

Project	New Central Urban Waterfront and MEDIASPACE in Aarhus Design competition
Subject	Client requirements: digital construction
Annex	20

1. Client requirements: digital construction

1.1 The client's expectations to the use of ICT

The client wishes to make use of the advantages afforded by today's information and communication technology (ICT), both in relation to the actual building process and in relation to the following use of the building. This applies to planning, execution, operation of the building and in connection with the dialogue between citizens and future users.

The client assesses that today ICT is practically useable in connection with 3D-oriented modelling of buildings and the surrounding terrain. Furthermore, ICT would be useable in connection with supervision and planning activities, administrative tasks, information etc.

It is the client's wish to use modern ICT tools to support work processes in which the tools are actively used for preparing proposals and not only as documentation of already agreed solutions. The client expects that the design is achieved through use of building modelling programs, visualisation and simulation tools, and that the following phases in the building process will benefit from the use of the information and communication technology.

The client is interested in basing methods and requirements on the use of ICT which applies to public building in Denmark after 1 January 2007 and known as Digital Construction.

1.1.1 Client's internal advantages

The client's organisation wishes to use visualisation and digital models in disseminating the visual expression of the project, the planned progress and the potential use of the building in relation to the building's stakeholders. Through access to the project material via project web the client will be able to choose and distribute material to individuals in the client's organisation as well as to stakeholders.

The client's organisation further wishes to be able to extract and analyse data with a view to maintenance and operation situations from the digital models made by designers and contractors.

1.1.2 Client's own advantages

The client wishes that the involved parties participating in the project – and in particular the designers – are capable of continuously utilising the information technology to illustrate the consequences, e.g. technical, space layout, comfort and economical, for the various alternatives to be chosen from during the design and execution phases. In the succeeding operation

and maintenance situation the client wishes to utilise the digital data. The client further wishes to use digital models in connection with handling the public comment period. The client expects further to be able to assess the degree of maintenance friendliness of the building through use of ICT.

1.1.3 **Promotion of re-using digital data**

The client wishes to stimulate re-using digital data at as high a level of information as possible, i.e. not as lines and basic text but as objects which may be walls, doors, windows, rooms etc. It is therefore a requirement that not only the designers but all involved parties utilise ICT tools wherever relevant and make their own data accessible to the other participants in the project, including the client's organisation and the contractors. By re-using other players' digital data, and in particular building models, the client anticipates that the project organisation will gain a better framework for the continuous coordination during the progress of the project.

1.2 **The purpose of Digital Construction**

Translated quote from www.detdigitalebyggeri.dk.

'Digital Construction is part of the Government's so-called competitiveness package "Will to Grow". It is financed through a government grant of DKK 20 million, a contribution of DK 10 million from The Realdania Foundation and a corresponding amount of co-financing from the parties participating in the development programme. Digital Construction has been implemented in the period 2003-2006.

The programme has been carried out in co-operation with public clients, the bips Association and a number of consortiums that have won tenders to develop specific parts of the background for future digital construction.

Digitalisation of the construction process from project to operation has been under way for many years. Visions of a digital construction project appeared as early as the beginning of the 1980s, when the first PC base CAD drawing programmes were introduced in engineering firms and architects' offices.

In such a visionary digital process data can be accumulated, processed, copied, re-used and retrieved on the basis of a selected criterion. In the digital process architects, engineers, contractors and suppliers each contribute to the establishment of the amount of data that constitutes the construction project. Subsequently, relevant data can be retrieved in the form and at the rate needed for use in calculations and specifications, or for ordering and planning.'

1.3 **Requirements to Digital Construction**

Translated quote from www.digitalebyggeri.dk

1. Obligatory use of project web: All building documents have to be exchanged via project web. Contractors should have access to project web and be able to print working drawings on A3-paperformat at building sites.

2. Requirements for projectweb-solutions: Clients have to ensure the projectweb solution can be used effectively and secure by all building partners.

