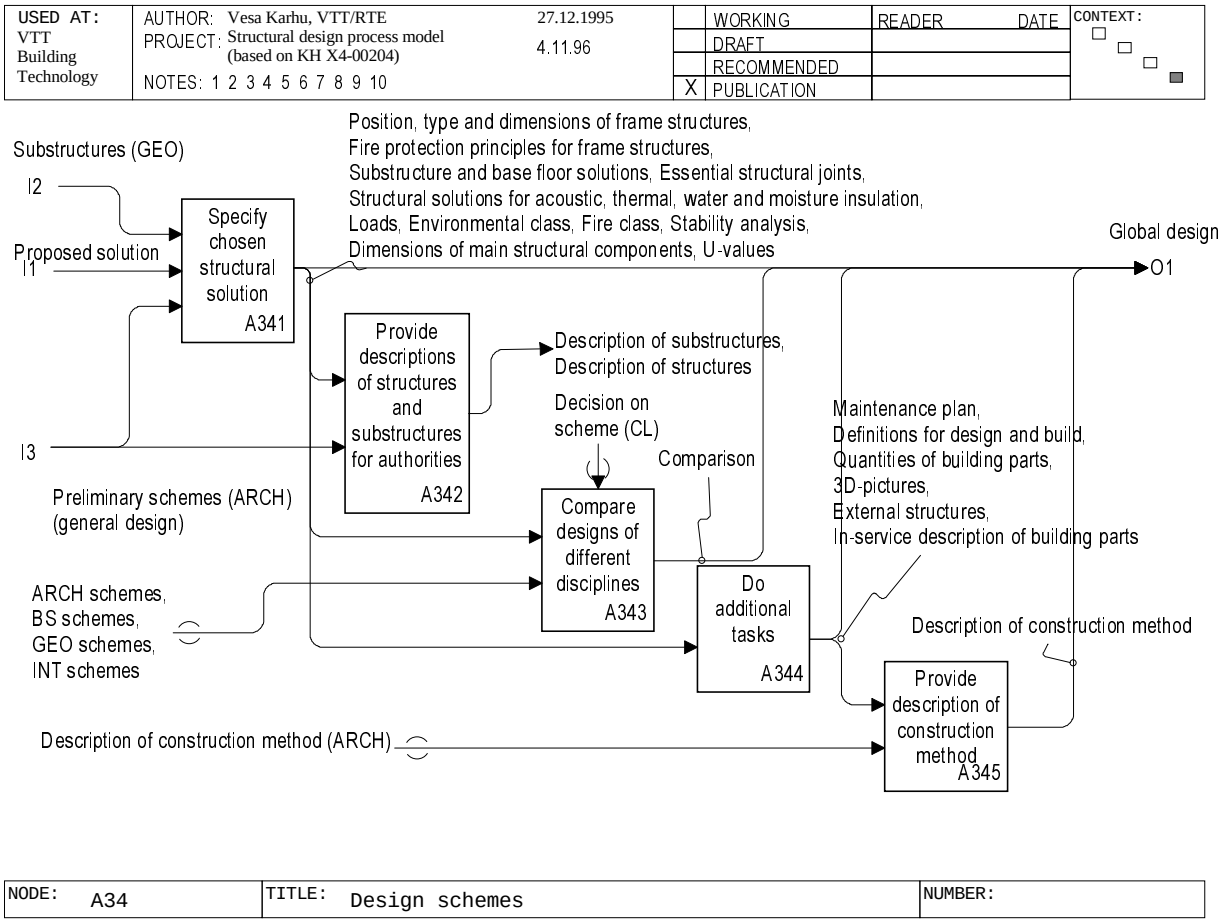


Figure 28. Design schemes.

A4 MAKE DETAIL DESIGN

Detail design (Figure 29) involves three subactivities. They are characterized as design for tenders, additional tasks and design for production. It should be noted that additional tasks do not automatically belong to the structural design unless an agreement to that effect is made. These tasks yield data for the invitation to tender.

Design for production is done when the contractor is chosen. The contractor may demand some changes to details. This is shown as a control to all activities, especially to activity A43. The contractor's products impose additional controls to activity A43.

In practice, the design schedule is usually tight which means that new ideas and design solutions are difficult to implement.

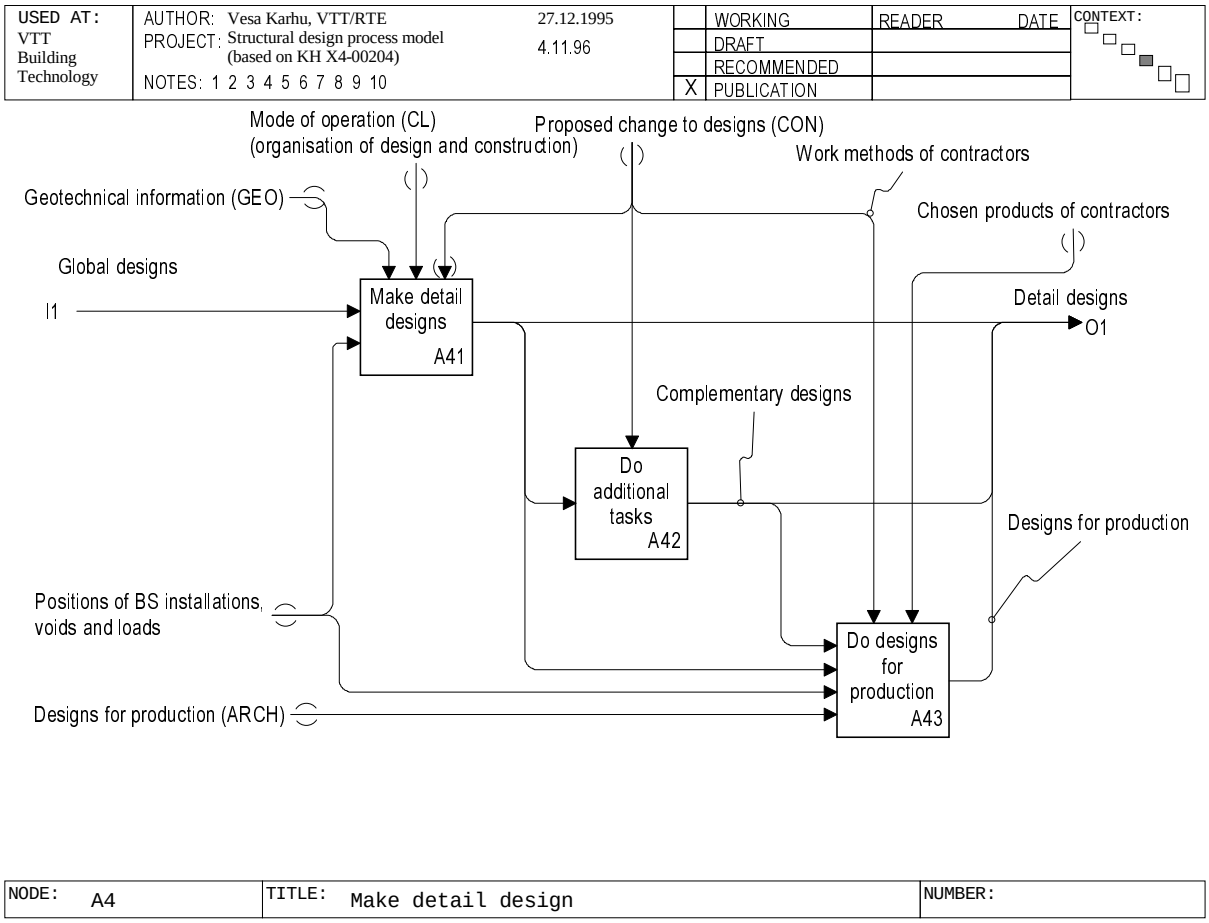


Figure 29. Make detail design.

In Figure 30, actual detailed design is shown. The first activity is not a design activity but defines the limitations of contract (foundation, frame, external wall and roof structures). An agreement on the required output documents is made. This activity is controlled by the mode of operation.

Structural calculations are done after which the initial activity the final dimensions are set. Some input is needed from building services design as installations require space and impose additional loads. Designing of substructures requires information from geotechnical design.

The last activity (A416) is to assemble a work specification.

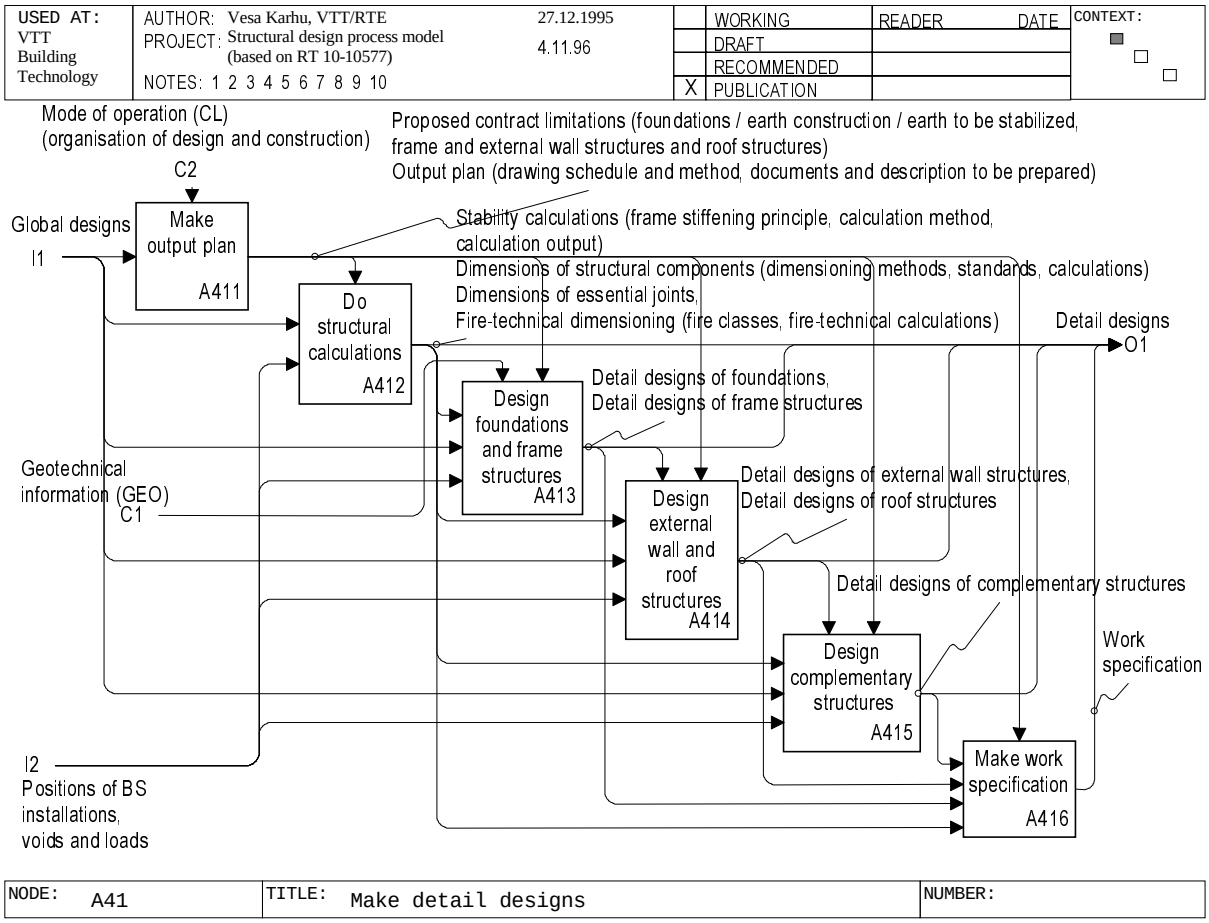


Figure 30. Make detail designs.

A5 DO DESIGN TASKS DURING CONSTRUCTION STAGE

The tasks performed during construction stage consist mainly of supervision and inspections. The control for these activities is imposed by procurement contracts.

At the final stage of this activity a handover decision is made.

A6 DO TASKS DURING USAGE AND MAINTENANCE

The tasks during handover involve inspections during the warranty period. Also, additional tasks may include checking the usage and the maintenance plan as well as planning guidance and archiving of the design documents.

A decision on warranty release responsibilities is made.

LIST OF ACTIVITIES

English

[A0] Produce and manage structural data

[A1] Draw up brief
- [A11] Analyse alternatives for solving space needs
- [A12] Determine condition, reparations need and in-service life
- [A13] Estimate new building and renovation costs

[A2] Draw up programme
- [A21] Define structural objectives
- [A22] Take part in defining quality and cost objectives
- [A23] Estimate in-service goal
- [A24] Estimate constructability of site
- [A25] Assist in selecting mode of operation
- [A26] Estimate condition, bearing capacity and fire capacity of existing structures

[A3] Make global design
- [A31] Start building design
- [A32] Design alternatives
  - [A321] Define substructures and location on site
  - [A322] Define structural possibilities
  - [A323] Define loads, fire classes and material alternatives
  - [A324] Decide structural possibilities for further design
  - [A325] Make recommendation for further design
- [A33] Propose solution
  - [A331] Design structural alternatives
  - [A332] Draw up documents for application for advance opinions

Finnish

[A0] Tuota ja hallitse hankkeen RAK-suunnittelun tiedot

[A1] Tee tarveselvitys
- [A11] Analysoi tilantarpeen ratkaisuvaihtoehdot
- [A12] Selvitä olemassa olevien rakenteiden kunto, korjaustarve ja käyttöikä
- [A13] Arvioi uudisrakennus- ja korjauskustannuksia

[A2] Hankesuunnittelu
- [A21] Määrittele hankkeen rakennetekniset tavoitteet
- [A22] Osallistu laatutason ja kustannustavoitteiden määrittelyyn
- [A23] Arvioi käyttöikätavoite
- [A24] Arvioi rakennuspaikan rakennettavuus
- [A25] Avusta toteutustavan valitsemisessa
- [A26] Arvioi vanhojen rakenteiden kunto, kantavuus ja palonkesto

[A3] Tee luonnossuunnittelu
- [A31] Käynnistä rakennussuunnittelu
- [A32] Laadi ratkaisuvaihtoehtoja
  - [A321] Määrittele perustaminen ja sijainti tontilla
  - [A322] Määrittele rakennejärjestelmä-mahdollisuudet
  - [A323] Määrittele kuormat, paloluokat ja materiaalivaihtoehdot
  - [A324] Päätä tutkittavat rakennejärjestelmämahdollisuudet
  - [A325] Tee suositus jatkosuunnittelusta
- [A33] Laadi ehdotus
  - [A331] Suunnittele rakennejärjestelmä-vaihtoehdot
  - [A332] Laadi ennakkolausuntoja varten selvitykset

[A333] Check compatibility of BS designs and bearing structures	[A333] Tutki taloteknisten järjestelmien ja kantavien rakenteiden yhteeensopivuus
[A334] Compare designs of different disciplines	[A334] Vertaile eri toimialojen suunnitelmia
[A335] Propose basic solution	[A335] Tee ehdotus perusratkaisusta
[A34] Design schemes	[A34] Laadi luonnos
[A341] Specify chosen structural solution	[A341] Täsmennä valittu rakennejärjestelmä
[A342] Provide descriptions of structures and substructures for authorities	[A342] Tee rakenteiden ja perustusten selvitys viranomaisia varten
[A343] Compare designs of different disciplines	[A343] Vertaile eri toimialojen suunnitelmia
[A344] Do additional tasks	[A344] Tee täydentävät tehtävät
[A345] Provide description of construction	[A345] Laadi rakennustapaselostus
[A4] Make detail design	**[A4] Tee toteutussuunnittelu**
[A41] Make detail designs	[A41] Tee toteutussuunnitelmat
[A411] Make output plan	[A411] Laadi tulostussuunnitelma
[A412] Do structural calculations	[A412] Laadi rakennelaskelmat
[A413] Design foundations and frame structures	[A413] Suunnittele perustukset ja runkorakenteet
[A414] Design external wall and roof structures	[A414] Suunnittele ulkoseinä- ja vesikattorakenteet
[A415] Design complementary structures	[A415] Suunnittele täydentävät rakenteet
[A416] Make work specification	[A416] Laadi työselostus
[A42] Do additional tasks	[A42] Tee täydentävät tehtävät
[A43] Make designs for production	[A43] Laadi tuotantosuunnitelma
[A5] Do tasks during construction stage	**[A5] Tee rakennusaikaiset tehtävät**
[A6] Do tasks during usage and maintenance	**[A6] Tee käyttöön ja ylläpitoon liittyvät tehtävät**

LIST OF FLOWS

English	Finnish
Approved cost objectives	Hyväksytyt kustannustavoitteet
Approved global design (ARCH, BS, GEO, INT)	Hyväksytyt luonnokset (ARK, TATE, GEO, SIS)
Approved loads, Approved fire classes	Hyväksytyt kuormat ja paloluokat
ARCH proposed solution, BS proposed solution, GEO proposed solution, INT proposed solution	ARK-ehdotus, TATE-ehdotus, GEO-ehdotus, SIS-ehdotus
ARCH schemes, BS schemes, GEO schemes, INT schemes	ARK-luonnos, TATE-luonnos, GEO-luonnos, SIS-luonnos
Assistance for selection of mode of operation	Toteutustapaan liittyvät selvitykset
Basic solutions (masses) (ARCH)	Vaihtoehtojen periaateratkaisut (massat) (ARK)
Brief (CL)	Tarveselvitys (RAP)
BS proposed solution	TATE-ehdotus
Building permit	Rakennuslupa
Checked design instructions	Tarkistetut suunnitteluohjeet
Chosen products of contractors	Urakoitsijoiden valitut tuotteet
Chosen proposed solution (ARCH)	Valittu arkkitehdin ehdotus (ARK)
Comparison	Vertailu
Comparisons (foundation, applicability to production, modifiability, extendability, effects of BS installations, in-service life, physical properties, costs)	Vertailut (perustukset, soveltuvuus tuotantoon, muunneltavuus / laajennettavuus, TATE-järjestelmien vaikutus, käyttöikäselvitys, rakennusfysikaalisten ominaisuuksien vertailu, kustannusvertailut)
Compatibility of designs of building services and bearing structures	Selvitys taloteknisten järjestelmien ja kantavien rakenteiden yhteensopivuudesta
Complementary designs	Täydentävät suunnitelmat
Condition, bearing capacity, and fire capacity of existing structures	Vanhojen rakenteiden kunto, kantavuus ja palonkesto
Condition, reparation need and in-service life of existing structures	Olemassa olevien rakenteiden kunto, korjaustarve ja käyttöikä
Constructability of site	Rakennuspaikan rakennettavuus

Controls, Inspections, etc.	Tarkastukset, Katselmukset
Cost objectives, Quality objectives	Rakennetekniset kustannus- ja laatutavoitteet
Decision on approved loads and fire classes	Päätös hyväksytyistä kuormista ja paloluokista
Decision on basic structural system to be implemented	Päätös toteutettavasta perusrakennejärjestelmästä
Decision on scheme (CL)	Päätös luonnoksesta (RAP)
Description of construction method	Rakennustapaselostus
Description of construction method (ARCH)	Rakennustapaselostus (ARK)
Description of substructures, Description of structures	Selvitys perustuksista, Selvitys rakenteista
Design instructions	Suunnitteluohjeet
Designs for production	Tuotantosuunnitelmat
Designs for production (ARCH)	Tuotantosuunnitelmat (ARK)
Detail designs	Toteutussuunnitelmat
Detail designs of complementary structures	Täydentävien rakenteiden toteutussuunnitelmat
Detail designs of external wall structures, Detail designs of roof structures	Ulkoseinärakenteiden toteutussuunnitelmat, Vesikaton toteutussuunnitelmat
Detail designs of foundations, Detail designs of frame structures	Perustusten toteutussuunnitelmat, Runkorakenteiden toteutussuunnitelmat
Documents for advance opinions	Ennakkolausuntoselvitykset
Estimate of new building costs, Estimate of renovation costs	Arvio uudisrakennus ja korjauskustannuksista
Existing structures	Olemassa olevat rakenteet
Feasibility and durability of architectural alternatives, Recommendation for further design, Input data	Selvitys arkkitehtonisten vaihtoehtojen toteutettavuudesta ja kestävyydestä, Suositus jatkosuunnittelusta, Lähtötiedot
Geotechnical information (GEO)	Pohjatutkimustiedot (GEO)
Global design	Luonnos
Global designs	Luonnossuunnitelmat
In-service goal	Käyttöikätavoite
Loads, Fire classes, Material alternatives	Kuormat, Paloluokat, Materiaalivaihtoehdot

Maintenance plan, Definitions for design and build, Quantities of building parts, 3D-pictures, External structures, In-service description of building parts	Ylläpitosuunnitelma, Tuoteosakauppaan liittyvät määrittelyt, Rakennusosien määrät, 3D-kuvat, Ulkoalueella olevat rakenteet, Rakennusosien käyttöikäselvitys
Mode of operation (CL) (organisation of design and construction)	Urakkamuoto (RAP) (rakentamisen ja suunnittelun organisointi)
Position, type and dimensions of frame structures, Fire protection principles for frame structures, Substructure and base floor solutions, Essential structural joints, Structural solutions for acoustic, thermal, water and moisture insulation, Loads, Environmental class, Fire class, Stability analysis, Dimensions of main structural components, U-values	Runkorakenteiden sijainti, tyyppi ja dimensiot, Runkorakenteiden palosuojauksen periaate, Perustus- ja alapohjaratkaisut, Oleelliset rakenteiden liitokset, Rakenteiden äänen-, lämmön-, veden- ja kosteudeneristysratkaisut, Kuormitukset, Ympäristöluokka, Paloluokka, Stabiliteettianalyysi, Päärakennusosien mitat, K-arvot
Positions of BS installations, voids and loads	TATE-installaatioiden sijoitus, vaadittavat tilavaraukset ja kuormitus
Preliminary geotechnical analyses (GEO)	Alustavat pohjatutkimustulokset (GEO)
Preliminary schemes (ARCH) (general design)	Alustavat arkkitehdin luonnokset (ARK) (yleissuunnitelma)
Programme (CL)	Hankesuunnitelma (RAP)
Proposed change to designs (CON)	Muutosehdotus (URA)
Proposed contract limitations (foundations / earth construction / earth to be stabilized, frame and external wall structures and roof structures) Output plan (drawing schedule and method, documents and description to be prepared)	Urakkarajaehdotus (perustukset / maarakennus / pohjanvahvistus, runko- ja ulkoseinärakenteet sekä vesikattorakenteet), Tulostussuunnitelma (piirustusluettelo, tulostustavan määrittely, laadittavat selostukset ja asiakirjat)
Proposed solution	Ehdotus
Resources	Resurssit
Schedule for detail design	Toteutussuunnittelun aikataulu
Stability calculations (frame stiffening principle, calculation method, calculation	Stabiliteettilaskelmat (rakennusrungon jäykistysperiaate, laskentamenetelmät,

output) Dimensions of structural components (dimensioning methods, standards, calculations) Dimensions of essential joints, Fire-technical dimensioning (fire classes, fire-technical calculations)	laskelmatulosteet), Rakenneosien mitoitus (mitoitusmenetelmät, normit, laskelmat), Oleellisten liitosdetaljien mitoitus, Palotekninen mitoitus (paloluokat, palotekniset mitoituslaskelmat)
STR brief	Rakennesuunnittelun tarveselvitys
STR programme	Rakennesuunnittelun hankesuunnitelma
Structural alternatives for space need	Tilantarpeen rakenteelliset selvitykset
Structural data	Rakennesuunnittelun tiedot
Structural designer	Rakennesuunnittelija
Structural frame alternatives (postion, type and main dimensions of frame, stability, foundation, structural types	Rakennejärjestelmävaihtoehdot (runkorakenteiden sijainti, tyyppi ja päädimensiot, stabiliteettiselvitys, perustusvaihtoehdot, rakennetyypit)
Structural needs	Rakenteelliset tarpeet
Structural objectives	Rakennetekniset tavoitteet
Structural possibilities	Rakennejärjestelmämahdollisuudet
Structural possibilities in further design	Tutkittavat rakennejärjestelmämahdollisuudet
Substructures (GEO)	Perustamistapaselvitys (GEO)
Substructures and location on site	Perustaminen ja sijainti tontilla
Warranty inspections, etc.	Takuuajan tarkastukset
Work methods of contractors	Urakoitsijoiden työmenetelmät
Work specification	Työselostus

SECTION D:

BUILDING SERVICES DESIGN PROCESS MODEL

Table of contents

ACTIVITY MODEL

A-0 MODEL SCOPE

The presented building services design process model is based on a task list (RT 10-10579). The model's main function is to coordinate and supervise the design work of all building services design subdisciplines (structural, HVAC, etc.).

The process is divided into six different stages, i.e., briefing, programming, global design, detail design and design during construction and use and maintenance stages.

It should be noted that the main building services design work concerns global and detail design, presented here as activities A3 and A4. Also, briefing and programming usually belong to the main designer's tasks (see Section B) or the client's work (see Section A).

The A-0 activity diagram is shown in Figure 31.

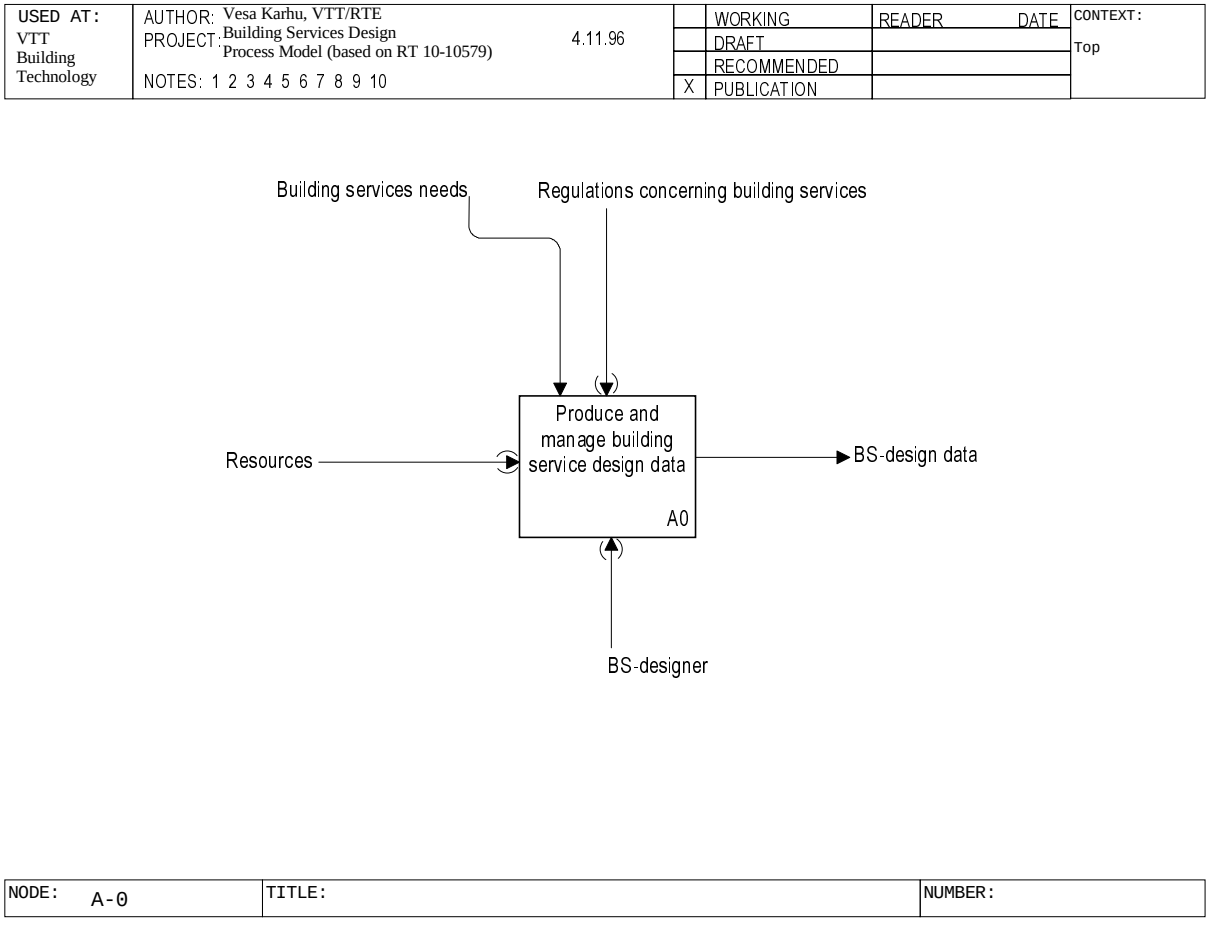


Figure 31. Model scope.

A0 PRODUCE AND MANAGE BUILDING SERVICES DESIGN DATA

The activity (Figure 32) is divided into briefing, programming, global design and etail design. Activities during the construction stage as well as handover are not of importance here. Anyhow, delivery contracts are needed during the construction stage.

Building services include building automation, electric, HVAC and telecommunications design. The presented process model takes into account all these disciplines being a coordinated model. It indicates a need for a main designer for building services.

Briefing and programming usually belong to the client's work. Here, they get input from the client's work. The project brief and programme are completed from building services point of view.

The purpose is to assist in defining the client's need for more space. The output, a project brief, will be part of the whole project brief that is done in the client's work (Section A).

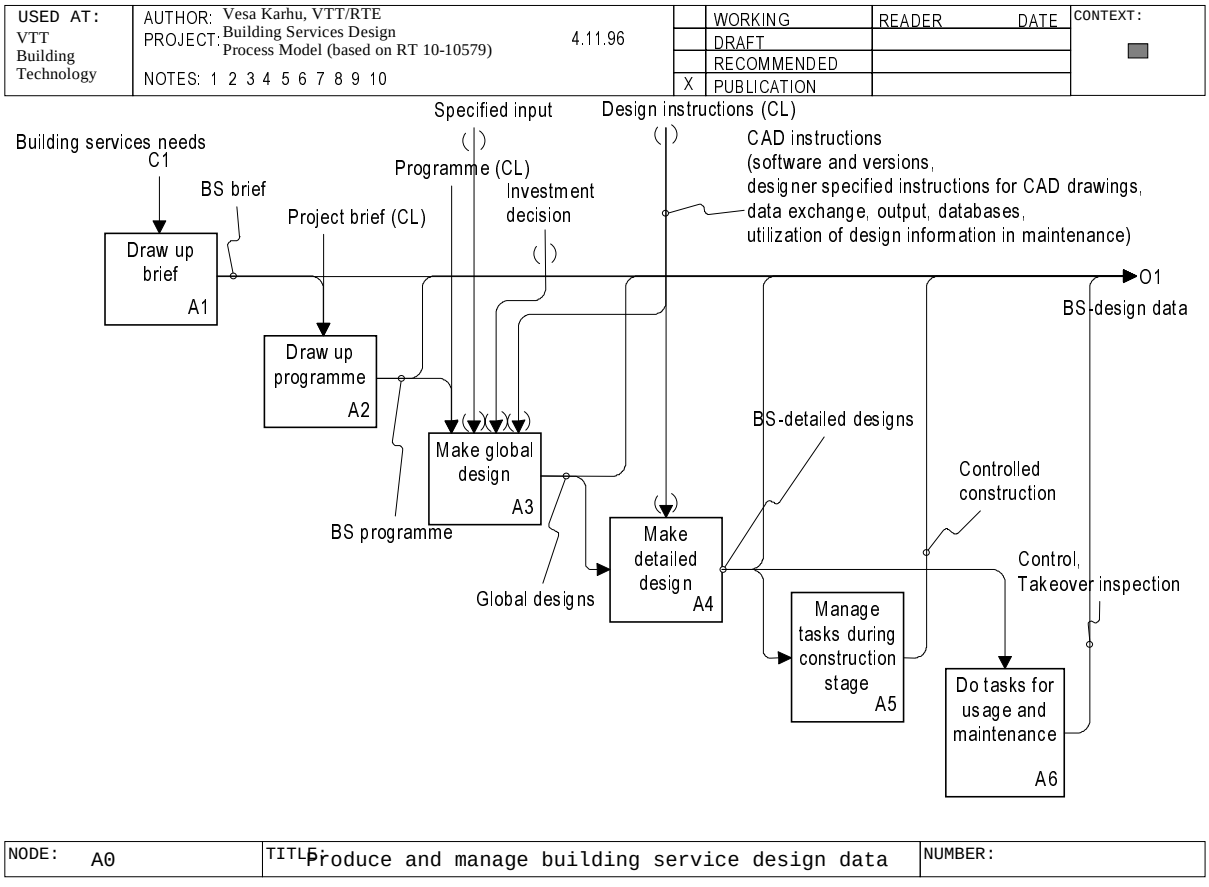


Figure 32. Produce and manage building services design data.

A1 DRAW UP BRIEF

The project brief (Figure 33) is a collection of basic information from the client concerning space requirements. The information consists of needs, requirements and possibilities.

The project brief may lead to drawing up of a programme if the brief indicates a need for more or less space. The brief here is focused on the building services points of view.

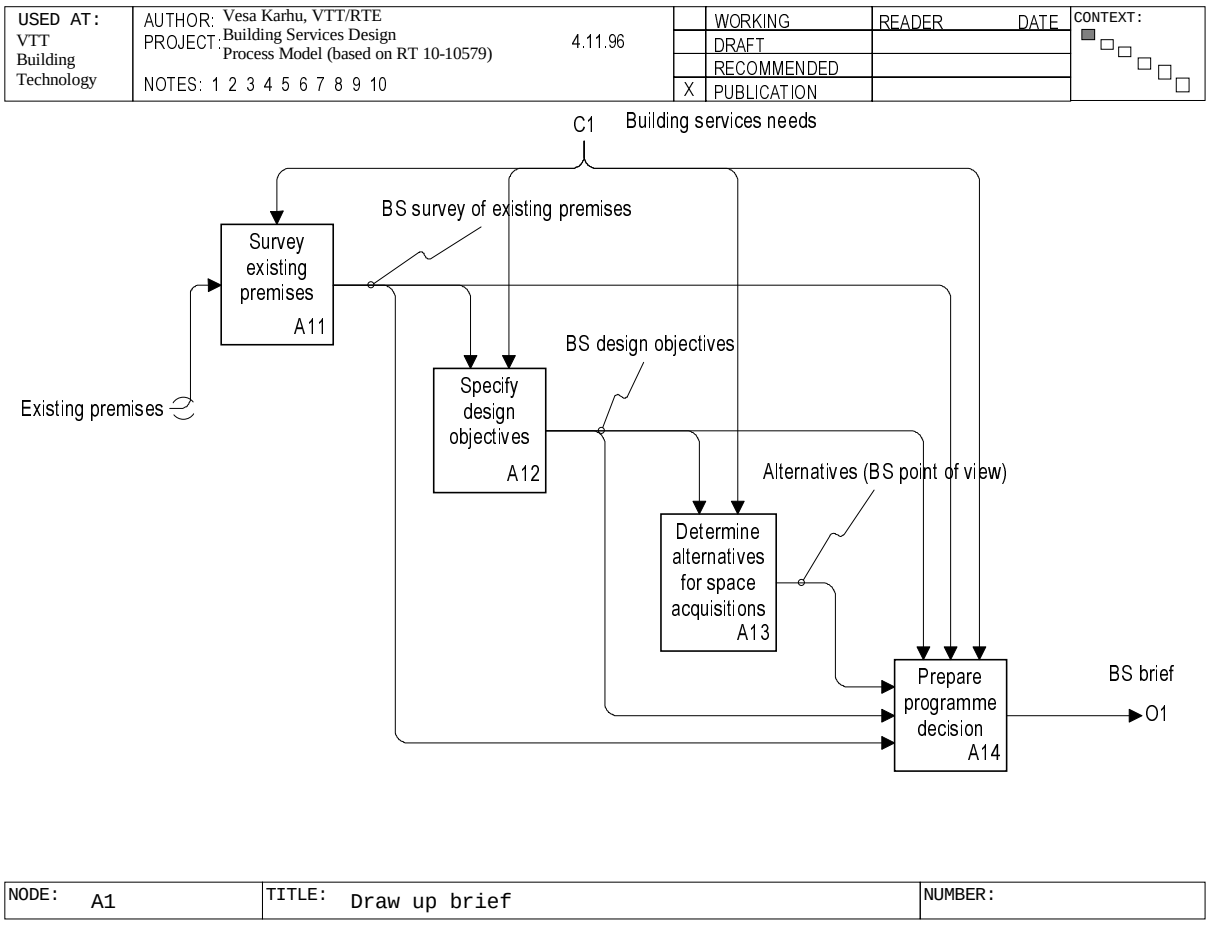


Figure 33. Draw up brief.

A2 DRAW UP PROGRAMME

Programming (Figure 34) is usually carried out as client's work (see Section A). The requirements concerning building services are

- building service quality level,
- indoor climate, thermal loads, usage period
- natural light, illumination,
- data exchange, safety,
- method for uninterrupted use

- special loads, disturbance,
- appearance, and
- multi-purpose use, modifications.

The programme here is included in the programme of the client's work (Section A).

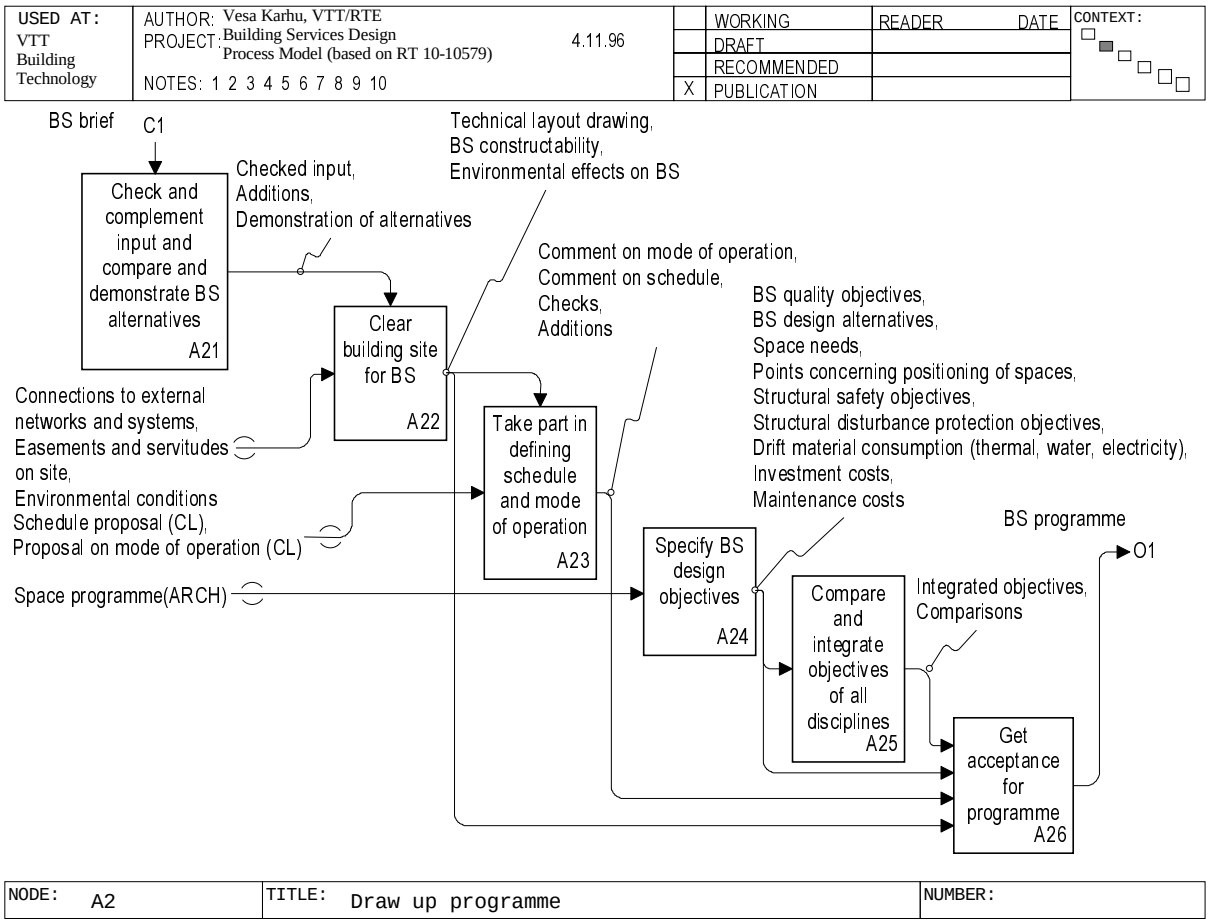


Figure 34. Draw up programme.

A3 MAKE GLOBAL DESIGN

Global design (Figure 35) starts with checking and complementing the programme. The programme is used as input. Architectural design solutions are used as input for establishing relevant building services design.

The global design of different building services disciplines takes place in subactivity A35. In A36, a comparison of different disciplines is done. The final result is the global design of all building services.

General design includes following:
- check input,

- agreement on data exchange formats and methods,
- specification of external connections,
- specification of technical space needs,
- position and dimensioning of main equipment,
- main wireroutings,
- type rooms,
- integration possibilities,
- specification of contract limits and procurement, and
- essential voids and holes.

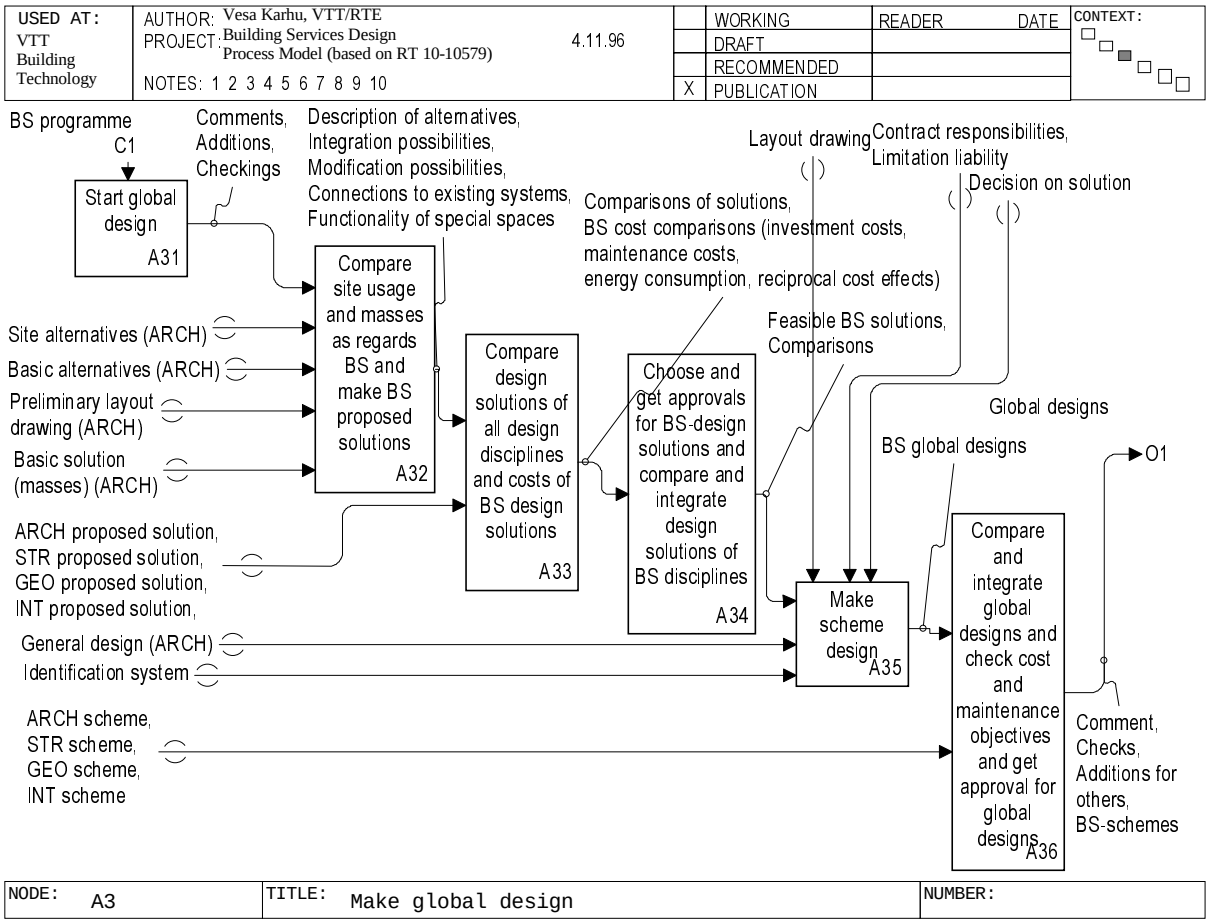


Figure 35. Make global design.

A31 Make scheme design

Schemes (Figure 36) are designed for all disciplines. These activities are usually done simultaneously. The design schedule is usually as part of the client's work. The result of the activity is checked design instructions which are used later in other activities.

HVAC-design includes:

- service areas,
- design HVAC-systems,
- energy measurements, and
- heating and cooling capacities.

Building automation design consists of the following:
- structure of system,
- extension and functions of system, and
- subdistribution equipment.

Telecommunication includes:
- design functions of systems,
- field experiments,
- design usage of special rooms,
- encoding of safety data and distribution, and
- disturbance and protection principles.

All these subactivities are done by the corresponding designers, for instance, the HVAC design is done by the HVAC designer. These individual designers are not shown in Figure 36.

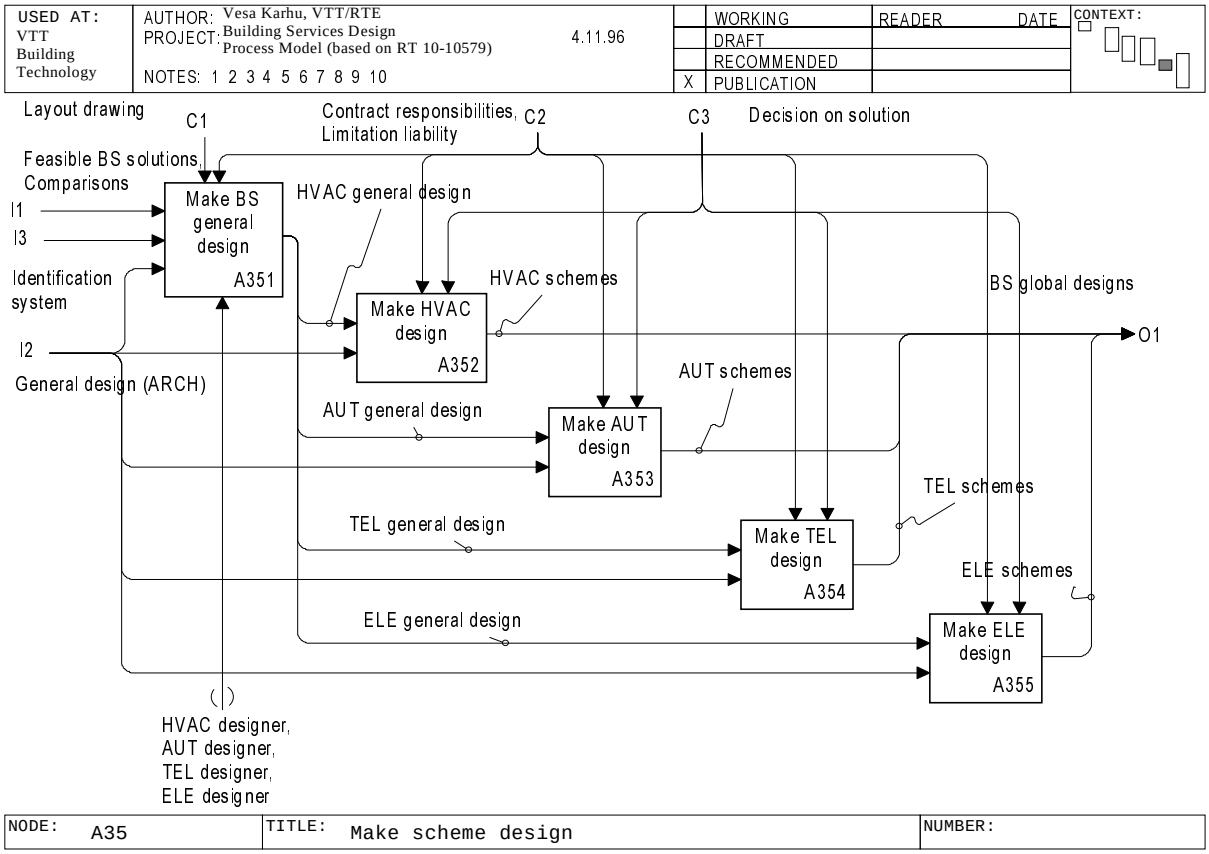


Figure 36. Make scheme design.

Electrical design includes:

- space (room) and isolation classes,
- lighting solutions,
- grouping areas,
- capacity, compensation and filtering requirements,
- secured and undisturbed usage,
- energy measurements,
- control systems and requirements, and
- disturbance and protection principles.

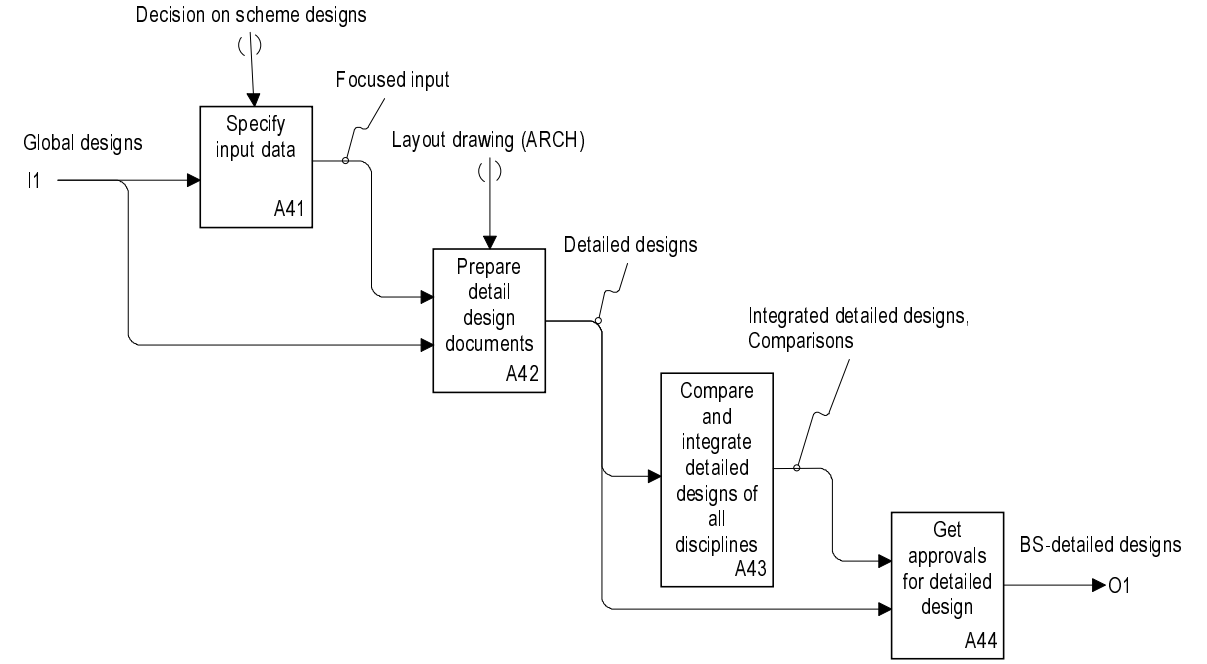
A4 MAKE DETAIL DESIGN

Procurements are decided in detail design (Figure 37). Documents are prepared for procurement. All these disciplines have some common tasks which are presented as one activity. The compatibility of all designs is checked on upper level A43.

General design involves the following:

- check input data,
- specify data exchange,
- design systems and equipment in detail,
- functional descriptions,
- technical and material requirements,
- equipment identification,
- integration of systems,
- contract limits, and
- voids and holes.

USED AT:	AUTHOR: Vesa Karhu, VTT/RTE				CONTEXT:
VTT Building Technology	PROJECT: Building Services Design Process Model (based on RT 10-10579)	4.11.96		WORKING / DRAFT / RECOMMENDED / PUBLICATION	READER DATE
	NOTES: 1 2 3 4 5 6 7 8 9 10		X	PUBLICATION	



NODE: A4	TITLE: Make detailed design	NUMBER:

Figure 37. Make detailed design.

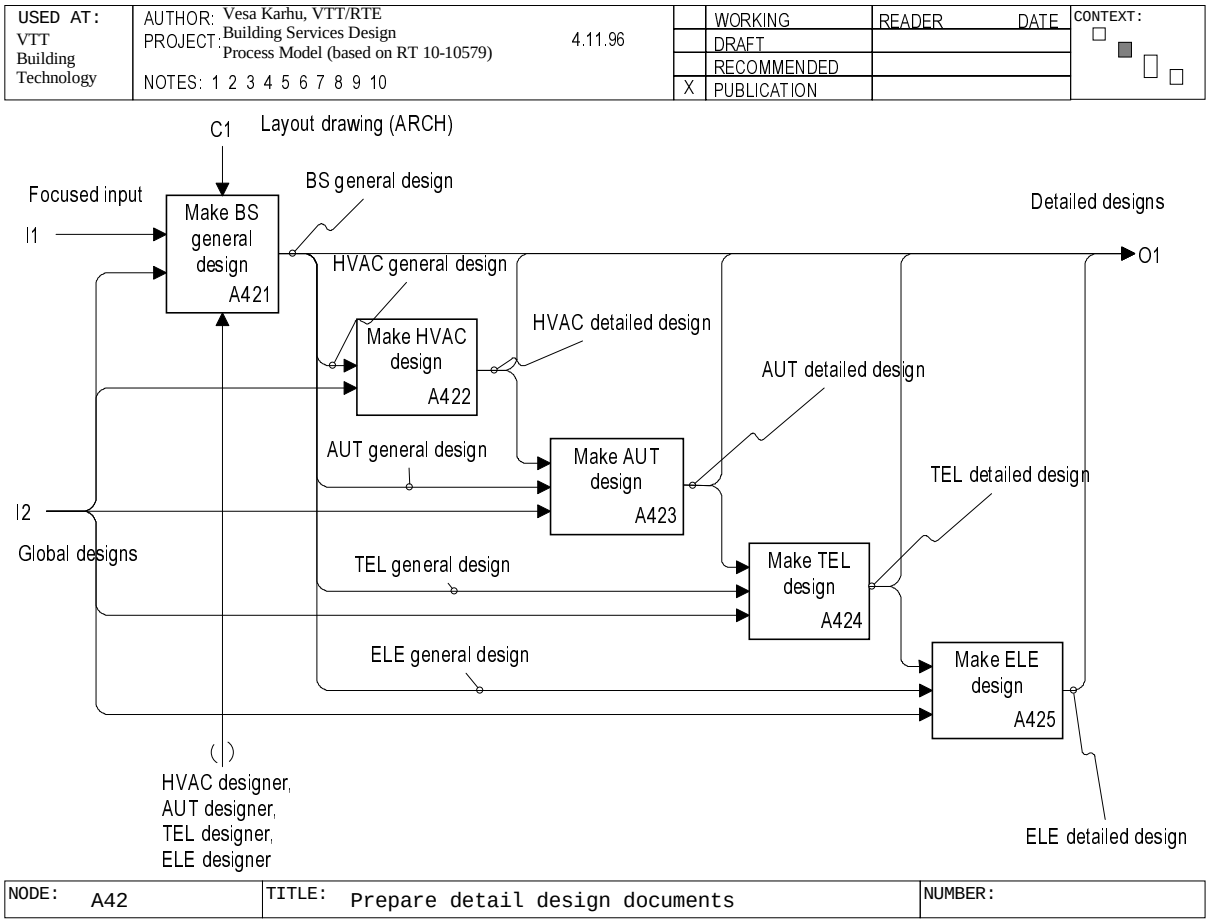


Figure 38. Prepare detail design documents.

A41 Make detailed design

Detail design is accomplished for all BS disciplines (Figure 38). The detail design includes following parts of each discipline.

HVAC includes:
- calculation of heating and cooling need of rooms,
- define and design room equipment,
- pipelines, control, adjustment, and
- define and design main distribution equipment.

Building automation includes:
- process control, methods, usage principles,
- adjustment functions,
- electrical and program interlocking,
- monitoring and control systems,
- software requirements,
- requirements on control, distribution, and field equipments,
- remote connections, reporting requirements, and
- user interfaces.

Telecommunication includes:

- specify point-positions,
- damping calculation, circuit values,
- wire-routings,
- check external disturbance and protection,
- protection against sabotage, and
- distribution central, switch cabinets.

Electrical design includes:

- lighting-fixture specification,
- wire-routings,
- distribution systems and switchboards,
- service areas,
- control systems and solutions, and
- final electrical point-position.

A5 DO DESIGN TASKS DURING CONSTRUCTION

These tasks do not usually belong to building services design. If needed the following tasks may be done:

- usage and maintenance plan,
- checking the contractor's designs
- general supervision concerning building services
- montage and equipment inspections, and
- tests and coordination

A taking over inspection could also be included in additional tasks.

A6 DO TASKS DURING USAGE AND MAINTENANCE

Most activities deal with inspection and checking of the functions of building services installations. Some general supervision may be imposed. The activities continue until the warranty period has elapsed.

LIST OF ACTIVITIES

English

[A0] Produce and manage building service design data

[A1] Draw up brief
- [A11] Survey existing premises
- [A12] Specify design objectives
- [A13] Determine alternatives for space acquisitions
- [A14] Prepare programme decision

[A2] Make programme
- [A21] Check and complement input and compare and demonstrate BS alternatives
- [A22] Clear building site concerning BS
- [A23] Take part in defining schedule and mode of operation
- [A24] Specify BS design objectives
- [A25] Compare and integrate objectives of all disciplines
- [A26] Get acceptance for programme

[A3] Make global design
- [A31] Start global design
- [A32] Compare site usage and masses as regards BS and make BS proposed solutions
- [A33] Compare design solutions of all design disciplines and costs of BS solutions
- [A34] Choose and get approvals for BS design solutions and compare and integrate design solutions of BS disciplines
- [A35] Make scheme design
  - [A351] Make BS-general design
  - [A352] Make HVAC design
  - [A353] Make AUT design
  - [A354] Make TEL design
  - [A355] Make ELE design

Finnish

[A0] Tuota ja hallitse TATE-suunnittelun tiedot

[A1] Tee tarveselvitys
- [A11] Kartoita olemassa olevat tilat
- [A12] Määrittele suunnittelutavoitteet
- [A13] Selvitä tilanhankintavaihtoehdot
- [A14] Valmistele hankepäätös

[A2] Tee hankesuunnittelu
- [A21] Tarkista ja täydennä lähtötiedot sekä vertaile ja havainnollista taloteknisiä vaihtoehtoja
- [A22] Selvitä rakennuspaikka taloteknisesti
- [A23] Osallistu hankkeen ajoituksen ja toteutustavan suunnitteluun
- [A24] Määritä talotekniset suunnittelutavoitteet
- [A25] Vertaile ja yhteensovita eri suunnittelualojen suunnittelutavoitteet
- [A26] Hyväksytä hankesuunnitelma

[A3] Tee luonnossuunnittelu
- [A31] Käynnistä luonnossuunnittelu
- [A32] Vertaile tontinkäyttö- ja massoitteluvaihtoehtoja talotekniikan osalta sekä laadi talotekniset ehdotukset
- [A33] Vertaile eri suunnittelualojen ratkaisuja ja taloteknisten ratkaisujen kustannuksia
- [A34] Valitse ja hyväksytä toteutettavat talotekniset ratkaisut sekä vertaile ja yhteensovita eri suunnittelualojen ratkaisut
- [A35] Laadi luonnossuunnitelma-asiakirjat
  - [A351] Tee TATE-yleissuunnittelu
  - [A352] Tee LVI-suunnittelu
  - [A353] Tee RAU-suunnittelu
  - [A354] Tee TEL-suunnittelu
  - [A355] Tee SÄH-suunnittelu

[A36] Compare and integrate global designs, check cost and maintenance objectives and get approvals for global designs	[A36] Vertaile ja yhteensovita eri suunnittelualojen luonnossuunnitelmat, tarkista kustannus- ja ylläpitotavoitteet ja hyväksytä luonnossuunnitelma
[A4] Make detailed design	**[A4] Tee toteutussuunnittelu**
[A41] Specify input data	[A41] Tarkenna toteutussuunnittelun lähtötiedot
[A42] Prepare detail design documents	[A42] Laadi toteutussuunnitelma-asiakirjat
[A421] Make BS general design	[A421] Tee TATE-yleissuunnittelu
[A422] Make HVAC design	[A422] Tee LVI-suunnittelu
[A423] Make AUT design	[A423] Tee RAU-suunnittelu
[A424] Make TEL design	[A424] Tee TEL-suunnittelu
[A425] Make ELE design	[A425] Tee SÄH-suunnittelu
[A43] Compare and integrate detailed designs of all disciplines	[A43] Vertaile ja yhteensovita eri suunnittelualojen toteutussuunnitelmat
[A44] Get approvals for detailed design	[A44] Hyväksytä toteutussuunnitelma
[A5] Manage tasks during construction stage	**[A5] Tee rakentamisvaiheen tehtävät**
[A6] Do tasks for usage and maintenance	**[A6] Tee käyttöön ja ylläpitoon liittyvät tehtävät**

LIST OF FLOWS

English	Finnish
Alternatives (BS point of view)	Vaihtoehdot TATE-näkökohdasta
ARCH proposed solution, STR proposed solution, GEO proposed solution, INT proposed solution	ARK-ehdotus, RAK-ehdotus, GEO-ehdotus, SIS-ehdotus
ARCH scheme, STR scheme, GEO scheme, INT scheme	ARK-luonnos, RAK-luonnos, GEO-luonnos, SIS-luonnos
AUT detailed design	RAU-toteutussuunnitelmat
AUT general design	RAU-yleisuunnitelma
AUT schemes	RAU-luonnossuunnitelmat
Basic alternatives (ARCH)	Vaihtoehtojen periaateratkaisut (ARK)
Basic solution (masses) (ARCH) • Basic solution is received from the architect.	Periaateratkaisu (massoittelu) (ARK) • Periaateratkaisu saadaan arkkitehdiltä.
BS brief	TATE-tarveselvitys
BS design data	TATE-suunnittelutiedot
BS design objectives	Talotekniset suunnittelutavoitteet
BS designer • Building services designers are HVAC, building automation, telecommunications and electrical designers.	TATE-suunnittelija • Talotekniset suunnittelijat ovat LVI-, rakennusautomaatio, tele- ja sähkösuunnittelijat.
BS detailed designs	TATE-toteutussuunnitelmat
BS general design	TATE-yleissuunnitelma
BS global designs	TATE-luonnossuunnitelma
BS programme	TATE-hankesuunnitelma
BS quality objectives, BS design alternatives, Space needs, Points concerning positioning of spaces, Structural safety objectives, Structural disturbance protection objectives, Drift material consumption (thermal, water, electricity), Investment costs, Maintenance costs	Talotekniset laatutasotavoitteet, Talotekniset ratkaisuvaihtoehdot, Tilantarpeet ja tilojen sijoitteluun liityvät näkökohdat, Rakenteelliset turvallisuus- ja häiriösuojanäkökohdat, Kiinteistönhoidon menekki Käyttöainemenekki (lämpö, vesi, sähkö), Investointi- ja ylläpitokustannukset
BS survey of existing premises	Olemassa olevien tilojen talotekninen kartoitus

Building services needs	Talotekniset tarpeet
CAD instructions (software and versions, designer specified instructions for CAD drawings, data exchange, output, databases, utilization of design information in maintenance)	CAD-suunnitteluohje (käytettävät atk-ohjelmat ja versiot, suunnittelijakohtaiset CAD-piitämisohjeet, tiedosiirto, tulostukset, tietokantojen käyttö, suunnittelutiedon hyödyntäminen ylläpidossa)
Checked input, Additions, Demonstration of alternatives	Tarkistetut lähtötiedot, Täydennykset, Vaihtoehtojen esitys
Comment on mode of operation, Comment on schedule, Checks, Additions	Toteutustapakannnotto, Tarkistukset Täydennykset
Comment, Checks, Additions for others, BS schemes	Kannanotto, Tarkistukset, Täydennykset muille, TATE-luonnokset
Comments, Additions, Checkings	Kannanotto, Tarkistukset, Täydennykset
Comparisons of solutions, BS cost comparisons (investment costs, maintenance costs, energy consumption, reciprocal cost effects)	Ratkaisujen vertailu TATE-kustannusten vertailu (investointi- ja ylläpitokustannukset, ernergiankulutus, järjestelmien keskinäiset kustannusvaikutukset)
Connections to external networks and systems, Easements and servitudes on site, Environmental conditions	Liittymät ulkopuolisiin verkostoihin, Tontilla olevat rasitteet, Ympäristöolosuhteet
Contract responsibilities, Limitation liability	Sopimusrajat, Urakkarajat
Control, Takeover inspection	Takuutarkastukset, vastaanottotarkistus
Controlled construction	Valvottu rakentaminen
Decision on solution	Päätös suunnitteluratkaisusta
Decision on scheme designs	Päätös luonnossuunnitelmasta
Description of alternatives, Integration possibilities, Modification possibilities, Connections to existing systems, Functionality of special spaces	Vaihtoehtojen kuvaus, Järjestelmien integrointimahdollisuudet, Järjestelmien muunneltavuus, Liittyminen olemassa oleviin järjestelmiin, Erikoistilojen toimivuus
Design instructions (CL)	Suunnitteluohje (RAP)
Detailed designs	Toteutussuunnitelmat
ELE detailed design	SÄH-toteutussuunnitelma
ELE general design	SÄH-yleissuunnitelma
ELE schemes	SÄH-luonnossuunnitelmat
Existing premises	Olemassa olevat tilat

Feasible BS solutions, Comparisons	Toteutettavat talotekniset ratkaisut, Vertailut
Focused input	Tarkennetut lähtötiedot
General design (ARCH)	Yleissuunnitelma (ARK)
Global designs	Luonnossuunnitelmat
HVAC designer, AUT designer, TEL designer, ELE designer	LVI-suunnittelija, RAU-suunnittelija, TEL-suunnittelija, SÄH-suunnittelija
HVAC detailed design	LVI-toteutussuunnitelmat
HVAC general design	LVI-yleissuunnitelma
HVAC schemes	LVI-luonnossuunnitelmat
Identification system	Laitetunnusjärjestelmä
Integrated detailed designs, Comparisons	Yhteensovitetut toteutussuunnitelmat Vertailut
Integrated objectives, Comparisons	Yhteensovitetut tavoitteet, Vertailut
Investment decision	Investointipäätös
Layout drawing	Asemapiirustus
Layout drawing (ARCH)	Asemapiirustus (ARK)
Preliminary layout drawing (ARCH)	Alustava asemapiirustus (ARK)
Programme (CL)	Hankesuunnitelma (RAP)
Project brief (CL)	Tarveselvitys (RAP)
Regulations concerning building services	Taloteknisiä järjestelmiä koskevat määräykset ja ohjeet
Resources	Resurssit
Schedule proposal (CL), Proposal on mode of operation (CL)	Hankkeen ajoitusehdotus (RAP), Toteutustapaehdotus (RAP)
Site alternatives (ARCH)	Tontikäyttövaihtoehdot (ARK)
Space programme(ARK)	Tilaohjelma (ARK)
Specified input	Tarkennetut lähtötiedot
Technical layout drawing, BS constructability, Environmental effects on BS	Tekninen asemapiirustus, Talotekninen rakennettavuus, Ympäristön vaikutukset talotekniikkaan
TEL detailed design	TEL-toteutussuunnitelmat
TEL general design	TEL-yleissuunnitelma
TEL schemes	TEL-luonnossuunnitelmat

SECTION E:
GEOTECHNICAL DESIGN PROCESS MODEL

Table of contents

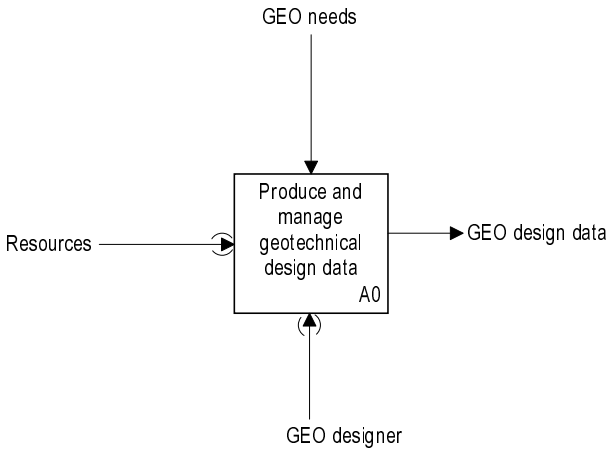
ACTIVITY MODEL

A-0 MODEL SCOPE

The process is divided into six different stages. These are briefing, programming, global design, detail design and design during construction and use and maintenance stages. The A-0 diagram is shown in Figure 39.

Briefing and programming usually belong to the client's work (see Section A).

USED AT: VTT Building Technology	AUTHOR: Vesa Karhu, VTT/RTE PROJECT: GEO-design process model (based on GEO 95, RT 10-10580) NOTES: 1 2 3 4 5 6 7 8 9 10	4.11.96	WORKING DRAFT RECOMMENDED PUBLICATION	READER DATE	CONTEXT: Top



NODE: A-0	TITLE:	NUMBER:

Figure 39. Model scope.

A0 PRODUCE AND MANAGE GEOTECHNICAL DESIGN DATA

The presented design process model is shown in Figure 40.