3. A3-format drawings: All drawings must be designed to ensure that the drawings can be printed in A3-format.
4. Obligatory use of 3D-modelling in competition: Clients must consider for each competition on construction projects whether it is advantageous to require the competing parties to establish a 3D model of their project as basis for judgement - including whether requirements should be made to specific types of simulation. Use of 3D models is obligatory for construction projects exceeding DKK 40 million.
5. Obligatory use of 3D-modelling for design stages and tendering: Clients must consider the use of digital building models (BIM) for every project based on an evaluation of economic and user benefits. For projects exceeding DKK 40 million the use of digital building models are mandatory and contractors should be stimulated to extract data on quantities from the model. The model must be exchangeable according to the IFC-standard (IFC compatible BIM).
6. Description of bill-of-quantities and standardisation of materials/supplies (obligatory from 2009): Descriptions are prepared according to bips Guideline B100. The tender material must comprise a descriptive list of amounts structured in accordance with a common classification system called Danish Construction Classification which will be brought into effect. This will enable contractors to take-off quantities from 3D-models (obligatory for construction projects exceeding DKK 40 million) that are being used.
7. Digital tender and procurement: Tendering (and call for tender) is effected electronically over the internet where the tendering documentation will be available throughout the tender period. The tenderers must submit their tenders to a portal on the internet where submitted tenders are announced simultaneously.
8. Digital hand-over of operation and maintenance data: The client must identify the relevant operation and maintenance data to be hand over electronically to the client along with the project. Among the participating parties one person is assigned the responsibility of handing over the documentation. The physical hand-over of documentation is subject to use of digital list of deficiencies in accordance with the bips standard.
9. Documents and model: The digital hand-over includes documents and the data model.
10. Hand-over formats: Clients will decide whether hand-over of the relevant operation and maintenance data are singly in XML-data format, as the total aggregated model in IFC-format – or are keyed directly into operation and maintenance systems.'

1.4 **Use of digital data and tools in the building process**

The client has the following expectations to the use of ICT throughout the building process.

1.4.1 **User involvement**

The client wishes to use ICT and digital work methods partly to identify the users' needs and partly to verify that the future building matches the needs specified by the users. ICT tools would also be part of the dialogue with the users on specific conditions where for instance visu-

alisation of alternative solutions may be used as basis for assessment or where the tools are used in a dialogue with the users where alternative solutions are posted and assessed.

1.4.2 **The public**

The client's organisation will decide how to handle the project in relation to the public and may for this purpose use visualisations in connection with announcing the project. Emphasis will be on solutions which facilitate user interaction and that the public can access the information without cost.

1.4.3 **Design**

Design: Requirements to development, exchange and submission of digital models to the parties in the project. Usage of models for extraction of quantities, visualisation, drawing production and as basis for analyses to such an extent as is rational. Requirements will be made so that any conflicts in the 3D building models are solved prior to pre-determined milestones.

From the 3D handbook '3D-PROJEKTERING', www.detdigitalebyggeri.dk

'3D design is the name of a design process based on preparation of a 3D model from which may be generated drawings and extracted bills of quantities. After design of the 3D model it is often handed over to the contractor along with drawings and descriptions for his further use in pricing, planning, producing and executing the project. The possibilities of 3D design present a number of advantages which make up for the extra time use normally associated with working with 3D rather than 2D. The CAD programs in use are object oriented meaning that you build the model of building components (objects) each with a number of characteristics and attributes. The building components may be beams, pillars, decks, channels, windows, doors, walls etc, which are retrieved from a database or are specified particularly for the project. The programs keep track of the components and can at any one time generate plans, elevations, sections, isometrics and bills of quantities.

Among the advantages of 3D designs are:

- Improved possibility of solving and recognising complex geometric problems
- Possibility of collision control and fault finding
- Exact bills of quantities which are easily updated upon changes
- Good possibilities for visualisation
- Not necessary to 'start over' when preparing work drawings
- Temporal advantages'

1.4.4 **Production planning**

Building models and other digital data must be made available to contractors who are encouraged to use the models in connection with production planning. The level of detailing of the building models is agreed among the parties but will after the production planning phase contain information on the products expected to be used.

The client expects that the production planning is carried out using so-called 4D tools where a 3D building model is combined with scheduling which can simulate deliveries, fitting and execution at the building site. Good experience has been gained through use of 4D tools in international projects.

The building model is also expected to be used in connection with execution oriented logistical activities which may take place in connection with production planning as well as the actual execution. The building model can – in combination with other planned building activities – procure an overview and thus avoid that several activities are carried out at the same place simultaneously.

1.4.5 **Execution**

It is expected that the contractors possess administrative ICT systems which support the production. Furthermore, the contractors will be encouraged to use building models in connection with simulation of execution, fitting and building activities.

The client prefers that the tenderers update the building components in the 3D building model in relation to the actual level whether they are production planned, supplied, fitted or complementary.

The client expects that the building site is supplied with access to the internet and the necessary connections for ICT equipment which will permit an expedient use of digital data from design, contractors' resources outside the building site, suppliers and experience data bases. It must be possible to inform of and illustrate the project to artisans, specialists and work gangs through use of ICT equipment in an appropriate extent.

1.4.6 **Delivery of digital data**

The client wishes to have delivered an updated building model after execution of the project.

The client will require receiving a coherent documentation on the construction of the building and material for the succeeding operation.

Relevant information from the building model must be transferred by the contractors to the municipality's operations management system.