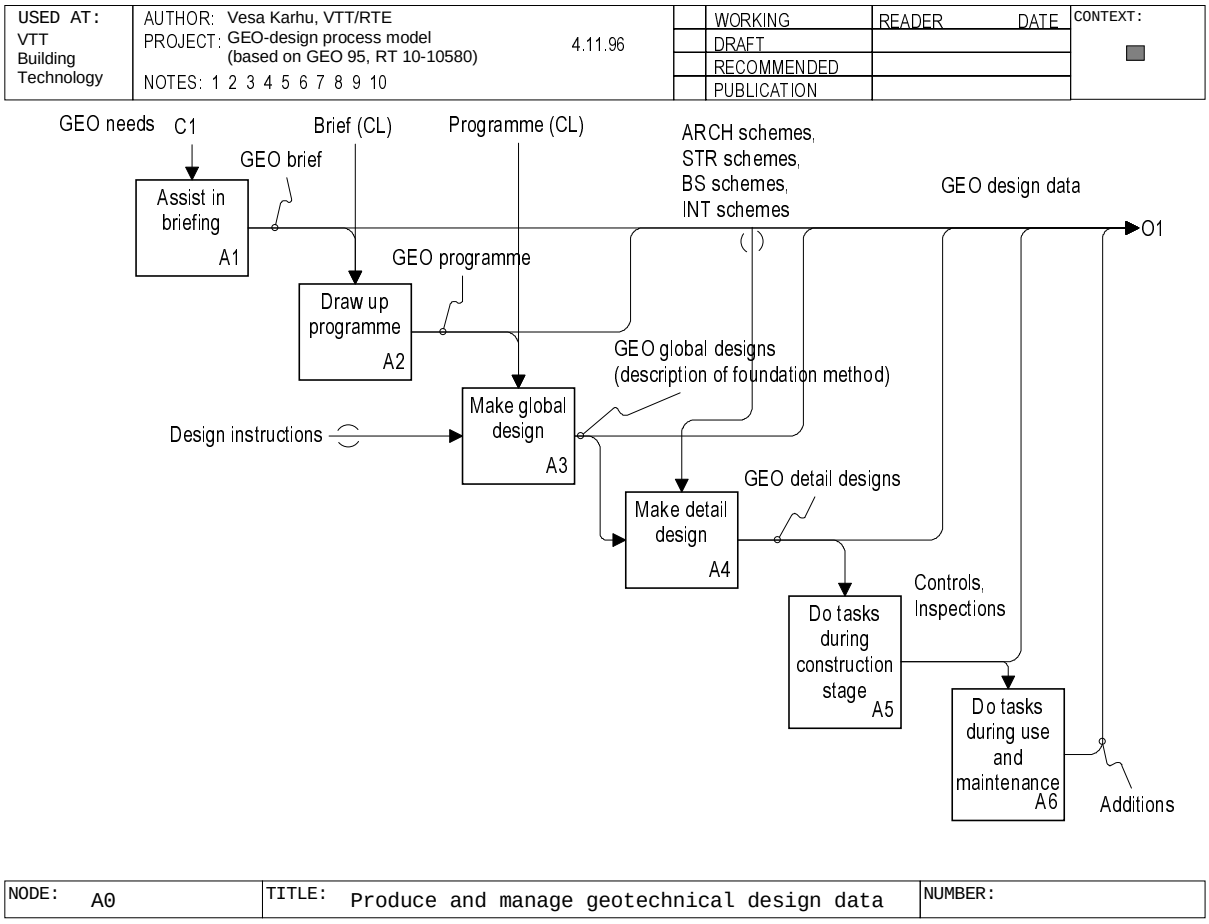


Figure 40. Produce and manage geotechnical design data.

In briefing and programming, needs are surveyed from the geotechnical point of view. The results of briefing and programming are gathered into a common project brief and programme which are synthesized in the client's work. In geotechnical design briefing and programming are considered as complemenatry to the client's work (see Section A).

A1 DRAW UP BRIEF

Briefing is not usually included in the geotechnical design tasks. If needed, an analysis of existing premises is carried out. Design requirements are determined. Space acquisition alternatives may also be assessed. Finally, a decision on the programme is made.

Space acquisition alternatives concern new building, renting or renovation.

A2 DRAW UP PROGRAMME

The geotechnical programme (Figure 41) complements the programme of the client's work. The input data is checked and completed. The requirements concerning geotechnical matters are included.

Design objectives are defined and existing geotechnical information are assembled into a document.

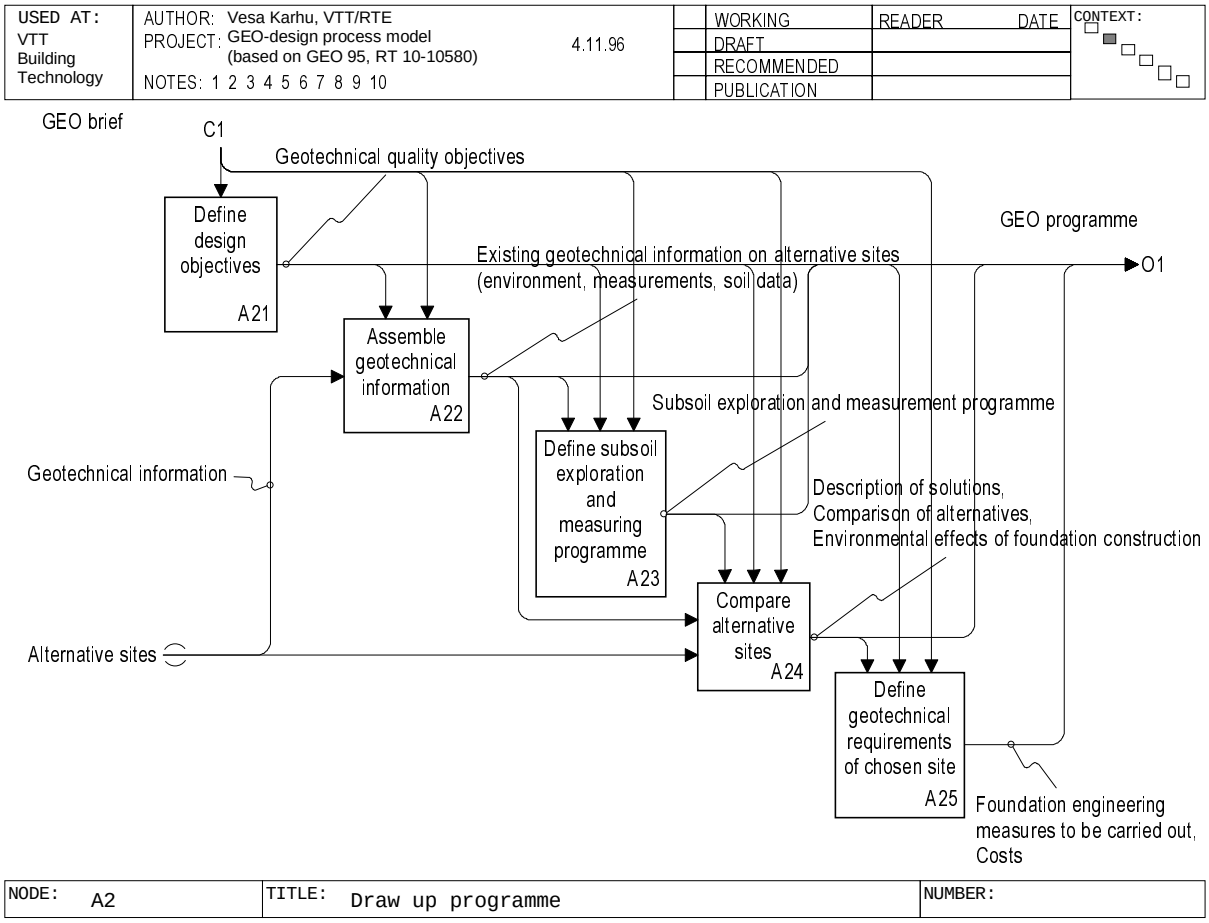


Figure 41. Draw up programme.

A3 MAKE GLOBAL DESIGN

Global design (Figure 42) starts with checking and complementing of the programme. The programme is used as input for this activity. Alternatives, a proposed solution and, finally, schemes are prepared.

Building design is started in conjunction with other design disciplines. The first actual geotechnical design task is to design alternatives which means that existing geotechnical information is gathered and a programme for additional experiments is agreed on. Also, descriptions of foundation types and methods are assembled.

The proposing of a solution involves more cooperation with other designers. A solution proposed from architectural design is needed as a control. The proposed solution includes

- foundation,
- underground spaces,
- excavations,
- drainage,
- subsoil structures,
- foundation, drainage and structure of yard, and
- underdrains.

The proposed solution takes into account aspects concerning ground water, environment, foundations to neighbouring buildings, further usage of excavated material, time and radiation.

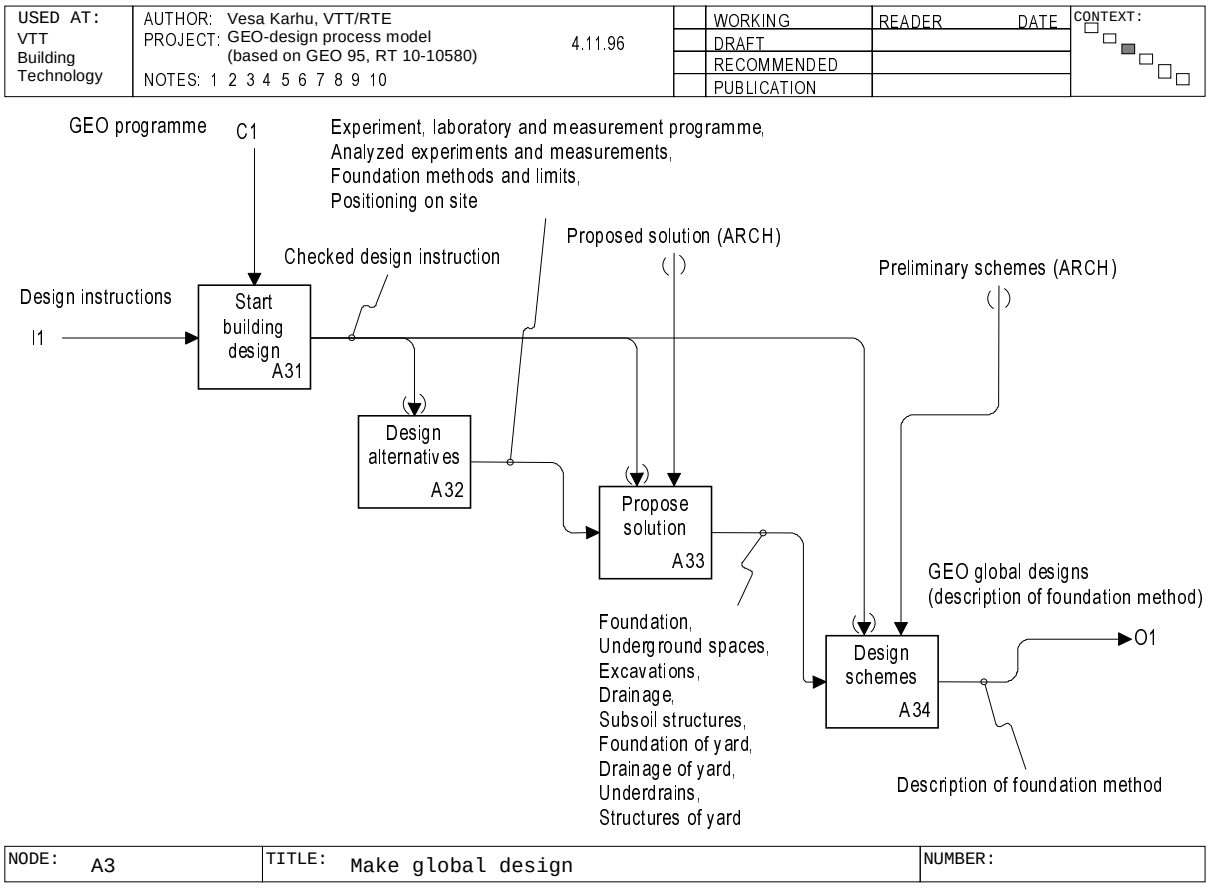


Figure 42. Make global design.

A4 MAKE DETAIL DESIGN

Detail design (Figure 43) is divided into three activities. Approved global designs of other design disciplines are used as controls. Geotechnical schemes shall also be approved earlier. The detailed designs do include

- output and documentation plan,
- analyzed experiments and measurements,
- designs for foundations of building,
- foundation of yard,
- subsoil drainage plan,
- plat of bottom and tubing plan,
- foundation structures plan, and
- excavation and bottom stoping plan.

A suffient number of drawings and other documents are provided.

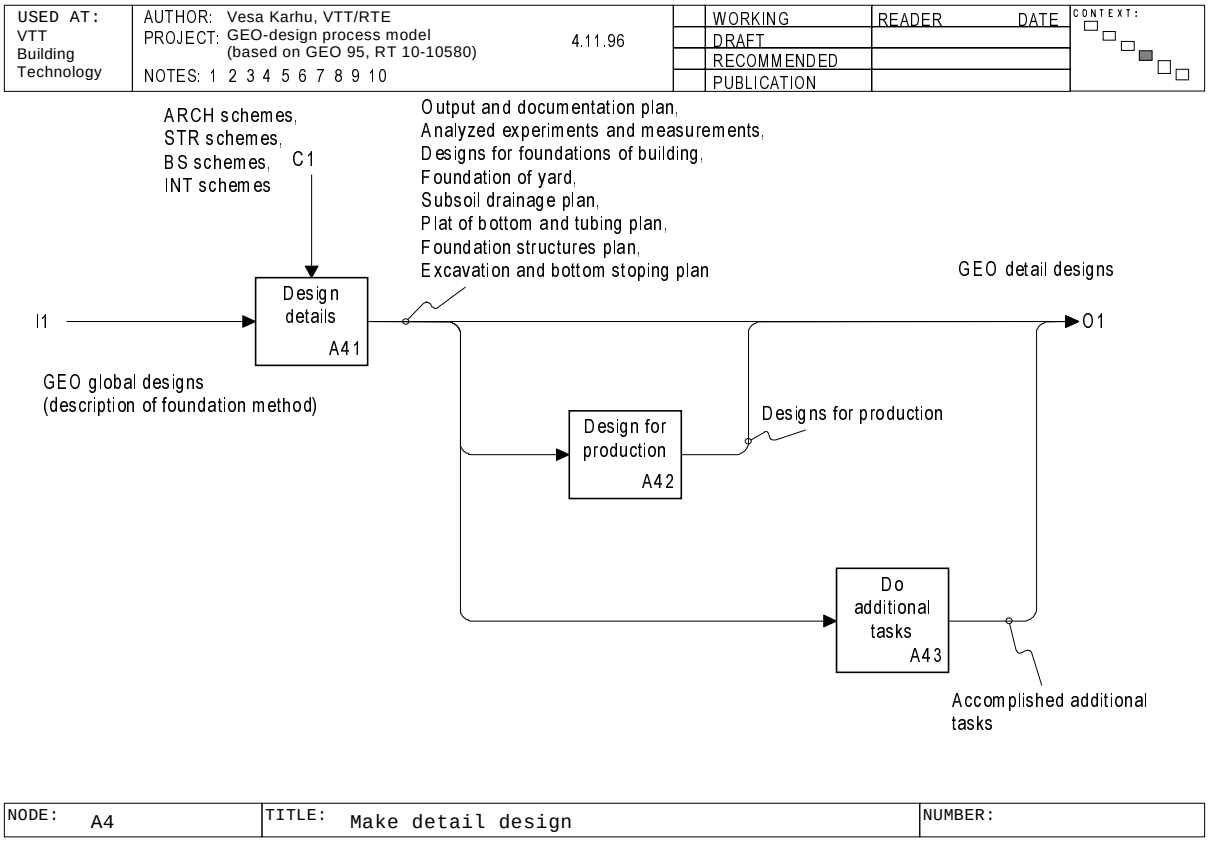


Figure 43. Make detail design.

A5 MAKE TASKS DURING CONSTRUCTION STAGE

Tasks during the construction stage include inspections and overall supervision. The activity ends at the taking over decision.

A6 DO TASKS DURING USE AND MAINTENANCE

This activity contains only additional tasks that are done during the initial phases of the use and maintenance. These activities are normally deal with measurements of ground water, subsidence and displacement of foundation. Ground frost is taken into account in the nordic countries.

LIST OF ACTIVITIES

English	Finnish
[A0] Produce and manage geotechnical design data	**[A0] Tuota ja hallitse GEO-suunnittelun tiedot**
[A1] Assist in briefing	**[A1] Avusta tarveselvityksessä**
[A2] Draw up programme	**[A2] Tee hankesuunnittelu**
[A21] Define design objectives	[A21] Määrittele suunnittelutavoitteet
[A22] Assemble geotechnical information	[A22] Kokoa pohjatutkimustiedot
[A23] Define subsoil exploration and measuring programme	[A23] Laadi pohjatutkimus- ja mittausohjelma
[A24] Compare alternative sites	[A24] Vertaile sijaintivaihtoehtoja
[A25] Define geotechnical requirements of chosen site	[A25] Määrittele valitun sijaintipaikan pohjarakentamisedellytykset
[A3] Make global design	**[A3] Tee luonnossuunnittelu**
[A31] Start building design	[A31] Käynnistä rakennussuunnittelu
[A32] Design alternatives	[A32] Laadi ratkaisuvaihtoehtoja
[A33] Propose solution	[A33] Laadi ehdotus
[A34] Design schemes	[A34] Laadi luonnos
[A4] Make detail design	**[A4] Tee toteutussuunnittelu**
[A41] Design details	[A41] Laadi toteutussuunnitelma
[A42] Design for production	[A42] Laadi tuotantosuunnitelmat
[A43] Do additional tasks	[A43] Tee täydentävät tehtävät
[A5] Do tasks during construction stage	**[A5] Tee rakennusaikaiset tehtävät**
[A6] Do tasks concerning takeover	**[A6] Tee käyttöönottoon liittyvät tehtävät**

LIST OF FLOWS

English	Finnish
Additions	Lisäykset
Alternative sites	Sijanintivaihtoehdot
ARCH schemes, STR schemes, BS schemes, INT schemes	ARK-luonnos, RAK-luonnos, TATE-luonnos, SIS-luonnos
Brief (CL) • brief from the client's work	Tarveselvitys (RAP) • rakennuttajan tarveselvitys
Checked design instruction	Tarkistettu suunnitteluohje
Description of foundation method	Perustamistapaselvitys
Description of solutions, Comparison of alternatives, Environmental effects of foundation construction	Ratkaisumallien kuvaus, Vaihtoehtovertailu, Pohjarakentamisen ympäristövaikutusselvitys
Design instructions	Suunnitteluohje
Existing geotechnical information on alternative sites (environment, measurements, soil data)	Vaihtoehtoisten sijaintipaikkojen pohjasuhde-, mittaus- ja ympäristötiedot
Foundation engineering measures to be carried out, Costs	Valitun sijaintipaikan pohjarakennustoimenpiteet, kustannukset ja rakentamisedellytykset
Foundation, Underground spaces, Excavations, Drainage, Subsoil structures, Foundation of yard, Drainage of yard, Underdrains, Structures of yard	Perustaminen, Maanalaiset tilat, Kaivannot, Kuivanapito, Maarakenteet, Piha-alueiden perustaminen, Piha-alueiden kuivanapito, Putkilinjojen perustaminen, Kaivannot, Pihojen rakenneratkaisut
GEO brief	GEO-tarveselvitys
GEO design data	GEO-suunnittelun tiedot
GEO designer	GEO-suunnittelija
GEO detail designs	GEO-toteutussuunnitelmat
GEO global designs (description of foundation method)	GEO-luonnossuunnitelma (perustamistapaselvitys)
GEO needs	GEO-tarpeet
GEO programme	GEO-hankesuunnitelma
Geotechnical information	Pohjatutkimustietoja
Geotechnical quality objectives	Maa- ja pohjarakenteiden laatutavoitteet

Output and documentation plan, Analyzed experiments and measurements, Designs for foundations of building, Foundation of yard, Subsoil drainage plan, Plat of bottom and tubing plan, Foundation structures plan, Excavation and bottom stoping plan

- Documentation plan contains a list of drawings, output method (CAD, drawing scales etc.). It also contains descriptions of foundation works and methods and work specifications. Analyzed experiments are detailed. Designs for building basement contain drawings of basement solution.

Tulostussuunnitelma, Pohjasuhdetarkastelu, Rakennuksen perustamisen suunnitelmat, Piha-alueen perustamissuunnitelma, Salaojitussuunnitelma, Tasaus- ja putkijohtosuunnitelma, Maarakennesuunnitelma, Kaivu- ja louhintasuunnitelma

- Tulostussuunnitelma sisältää piirustusluettelon, tulostustavan (CAD, piirustuskoko). Se sisältää myös pohjarakennusselostukset ja työohjeet. Analysoidut kokeet tarkennetaan. Perustusten piirustukset laaditaan.

Preliminary schemes (ARCH)

Alustavat luonnokset (ARK)

Programme (CL)

Hankesuunnitelma (RAP)

Experiment, laboratory and measurement programme, Analyzed experiments and measurements, Foundation methods and limits, Positioning on site

Luonnosvaiheen tutkimus-, laboratorio- ja mittausohjelma, Analysoidut pohjatutkimus- ja mittaustulokset, Perustamistavat ja pohjarakennusrajaukset, Sijoitus tontilla

Proposed solution (ARCH)

Ehdotus (ARK)

Resources

Resurssit

Subsoil exploration and measurement programme

Pohjatutkimus- ja mittausohjelma

SECTION F:

PRODUCTION PROCESS MODEL

Table of contents

ACTIVITY MODEL

A-0 MODEL SCOPE

The flowcharts of the production process model for a new-building-construction project with the tasks and flows are presented on the following pages. The textual part explains the purpose and goals of an individual task of the model and its subtasks.

The "implement building" task (Figure 44) describes the entire production process that yields a building that corresponds to the client's goals. The "resources" input of the task includes materials, products, services, time, energy and money. Task control is based on project documentation which contains the plans and goals that define the end product and the limiting conditions for erecting the building. The mechanism of the task, ie. its implementer, is indicated to ensure the viewpoint of the model. This process model describes the new-building-construction project from the viewpoint of the main implementer of the production process from the arrival of the invitation to tender to the end of the final guarantee inspection, ie. the traditional tasks of the construction company.

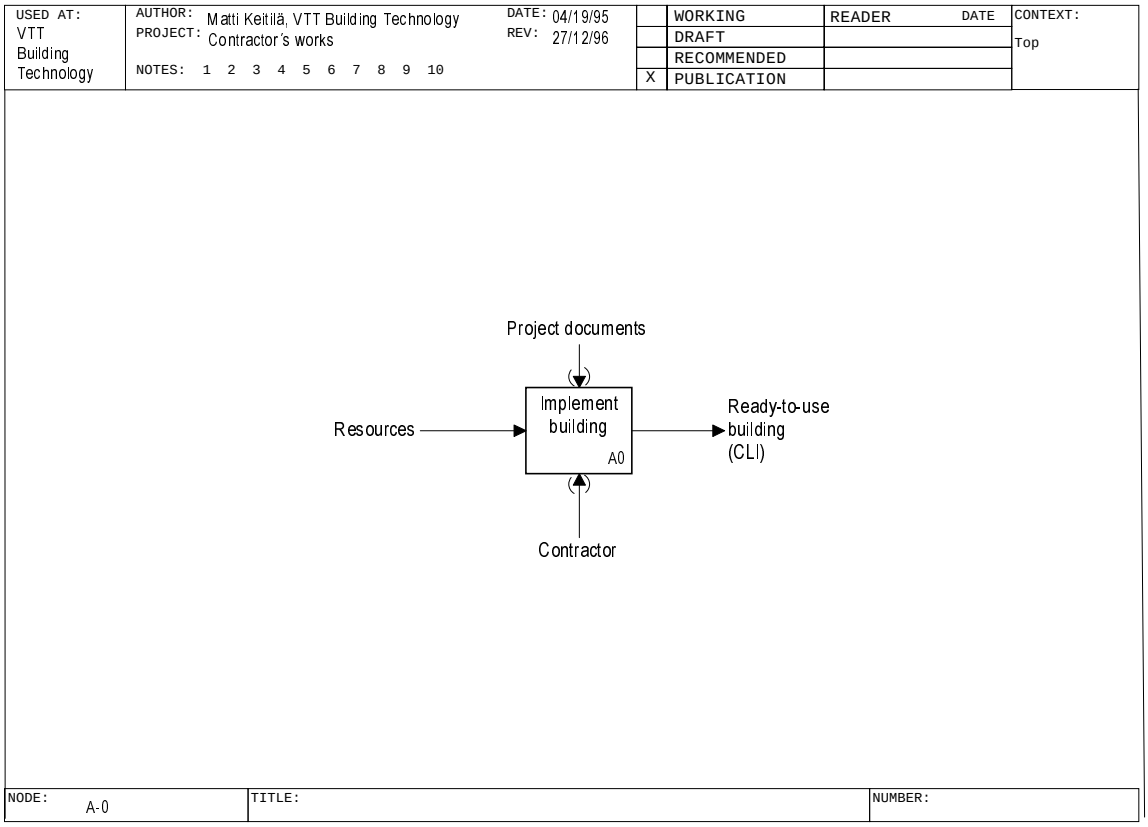


Figure 44. Model scope.

A0 IMPLEMENT BUILDING

The purpose of this task (Figure 45) is to produce a building that conforms to the plans drawn according to the wishes of the client within the agreed time and in accordance with set quality goals. The task also aims to ensure realization of the main contractor's goals for the project such as maintaining the customer relationship, turning a profit and ensuring continued operation. In the model the implementation of the building divides into five subtasks.

At the tender phase of the project an offer is produced for the client concerning project implementation; data that is utilizable if the project is won is also produced at this phase. The "prepare for production" subtask includes activities that are initiated as soon as the contract is signed and need to be completed before construction or the construction phase commences. Production control guides construction in the planned direction. It starts before construction and continues until handover.

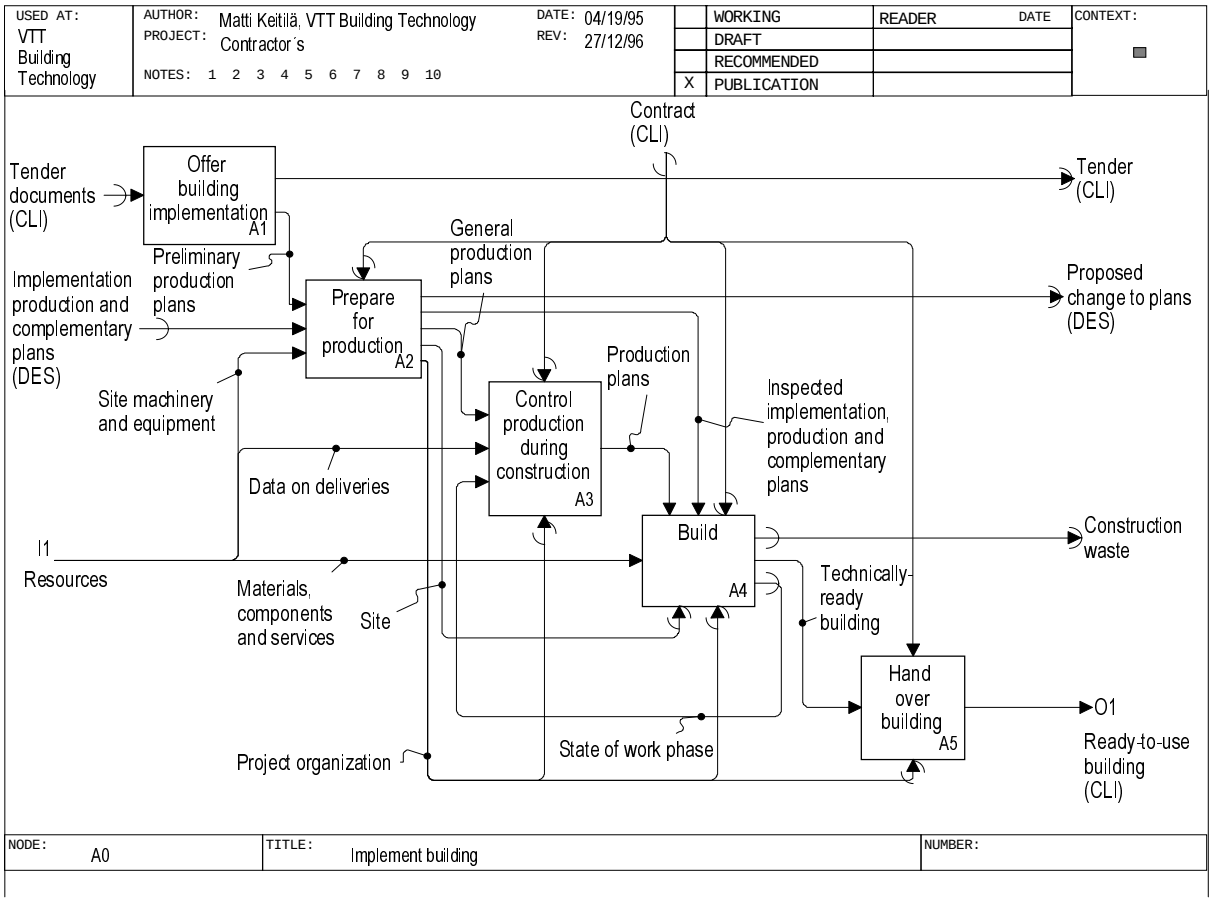


Figure 45. Implement building.

All the preceding subtasks of the production process also serve the attainment of the result of the "build" subtask. The subtask involves all the activities connected to physical construction. The handover phase of the project produces a ready-to-

use building which is the goal of the entire building process. The handover phase is intended to ensure that the technically-ready building meets all set goals.

A1 OFFER BUILDING IMPLEMENTATION

The aim of submitting tenders (Figure 46) is to procure work for the company and to win contracts that meet set requirements of both the client and the implementer. Tendering is to meet the following goals:

- cost targets are to be prepared effectively while also ensuring reliability of cost estimate
- submitted tenders are to be profitable
- tender-related risks are to be manageable
- the tender price is to be set so as to allow winning by a small margin.

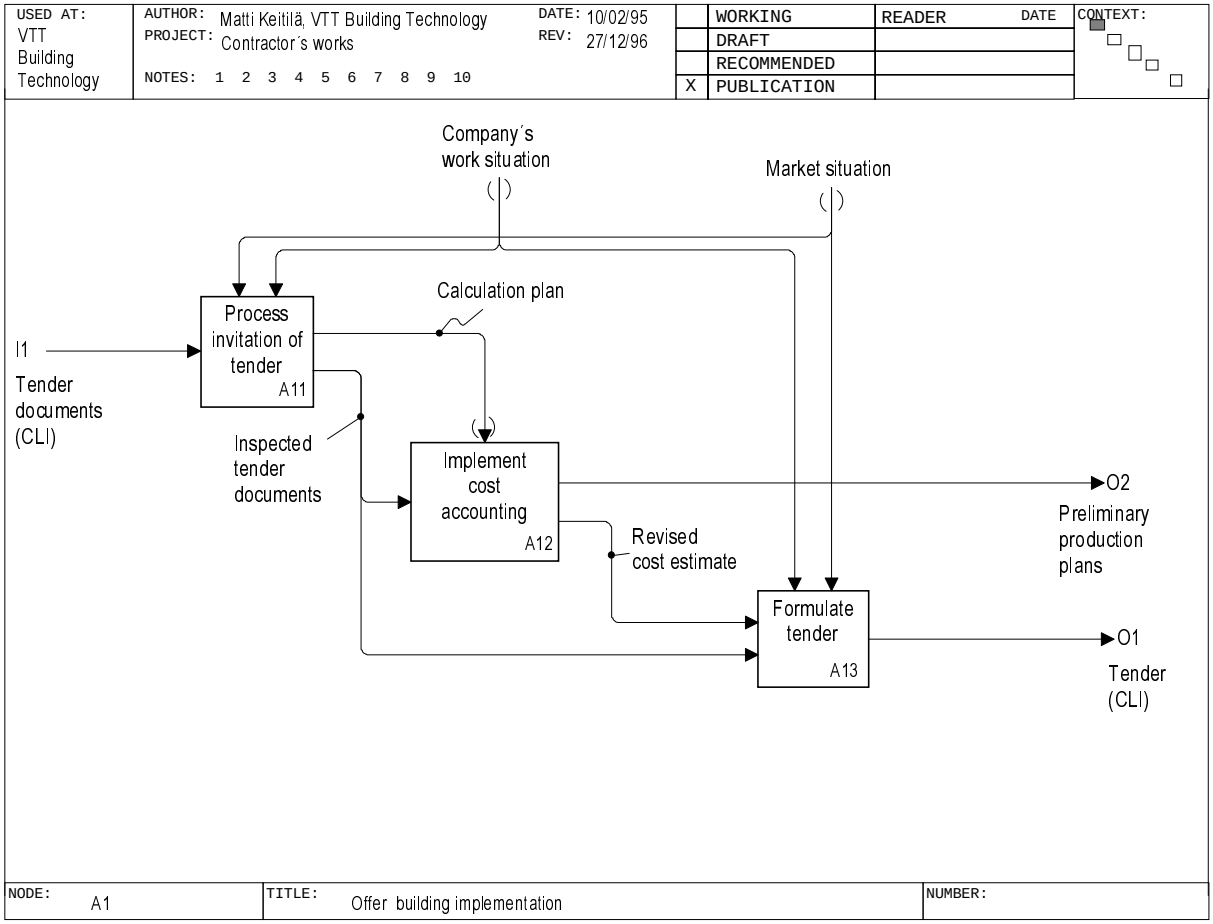


Figure 46. Offer building implementation.

After the invitation to tender is received, the company acquaints itself with the project, decides whether to submit a tender and tender calculations are planned. A cost estimate is prepared using the firm's input files, method files and schedule of prices as well as information derived from the tender documents. The revised cost

estimate and tender documents are used to prepare a tender that is finalized during the negotiations for a contract. The client organizes the negotiations for a contract and, thus, the subtask is not shown in this part of the model. It is ensured during the negotiations that the parties have similar understanding of the plans, the contents and limitations of the contract and the procedure of additional and modification works is agreed on. The need to change plans or the tender price may come up at the negotiations which means that the proposed amendment is sent to those responsible for design or tender calculations. Finally, the contract is signed by the parties.

A11 Process invitation to tender

The purpose of the task (Figure 47) is to familiarize the main implementer thoroughly with the project, produce the decision to do tender calculations in accordance with company policy and to plan implementation of the calculations.

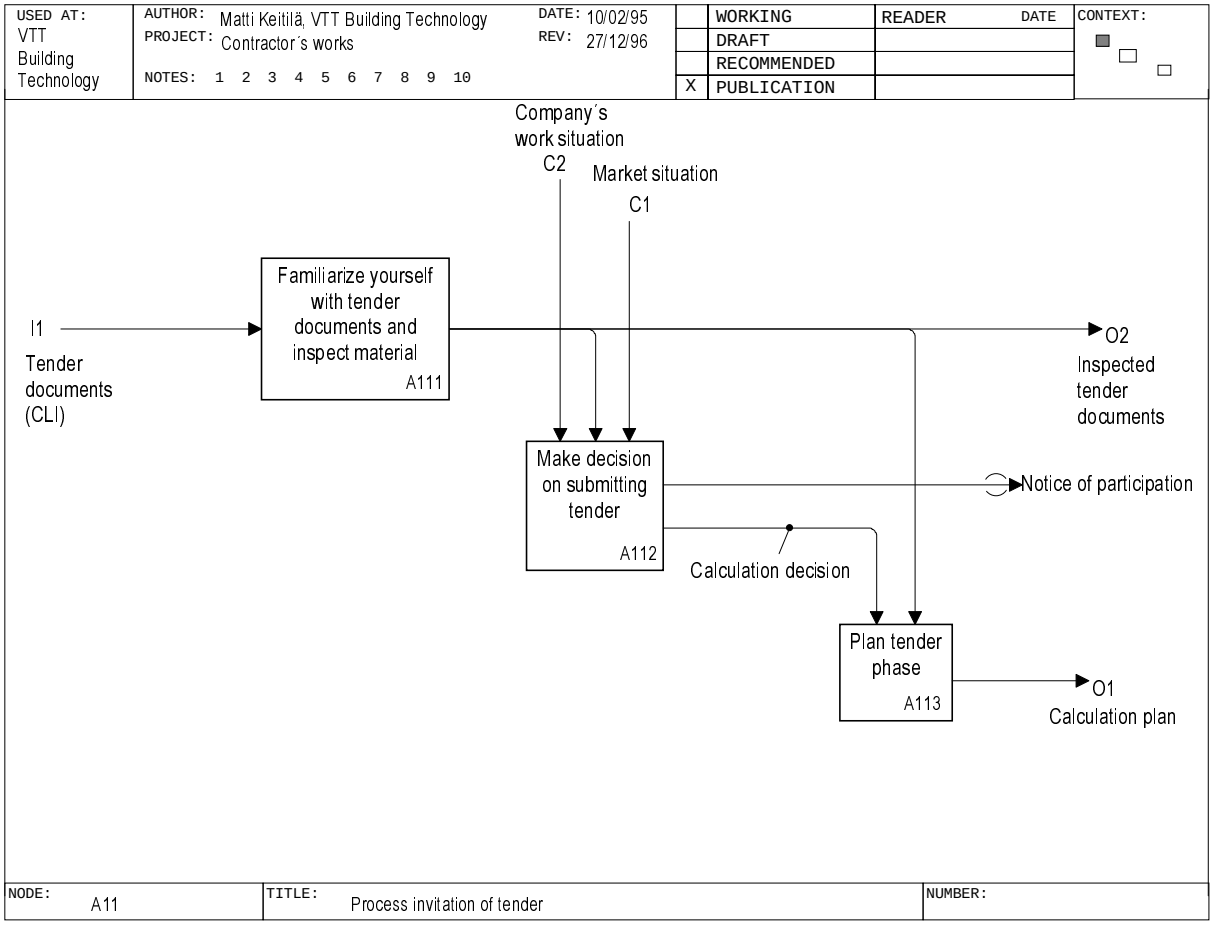


Figure 47. Process invitation to tender.

The first phase of the task involves familiarizing the person responsible for tender calculations in the main implementer's organization with the tender documents and checking for anything missing and asking the party requesting a tender to immediately provide it. When the main implementer has examined and

familiarized himself with the invitation to tender, he decides whether to participate in competitive bidding. The decision to initiate tender calculations is influenced, for instance, by the company's resources and ability to carry through the project according to set goals. The chances of the company winning the contract are also assessed in the same connection.

The party inviting the tender is notified of his inclusion in competitive bidding. Tender calculations are planned in outline including, for instance, definition of tasks, procurements, scope and detailedness of production planning and definition of the nomenclature to be used. A calculation meeting is held in accordance with the calculation plan where the tasks, responsibilities and schedule for the calculation organization are determined.

A12 Implement cost accounting

The purpose of this task (Figure 48) is, for instance, to familiarize the accounting organization with the project and to produce a preliminary production plan initially for the cost estimate and also as a basis for later production planning for

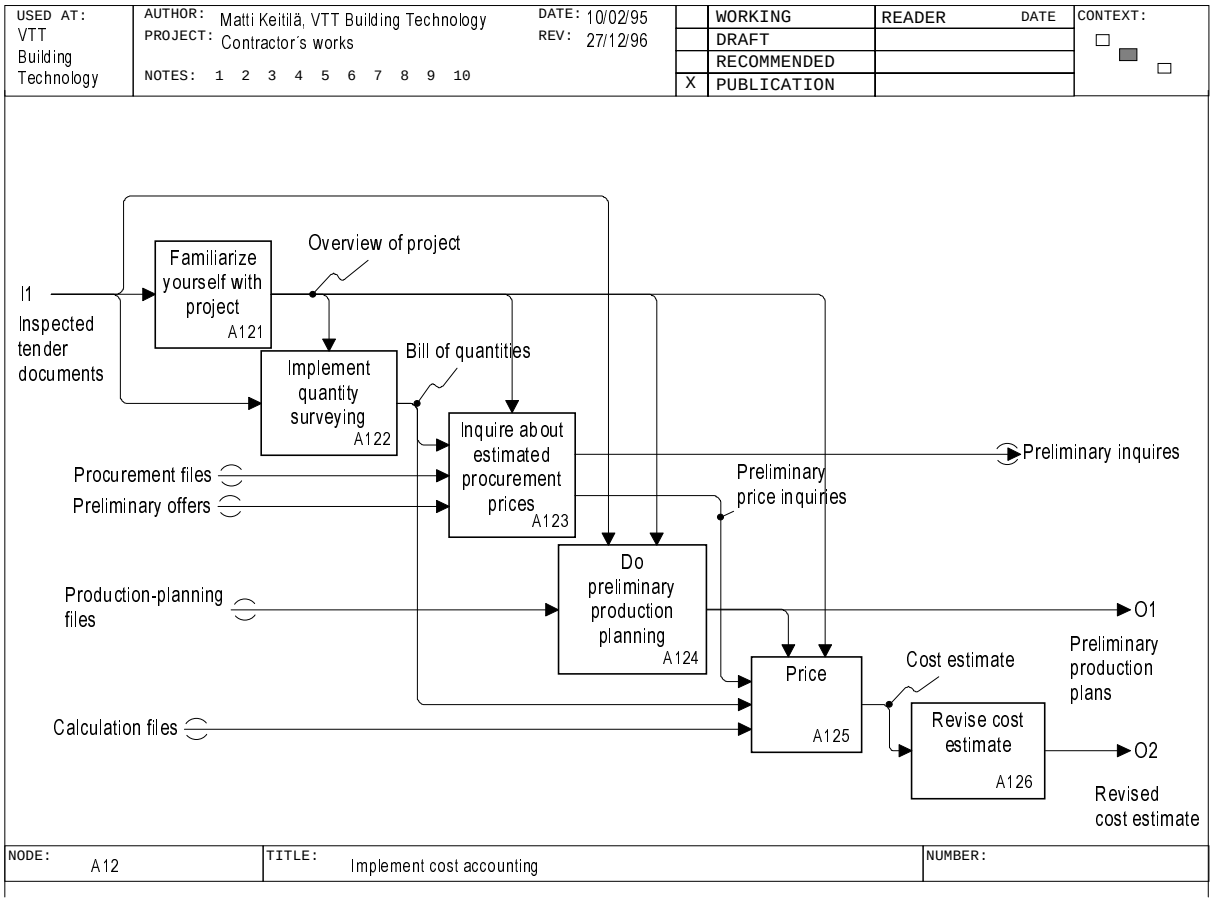


Figure 48. Implement cost accounting.

the project. Cost accounting produces a revised cost estimate for setting the final tender price.

After the accounting organization has familiarized itself with the project, quantity surveying is done by the main implementer or it is contracted out. Preliminary calls for offers regarding agreed-on work entities or procurements are made which provide additional information for a cost estimate. The calls for offers are implemented according to the company's established action plan. The main production methods, need of work-supervision resources, construction time, need of equipment, need of personnel facilities, use of site area and other factors influencing construction costs are defined in preliminary production planning. Finally, the data generated in accounting is compiled and a cost estimate is prepared for the project. The cost estimate is to be revised on the basis of indicators and experience before it is used for a new subtask.

A13 Formulate tender

The purpose of formulating a tender (Figure 49) is get one that can be submitted to the sender of the invitation to tender by the deadline. The goal of the task is a

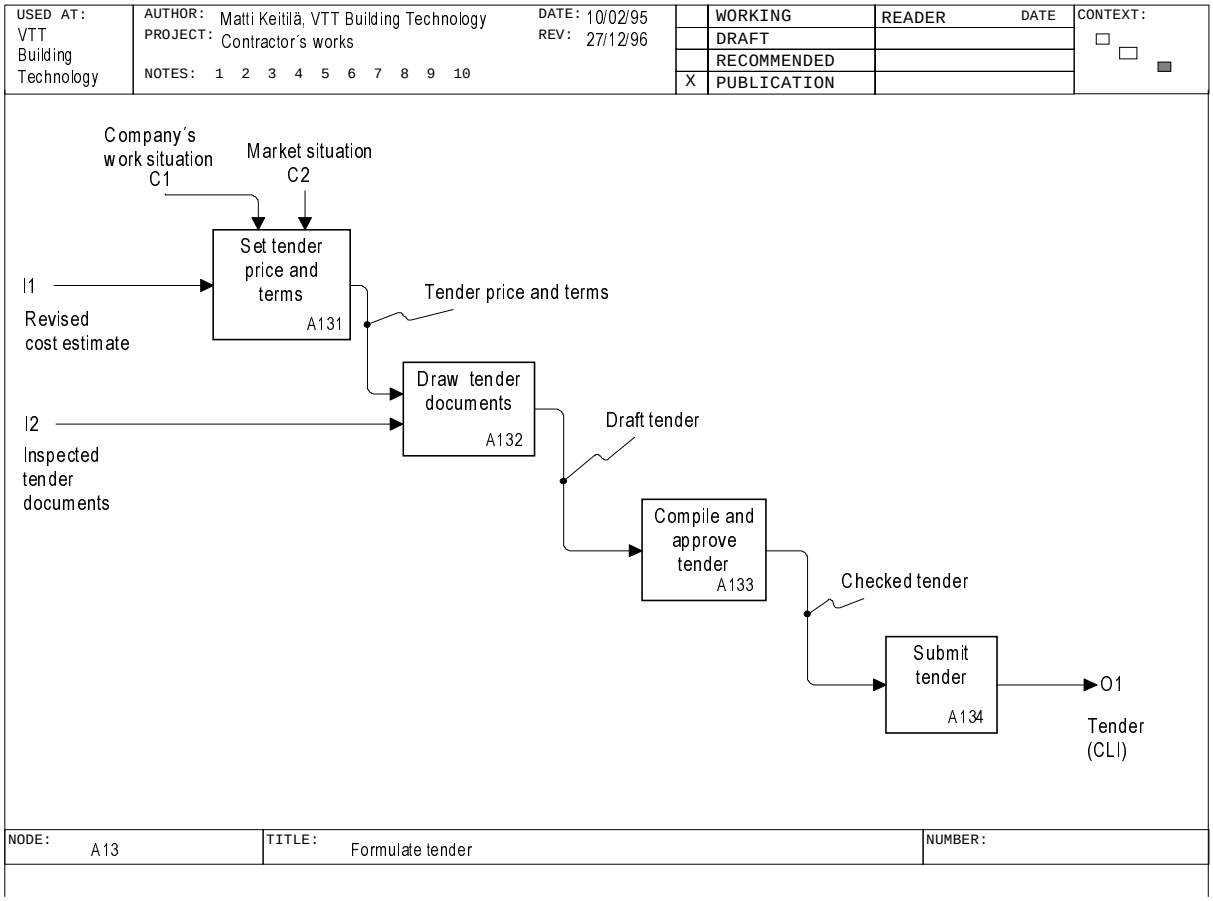


Figure 49. Formulate tender.

tender that wins the competitive bidding by as close a margin as possible.

The first subtask sets the tender price and terms and involves holding a tender meeting where fixed costs, an allowance for risk, an allowance for price increases and the target profit are added to the revised cost estimate according to company policy. The sum is the tender price. Next, the documents required for a tender, such as a schedule, a quality plan, a payment programme and a unit-price list are prepared and compiled. The tender documents and price are finally checked against indicators and experience from previous projects before submitting them.

A2 PREPARE FOR PRODUCTION

The purpose of this task (Figure 50) is to provide conditions for effective and trouble-free implementation of the project.

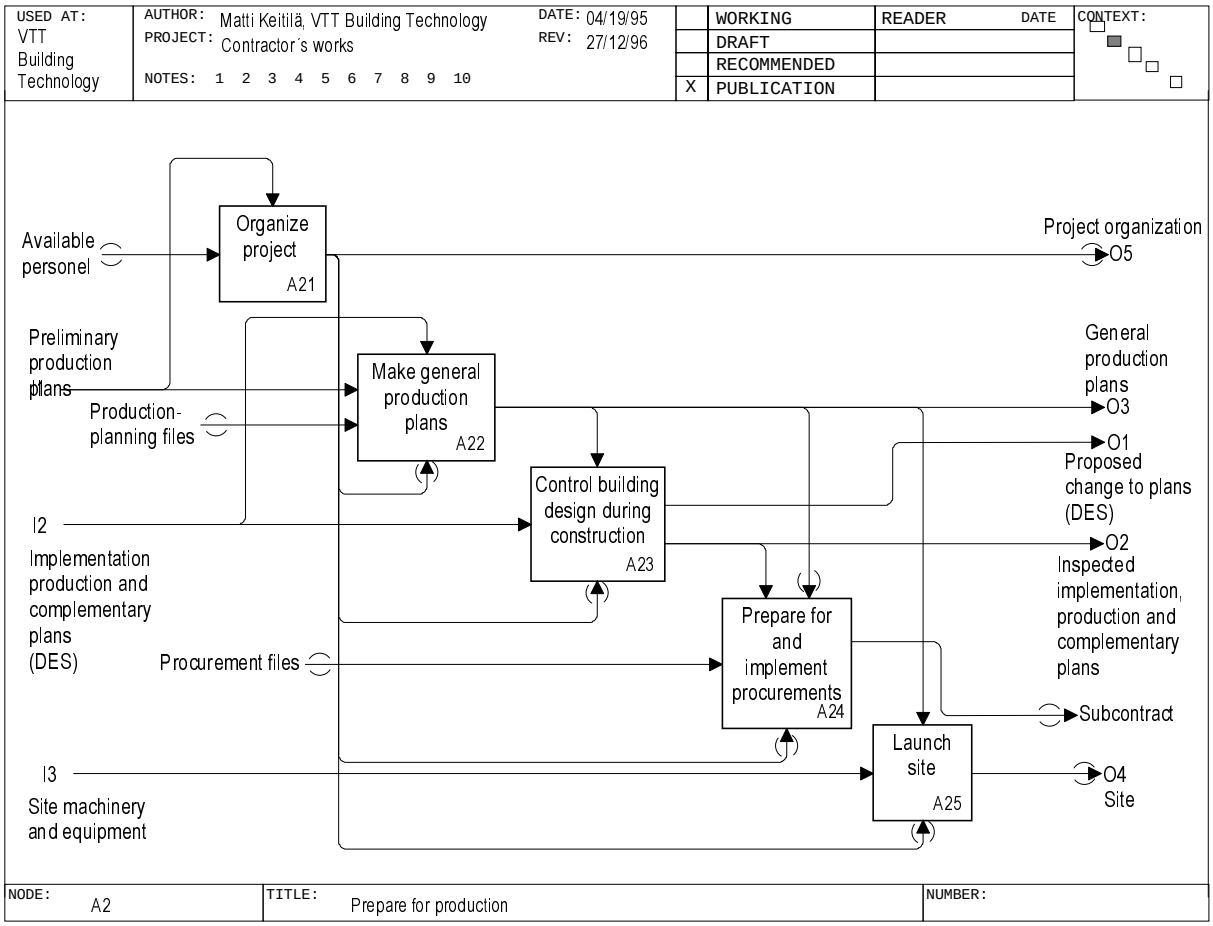


Figure 50. Prepare for production.

The goals of the task are:

- to build an effective project organization

- to plan the project's production methods, orders of works and site layout in a way that ensures the lowest overall costs, lowest risk of disturbances and preconditions for good occupational safety
- to plan and assign responsibilities for quality assurance measures
- to set a clear cost goal for the project, and
- to launch site works efficiently.

The task produces readiness for launching construction and plans for tools in production control. Various parties engaged in design also get feedback from the task which communicates the key viewpoints of production to building desing. The task utilizes preliminary tender-phase production plans and implementation plans of design as well as the company's own files such as the supplier register and input and method files.

A21 Organize project

The purpose of this task (Figure 51) is to select and recruit a capable organization for the project that is capable of carrying out the project without problems.

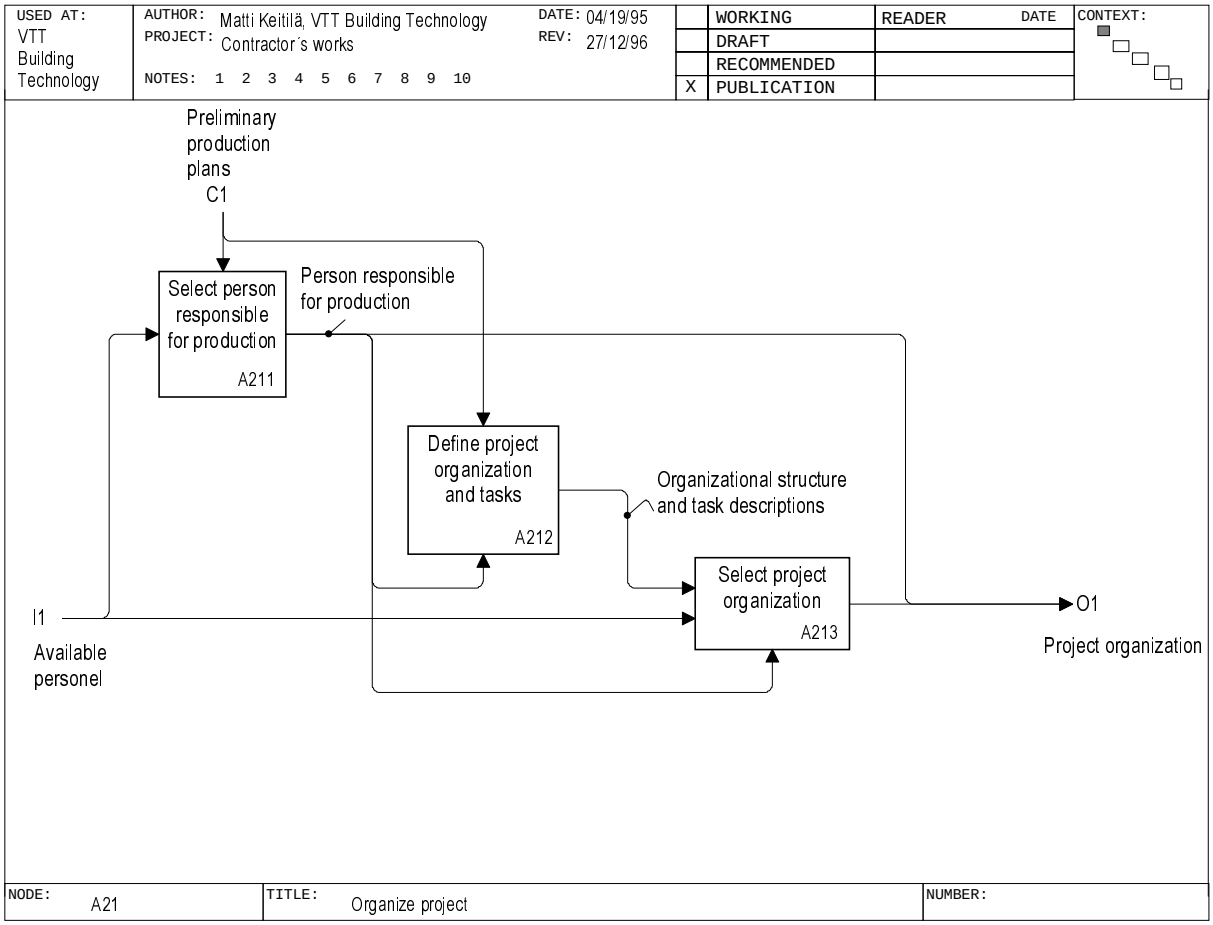


Figure 51. Organize project.

The first subtask involves selecting a site manager of sufficient experience for the project. The project organization and its functions are defined in cooperation with the manager. Then, the most suitable implementing organization can be chosen for the task. The implementing organization may be formed of the company's own resources or its network of subcontractors may be utilized. Completition of the entire task produces the project organization from available resources. The scope-, quality- and schedule- related requirements for the project govern the subtasks.

A22 Make general production plans

The purpose of this task (Figure 52) is to make plans to assist in the implementation of production to enable controlled implementation of the project. The production plans devised as part of this task are, for the most part, made before commencing construction.

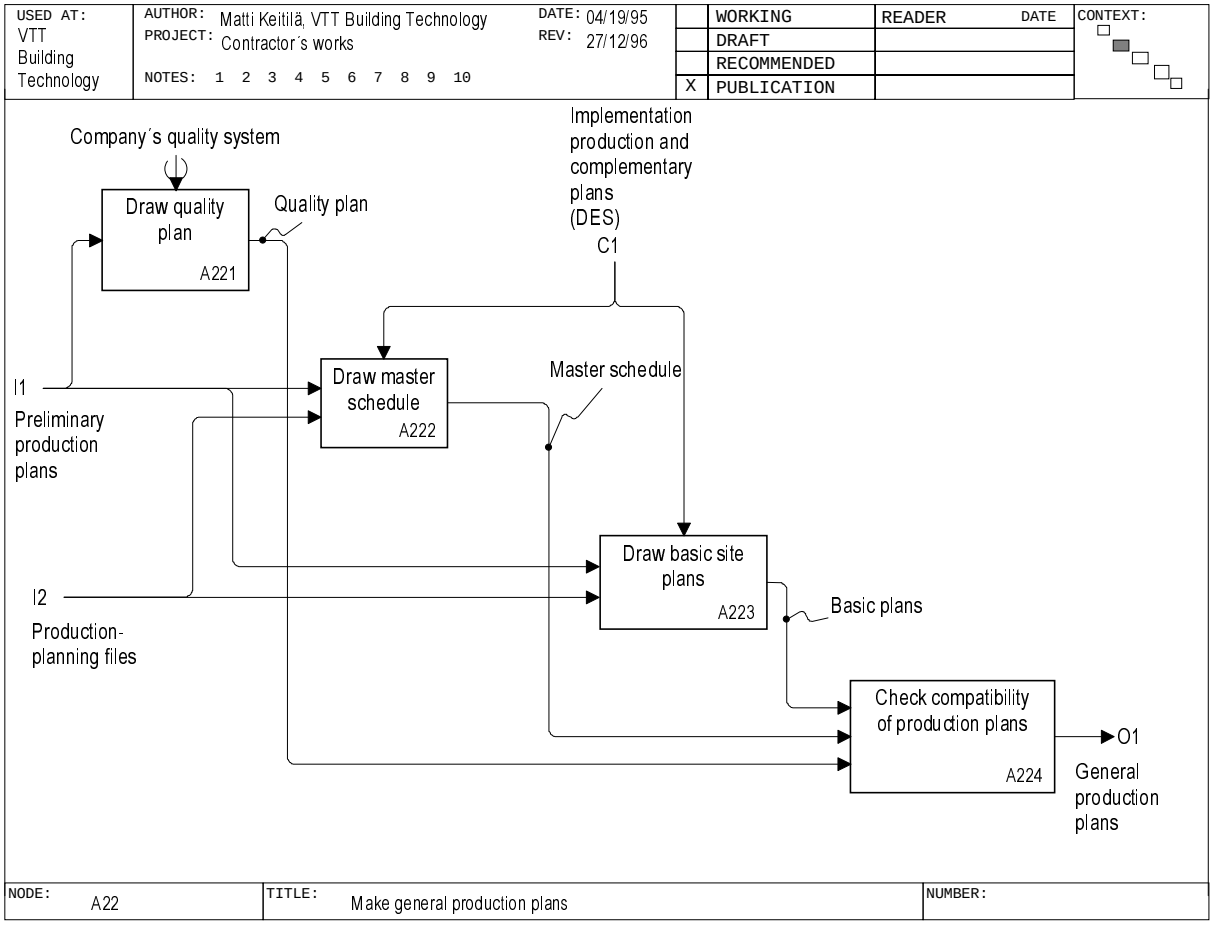


Figure 52. Make general production plans.

General production planning prepares plans that serve as tools in implementation control. First, a quality plan is made which defines, for instance, the procedures that produce the desired quality, the scope and special characteristics of the building and the risks related to the project. A master schedule is devised at this point. The basic plans comprise a budget as well as site, labour, safety and machinery and equipment plans. Finally all devised plans are combined, the date

each plan was devised and revised is marked and their mutual compatibility is checked. This way, disturbances resulting form conflicts in production planning are avoided.

A23 Control building design during construction

The purpose of this task (Figure 53) is to make building design more production-friendly and to assess plans from the standpoint of production. Control of design ensures availability of plans at the right time as well as their flawlessness.

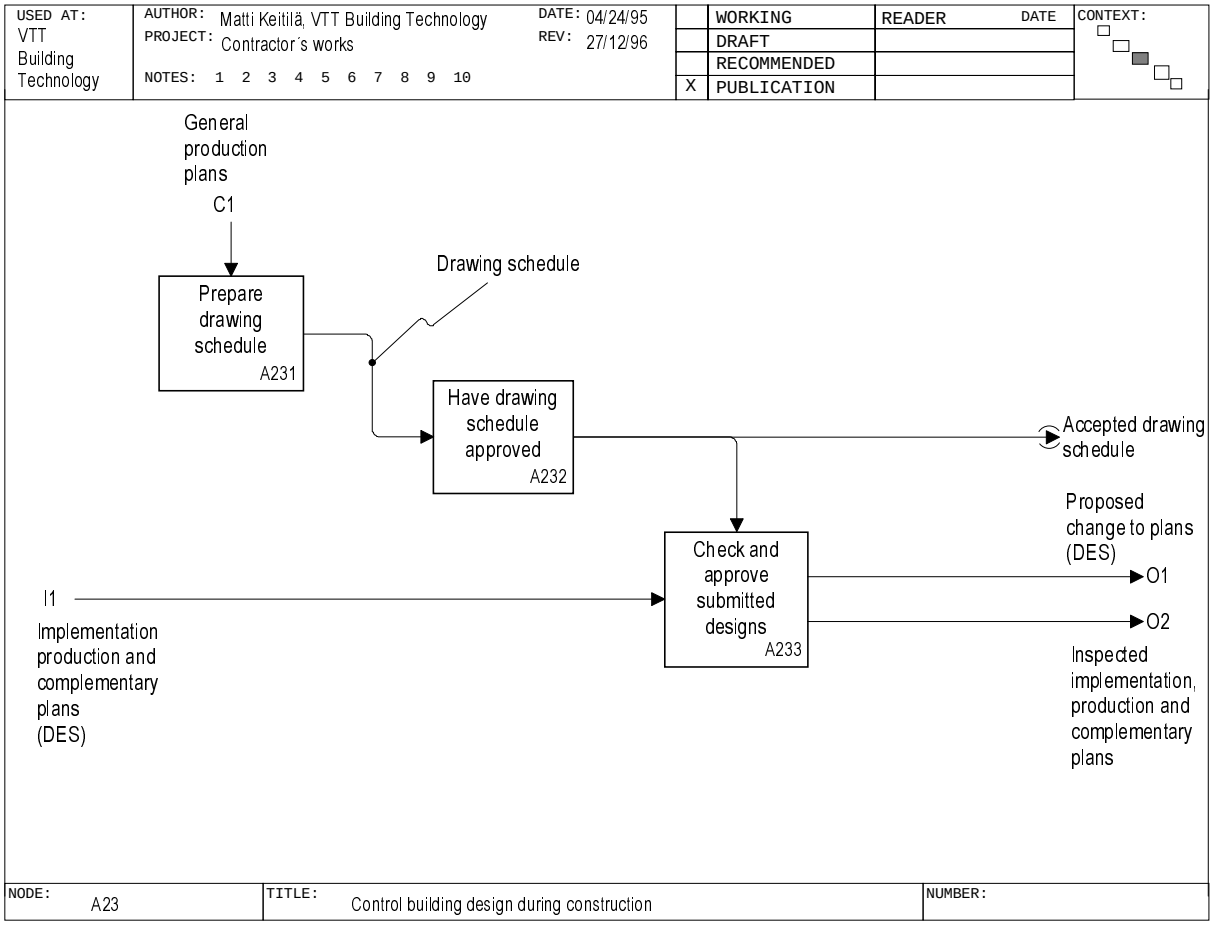


Figure 53. Control building design during construction.

Production prepares a drawing schedule which sets the dates when plans are to be available to the implementing organization so as to allow realizing planned production goals. Production is to also inform all designers of needed drawings that are compiled into a drawing schedule. Before designs are supplied to work phases they are to be checked and their correctness assured, for instance, with regard to revisions.

This task produces revised designs for the site and feedback to designers on the needs of production. Production may also give feedback to various designers in design meetings. These meeting are organized by the client, but the main implementer can generally also participate.

A24 Prepare for and implement procurements

The purpose of this task (Figure 54) is to procure the products and services needed in the project in the most advantageous way from the company's viewpoint and to assure the quality and reliable delivery of procurements. The most important goals of preparing for and implementing procurements are:

- adherence to contract in procurements
- use of suppliers that meet quality and other goals
- to draw up a sufficiently accurate procurements schedule
- to develop cooperation with suppliers
- to ensure efficiency and advantageousness of procurements
- to draw clear-cut, unambiguous contracts, and
- to minimize overall procurement costs.

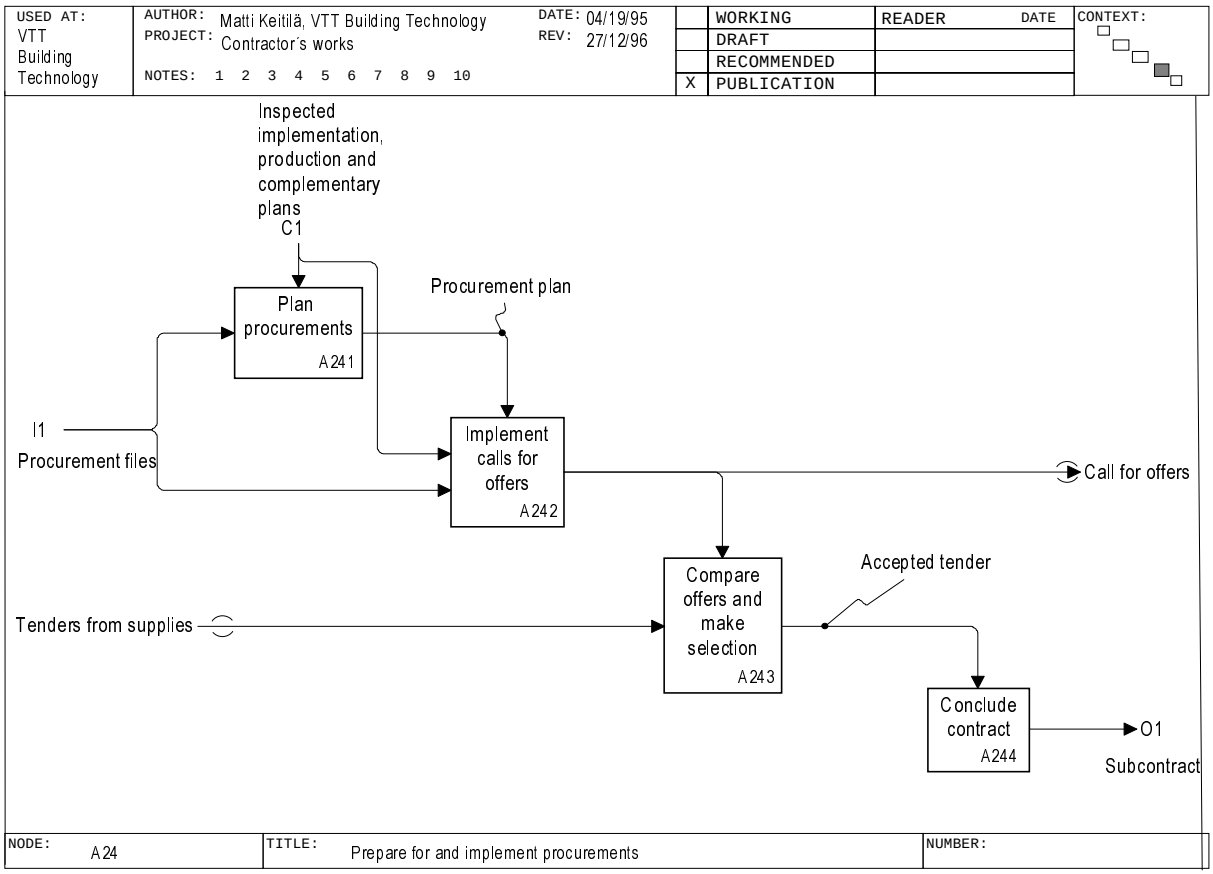


Figure 54. Prepare for and implement procurements.

The task begins with the planning of procurements which involves defining needs and their timetables and assignment of responsibilities for procurement tasks. Urgent procurements that need to be implemented first are determined during planning. Calls for offers are prepared for procurements and are sent to carefully selected suppliers. When tenders are submitted, the best one is selected according to earlier agreed criteria. After negotiations for a contract, a contract is signed for delivery of a service or product. This "prepare for and implement procurements" task is used to procure both materials and services.

A25 Launch site

The purpose of launching the site (Figure 55) is to provide the preconditions for starting production by bringing the site to a state of readiness that allows workers and materials to arrive and construction to begin.

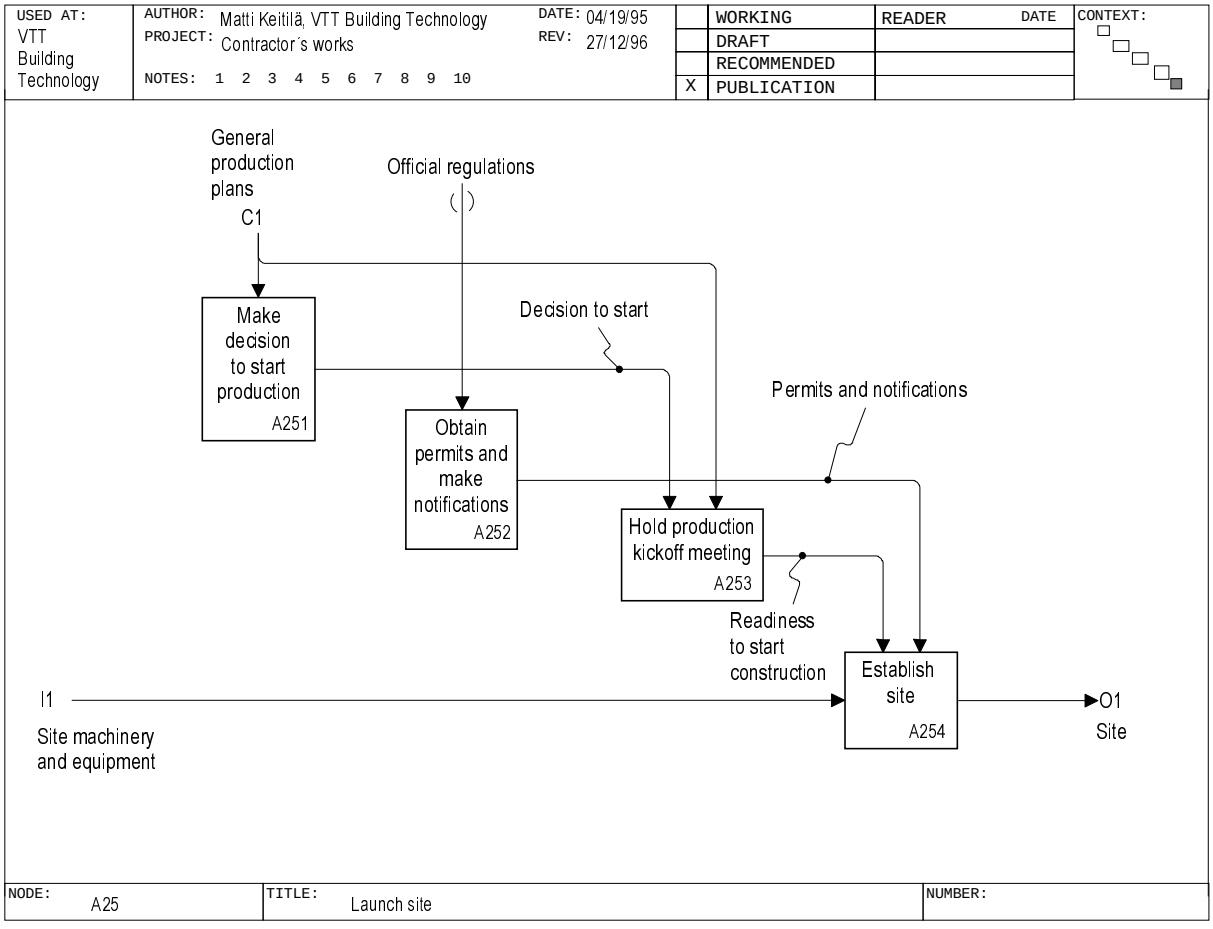


Figure 55. Launch site.