1.5 **ICT requirements in connection with design, execution and delivery**

Basically, requirements given in Digital Construction (Det Digitale Byggeri) will be valid. These requirements were stated earlier and may be found on the internet at www.detdigitalebyggeri.dk in a Danish version. There is no official English version of the requirements but the translation of the requirements above is believed to be valid for the present project.

Furthermore, for internal use the client wishes not only the building models made available at the final hand-over in IFC format but also in the original format. Likewise, requirements will be made that access to the models should basically be made available throughout the project and that the contractors use the models for production planning and during the execution phases. All parties to the project must therefore expect to make available their digital data to the client, the client's consultant, other parties to the project and the authorities.

The client will prepare an ICT agreement which will specify the digital services in greater detail. The specifications will be carried out in accordance with the principles of 3D work methods, which have been prepared in connection with Digital Construction and which are available in

both Danish and English. The material can be found at www.detdigitalebyggeri.dk. The ICT agreement itself will be based on bips Guideline F101.

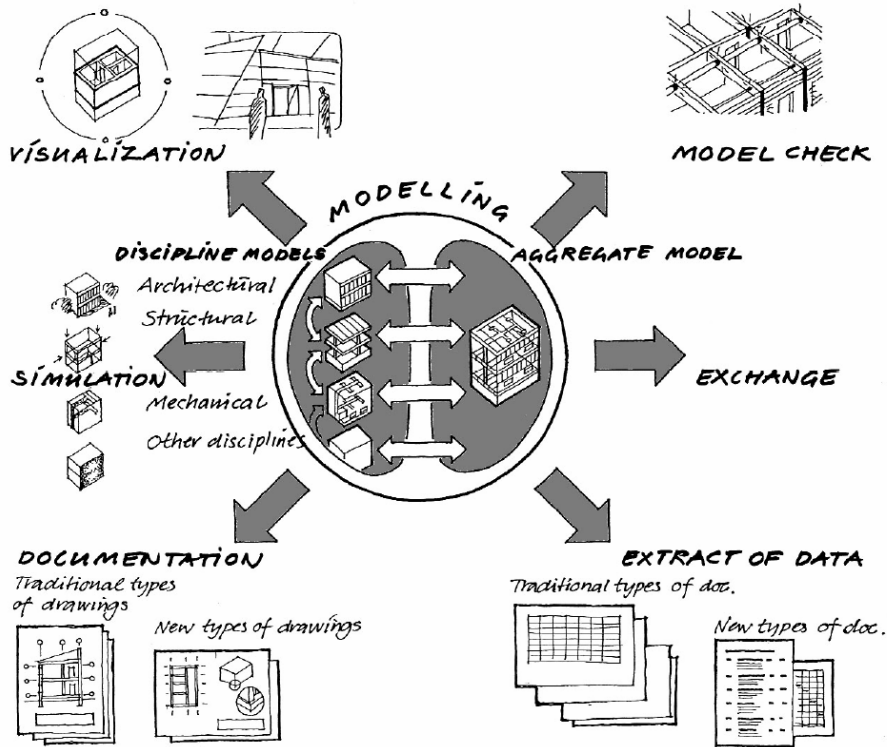


Figure 3: Modelling concept for a 3D object-based model.
 The diagram shows the general modelling concept for a typical section of the design process. The main activities will vary in extent depending on the timing of the section and in relation to the discipline group involved.
 The individual parties build up discipline models within their specialist areas. These are coordinated mutually and towards an aggregate model. Model consistency checks and simulations can be carried out via the individual discipline models, and also in the aggregate model. New, more model-orientated types of drawings and documents can be generated and parts lists can be extracted from discipline models.

Figure 1: Illustration from 3D-Working Method 2006, www.detdigitalebyggeri.dk

The client will require that the contributions to the building models are mutually consistent, e.g. do not contain collisions and double components.

The client will, as per requirement in Digital Construction, make a project web available to the parties. The client organisation will administer the project web.

The client expects that all requirements in Digital Construction will apply, but that the requirements in items 6 and 7 are adjusted in accordance with the tendering procedure. The use of descriptive quantities is expected to be changed to a bill of quantities. The level of detailing of the bill of quantities will depend on the time and the basis on which the contractors' services

are tendered. Building models prepared during the design phase must be made available to the tendering contractors.

1.6 **ICT requirements to construction activities**

In addition to the requirements to using ICT in connection with the building, requirements will be made to the Civil Engineering activities associated with the project. Requirements to exchange of data among the parties to the project would also apply to Civil Engineering tasks and the client's wishes that design and execution are supported by ICT tools including the use of 3D CAD tools.

As a basis, the involved parties must expect to utilise relevant existing digital data. Further, the parties must expect to supply data from the design and as-built data to the client, utility owners, owners of roads and railways and waterfront areas.