The decision to commence production may be taken when the required building and production plans are ready and the project has been established in the company's information systems. All required permits are obtained and notifications made to allow construction to start, such as:

- building permit
- approval of site manager
- commencement notice to building and occupational safety official
- other commencement notices, and
- certain permits and notices related to occupational safety.

The building project and its goals are presented to the site organization contact and the tasks and responsibilities related to launching production are decided in the kickoff meeting. Establishing a site involves arranging the following necessities:

- site roads
- personnel facilities
- interim telephone, electricity, water and sewer connections
- basic site equipment and warehouse
- rental contracts,and
- site office.

A3 CONTROL PRODUCTION DURING CONSTRUCTION

The purpose of production control (Figure 56) is to supervise the project in accordance with contracted quality standards and target costs. Thus, the goals of production control are:

- implementation of project according to production plans
- staying under cost targets
- prevention of quality defects
- prevention of employment accidents, and
- assuring that deliveries conform to contract terms.

Production control produces information for physical construction to enable its implementation according to plan. Simultaneously, data on implementation is collected and utilized to control the ongoing project. The collected data is also refined for use in new projects.

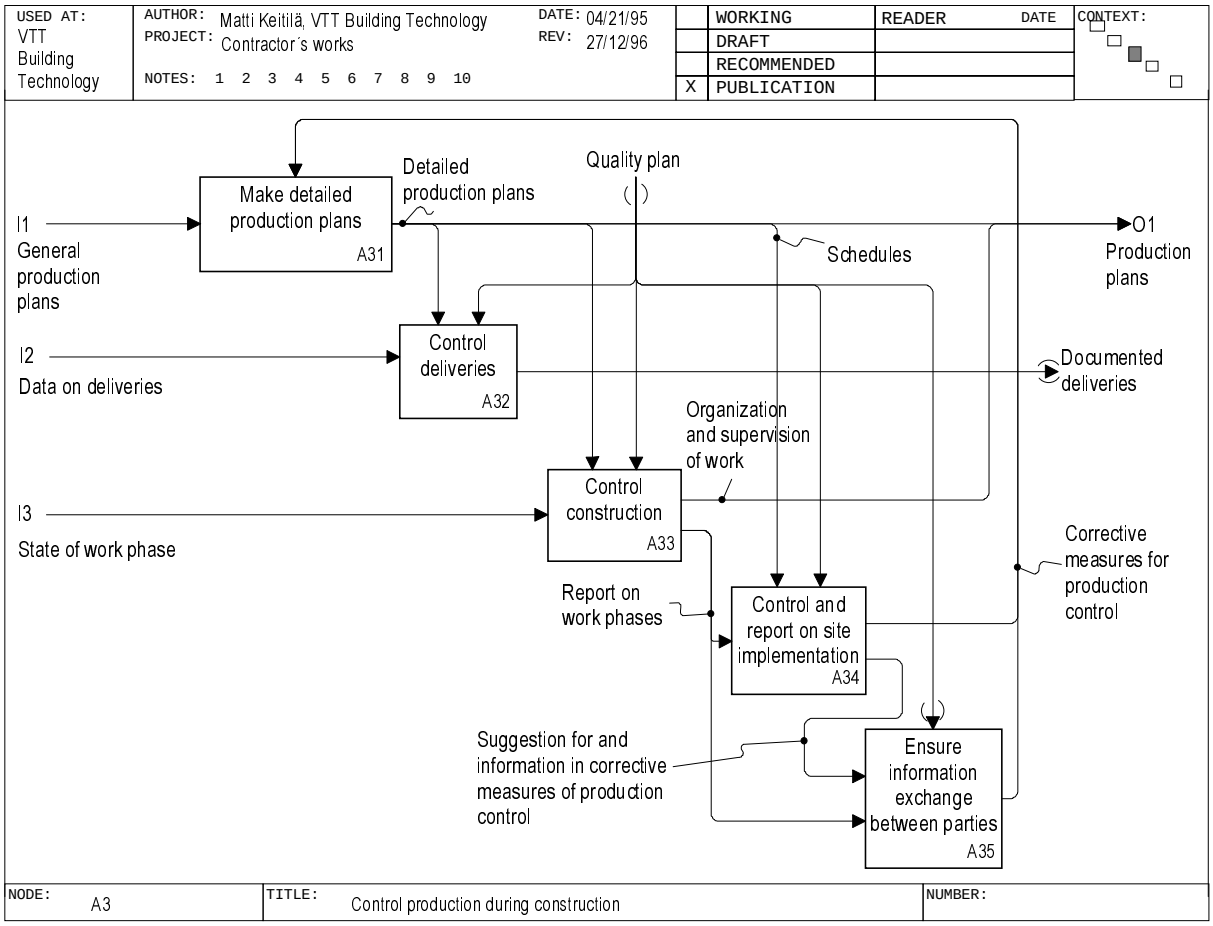


Figure 56. Control production during construction.

A31 Make detailed production plans

The purpose of making production plans more detailed (Figure 57) is to synchronize work phases and to set precise time frames. In practice production plans are made as detailed as required by the site by

- a more detailed procedural and equipment plan
- planning the order and progression of works
- construction-phase schedules
- weekly schedules, and
- special plans.

Construction-phase production planning is made more detailed at the foundation, frame and interior-works phases of the project. Special plans include, for instance, blasting, demolition, shoring and scaffolding plans.

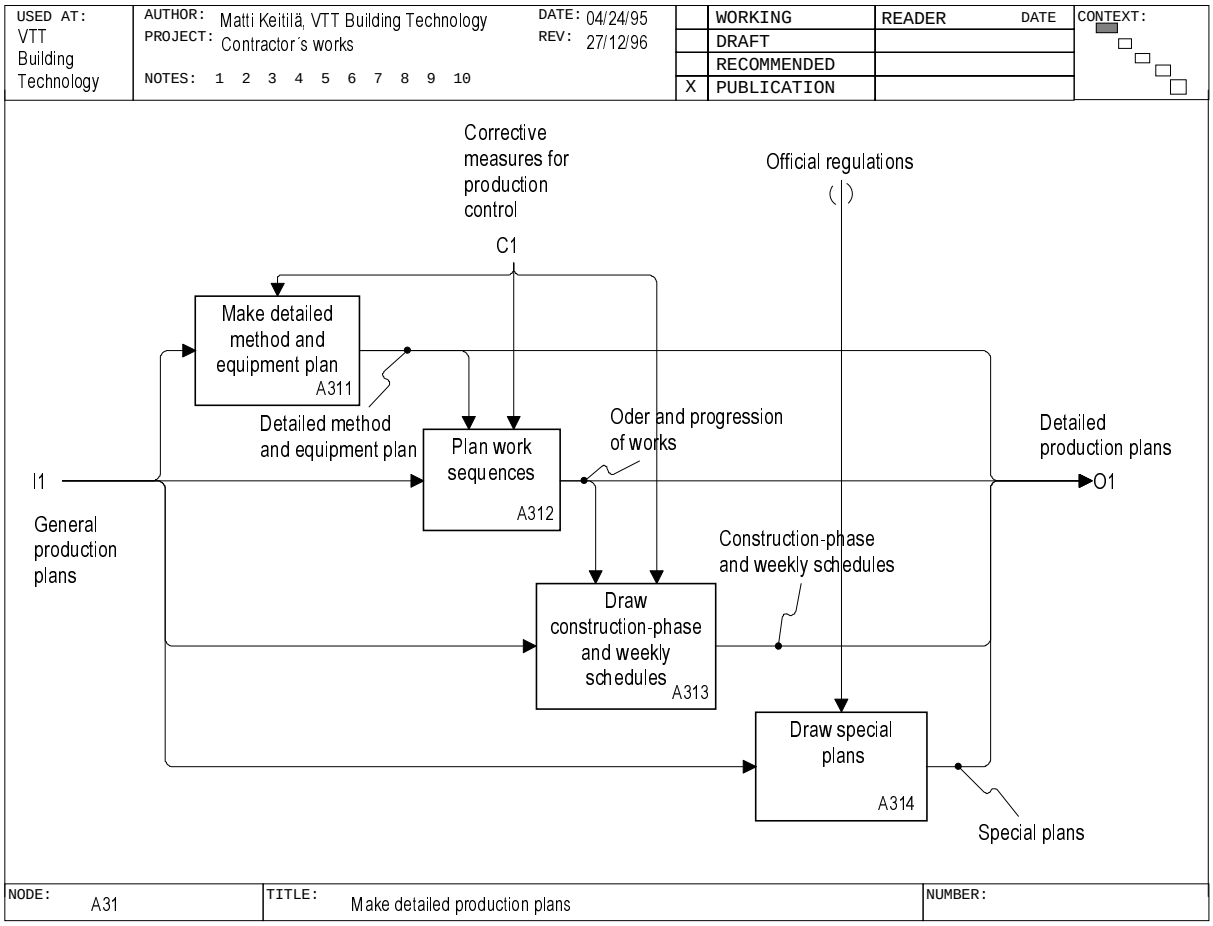


Figure 57. Make detailed production plans.

A32 Control deliveries

The purpose of this task (Figure 58) is to ensure that each work phase gets the planned necessary products and services at the right time. Control of deliveries focusses here primarily on examining the reception of deliveries and fulfillment of requirements as well as documentation of relevant matters for later use. Deliveries that have not yet been finalized may be revised quantitatively or time-wise as needs become clear during the implementation of construction and design. The revision of a delivery informs the supplier about the following:

- delivery lots; their order and time of delivery
- packing and protection methods
- quality inspections by supplier and site personnel, and
- handling of delivery on site.

Finally, it is ensured that the supplier has received the above-mentioned information and understands it. When a delivery lot arrives to the site, its conformity with the contract is checked; nonconformities are recorded and

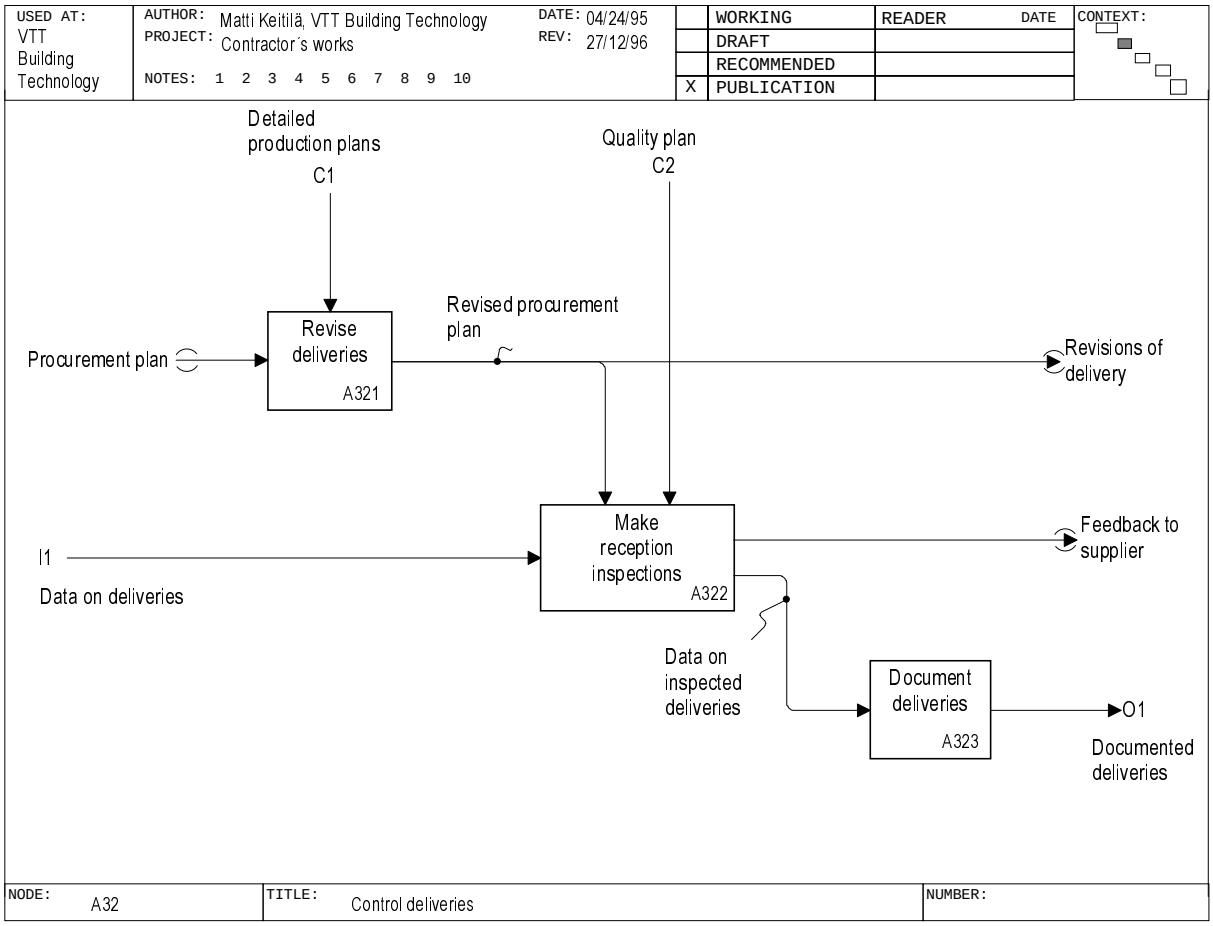


Figure 58. Control deliveries.

reported immediately to the supplier. Things that need to be checked:

- delivery documents
- quantity and contents of delivery
- quality defects and transport damages, and
- time and place of delivery and packing method.

A33 Control construction

The purpose of construction control (Figure 59) is to oversee one's own and subcontractors work in order to prevent quality defects and to attain the cost- and time-related goals for each work phase.

Construction control starts with familiarization with the contracts that define the goals of a work phase. Then, the preconditions for launching a work phase are evaluated, such as availability of labour and materials, stage of preceding job and job planning. In the kickoff meeting the quality standards, control method of the work phase and work-phase plan are examined with own personnel or subcontractors.

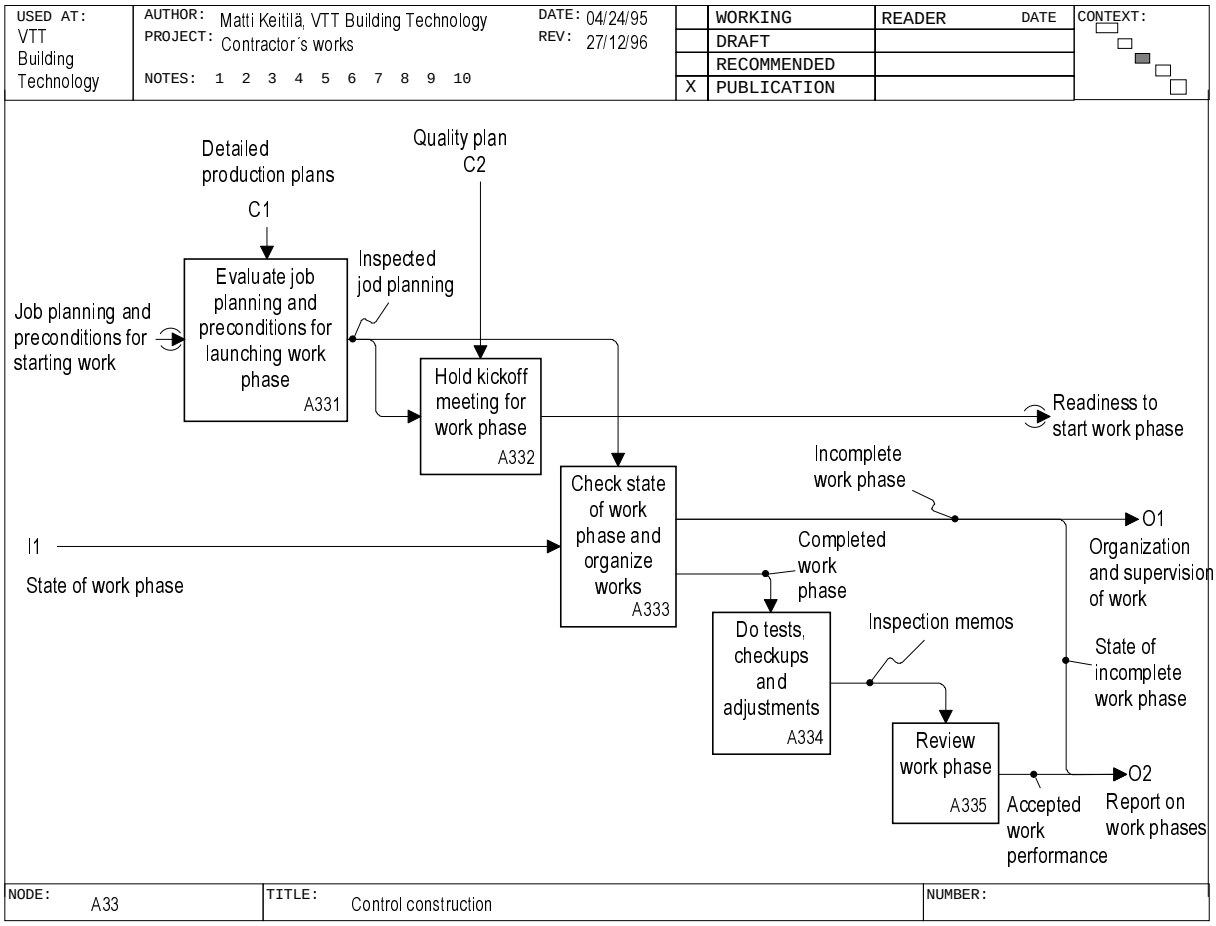


Figure 59. Control construction.

In time each completed job is inspected and approved and defects or mistakes are reported immediately to the responsible party. Documented data on work phases and their implementation are refined for later use in new projects.

A34 Control and report on site implementation

The purpose of this task (Figure 60) is to assess the state of the project at for example, 1 month intervals to determine the cost- and schedule-related goals and attainment of quality standards. The results are reported for later processing. If the progress of the project requires some revising, corrective measures must be initiated immediately. Schedules are controlled on site by marking the actual progress of works, i.e. the situation at the time of observation, in the drawn schedule. Costs are monitored by comparing actual costs with planned ones, considering the tasks´ degree of completion.

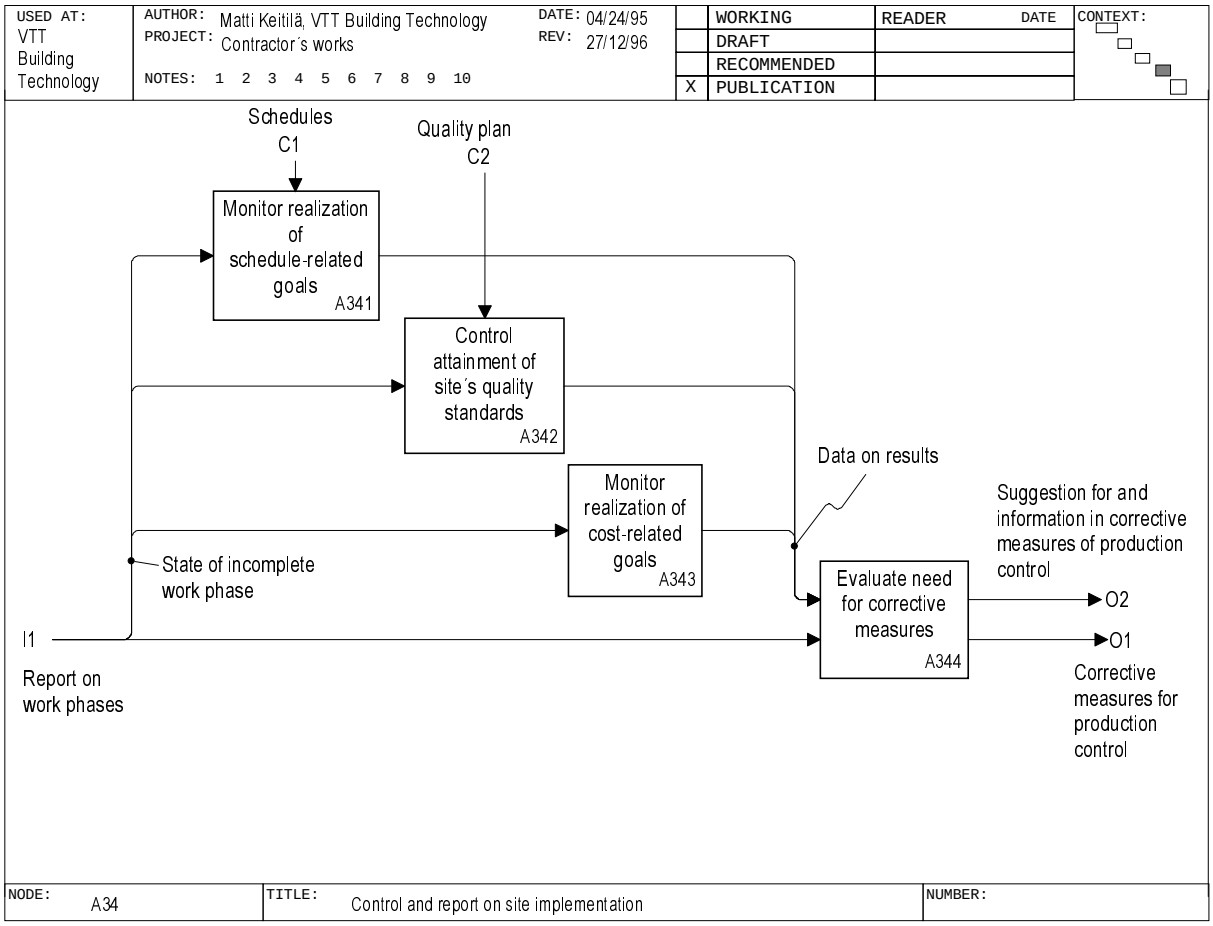


Figure 60. Control and report on site implementation.

A35 Ensure information exchange between parties

The purpose of this task (Figure 61) is to ensure exchange of information between all parties to the project during construction so as to prevent disturbances from deficient flow of information.

The task consists of various types of meetings and reviews where people are in direct contact with each other. Daily entries are made in the site journal concerning, for instance, conducted inspections, beginning and end of work phases, material deliveries, received designs, extra and modification work, size of labour force and approved installments.

The client calls site meetings which are intended to enhance information flow between the parties to the project. Site meetings are the venue where, for instance, the situation concerning the schedule and design as well as additional and modification works are dealt with. The main implementer takes part in the meetings along with all major subcontractors and designers. Main, subsidiary and subcontractors meet in 1-2 weeks intervals. In the meetings they examine:

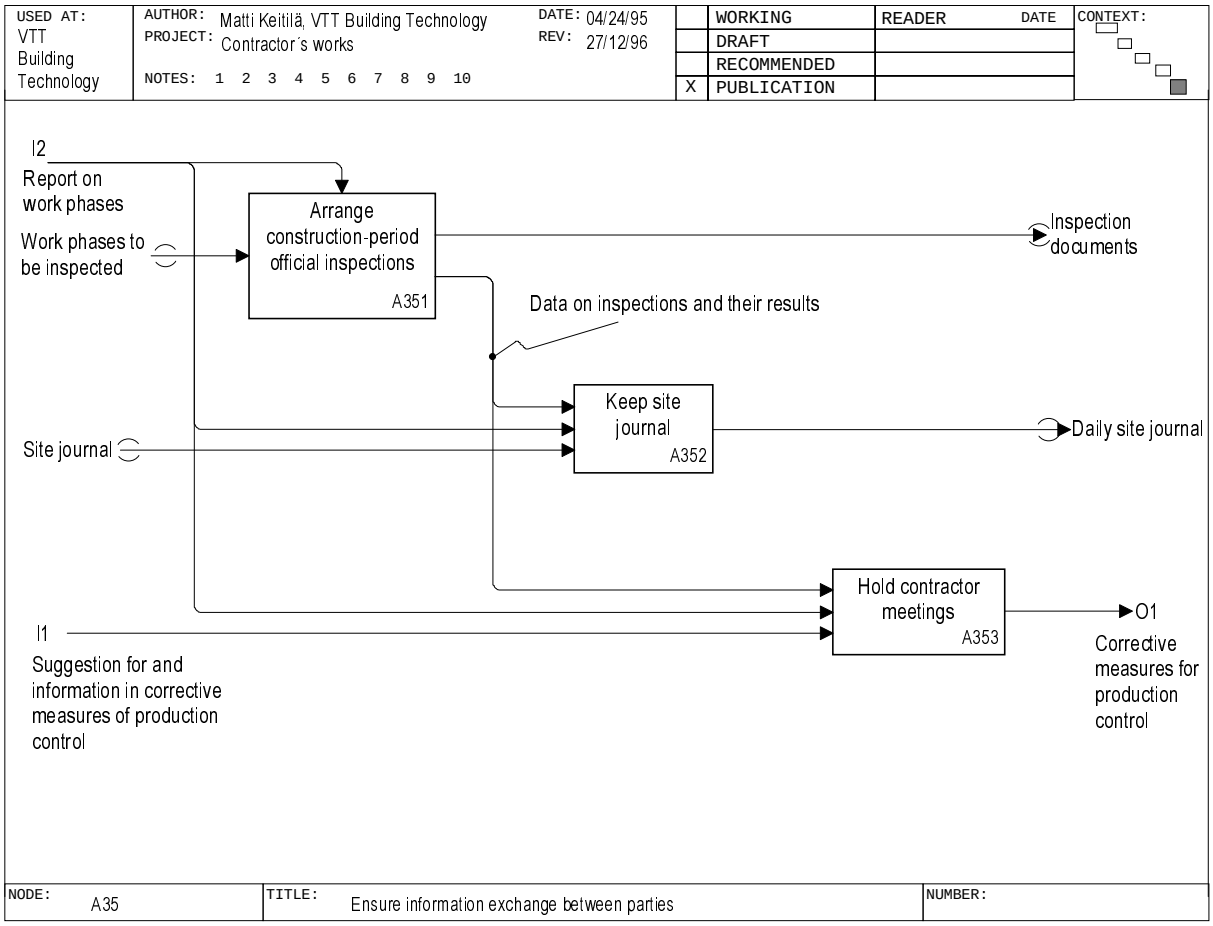


Figure 61. Ensure information exchange between parties.

- the state and schedule of works
- conducted inspections and reviews
- notices and inspections by client
- main contractor's production plans
- other contractors' work schedules, and
- coordination of various contractors' works.

The main contractor arranges the necessary official inspections when work phases so require. Official inspections consist of:

- position review
- foundation review
- structural review
- inspection of HVAC systems and smoke flues
- final inspection
- fire and civil-defence shelter inspections
- final inspection of lifts
- inspections by health officials and police, and
- inspections by electric and water utilities.

A4 BUILD

The purpose of this task (Figure 62) is to bring the physical construction to completion. All that has been done earlier in the production process is aimed at implementing this task. Its intention, thus, is to produce a product that conforms to the plans that are based on the client's needs. The task divides into five parts:

- earth and foundation works
- foundation structures and frame
- complementary internal components, fixtures and equipment
- internal surfaces, and
- buildings services.

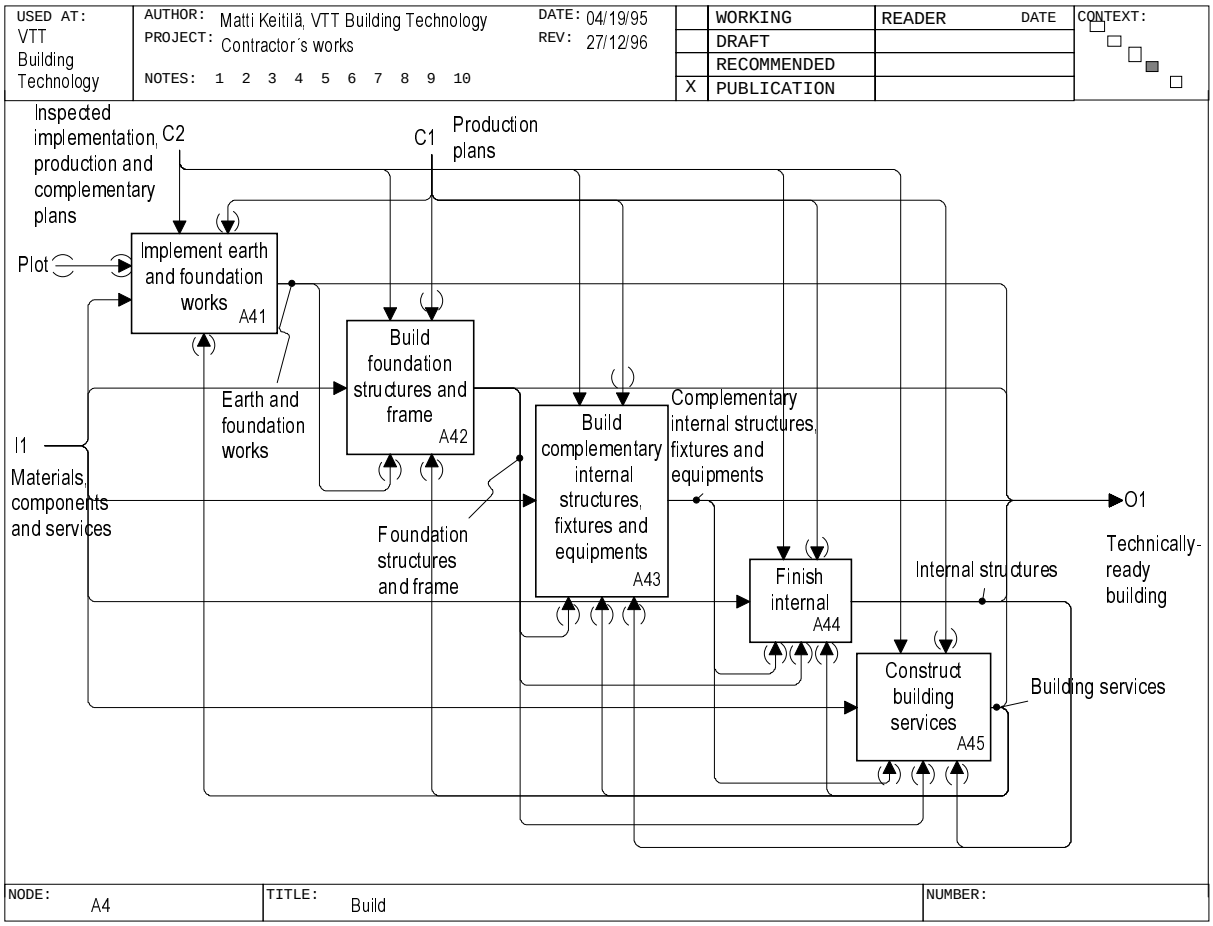


Figure 62. Build.

The subtasks of construction include the preparation of the work area for various work phases, such as erection of scaffolding and making machinery operational. Cleaning of the work area after the work phase is also considered a subtask of these tasks.

A41 Implement earth and foundation works

The purpose of this task (Figure 63) is to bring the project's earth and foundation works to completion. The earth construction phase starts with clearing of the construction site and demolition of old obsolete buildings. Clearing means removal of large rocks, tree stumps, roots and soils rich in humus from the construction site. The task also includes, besides demolition of old buildings, also protection of the surrounding structures and plant-life as well as harvesting of useful timber.

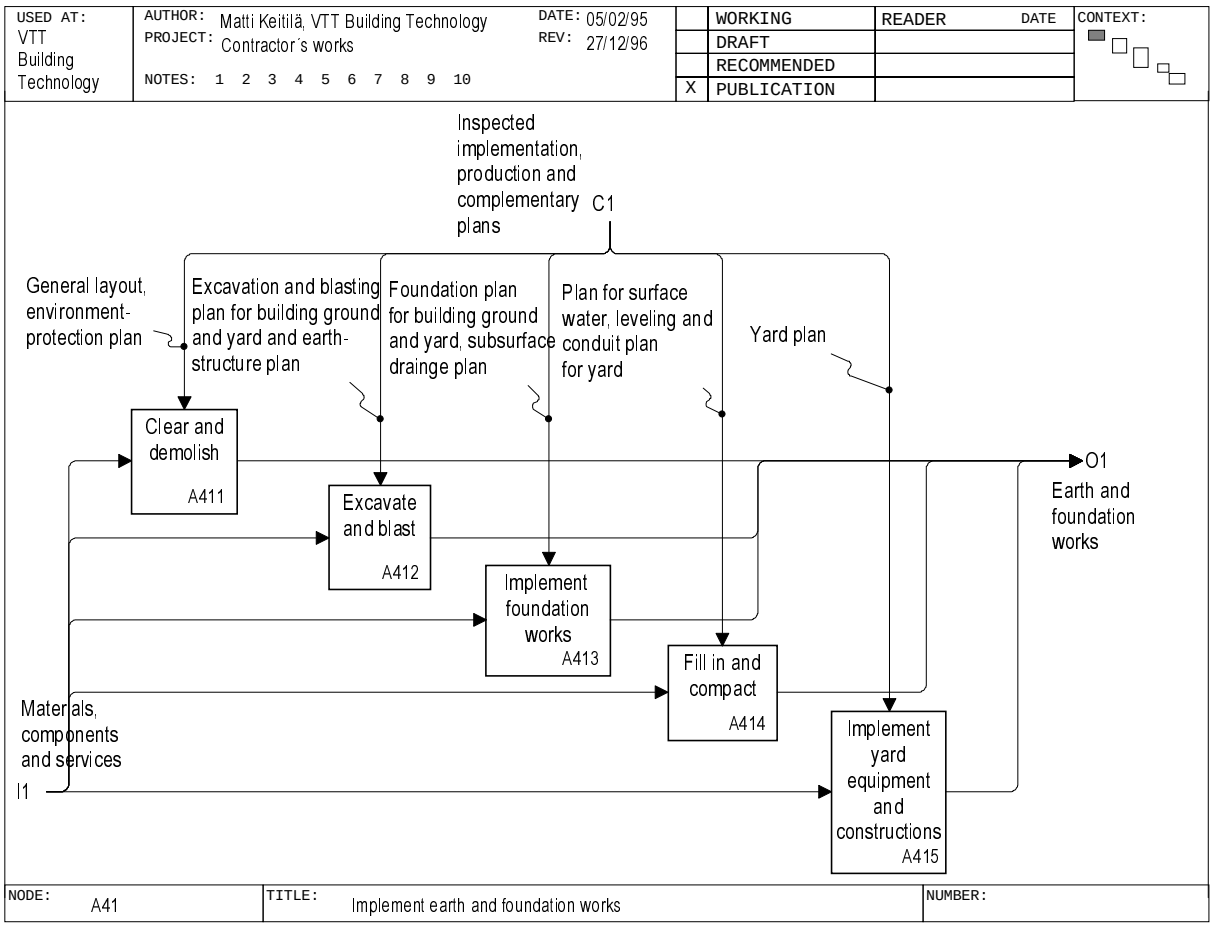


Figure 63. Implement earth and foundation works.

Earthworks include excavations on the site and hauling away of dug-up soil. Blasting refers to rock stabilization and compaction in addition to the blasting and hauling away of rock. Foundation works comprise, for instance, piling, soil stabilization, reinforcement of foundations and building of sewers and subsurface drainage.

Backfill and compaction works consist of filling in the space under and around foundations as well as levelling of the grounds of the site to the planned height. The surface structures of the site include lawns, planted areas and paving of the

trafficked area. Outdoor equipment includes lighting fixtures, play and sports equipment and fencing.

The content of the drawings and plans governing subtasks are explained in app. 1.

A42 Build foundation structures and frame

The purpose of this task (Figure 64) is to build the foundation structures and frame of the building according to agreed goals. The foundations consist of:

- footings, ie. wall, column and plinth footings
- plinths, ie. subfloor foundation columns, plinths and plinth beams
- base floors, bearing and non-bearing structures, and
- special structures of base floors that include foundation structures essentially different from other base-floor structures such as ramps and shafts, internal channels and tunnels, machinery and equipment beds, leakage containers, service and other special pits as well as swimming pools and other basins.

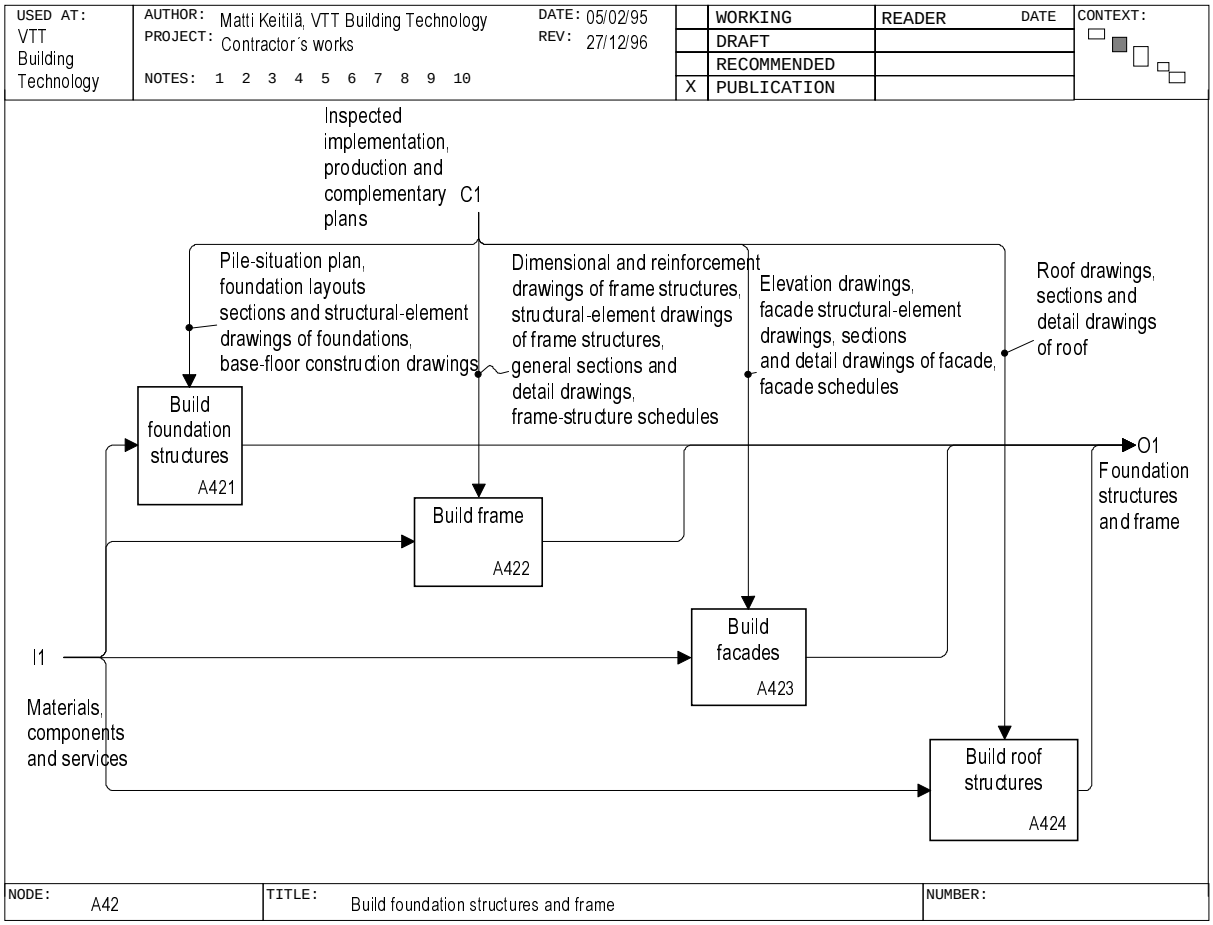


Figure 64. Build foundation structures and frame.

The building frame comprises the frame structures of the floors of the building: the parts of the frame above the base floor which include:

- the civil defence shelter
- stairwells and lift shafts
- stairways consisting of flights of stairs, landings and concrete railings
- internal bearing partition walls
- columns, beams, slabs, and
- precast box units, i.e. elements made up of several structural units which are not complementary structural elements or fixtures.

The facade consists of vertical structures that separate the building spaces from the outdoors such as external walls including windows and doors. Complementary sections that form an integral part of the facade, such as balconies and shelters, are included. The structural elements of the facade are:

- external walls including bearing and light-weight, prefabricated or on site-built, ones
- wood-, metal- and plastic-framed windows
- external doors, and
- facade-complementing sections including structures that complement the external wall or that form an integral part of it such as loading platforms, balcony-structures, ladders on external walls, sun protections, etc. which are generally specified by project.

The roof structures consist of:

- the bearing roof structures, their complementary structures, eaves and the roofing as well as sheet-metal edging strips and cladding of chimneys and hatches
- roof fixtures consisting of gutters, downpipes, roof outlets, catwalks and snow guards
- skylights
- above-well machine rooms consisting of machine rooms and equipment shelters built on the roof that are structurally different from other structural elements, and
- terraces, etc. above a heated space.

The content of the drawings and plans governing subtasks are explained in app. 1.

A43 Build complementary internal structures, fixtures and equipments

The purpose of this task (Figure 65) is to build the complementary internal structures, fixtures, and equipments as agreed. Complementary internal structures include:

- internal doors with frames

- light partition walls including internal ones built on site and light-weight prefabricated partition walls
- suspended ceilings underneath the ceiling proper
- raised floors built on top of a horizontal bearing structure
- surface structures of sauna, cold cellar, machine rooms, etc. which it is not practical to classify as walls, ceilings and floors
- internal railings, ladders, working platforms, catwalks and complementary stairs, and
- ducts, channels and fireplaces.

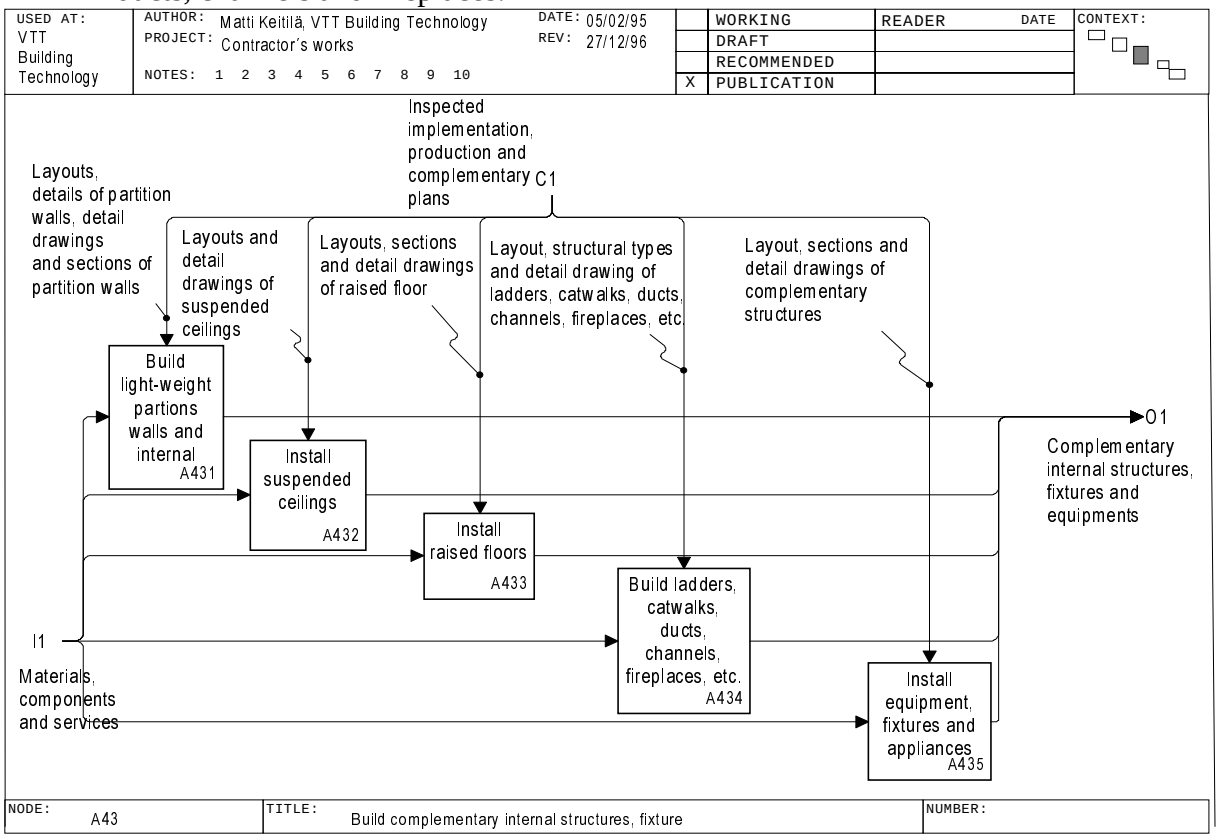


Figure 65. Build complementary internal structures, fixtures and equipments.

Building equipment includes internal fixtures, equipment and machinery that are not movables or investments in in-house operations. Fixtures consist of internal fixed wooden or metal fixtures such as closets, cupboards, shelving, work tops, sinks and benches. Accessories consist of internal accessories such as coat racks, hooks, mirrors, airing racks, installed internal window sills, directories, foot scrapers, hall carpets, sports-equipment racks, curtain rails and cover boards, venetian blinds, etc. Appliances consist of ranges, refrigerators, freezers, sauna stoves and common laundry equipment.

Handling equipment is the most important equipment consisting of mechanized equipment and procurements that serve building traffic and materials handling and which are included in construction costs and are, thus, not operational investments. These include, for instance, lifts, escalators and conveyors.

The content of the drawings and plans governing subtasks is explained in app. 1.

A44 Finish internal surfaces

The purpose of this task (Figure 66) is to finish the surfaces of internal spaces by coating, panelling and painting them including also levelling and topping. The finishing of wall surfaces consists of painting and wallpapering as well as applying other coatings, after the required preparatory work, independent of whether a surface is part of an external or partition wall of a building.

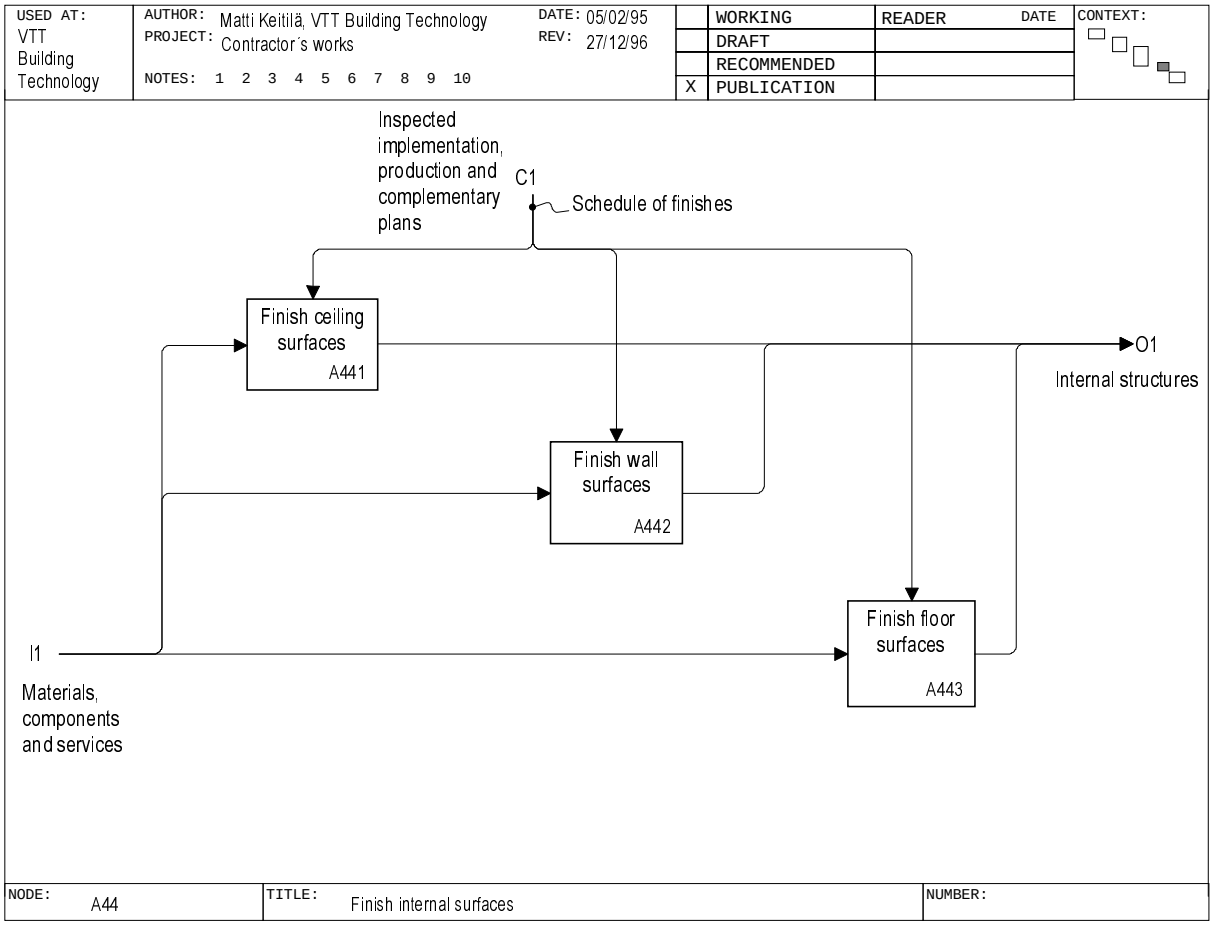


Figure 66. Finish internal surfaces.

The finishing of ceilings consists of painting and plastering, laying of insulation or similar materials as a finish including the preparatory work. Floors are finished by applying coverings, coatings and other materials such as floorings, parquets, tiles and boards including the necessary painting, levelling and topping.

A45 Construct building services

The purpose of this task (Figure 67) is to construct the building services. Construction of the heating system consists of building the heat generating, distribution and heat release systems and related insulations. The construction of a plumbing and drainage system comprises plumbing fittings, water-supply piping, wastewater treatment, drainage systems, sanitary appliances and related insulations. Air-conditioning system construction involves mechanical rooms, ductwork, air distributors, ventilation equipment and special systems of the civil-defence shelter and the insulations pertaining to each.

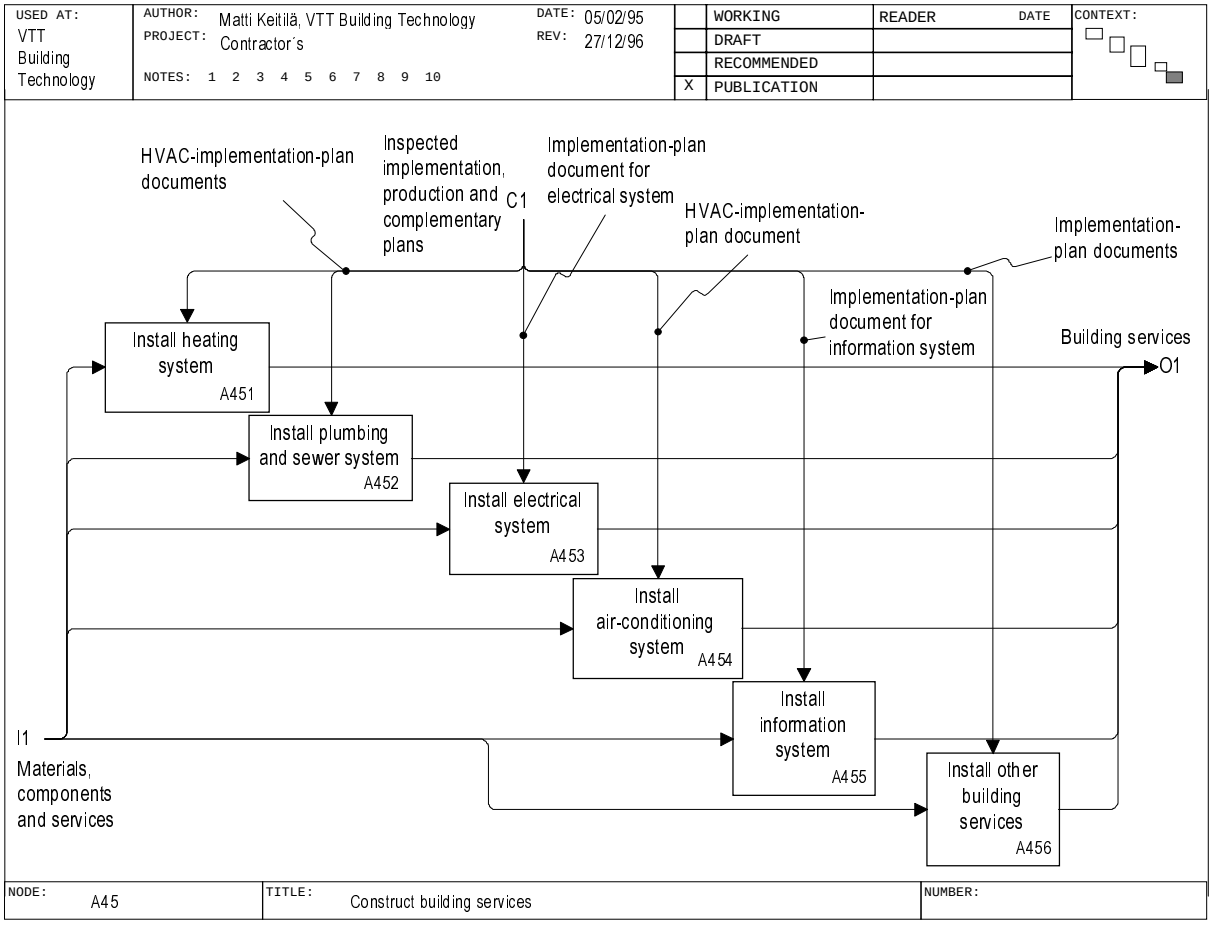


Figure 67. Construct building services.

The construction of the electrical system involves, for instance, areal electrification, power distribution stations, switchboards, cable routes, lighting fixtures, devices and equipment. Installation of information systems involves telephone, antenna, sound reproduction, security, computer and building automation systems and their combinations. Other building services to be built include, for instance, refrigeration-technical, steam and fire-fighting systems.

The content of the drawings and plans governing subtasks is explained in app. 1.

A5 HAND OVER BUILDING

The purpose of this task (Figure 68) is to hand over the building to the client on the agreed schedule and to the close the project and meet the guarantee period obligations.

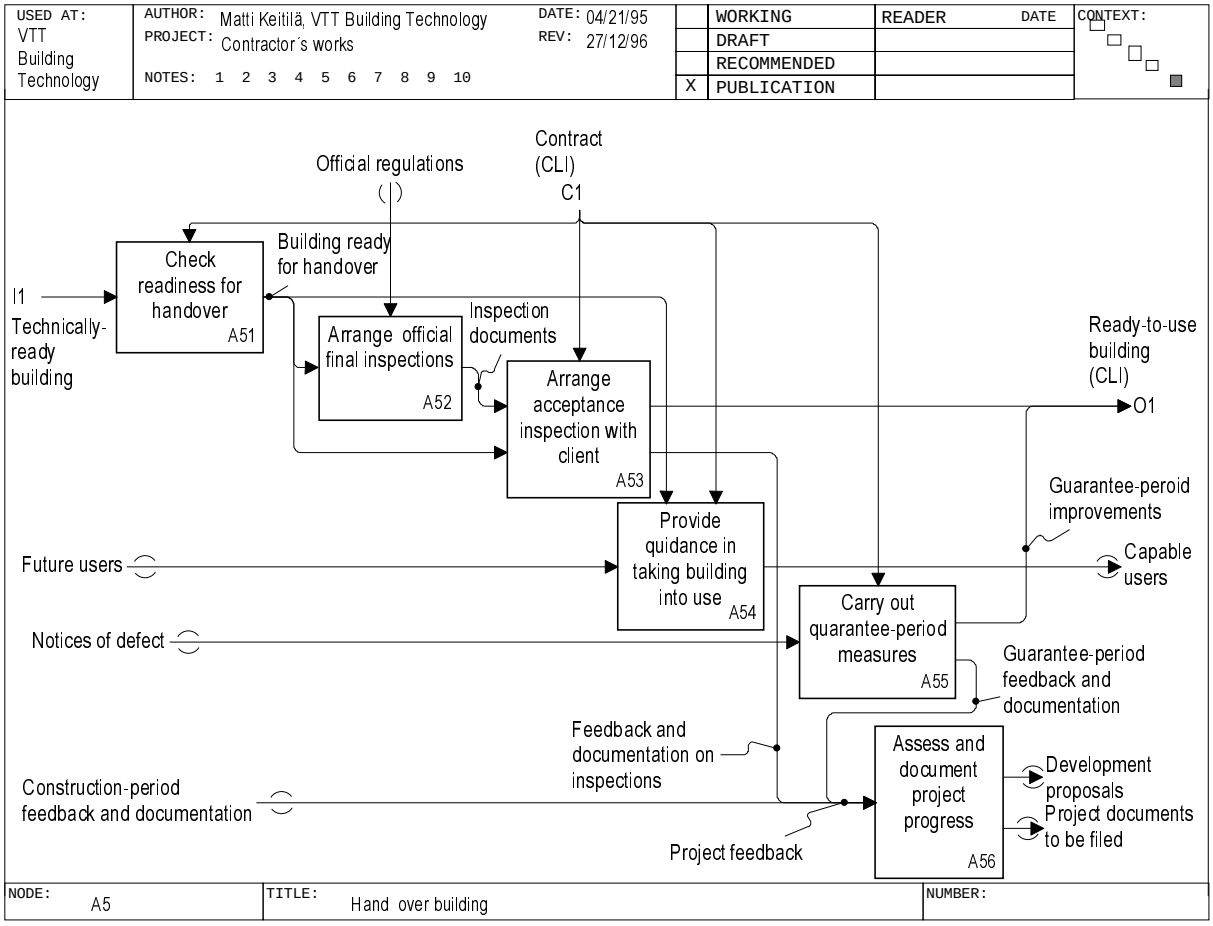


Figure 68. Hand over building.

The readiness of the building for handover is ascertained by the main implementer at first. Then, officials inspect the building before it is handed over to the client. It must be ensured that the points to be inspected are in order before officials inspect them. A signed inspection certificate must be received from the inspectors.

The final official inspections include:

- the building official's final inspection
- fire inspection
- final inspection of civil-defence shelter and performance test
- final inspection of HVAC systems and inspection of smoke flues
- final inspection of lifts
- inspections by health officials and police, and
- inspections by electric, water and telephone utilities.

The main contractor and the subcontractor who implemented or supplied a system unit participate in the inspections besides the official.

To ensure that the building will be used as planned, the future users must be given instructions for its use. The company carries out guarantee-period measures as contracted in order to secure a continued relationship with the customer. Finally, the project process is evaluated and documented within the company.

A51 Check readiness for handover

The purpose of this task (Figure 69) is to ensure that the building may be handed over to the client in flawless condition and on the agreed schedule. The state of all the building's spaces and technical systems is inspected. Deficiencies and nonconformities are recorded and are fixed immediately. When the structures and systems are found faultless, their use is avoided and they are cleaned for the last time before handover to client. Own foremen as well as subcontractors' foremen take part in the inspection.

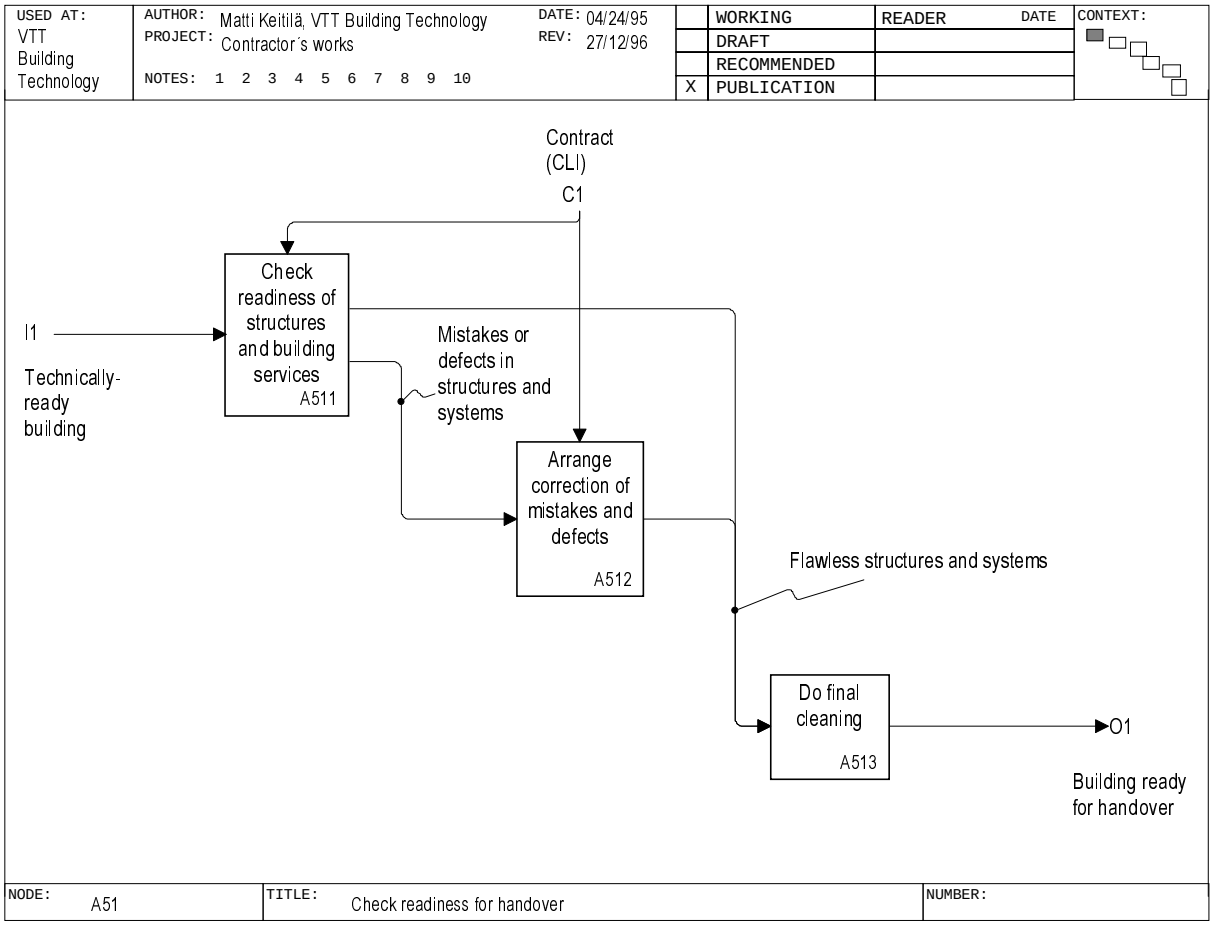


Figure 69. Check readiness for handover.

A53 Arrange acceptance inspection with client

The purpose of this task (Figure 70) is to hand over the building to the client on the agreed schedule and in a flawless condition. Before the acceptance inspection, all construction-period inspection, review and setting-up logs are submitted to the client for approval and the handover date is agreed with the client after the readiness of the building for handover is ensured. Mistakes and defects are recorded during the inspection and agreement on their correction procedure and liabilities and the schedule of repairs is reached. The building may be handed over and taken into use in sections. Then, an acceptance inspection is arranged separately for each section. The acceptance inspection terminates the contractor's liability for the building as concerns insurances, security and user fees.

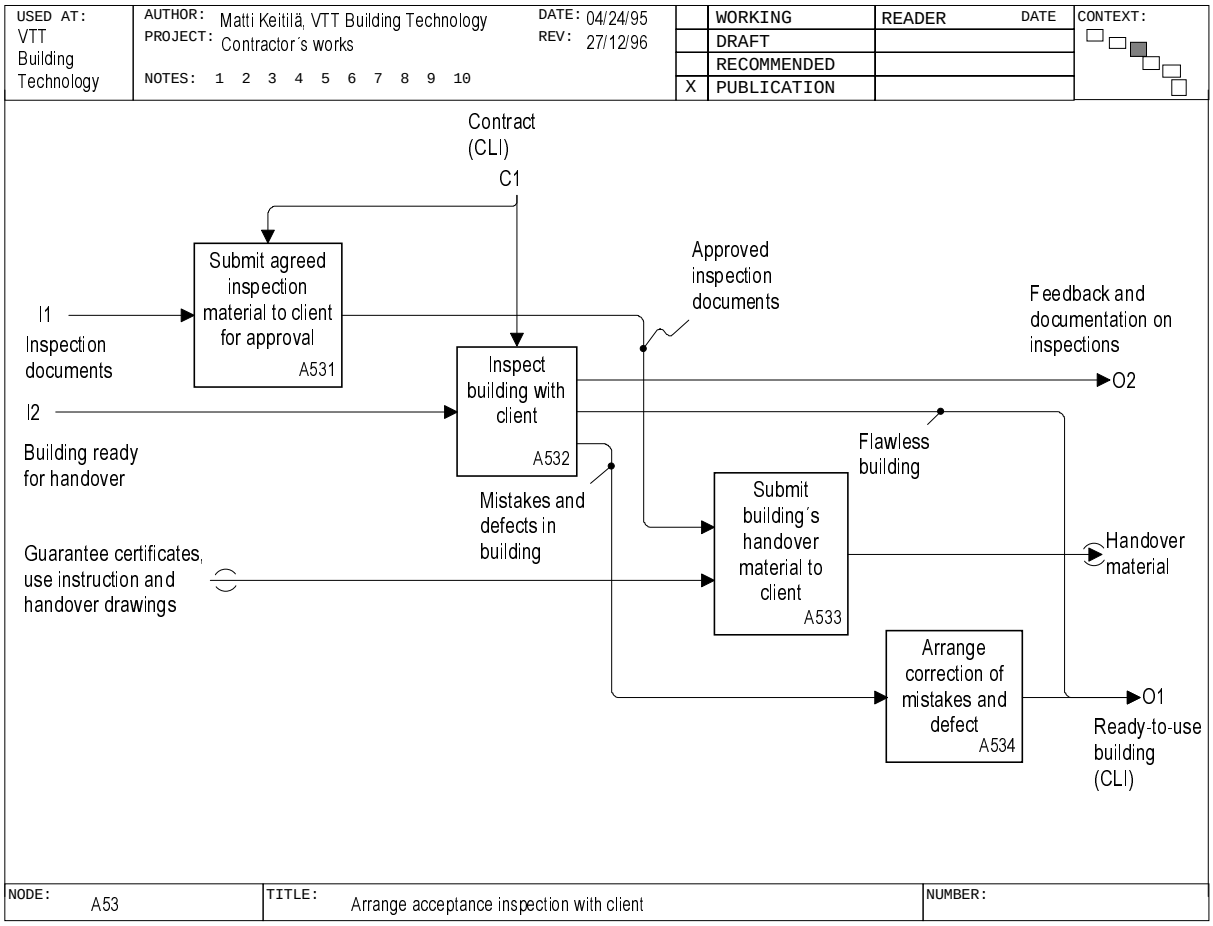


Figure 70. Arrange acceptance inspection with client.

In connection with the handover, the client receives handover material consisting of the guarantee certificates, operating instructions and handover drawings related to the building and its equipment and machinery.

A54 Provide guidance in taking building into use

The purpose of this task (Figure 71) is to teach the future user to maintain and use the building correctly and in the most advantageous way. First, an agreement is reached with the client on how and who will be provided guidance. The actual instruction is given on several occasions, if necessary, and to various groups and concerning various sections of the building.

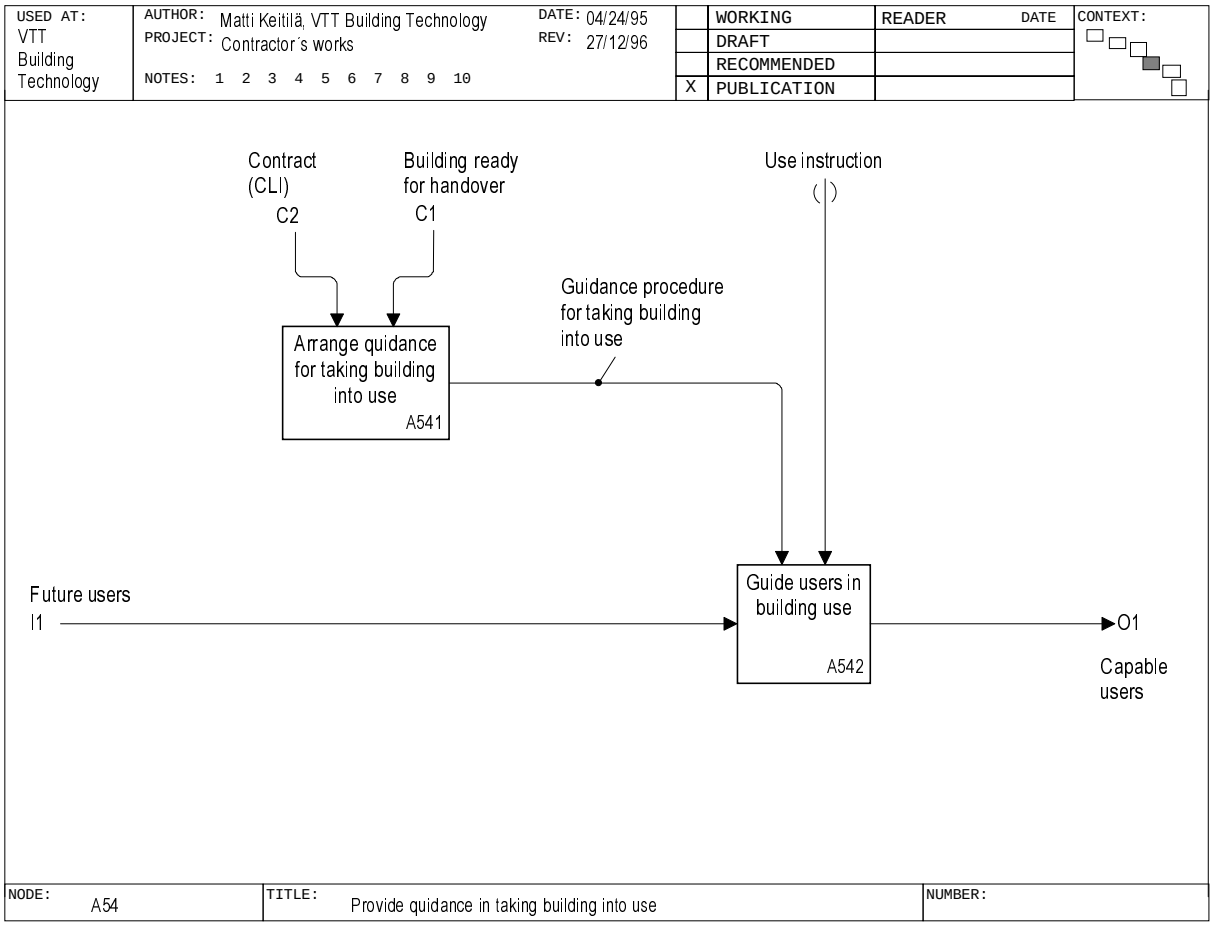


Figure 71. Provide guidance in taking building into use.

A55 Carry out guarantee-period measures

The purpose of this task (Figure 72) is to take care of post-handover obligations and any possible notices of defect in a controlled manner and to create conditions for development of operations by learning from detected quality problems. Controlled discharge of guarantee-period obligations is intended to maintain client relationships and to create a favourable image of the company's construction services.

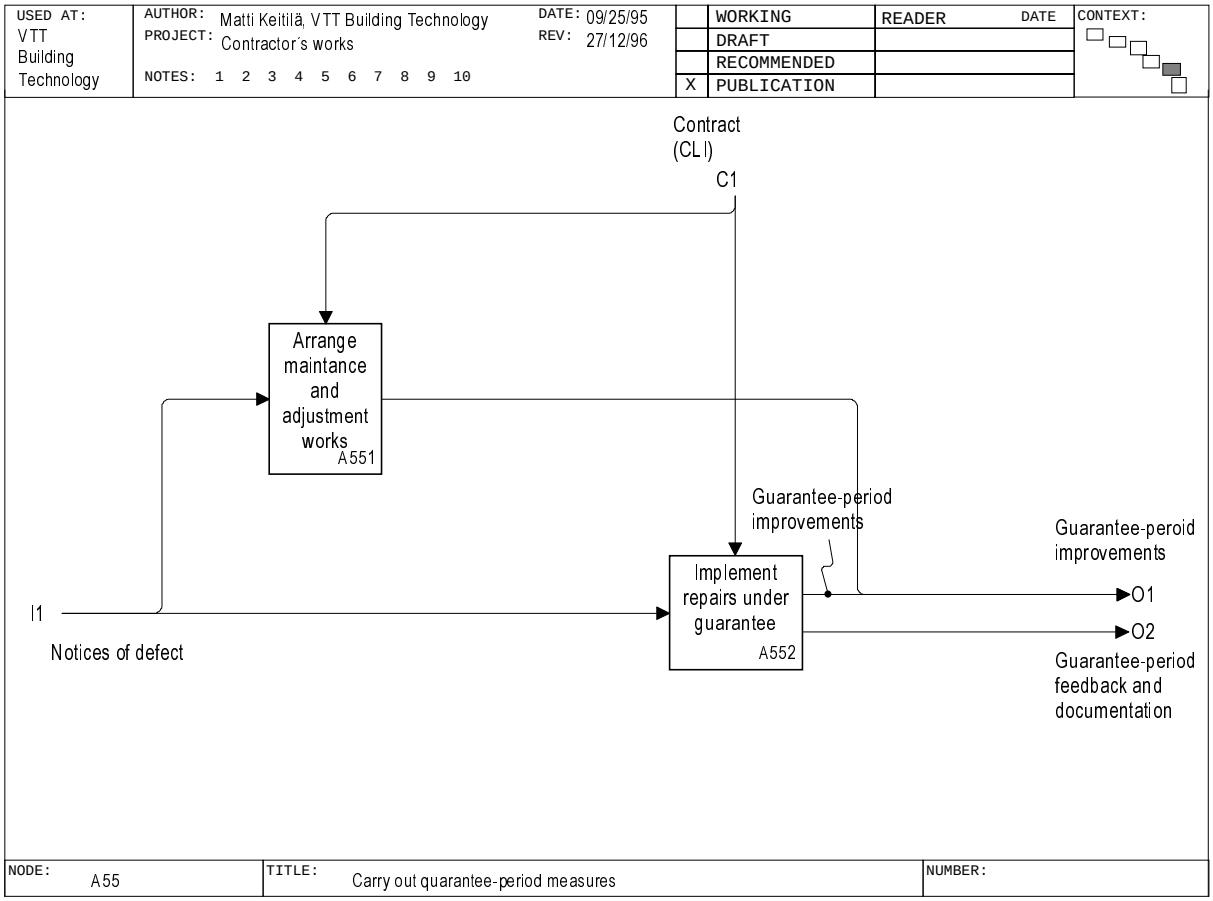


Figure 72. Carry out guarantee-period measures.

Guarantee-period activities begin with the creation of a guarantee repairs folder in which notices of defect and documents on implemented repairs as well as other guarantee-related documents are compiled. Servicing and adjustment works that are part of the contract, but which have not been done during construction, are done as soon as possible. These works include adjustment of the heating system, finishing of outdoor areas, etc.

The defects reported by the client are assessed as to liability and repair obligation, and repairs are started without delay, if necessary. When repairs under guarantee have been done and the guarantee expires, the client releases the security furnished for the guarantee period. The company also accepts notices of defect after the one-year guarantee period, but scrutinizes them more closely with respect to liability and repair obligation.

A56 Assess and document project progress

The purpose of this task (Figure 73) is to assess the success of the project and to file documents. The task starts with preparations for a follow-up meeting which involves project analysis based on, for instance, indicators and seeking out of positive and negative factors. Items of the agenda of the follow-up meeting

include the smoothness of production, financial issues, evaluation of the interest groups, feedback from clients, etc. A final report on the project is prepared to show its progress by stages. Corrective measures for company-level mistakes are started. Finally, project documentation and other documents are filed in the company archives. The collected project data is utilized in developing the company's operations.

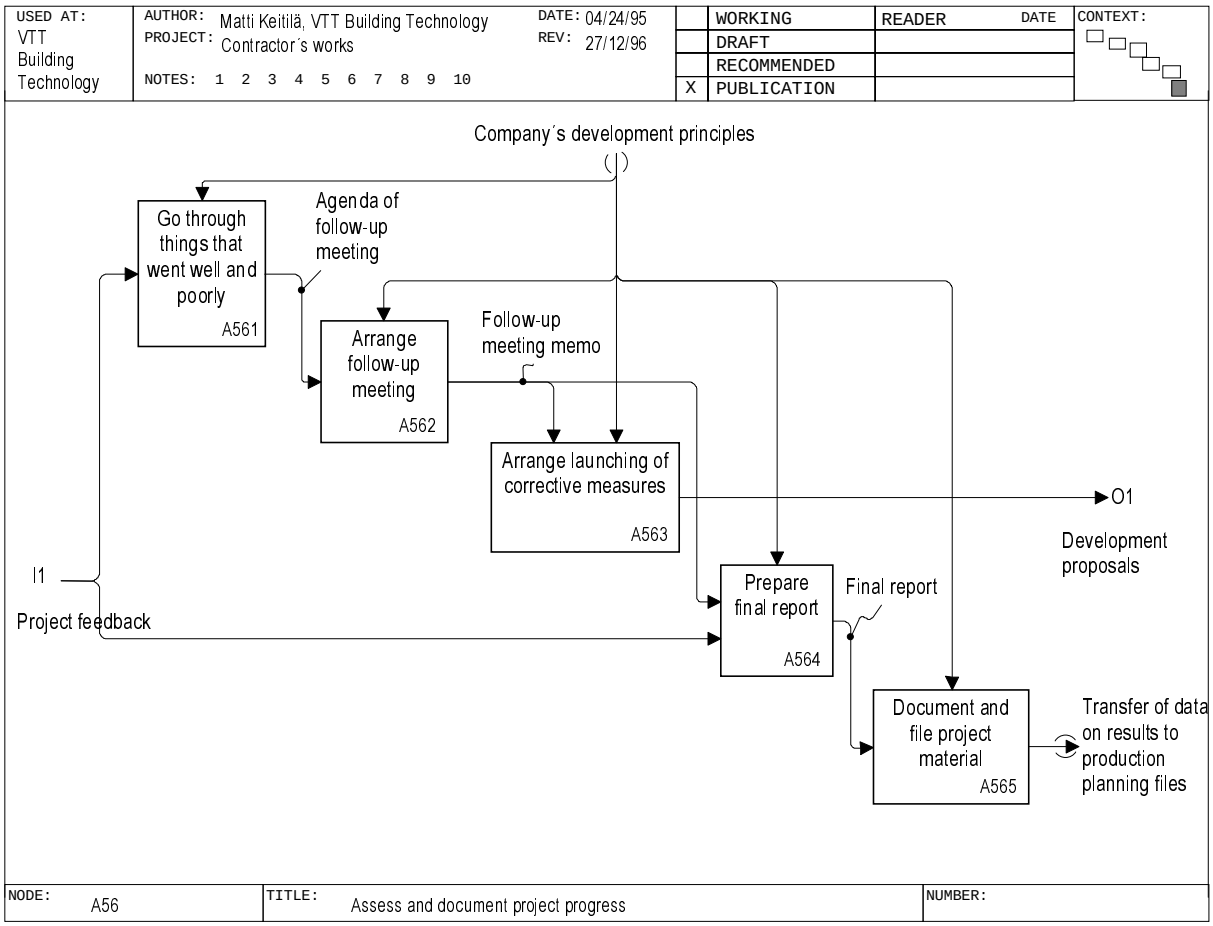


Figure 73. Assess and document project progress.

LIST OF ACTIVITIES

[A0] Implement building

[A1] Offer building implementation

[A11] Process invitation to tender
[A111] Familiarize yourself with tender documents and inspect material
[A112] Make decision on submitting tender
[A113] Plan tender phase

[A12] Implement cost accounting
[A121] Familiarize yourself with project
[A122] Implement quantity surveying
[A123] Inquire about estimated procurement prices
[A124] Do preliminary production planning
[A125] Price
[A126] Revise cost estimate

[A13] Formulate tender
[A131] Set tender price and terms
[A132] Draw tender documents
[A133] Compile and approve tender
[A134] Submit tender

[A2] Prepare for production

[A21] Organize project
[A211] Select person responsible for production
[A212] Define project organization and tasks
[A213] Select project organization

[A22] Make general production plans
[A221] Draw quality plan
[A222] Draw master schedule
[A223] Draw basic site plans
[A224] Check compatibility of

[A0] Toteuta rakennus

[A1] Tarjoa rakentamisen toteutusta

[A11] Käsittele tarjouspyyntö
[A111] Tutustu tarjouspyyntöasiakirjoihin ja tarkasta aineisto
[A112] Tee päätös tarjouksen jättämisestä
[A113] Suunnittele tarjousvaihe

[A12] Tee kustannuslaskenta
[A121] Perehdy kohteeseen
[A122] Suorita määrälaskenta
[A123] Kysy ennakkohintoja hankinnoille
[A124] Tee alustava tuotannon suunnittelu
[A125] Hinnoittele
[A126] Tarkasta kustannusarvio

[A13] Muodosta tarjous
[A131] Määrittele tarjoushinta ja -ehdot
[A132] Laadi tarjouksen asiakirjat
[A133] Kokoa ja hyväksy tarjous
[A134] Toimita tarjous perille

[A2] Valmistele tuotanto

[A21] Organisoi projekti
[A211] Valitse tuotannosta vastaava henkilö
[A212] Määrittele projektiorganisaatio ja tehtävät
[A213] Valitse projektiorganisaatio

[A22] Tee tuotannon yleissuunnitelmat
[A221] Laadi laatusuunnitelma
[A222] Laadi yleisaikataulu
[A223] Laadi työmaan perussuunnitelmat

production plans

[A23] Control building design during construction
[A231] Prepare drawing schedule
[A232] Check and approve submitted designs
[A233] Have drawing schedule approved

[A24] Prepare for and implement procurements
[A241] Plan procurements
[A242] Implement calls for offers
[A243] Compare offers and make selection
[A244] Conclude contract

[A25] Launch site
[A251] Make decision to start production
[A252] Obtain permits and make notifications
[A253] Hold production kickoff meeting
[A254] Establish site

[A3] Control production during construction

[A31] Make detailed production plans
[A311] Make detailed method and equipment plan
[A312] Plan work sequences
[A313] Draw construction-phase and weekly schedules
[A314] Draw special plans

[A32] Control deliveries
[A321] Revise deliveries
[A322] Make reception inspections
[A323] Document deliveries

[A33] Control construction
[A331] Evaluate job planning and preconditions for launching work

[A224] Tarkasta tuotannonsuunnitelmien yhteensopivuus

[A23] Ohjaa rakennussuunnittelua rakentamisen aikana
[A231] Laadi piirustusaikataulu
[A232] Tarkasta ja hyväksy saapuvat suunnitelmat
[A233] Hyväksytä piirustusaikataulu

[A24] Valmistele ja toteuta hankinnat
[A241] Suunnittele hankinnat
[A242] Tee tarjouskyselyt
[A243] Vertaile tarjouksia ja tee valinta
[A244] Tee sopimus

[A25] Aloita työmaa
[A251] Tee tuotannon aloituspäätös
[A252] Hae luvat ja tee ilmoitukset
[A253] Pidä tuotannon aloituspalaveri
[A254] Perusta työmaa

[A3] Ohjaa tuotantoa rakentamisen aikana

[A31] Tarkenna tuotannonsuunnitelmia
[A311] Tarkenna menetelmä- ja kalustosuunnitelma
[A312] Suunnitele työ- ja etenemisjärjestykset
[A313] Laadi rakentamisvaihe ja viikkoaikataulut
[A314] Laadi erityissuunnitelmat

[A32] Ohjaa toimituksia
[A321] Tarkenna toimitukset
[A322] Tee vastaanottotarkastukset
[A323] Dokumentoi toimitukset

[A33] Ohjaa rakentamisen työvaiheita
[A331] Tarkasta työn suunnittelu ja aloitusedellytykset

phase
[A332] Hold kickoff meeting for work phase
[A333] Check state of work phase and organize works
[A334] Do tests, adjustments and checkups
[A335] Review work phase

[A332] Pidä työvaiheen aloituspalaveri

[A333] Tarkasta työvaiheen tila ja tee työn järjestelyt
[A334] Tee kokeet, tarkistukset ja säädöt
[A335] Vastaanota työvaihe

[A34] Control and report on site implementation
[A341] Monitor realization of schedule-related goals
[A342] Control attainment of site's quality standards
[A343] Monitor realization of cost-releted goals
[A344] Evaluate need for corrective measures

[A34] Valvo työmaan toteutumista
[A341] Seuraa työmaan ajallista toteutumista
[A342] Valvo työmaan toteutumista laatuvaatimusten mukaan
[A343] Seuraa työmaan kustannusten toteutumista
[A344] Arvioi korjaavien toimenpiteiden tarve

[A35] Ensure information exchange between parties
[A351] Arrange construction-period official inspections
[A352] Keep site journal
[A353] Hold contractor meetings

[A35] Varmista osapuolten tiedonvaihto
[A351] Järjestä rakentamisen aikaiset viranomaistarkastukset
[A352] Pidä työmaapäiväkirjaa
[A353] Järjestä urakoitsijakokouksia

[A4] Build

[A4] Rakenna

[A41] Implement earth and foundation works
[A411] Clear and demolish
[A412] Excavate and blast
[A413] Implement foundation works
[A414] Fill in and compact
[A415] Implement yard equipment and constructions

[A41] Rakenna maa- ja pohjarakenteet
[A411] Raivaa ja pura
[A412] Kaiva ja louhi
[A413] Tee pohjarakenteet
[A414] Täytä ja tiivistä
[A415] Tee pihavarusteet ja rakenteet

[A42] Build foundation structures and frame
[A421] Build foundation structures
[A422] Build frame
[A423] Build facades
[A424] Build roof structures

[A42] Rakenna perustukset ja runko
[A421] Tee perustukset
[A422] Tee runkorakenteet
[A423] Tee julkisivut
[A424] Tee yläpohjarakenteet

[A43] Build complementary internal structures, fixtures and equipment

[A43] Tee täydentävät sisäosat, varusteet ja laitteet

[A431] Build light-weight partions walls and internal doors
[A432] Install suspended ceilings
[A433] Install raised floors
[A434] Build ladders, catwalks, ducts, channels, fireplaces, etc.
[A435] Install equipment, fixtures and appliances

[A44] Finish internal surfaces
[A441] Finish ceiling surfaces
[A442] Finish wall surfaces
[A443] Finish floor surfaces

[A45] Construct building services
[A451] Install heating system
[A452] Install plumbing and sewer system
[A453] Install electrical system
[A454] Install air-conditioning system
[A455] Install information system
[A456] Install other building services

[A5] Hand over building

[A51] Check readiness for handover
[A511] Check readiness of structures and building services
[A512] Arrange correction of mistakes and defects
[A513] Do final cleaning

[A52] Arrange official final inspections

[A53] Arrange acceptance inspection with client
[A531] Submit agreed inspection material to client for approval
[A532] Inspect building with client
[A533] Submit building's handover material to client
[A534] Arrange correction of mistakes and defects

[A431] Tee kevyet väliseinät ja sisäovet
[A432] Asenna alakatot
[A433] Asenna korokelattiat
[A434] Tee kulkurakenteet, hormit, kanavat ja tulisijat
[A435] Asenna varusteet, laitteet, kalusteet

[A44] Tee sisäpinnat
[A441] Tee katon pintarakenteet
[A442] Tee seinän pintarakenteet
[A443] Tee lattian pintarakenteet

[A45] Rakenna talotekniikka
[A451] Asenna lämmitysjärjestelmä
[A452] Asenna vesi- ja viemärijärjestelmä
[A453] Asenna sähköjärjestelmä
[A454] Asenna ilmastointijärjestelmä
[A455] Asenna tietojärjestelmä
[A456] Asenna muut tekniset järjestelmät

[A5] Luovuta rakennus käyttöön

[A51] Tarkasta luovutusvalmius
[A511] Tarkasta tilojen ja teknisten järjestelmien valmius
[A512] Järjestä virheiden ja puutteiden korjaaminen
[A513] Tee loppusiivous

[A52] Järjestä viranomaisten lopputarkastukset

[A53] Järjestä vastaanottotarkastus tilaajan kanssa
[A531] Luovuta sovittu tarkastusaineisto tilaajalle hyväksyttäviksi
[A532] Tarkasta kohde yhdessä tilaajan kanssa
[A533] Anna asiakkaalle kohteen luovutusaineisto
[A534] Huolehdi puutteiden ja virheiden korjaamisesta

[A54] Provide guidance in taking building into use
- [A541] Arrange guidance for taking building into use
- [A542] Guide users in building use

[A55] Carry out quarantee-period measures
- [A551] Arrange maintenance and adjustment works
- [A552] Implement repairs under guarantee

[A56] Assess and document project progress
- [A561] Go through things that went well and poorly
- [A562] Arrange follow-up meeting
- [A563] Arrange launching of corrective measures
- [A564] Prepare final report
- [A565] Document and file project material

[A54] Opasta rakennuksen käyttöönotossa
- [A541] Järjestä käyttöönopastus
- [A542] Anna rakennuksen käyttöönopastus

[A55] Hoida takuuajan toimenpiteet
- [A551] Järjestä huolto- ja säätötyöt
- [A552] Hoida takuukorjaukset

[A56] Arvioi ja dokumentoi projektin kulku
- [A561] Käy läpi hyvin ja huonosti menneet asiat
- [A562] Järjestä jälkipalaveri
- [A563] Sovi korjaavien toimenpiteiden käynnistämisestä
- [A564] Tee loppuraportti
- [A565] Dokumentoi ja arkistoi projektin aineisto

GLOSSARY OF FLOWS

English	Finnish
A	
Accepted drawing schedule: An accepted drawing schedule is a schedule for formulating implementation, production and supplementary building plans approved by the designers and the main implementer.	**Hyväksytty piirustusaikataulu:** Hyväksytty piirustusaikataulu on suunnittelijoiden ja päätoteuttajan yhteisesti hyväksymä aikataulu toteutus-, tuotanto- ja taydentävien rakennussuunnitelmien laadinnalle.
Accepted tender: The client accepts a tender which meets required criteria and is most advantageous to the him.	**Hyväksytty tarjous:** Hyväksytty tarjous on asiakkaan valinta ja se täyttää vaaditut kriteerit sekä on edullisin asiakkaan kannalta.
Accepted work performance: An accepted work performance refers to one reviewed and meeting the requirements of the contract.	**Hyväksytty työsuoritus:** Hyväksytty työsuoritus tarkoitaa tarkastettua ja sopimuksessa asetetut vaatimukset täyttävää työsuoritusta.
Agenda of follow-up meeting: The follow-up meeting takes up issues such as preparing for production, profitability of project, evaluation of designers, evaluation of subcontractors and suppliers as well as feedback from the client.	**Jälkipalaverin asialista ja aineisto:** Jälkipalaverissa käsiteltäviä asioita ovat mm. tuotannon valmistelu, rakennustyön talous, suunnittelijoiden arviointi, aliurakoitsijoiden ja toimittajien arviointi sekä asiakkaalta saatu palaute.
Approved inspection documents: All construction-period inspection, review and setting-up logs are accepted by the client before the acceptance inspection.	**Hyväksytyt tarkastusasiakirjat:** Kaikki rakentamisen aikaiset tarkastus-, katselmus- ja mittauspöytäkirjat hyväksytetään asiakkaalla ennen vastaanottotarkastusta.
Available personnel: Available personnel consists of the company's work force and available external skilled labour.	**Käytettävissä oleva henkilöstö:** Käytettävissä olevaan henkilöstöön kuuluu yrityksen oma sekä ulkopuolelta kohteeseen saatavissa oleva ammattitaitoinen työvoima.

B

Basic plans: Basic production plans include a budget as well as site, labour, safety and machinery and equipment plans.

Perussuunnitelmat: Tuotannon perussuunnitelmiin kuuluvat tulo-meno-, alue-, työvoima-, turvallisuus- sekä kone- ja kalustosuunnitelma.

Bill of quantities: Bill of materials required for a building project and their quantities based on the quantity survey.

Määräluettelo: Määrälaskennan tuloksena syntyvä luettelorakennuskohteessa tarvittavista materiaaleista ja niiden määrästä.

Building ready for handover: The entire building can be handed over to the client after the main implementer has inspected the structures and systems and found them ready for handover as well as done the final cleaning.

Luovutusvalmis rakennus: Päätoteuttaja on tarkastuksissaan todennut rakenteet ja järjestelmät luovutusvalmiiksi sekä tehnyt loppusiivouksen, jolloin koko rakennus on valmis luovutettavaksi asiakkaalle.

Building services: Building services consist of the building's technical systems such as heating, electrical, air-conditioning, information and water supply and drainage systems.

Talotekniikka: Talotekniikka käsittää rakennuksen tekniset järjestelmät, kuten lämmitys-, sähkö-, ilmastointi-, tieto- sekä vesi- ja viemärijärjestelmät.

C

Calculation decision: The decision to commence tender calculations.

Laskentapäätös: Laskentapäätös antaa impulssin tarjouslaskenna aloittamiselle.

Calculation files: Calculation files contain general input, method and price files and ones the company has compiled for itself.

Laskentatiedostot: Laskentatiedostot sisältävät yleisiä sekä yrityksen itselleen keräämiä menekki-, menetelmä- ja hintatiedostoja.

Calculation plan: The calculation plan defines those responsible for tender calculations, the nomenclatures of the company, the scope and detailedness of production planning and the calculation schedule.

Laskentasuunnitelma: Laskentasuunnitelma määrittelee laskennan vastuuhenkilöt, yrityksen käyttämät nimikkeistöt, tuotannonsuunnittelun laajuuden ja tarkkuuden sekä laskennan aikataulun.

Call for offers: Calls for offers are

Tarjouskysely: Edullisimman työsuo-

submitted to subcontractors to find the most advantageous offer for a work performance or material delivery.

Capable users: Capable users have undergone training in building use.

rituksen tai materiaalitoimituksen selvittämistä varten alihankkijoille lähetettävä tarjouspyyntö eli tarjouskysely.

Osaavat käyttäjät: Osaavat käyttäjät ovat käyneet läpi koulutuksen, jossa on opastettu rakennuksen käyttöä.

Checked tender: Tender prepared by the main implementer that is ready to be submitted to the inviter of the tender.

Tarkastettu urakkatarjous: Päätoteuttajan laatima urakkatarjous on siinä valmiudessa, että se voidaan toimittaa tarjouspyynnön lähettäjälle.

Company's quality system: The quality system comprises the measures, liabilities and documents that assure meeting set or supposed demands and development of the company.

Yrityksen laatujärjestelmä: Laatujärjestelmä sisältää toimenpiteet, vastuut ja dokumentit, joilla varmistetaan asetettujen tai oletettujen vaatimusten täyttyminen ja yrityksen kehittyminen.

Company´s development principles: Organizational quality principles defined by company management and a declaration of intent for continuous improvement as well as related procedural instructions.

Yrityksen kehittämisperiaatteet: Yrityksen johdonmäärittelemät organisaation laatuperiaatteet ja tahdonilmaus jatkuvaan parantamiseen sekä vastaavat menettelytapaohjeet.

Company´s work situation: The company's present and future work situation affects availability of resources and must be taken into account when deciding whether to start doing calculations.

Yrityksen työkanta: Yrityksen nykyinen ja tuleva työtilanne vaikuttaa resurssien saatavuuteen, joten se on otettava huomioon laskentapäätöstä tehtäessä.

Complementary internal structures, fixtures and equipments: Complementary internal structures, fixtures and equipments consist of internal doors, light-weight partition walls, suspended ceilings and raised floors, etc.

Täydentävät sisäosat, varusteet ja laitteet: Täydentävät sisäosat, varusteet ja laitteet käsittää mm. sisäovet, kevyet väliseinät, alakatot ja korokelattiat.

Completed work phase: The completion of a work phase and its compliance with goals is established by an inspection which makes its acceptance possible.

Valmis työvaihe: Valmis työvaihe on todettu tarkastuksessa loppun suoritetuksi ja tavoitteiden mukaiseksi, joten se voidaan vastaanottaa.

Construction waste: All excess material of the site including soils, rock, wood and metal scrap.

Rakennusjäte: Rakennusjätteeksi luokitellaan kaikki työmaalta ylijäävä materiaali, kuten mm. maa-ainekset sekä kivi-, puu-, ja metallijäte.

Construction-period feedback and documentation: Compiled data and feedback on implementation of project from tender phase to handover.

Palaute ja dokumentointi rakennusajalta: Kerätty tieto ja palaute kohteen toteutuksesta tarjousvaiheesta luovutukseen.

Construction-phase and weekly schedules: Construction-phase and weekly schedules describe the progress of work and events that influence production in more detail than the master schedule.

Rakentamisvaihe- ja viikkoaikataulut: Rakentamisvaihe- ja viikkoaikataulut määrittelevät yleisaikataulua tarkemmin työn etenemisen ja tapahtumat, jotka vaikuttavat tuotantoon.

Contract: The contract defines the building project's construction works and time-wise limits for their implementation.

Urakkasopimus: Urakkasopimus määrittelee mm rakennushankkeeseen kuuluvat rakennustyöt sekä ajalliset rajat sen toteuttamiselle.

Contractor: In traditional building contracting, the main implementer performs construction-technical works on the basis of existing plans either himself or by contracting them out.

Päätoteuttaja: Päätoteuttaja hoitaa perinteisessä rakennusurakassa ainakin rakennustekniset työt valmiiden suunnitelmien pohjalta joko omana työnään tai alihankintana sekä koordinoi koko työmaan tuotantoa.

Corrective measures for production control: Production control receives feedback which is used to correct implementation or plans in the right direction.

Ehdotukset tuotantoa korjaaviksi toimenpiteiksi: Tuotannon ohjaukselle annetaan palautetta, jolla korjataan toteutusta tai suunnitelmia oikeaan suuntaan.

Cost estimate: The cost estimate is a tender-phase estimate of construction-related costs.

Kustannusarvio: Kustannusarvio on tarjousvaiheessa laadittava arvio rakennustyössä syntyvistä kustannuksista.

D

Daily site journal: Daily entries are made in the site journal concerning beginning and end of work phases and all major events such as inspections, deliveries and tests

Päivitetty työmaapäiväkirja: Työmaapäiväkirjaan merkitään päivittäin käynnissä olevat, alkavat ja päättyneet työvaiheet sekä kaikki merkittävät tapahtumat, kuten tarkastukset, toimitukset ja kokeet.

Data on deliveries: The data include delivery lots, order and time as well as packing and protection methods.

Tiedot toimituksista: Tiedot sisältävät toimituserät, -järjestyksen ja -ajan sekä pakkaus- ja suojaustavat.

Data on inspected deliveries: The data include the scope of delivery, delivery time, quality defects and inspections as well as handling of delivery on site.

Tiedot tarkastetuista toimituksista: Tiedot sisältävät toimituksen määrän, toimitusajan, laatuvirheet ja laatutarkastukset sekä toimituksen käsittelyn työmaalla.

Data on inspections and their results: The timing and content of on-site inspections and reviews, and later their results, are to be conveyed to the key perties and the site journal.

Tiedot tarkastuksista ja niiden tuloksista: Ajoitus ja sisältö tiedot työmaalla tehtävistä tarkastuksista ja katselmuksista sekä myöhemmin niiden tuloksista tulee toimittaa merkityksellisille osapuolille sekä työmaapäiväkirjaan.

Data on results: The data describe the progress of construction in accordance with plans and problems that have arisen and the reasons for them.

Tieto toteutuneesta ja poikkeamista: Tieto kuvaa rakennustyön edistymistä laadittuihin suunnitelmiin nähden sekä syntyneitä ongelmia ja niiden syitä.

Decision to start: The launching decision provides an impetus for holding a kickoff meeting and establishing the site.

Aloituspäätös: Aloituspäätos antaa impulssin aloituspalaverin pitämiselle ja työmaan perustamiselle.

Detailed method and equipment plan: The method plan defines the main production methods, modes of implementation by work types, division of the building into jobs and the sequence of implementing blocks and jobs. The equipment plan defines the machinery needed on site, the required ratings and capacities and how long it is needed.

Tarkennettu menetelmä- ja kalustosuunnitelma: Menetelmäsuunnitelma määrittelee päätuotantomenetelmät, toteutustavat työlajeittain, rakennuksen jaon työkohteisiin sekä lohkojen ja työkohteiden suoritusjärjestyksen. Kalustosuunnitelma määrittelee työmaalla tarvittavat koneet, koneiden teho- ja kapasiteettivaatimukset sekä tarveajan.

Detailed production plans: General production plans have been made more detailed to correspond to the daily needs of production.

Tarkennetut tuotannonsuunnitelmat: Tuotannon yleissuunnnitelmat on tarkennettu tuotannon päivittäisen käytön vaatimusten mukaisiksi.

Development proposals: Proposals for measures to improve production methods and procedures.

Kehitysehdotukset: Tuotannon menetelmien ja toimintatapojen kehittämiseksi annetut toimenpide-ehdotukset.

Documented deliveries: The documents contain data on deliveries. See "Data on deliveries" and "Data on inspected deliveries".

Toimitukset dokumentoituna: Dokumentit sisältävät tiedon toimituksista. Ks. ”tiedot toimituksista” ja ”tiedot tarkastetuista toimituksista”.

Draft tender: The draft tender is a preliminary form of tender of the calculation phase when the final price has not yet been fixed.

Urakkatarjousluonnos: Urakkatarjousluonnos on laskentavaiheessa urakkatarjouksen esiaste, jolloin ei vielä ole tarkistettu lopullista hintaa.

Drawing schedule: The drawing schedule sets the completion dates of various building plans from the viewpoint of production.

Piirustusaikataulu: Piirustusaikataulu määrittelee tuotannon tarpeiden perusteella eri rakennussuunnitelmien valmistumisaikataulun.

E

Earth and foundation works: Earth and foundation works include excavation, rock blasting, soil stabilization, piling, building of sewers and subsurface drainage as well as surface structures of the site.

Maa- ja pohjarakenteet: Maa- ja pohjarakenteisiin kuuluvat kaivannot, louhinnat, maaperän lujitukset, paalutukset, viemäröinnit ja salaojitukset sekä rakennusalueen pintarakenteet

F

Feedback and documentation on inspections: Memos are prepared on site inspections which serve as feedback and documentation for inspections.

Palaute ja dokumentointi tarkastuksista: Kohteessa tehtävistä tarkastuksista tehdään muistiot, jotka toimivat palautteena ja dokumentaationa tarkastuksista.

Feedback to supplier: Feedback to subcontractor on delivered products or services, if necessary.

Palaute toimittajalle: Alihankkijalle annettava palaute toimitetuista tuotteista tai palveluista, jos niissä on jotain huomauttamista.

Final report: The final report explains the project from start to finish including problem areas and things that went well.

Loppuraportti: Loppuraportissa selvitetään hankkeen kulku alusta loppuun sekä siinä ilmenneet ongelmakohdat ja hyvin sujuneet asiat.

Flawless building: Inspected spaces and systems on site that are in compliance with plans and agreements and accepted as such by the client constitute a flawless building.

Virheetön rakennus: Rakennuskohteessa tarkastetut tilat ja järjestelmät, jotka ovat suunnitelmien ja sopimusten mukaiset ja tilaajan sellaisina vastaanottamat.

Flawless structures and systems: An

Virheettömät rakenteet ja järjes-

inspection reveals individual structures´ and systems´ compliance with goals and plans. Unless mistakes and defects are noticed, they can be considered flawless.

telmät: Tarkastuksessa todetaan yksittäisten rakenteiden ja järjestelmien tavoitteiden ja suunnitelmien mukaisuus ja ellei virheitä ja puutteita havaita, voidaan niitä pitää virheettöminä

Follow-up meeting memo: The memo contains all topics dealt with in the meeting as well as decisions taken with respect to further measures.

Jälkipalaverin muistio: Muistioon kirjataan asiat, joita palaverissa on käsitelty sekä päätökset, jotka on tehty jatkotoimenpiteitä ajatellen.

Foundation structures and frame: Foundation structures include the footings, plinths, base floors and special structures of the base floor of a building. The building frame consists of the parts of the frame above the base floor which include columns, beams, slabs, facades and the roof slab.

Perustukset ja runko: Perustuksiin kuuluvat rakennuksen aturat, perusmuurit, alapohjat ja alapohjan eritysrakenteet. Rakennuksen runkoon luetaan kuuluvaksi alapohjan yläpuolella olevat kantavat rakenteet, joita ovat mm. pilarit, palkit, laatat, julkisivut ja yläpohja.

Future users: People and/or organizations that will be involved in the activity taking place in the building.

Tulevat käyttäjät: Rakennukseen sijoittuvaan toimintaan osallistuvat henkilöt ja/tai organisaatiot.

G

General production plans: General production plans include the quality plan, the master schedule and basic plans.

Tuotannon yleissuunnitelmat: Tuotannon yleissuunnitelmiin kuuluvat laatusuunnitelma, yleisaikataulu ja perussuunnitelmat.

Guarantee certificates, use instructions and handover drawings: Guarantee certificates, use instructions and handover drawings comprise the material to be submitted to the client. They include use instructions and guarantee certificates for machinery and equipment and use and maintance instructions for various structures.

Takuutodistukset, käyttöohjeet ja luovutuspiirustukset: Takuutodistukset, käyttöohjeet ja luovutuspiirustukset muodostavat asiakkaalle luovutettavan aineiston, joka sisältää koneita ja laitteita koskevat ohjeet ja takuutodistukset sekä erilaisten rakenteiden käyttö- ja huolto-ohjeet.

Guarantee-period feedback and documentation: Guarante-period feedback on the building is collected internally and recieved from clients (incl. notice of defect) and is then documented along with the required corrective measures.

Palaute ja dokumentointi takuuajalta: Rakennuksen takuuajalta kerätään ja saadaan käyttäjiltä palautetta (sis. reklamaatiot), joka dokumentoidaan yhdessä vaadittujen korjaavien toimenpiteiden kanssa.

Guarantee-period improvements: Guarantee-period improvements include correction of any possible mistakes and flaws in the contracted works.

Takuuajan parannukset: Takuuajan parannukset sisältävät kaikki mahdollisesti jäljelle jääneiden urakkasuorituksen virheiden ja puutteiden korjaustyöt.

Guidance procedure for taking building into use: Main implementer´s method of guiding building´s future users.

Käytönopastuksen menettelyt: Päätoteuttajan tapa toimia opastettaessa rakennuksen tulevia käyttäjiä.

H

Handover material: Handover material consists of the building-project handover documents, HVAC-works handover documents, electrical-works documents, automation-works documents, building-specific documents, apartment-specific documents and administrative handover documents of the housing corporation.

Luovutusaineisto: Luovutusaineistoon kuuluvat rakennusurakan, LVI-urakan, sähköurakan ja automaatiourakan luovutusasiakirjat, rakennuskohtaiset asiakirjat, huoneistokohtaiset asiakirjat ja asuntoyhtiön hallinnolliset luovutusasiakirjat.

I

Implementation, production and complementary plans: Building, production and installation plans of various designers.

Toteutus-, tuotanto- ja täydentävät suunnitelmat: Eri suunnittelualoilta tuotantoon tulevat rakennus-, valmistus- ja asennussuunnitelmat.

Incomplete work phase: Incomplete work phase refers to an ongoing or uninspected task.

Keskeneräinen työvaihe: Keskeneräinen työvaihe viittaa meneillään olevaan tai tarkastamattomaan tehtävään.

Inspected implementation, production and complementary plans: Implementation, production and complementary plans received from various designers whose flawlessness and

Tarkastetut toteutus-, tuotanto- ja täydentävät suunnitelmat: Eri suunnittelualoilta tulevat toteutus-, tuotanto- ja täydentävät suunnitelmat, joiden virheettömyys ja toteutettavuus on

implementability have been inspected.

Inspected job planning: Job planning have been inspected by the main contractor.

tarkastettu.

Tarkastettu työnsuunnittelu: Pääurakoitsijan työnjohto on tarkastanut työnsuunnittelun.

Inspected tender documents: Tender documents submitted by the client are inspected to determine that they include all necessary documents and are free of errors.

Tarkastetut tarjouspyyntöasiakirjat: Asiakkaalta tulleet tarjouspyyntöasiakirjat tarkastettuina siten, että ne sisältävät kaikki tarvittavat asiakirjat eivätkä sisällä virheitä.

Inspection documents: Inspection documents are documents signed by officials after inspections which they submit to the main contractor.

Tarkastusasiakirjat: Tarkastusasiakirjat ovat viranomaistarkastuksissa viranomaisen allekirjoittamat ja pääurakoitsijalle luovuttamat asiakirjat.

Inspection memos: A memo on a work-phase inspection that records defects and mistakes as well as things that went smoothly.

Tarkastusmuistiot: Työvaiheiden tarkastuksista tehdyt muistiot, joissa ovat kirjattuna puutteet ja virheet sekä hyvin sujuneet asiat.

Internal structures: Internal surfaces consists of the surface structures of a building's internal spaces including levelling and topping, etc.

Sisäpinnat: Sisäpinnat käsittävät rakennuksen sisäpuolisten tilojen pintarakenteet alustoineen.

J

Job planning and preconditions for starting work: Job planning involves assessment of the work phase, choice of method, determination of resource needs, establishment of order of works and planning of quality inspections.

Työnsuunnittelu ja aloitusedellytykset: Työnsuunnittelu sisältää työvaiheen arvioinnin, menetelmävalinnan, resurssien määrittämisen, työjärjestyksen määräämisen ja laatutarkastusten suunnittelun.

M

Market situation: Market situation refers to the situation in the construction market that affect the tender-phase calculation decision and setting of tender price.

Markkinatilanne: Markkinatilanne on rakennusalalla valitseva suhdanne tilanne, joka vaikuttaa tarjousvaiheessa laskentapäätökseen ja tarjoushinnan määrittämiseen.

Master schedule: The master schedule is the backbone of implementation and a tool for controlling construction. It sets the key time-wise goals and

Yleisaikataulu: Yleisaikataulu on toteutuksen runko ja rakennustyön ohjausväline. Yleisaikataulu määrittää tärkeimmät ajalliset tavoitteet ja on

serves as basic data for lower-level job planning.

lähtötietona alemman tason työnsuunnittelulle.

Materials, components and services: Materials include cement, lumber, etc. Components consist of windows, doors, elements, etc. Services include work performances, haulage, etc.

Materiaalit, tuoteosat ja palvelut: Materiaaleja ovat mm. sementti ja puutavara. Tuoteosiin kuuluvat mm. ikkunat, ovet ja elementit. Palveluihin luetaan kuuluvaksi mm. työsuoritukset ja kuljetukset.

Mistakes and defects in building: Mistakes or defects in the building detected by the client that constitute a breach of contract.

Virheitä ja puutteita rakennuksessa: Asiakkaan kohteessa havaitsemat sopimuksen vastaiset virheet tai puutteet.

Mistakes or defects in structures and systems: Mistakes or defects detected by main contractor in own inspection.

Virheitä tai puutteita rakenteissa ja järjestelmissä: Pääurakoitsijan itselleluovutuksessa havaitsemat virheet tai puutteet kohteen tiloissa tai järjestelmissä.

N

Notice of participation: The tenderer is informed of the company's inclusion in competitive bidding.

Ilmoitus osallistumisesta: Tarjouspyynnön lähettäjälle lähetetään ilmoitus siitä, että yritys osallistuu tarjouskilpailuun.

Notices of defect: A notice of defect is an announcement of some work performance being contrary to contract as well as a demand for repair or compensation.

Reklamaatiot: Reklamaatiot ovat ilmoituksia rakennustyön sopimuksenvastaisuudesta sekä vaatimuksia korjaustyöstä tai korvauksesta.

O

Official regulations: Society controls construction by issuing regulations, ordinances, laws and rules that govern construction.

Viranomaismääräykset: Yhteiskunnan taholta valvotaan rakentamista antamalla ohjeita, asetuksia, lakeja ja määräyksiä, jotka ohjaavat rakentamista.

Organizational structure and task descriptions: Organizational structure and task descriptions define the project´s main tasks and the responsible persons including their

Organisaatiorakenne ja tehtäväkuvaukset: Organisaatiorakenne ja tehtäväkuvaukset määrittelevät projektin päätehtävät ja niiden vastuuhenkilöt vastuu- ja raportointisuhteineen.

responsibilities and who reports to whom.

Order and progression of works: Order and progression or works refers to the order in which various work phases are performed and individual phases' progression in various parts of the project.

Työ- ja etenemisjärjestykset: Työ- ja etenemisjärjestykset määrittelevät eri työvaiheiden keskinäiset suoritusjärjestykset ja yksittäisten työvaiheiden etenemisjärjestyksen kohteen eri osissa.

Organization and supervision of work: Organization and supervision of work consists of site management´s daily supervisory and organizing tasks that enable work to proceed and various work phases to be completed.

Työnjärjestely ja -ohjaus: Työnjärjestely ja -ohjaus ovat kohteen työjohdon päivittäisiä työnohjaus ja työmaan järjestelytehtäviä, joilla luodaan edellytykset työntekemiselle ja eri työvaiheiden valmistumiselle.

Overview of project: Familiarization with the project on site and through drawings well enough to ensure that special features are taken into account in detailed examinations.

Kokonaisnäkemys kohteesta: Kohteeseen tutustutaan paikan päällä ja piirustuksien avulla niin hyvin, että varmistetaan kohteen erityispiirteiden huomioon ottaminen yksityiskohtaisissa tarkasteluissa.

P

Permits and notifications: Permits and notifications to be secured and made before establishing site.

Luvat ja ilmoitukset: Luvat ja ilmotukset, jotka tulee hakea ja tehdä ennen työmaan perustamista.

Person responsible for production: The site manager is generally the person responsible for production.

Tuotannosta vastaava henkilö: Tuotannosta vastaava henkilö on yleensä työmaan vastaava mestari.

Plot: The area on which a building is to be built.

Tontti: Alue, jolle tuleva rakennus on tarkoitus rakentaa.

Preliminary price inquiries: Preliminary price inquiries give some idea of the price of a system unit or service - it is not, however, always binding on the party quoting the price.

Ennakkohinnat: Ennakkohinnat antavat käsityksen rakennusosan tai palvelun hinnasta, mutta eivät kuitenkaan aina ole ennakkotarjouksen antanutta sitovia.

Preliminary inquires: Preliminary inquires are made about subcontracts to determine the price level at the tender calculation phase or, some-

Ennakkokyselyt: Ennakkokyselyt tehdään alihankinnoista niiden hintatason määrittämiseksi urakkalaskentavaiheessa tai toisinaan suunnittelun-

times, to aid design control.

Preliminary offers: Preliminary inquires result is preliminary offers by subcontractors which are utilized for tender calculation.

Preliminary production plans: A preliminary production plan sets the construction time, the production mode and main work methods at the tender phase.

Procurement files: Procurement files contain general price and subcontractor files and ones compiled by the company.

Procurement plan: The procurement plans sets out, for instance, the people responsible for procurements, delivery times and quantities as well as the cost target of procurements.

Production control: Production control is the general term used for the planning, coordination and supervision of site tasks and procurements.

Production-planning files: Production-planning files include general files such as the input and methods files of the building information file and files compiled by the company from previous projects.

Project documents to be filed: Calculation documents, contracts, inspection records, building-permit drawings and production plans are among the documents that are to be filed.

Project documents: Project documents comprise tender documents, the contract as well as implementation, production and complementary plans.

ohjauksen tarpeisiin.

Ennakkotarjoukset: Ennakkokyselyt tuottavat alihankkijoilta ennakkotarjoukset, joita käytetään apuna urakkalaskennassa.

Alustavat tuotantosuunnitelmat: Alustavat tuotantosuunnitelmat määrittävät tarjousvaiheessa rakennusajan samoin kuin tuotantotavan ja päätyömenetelmät.

Hankintatiedostot: Hankintatiedostot sisältävät yleisiä sekä yrityksen itsensä keräämiä hinta- ja alihankkijatiedostoja.

Hankintasuunnitelma: Hankintasuunnitelma määrittelee mm. hankintojen vastuuhenkilöt, toimitusajat ja -määrät sekä hankintojen kustannustavoitteen.

Tuotannon ohjaus: Tuotannonohjaus on yleisnimitys työmaatehtävien ja hankintojen suunnittelulle, koordinoinnille ja valvonnalle.

Tuotannonsuunnittelutiedostot: Tuotannonsuunnittelutiedostoihin kuuluvat yleiset tiedostot, kuten Ratu-kortiston menekki- ja menetelmätiedot, sekä yrityksen omat aikaisemmista projekteista keräämät tiedostot.

Arkistoitavat projektiasiakirjat: Arkistoitaviin asiakirjoihin kuuluvat mm. laskenta-asiakirjat, sopimukset, tarkastuspöytäkirjat, rakennuslupapiirustukset ja tuotannonsuunnitelmat.

Hankeasiakirjat: Hankeasiakirjoihin kuuluvat tarjousasiakirjat, urakkasopimus, toteutus-, tuotanto- ja täydentävät suunnitelmat.

Project feedback: Documented monitoring and feedback data for the duration of the project.

Palaute projektista: Koko projektin ajalta kerätty seuranta- ja palautetieto dokumentoituna.

Project organization: The project organization consists of the workers and organizations recruited by the main implementer for the project.

Projektiorganisaatio: Projektiorganisaation muodostavat päätoteuttajan hankkeeseen rekrytoimat työntekijät ja organisaatiot.

Proposed change to plans: A change proposal acquaints building design with the production viewpoint in order to allow improving implementability of plans.

Muutosehdotukset rakennussuunnitelmiin: Muutosehdotus antaa tuotannon näkökulman rakennussuunnitteluun, jotta suunnitelmien toteutettavuutta voitaisiin parantaa.

Q

Quality plan: The quality plan is a plan for the quality control and assurance of the building project and application of the company's quality system to the project.

Laatusuunnitelma: Laatusuunnitelma on suunnitelma rakennushankkeen toteutuksen laadunohjauksesta ja -varmistuksesta sekä yrityksen laatujärjestelmän soveltamisesta työkohteeseen.

R

Readiness to start construction: Readiness to start construction exists when the plans required for starting implementation are ready and the permits and notifications required for commencement are in order.

Valmius rakentamisen aloittamiselle: Valmius rakentamisen aloittamiselle saavutetaan, kun toteutuksen aloittamisen vaatimat suunnitelmat ovat valmiina sekä aloittamiseen vaadittavat luvat ja ilmoitukset ovat kunnossa.

Readiness to start work phase: Readiness to start a work phase exists when the kickoff meeting has been held and the preconditions for work have been ascertained.

Valmius aloittaa työvaihe: Valmius työvaiheen aloittamiselle on, kun aloituspalaveri on pidetty ja työn aloitusedellytykset on tarkastettu.

Ready-to-use building: A building that is ready to receive its future users and serve them as planned.

Käyttövalmis rakennus: Rakennus on valmis ottamaan vastaan tulevat käyttäjänsä ja palvelemaan heitä suunnitellulla tavalla.

Report on work phases: The report on work phases reveals the degrees of completion of various work phases,

Työvaiheiden tilannetiedot: Työvaiheiden tilannetiedot kertovat eri työvaiheen valmiusasteen, kustannustilan-

accrued costs and how well plans have materialized at a certain point in time.

teen ja suunnitelman mukaisuuden tietyllä ajanhetkellä.

Resources: Resources are the economic, physical and mental factors of production required in the building production process.

Resurssit: Resurssit ovat rakentamisen tuotantoprosessissa tarvittavat taloudelliset, fyysiset ja henkiset tuotannontekijät.

Revised cost estimate: Cost estimate revised on the basis of indicators and experience.

Tarkastettu kustannusarvio: Kustannusarvio, joka on tarkastettu tunnuslukujen ja kokemuksen avulla.

Revised procurement plan: The procurerment plan is initially revised to correspond to the schedules revised during the project and then, to correpond to the delivery times agreed with suppliers.

Tarkennettu hankintasuunnitelma: Hankintasuunnitelma on tarkennettu vastaamaan ensinnä projektin aikana tarkentuneita aikatauluja ja edelleen toimittajien kanssa sovittuja toimitusaikoja.

Revisions of delivery: A change makes a previously concluded contract more detailed time- and/or quantity-wise.

Muutokset tilaukseen: Muutos tarkentaa aikaisemmin tehtyä sopimusta ajallisesti ja/tai määrällisesti.

S

Schedules: Schedules are plans for timewise control of project implementation.

Aikataulut: Aikataulut ovat kohteen toteutuksen ajallisen ohjauksen apuvälineeksi tehtyjä suunnitelmia.

Site: The site consists of personnel facilities, site roads, machinery and equipment and interim water, electricity and telephone connections that make commencement of construction possible.

Työmaa: Työmaa käsittää fyysisen valmiuden rakentamisen aloittamiselle eli työmaan sosiaalitilat, työmaatiet, koneet ja kaluston sekä väliaikaiset vesi-, sähkö- ja puhelinlinjat.

Site machinery and equipment: Site machinery and equipment include the interim water, electricity and telephone connections as well as site machinery and personnel facilities.

Työmaan koneet ja laitteet: Työmaan koneet ja laitteet käsittävät työmaalle asennettavat väliaikaiset vesi- sähkö- ja puhelinlinjat sekä työmaan kaluston ja sosiaalitilat.

Site journal: the site journal is an official document where all significant site events, such as inspections, deliveries and tests as well as

Työmaapäiväkirja: Työmaapäiväkirja on virallinen asiakirja, johon tulevat kaikki merkittävät työmaan tapahtumat, kuten tarkastukset, toimitukset

information about ongoing works are recorded.

ja kokeet sekä tiedot meneillään olevista töistä.

Special plans: Special plans consist of demolition, element installation, shuttering rotation, occupational safety, scaffolding, blasting and soil excavation and concreting and test-cube plans.

Erityissuunnitelmat: Erityissuunnitelmiin kuuluvat purkutyö-, elementtiasennus-, muottikierto-, työturvallisuus-, teline-, louhinta- ja maankaivuusuunnitelmat sekä betonointi- ja koekuutiosuunnitelmat.

State of incomplete work phase: Degree of readiness of incomplete work phases including labour input and cost data as well as realized quality.

Keskeneräisten työvaiheiden tilannetiedot: Kesken olevien työvaiheiden valmiusaste työmenekki- ja kustannustietoineen sekä tieto toteutuneesta laadusta.

State of work phase: The state of a work phase refers to how far a completed or incomplete work phase has progressed quantitatively, its timewise progress and quality.

Työvaiheen tila: Työvaiheen tila on tieto valmistuneen tai kesken olevan työvaiheen määrästä, ajallisesta edistymisestä ja laadusta.

Subcontract: A subcontract is a contract into which the main contractor enters as a client with another enterprise for implementing work or delivering goods, or both.

Alihankintasopimus: Alihankintasopimus on pääurakoitsijan tilaajana tekemä sopimus toisen yrityksen kanssa koskien työn toteutusta tai tavaran toimittamista tai molempia.

Suggestion for and information on corrective measures in production control: The main contractor informs the other parties about changes to plans that concern them and makes suggestion about corrective measures in production control to be decided jointly.

Ehdotukset ja tieto tuotantoa korjaaviksi toimenpiteiksi: Pääurakoitsija informoi muita osapuolia heitä koskevista suunnitelmamuutoksista sekä tekee ehdotuksia yhteisesti päätettävistä tuotantoa korjaavista toimenpiteistä.

T

Technically-ready building: A building ready from the viewpoint of construction work, only inspections by the main contractor and officials and handover to client remain to be implemented before the building is taken into use.

Teknisesti valmis rakennus: Rakennus on valmis rakennustöiden osalta, vain viranomaistarkastukset sekä itselle ja asiakkaalle luovutus ovat tekemättä ennen rakennuksen käyttöönottoa.

Tender documents: Tender docu-

Tarjouspyyntöasiakirjat: Tarjous-

ments consist of an invitation to tender, a schedule of the works included in the contract and implementation plans.

pyyntöasiakirjat sisältävät urakkatarjouspyynnön, urakkaohjelman ja toteutussuunnitelmat.

Tender price and terms: The tender price and terms consist of price and other data related to implementing construction which are determined by the main implementer on the basis of tender- calculation data.

Urakkatarjoushinta ja -ehdot: Tarjoushinta ja -ehdot ovat päätoteuttajan tarjouslaskennasta saatujen tietojen avulla määrittelemiä hinta- ym. tietoja rakennustyön toteutuksesta.

Tender: The main implementer providers the inviter of a tender information about the work he offers to do and its price which constitutes a tender.

Urakkatarjous: Päätoteuttaja toimittaa tarjouspyynnön lähetäjälle tiedon tarjoamastaan työstä ja sen hinnasta, joka on urakkatarjous.

Tenders from suppliers: Tenders submitted by subcontractors invited by the main contractor.

Tarjouksia toimittajilta: Alihankkijoilta tulevat tarjoukset toimituksista ja palveluista, joista pääurakoitsija on tehnyt tarjouskyselyt.

Transfer of data on results to production planning files: Experiences gained during the project including work-specific data on conditions, labour inputs and suppliers are transferred to production planning files for utilization in the planning of new projects.

Toteutumatiedot tuotannonsuunnittelutiedostoihin: Projektissa saadut kokemukset työlajikohtaisine olosuhde-, työmenekki- ja toimittajatietoineen siirretään tuotannonsuunnittelutietoihin hyödynnettäväksi uusien projektien suunnittelussa.

U

Use instructions: Use instructions for the building systems, equipment and structural elements are compiled and submitted to the client. They describe the system and its proper use, required servicing and instructions in case of malfunctions.

Käyttöohjeet: Rakennuksen järjestelmistä, laitteista ja rakennusosista tehdään asiakkaalle luovutettavat käyttöohjeet, jotka kuvaavat järjestelmän ja sen soveltuvan käytön, vaaditut huoltotoimenpiteet sekä toimintaohjeet häiriötilanteiden varalle.

W

Work phases to be inspected: A work phase that is completed or at a stage requiring inspection.

Tarkastettavat työvaiheet: Työvaihe, joka on valmis tai siinä vaiheessa, että se tulee tarkastaa.

APPENDIX 1:
CONTENT OF PLANS AND DRAWINGS (ACTIVITIES A41 - A45)

(Source: RT 10-10576 ... RT 10-10580)

EARTH AND FOUNDATION WORKS

Environment-protection plan
- areas to be stabilized and structures to be reinforced and applied methods
- suggested order of works
- monitoring systems

Earth-structure plan for building and yard
- detail sections of earth structures (base floors, building backfill, trenches for conduits)
- backfill soil types
- surface structure types
- transition-wedge and frost-protection types
- grain-size, compaction and bearing-capacity requirements for earth structures

Excavation and blasting scheme for building and yard
- excavation and blasting levels and tolerances
- slopes
- types of bracing and position of abutment walls
- drainage during work
- order of excavation and blasting works

Foundation plan for building ground and yard
- outline of building and bottom floors
- limitations on substructures
- soil-stabilization areas
- foundation sections of building
- level of lower ends of footings and piles

MAA- JA POHJARAKENTEET

Ympäristön suojaussuunnitelma
- vahvistettavat alueet ja rakenteet ja vahvistustavat
- ohjeellinen työjärjestys
- tarkkailujärjestelmät

Rakennuksen ja piha-alueen maa-rakennesuunnitelma
- maarakenteiden detaljileikkaukset (alapohjat, rakennuksen vierustäyttö, johtokaivannot
- täyttöjen maarakennetyypit
- päällysrakennetyypit
- siirtymäkiila- ja routasuojaustyypit
- maarakenteiden rakeisuus-, tiivistys- ja kantavuusvaatimukset

Rakennuksen ja piha-alueen kaivu- ja louhintasuunnitelma
- kaivu- ja louhintatasot ja toleranssit
- luiskankaltevuudet
- tuentatyypit ja tukiseinien sijainti
- työnaikainen kuivaanapito
- kaivu- ja louhintatöiden työjärjestys

Rakennuspohjan ja piha-alueen pohjarakennesuunnitelma
- rakennuksen ääriviivat ja alimmat lattiatasot
- perustamistaparajaukset
- maapohjan vahvistusalueet
- rakennuksen pohjarakennusleikkaukset
- perustamistasot ja paalujen alapäiden

- excavation levels
- soil-stabilization details
- drainage principle during work

tasot
- kaivu- ja massanvaihtotasot
- pohjanvahvistusdetaljit
- työnaikaisen kuivanapidon periaate

Subsurface drainage plan
- location, pipe size, material and transition wedges of subsurface drains
- subsurface-drain backfills and material requirements
- drainage wells and inspection pipes

Salaojitussuunnitelma
- salaojien sijainti, putkikoot, materiaalit ja siirtymäkiilat
- salaojien ympärystäyttö ja materiaalivaatimukset
- salaojakaivot ja tarkastusputket

Levelling and conduit plan for yard
- existing mapping and elevation data
- limitations on surface-structure types and transition wedges
- contour lines of levelling
- surface-drainage structures
- rainwater drainage to collector well, discharge into terrain or absorption
- other drainage of surface water
- site drainage
- location of conduits and special structures in yard
- limitations on laying of conduits and special structures
- frost protection of conduits and special structures

Piha-alueen tasaus- ja putki-johtosuunnitelma
- olemassa olevat kartoitus- ja korkeustiedot
- päällysrakennetyyppien rajaukset ja siirtymäkiilat
- pinnantasauksen korkeuskäyrät
- pintakuivatuksen rakenteet
- sadevesiviemäröinti kokoojakaivoon saakka, maastoon purkautus tai imeytys
- muu pintavesien poisto
- tonttialueen salaojitus
- johto- ja erillisrakenteiden sijainti piha-alueella
- johto- ja erillisrakenteiden perustamistaparajoitukset
- johto- ja erillisrakenteiden routasuojaukset

Yard plan
- detailed use of plot
- outdoor-equipment plan
- planting scheme
- landscaping scheme

Pihasuunnitelma
- tontin yksityiskohtainen käyttö
- ulkovarustesuunnitelma
- istutussuunnitelma
- maisemasuunnitelma

FOUNDATION STRUCTURES AND FRAME

PERUSTUKSET JA RUNKO

Pile-situation plan 1:100/1:50
- position and types of piles and pile groups
- upper pile cutoff level and depth of penetration
- structural requirements for piles

Paalukartta 1:100/1:50
- paalujen ja paaluryhmien sijainti ja tyypit
- paalujen katkaisutaso ja tunkeutumissyvyys
- paalujen rakenteelliset vaatimukset

Foundation layouts 1:50/1:100

- position of foundations and plinths, types and dimensions
- upper joining structures and their dimensions
- positions of piles without dimensions
- anchor bolts, starter bars and rock bolts
- essential penetrations and voids

Perustusten tasopiirustukset
1:50/1:100

- perustusten ja perusmuurien sijainti, tyypit ja mitat
- yläpuoliset liittyvät rakenteet ja niiden mitat
- paalujen sijainti ilman mitoitusta
- peruspultit, tartuntateräkset ja kallioankkurit
- oleelliset reiät ja varaukset

Detail drawings of foundations

- reinforcement of typical cast-in-place structures
- sections and detail drawings of foundations 1:20/1:50
- different plinth structures
- position of thermal insulation and water- and moisture- proofings
- joining of foundations with upper structures
- scope and type of frost protection

Perustusten rakennusosapiirustukset

- tyypillisten paikallavalurakenteiden raudoitus
- perustusten leikkaus- ja detaljipiirustukset 1:20/1:50
- erilaiset perusmuurirakenteet
- lämmön-, veden- ja kosteudeneristeiden sijainti
- perustusten liittyminen yläpuolisiin rakenteisiin
- routasuojauksen laajuus ja tyypit

Base-floor construction drawings

- typical reinforcements of canals, etc.
- reinforcements and details of base floor and joining beams, canals, etc.

Alapohjan rakennepiirustukset

- kanaalien yms. tyypilliset raudoitukset, alapohjan ja siihen liittyvien palkkien, kanaalien yms. raudoitukset ja detaljit

Dimensional and reinforcement drawings of frame structures
1:50/1:100

- position, types, dimensions and materials of frame structures
- position and types of frame elements
- dimensions and reinforcements of cast-in-place structures
- non-bearing concrete and reinforced concrete structures
- joint reinforcements of element levels
- position of joints
- structural types/position
- quality and strength requirements for materials
- essential penetrations and voids
- position of expansion joints
- building-services shafts
- directions of expansion and voids
- loadings and fire ratings

Runkorakenteiden mitta- ja raudoituspiirustukset
1:50/1:100

- runkorakenteiden sijainti, tyypitys, mitat ja materiaalit
- runkoelementtien sijainti ja tyypitys
- paikallavalurakenteiden mitat ja raudoitukset
- ei-kantavat betoni- ja teräsbetonirakenteet
- elementtitasojen saumaraudoitukset
- liitosten sijainti
- rakennetyypit/sijainti
- materiaalien laatu- ja lujuusvaatimukset
- oleelliset reiät ja varaukset
- liikuntasaumojen sijainti
- LVIS-kuilut
- laajennussuunnat ja varaukset
- kuormitukset ja paloluokat

Detail drawings of frame structures 1:50/1:20

- dimensions and reinforcement of cast-in-place structures
- element drawings with schedules of accessories
- profiles and steel specifications of bearing steel structures
- main dimensional drawings of bearing wooden elements

Runkorakenteiden rakennus-osapiirustukset 1:50/1:20

- paikallavalurakenteiden mitat ja raudoitus
- elementtipiirustukset tarvikeluetteloineen
- kantavien teräsrakenteiden profiilit ja teräserittelyt
- kantavien puuelementtien päämittapiirustukset

General sections of frame 1:100/1:50

- elevation of structures and surface-structure voids, prestresses
- position of main structural types

Rungon yleisleikkauspiirustukset 1:100/1:50

- rakenteiden korkeusasema ja pintarakennevaraukset, esikorotukset
- päärakennetyyppien sijainti

Frame sections and detail drawings 1:20/1:50

- joints of structures
- position of thermal insulation and water- and moisture- proofings
- joint details of prefabricated parts
- expansion-joint structures
- fire protections
- reinforcement and bracing of masonry structures

Rungon leikkaus- ja detalji-piirustukset 1:20/1:50

- rakenteiden liittymäkohdat
- lämmön-, veden- ja kosteudeneristeiden sijoitus
- valmiosien liitosdetaljit
- liikuntasaumarakenteet
- palosuojaukset
- muurattujen rakenteiden raudoitus ja tuenta

Frame-structure schedules

- precast-element schedules by main types
- profile specifications of bearing steel structures

Runkorakenteiden luettelot

- betonielementtiluettelot päätyypeittäin
- profiilierittelyt kantavista teräsrakenteista

Elevation drawings 1:50/1:100

- position and types of elements
- types and position of structures
- position of joints
- essential penetrations and voids

Julkisivupiirustukset 1:50/1:100

- elementtien sijainti ja tyypitys
- rakennetyypit ja sijainti
- liitosten sijainti
- oleelliset reiät ja varaukset

Detail drawings of facade

- reinforcement of masonry and cast-in-place structures
- element drawings with schedules of accessories
- main dimensional drawings of wooden elements

Julkisivun rakennusosapiirustukset

- muurattujen ja paikallavalurakenteiden raudoitus
- elementtipiirustukset tarvikeluetteloineen
- puuelementtien päämittapiirustukset

Sections and detail drawings of facade
- joints of structures
- attachment details of prefabricated parts
- joints, sealings and insulations
- structure types and suggestions
- profiles and joints of steel structures supporting the facade
- standard structures, attachments and bracings of facade surface materials

Julkisivun leikkaus- ja detalji-piirustukset
- rakenteiden liittymäkohdat
- valmisosien kiinnitysdetaljit
- saumat, tiivistykset ja eristykset
- rakennetyypit ja rakennetyyppiviittaukset
- julkisivua tukevien teräsrakenteiden profiilit ja liitokset
- julkisivun pintamateriaalien tyyppirakenteet, kiinnitykset ja tuennat

Facade schedules
- precast-element catalogues
- profile specifications of facade-supporting steel structures

Luettelot
- betonielementtiluettelot
- profiilierittelyt julkisivua tukevista teräsrakenteista

Roof drawings 1:50/1:100
- structure types and position
- slopes and position of rainwater outlets
- ventilation
- expansion joints, compartmentation structures, penetrations
- catwalks, railings
- penetrations for hatches, etc.

Vesikattopiirustukset 1:50/1:100
- rakennetyypit ja sijainti
- kallistukset ja sadevesikaivojen sijainti
- tuuletus
- liikuntasaumat, palokatkot, läpiviennit
- kulkusillat, kaiteet
- luukkujen yms. Läpiviennit

Sections and detail drawings of roof 1:20/1:50
- joints of structures 1:5/1:10
- water-proofing details
- eaves details
- ventilation details
- details of penetrations and attachments
- details of skylights and glazed structures

Vesikaton leikkaus- ja detalji-piirustukset 1:20/1:50
- rakenteiden liittymäkohdat 1:5/1:10
- vedeneristysdetaljit
- räystäsdetaljit
- tuuletusdetaljit
- läpivientien ja kiinikkeiden detaljit
- kattoikkunoiden ja valokatteiden rakennedetaljit

COMPLEMENTARY INTERNAL STRUCTURES, FIXTURES AND EQUIPMENTS

TÄYDENTÄVÄT SISÄOSAT, VARUSTEET JA LAITTEET

Detail drawings of complementary structures
- type drawings of working platforms, railings, etc.
- loading schemes and bracings of glazed roofs

Täydentävien rakenteiden rakennusosapiirustukset
- hoitotasojen, kaiteiden ym. tyyppipiirustukset
- lasikattojen kuormituskaaviot ja tukirakenteet

Details of partition walls

Väliseinädetaljit

- structural joints and bracings
- expansion joints
- wall reinforcements
- bracings of apertures

- rakenteelliset liitokset ja tuennat
- liikuntasaumat
- seinien vahvistukset
- aukkojen tuennat

Types of complementary structures 1:10
- base floor, intermediate floor and roof structures
- partition and external wall structures

Täydentävien rakenteiden rakennetyypit 1:10
- ala-, väli- ja yläpohjarakenteet
- väliseinä- ja ulkoseinärakenteet

Sections and detail drawings of complementary structures 1:10/1:5
- fire-, thermal-, sound-, water- and moisture-proofing
- attachment and bracing of special doors and windows
- attachment of railings and fire ladders

Täydentävien rakenteiden leikkaus- ja detaljipiirustukset 1:10/1:5
- palo-, lämmön-, äänen-, veden- ja kosteudeneristys
- erikoisovien ja -ikkunoiden kiinnitykset ja tuennat
- kaiteiden ja palotikkaiden kiinnitykset

INTERNAL SURFACES

SISÄPINNAT

Schedule of finishes
- surface materials
- surface-material colours
- trademarks of surface materials

Huoneselostus
- pintamateriaalit
- pintamateriaalien värit
- pintamateriaalien tuotemerkit

BUILDING SERVICES

TALOTEKNIIKKA

HVAC-implementation-plan documents
- work specification
- general layout
- layouts, sections, details and elevations
- type room drawings
- system diagrams
- equipment schedules
- material specifications

LVI- toteutussuunnitelma-asiakirjat
- työselitys
- asemapiirustus
- pohjapiirustukset, leikkaukset, detaljit ja julkisivut
- tyyppihuonepiirustukset
- järjestelmäkaaviot
- laiteluettelot
- materiaalierittelyt

Implementation-plan documents for information system
- work specification
- general layout
- layouts
- type room drawings
- system diagrams

Tietojärjestelmän toteutussuunnitelma-asiakirjat
- työselitys
- asemapiirustus
- pohjapiirustukset
- tyyppihuonepiirustukset
- järjestelmäkaaviot

- equipment schedules
- diagrams and tables of electric interlockings
- program and report catalogues
- control diagrams including operating principles
- control and monitoring point lists
- material specifications
- point-position drawings
- wire-routing drawings
- wiring and grouping drawings
- assembly drawings of distribution boards and switch cabinets
- installation drawings of door electrification
- document-preparation instructions for contractors and equipment suppliers
- complementing plan with equipment and connection data into working drawings

- laiteluettelot
- sähköisten lukitusten kaaviot ja taulukot
- ohjelma- ja raporttiluettelot
- säätökaaviot toimintaselostuksineen
- säätö-, ohjaus- ja valvontapisteluettelot
- materiaalierittelyt
- pistesijoituspiirustukset
- johtotiepiirustukset
- johdotus- ja ryhmityspiirustukset
- keskusten ja kytkentäkaappien kokoonpanopiirustukset
- ovisähköistyksen asennusohjepiirustukset
- dokumenttiohje urakoitsijoita ja laitetoimittajia varten
- suunnitelman täydennys laite- ja kytkentätiedoilla työpiirustuksiksi

Implementation-plan documents for electrical system

- work specification
- general layout
- layouts, sections, details and elevations
- type room drawings
- system diagrams
- equipment schedules
- material specifications
- point-position drawings
- wire-routing drawings
- wiring and grouping drawings
- assembly drawings of distribution boards and switch cabinets
- installation drawings of door electrification
- document-preparation instructions for contractors and equipment suppliers
- lighting-fixture specifications, drawings of special fixtures
- diagrams and tables of electric interlockings
- complementing plan with equipment and connection data

Sähköjärjestelmän toteutussuunnitelma-asiakirjat

- työselitys
- asemapiirustus
- pohjapiirustukset, leikkaukset ja detaljit ja julkisivut
- tyyppihuonepiirustukset
- järjestelmäkaaviot
- laiteluettelot
- materiaalierittelyt
- pistesijoituspiirustukset
- johtotiepiirustukset
- johdotus- ja ryhmityspiirustukset
- keskusten ja kytkentäkaappien kokoonpanopiirustukset
- ovisähköistyksen asennusohjepiirustukset
- dokumentointiohje urakoitsijoita ja laitetoimittajia varten
- valaisinerittelyt, erikoisvalaisinten piirustukset
- sähköisten lukitusten kaaviot ja taulukot
- suunnitelman täydennys laite- ja kytkentätiedoilla