CONSTRUCTION MANAGEMENT

* In schemes which include interior fittings and design, preparing detailed drawings of the rooms and fittings to scales 1:25 to 1:1, together with the necessary specifications of materials and workmanship
* Coordination of the input of the other members of the design team and integrating their information to produce a viable solution
* Preparation and co-ordination of the production drawings during the building stage

Additional services

These additional services can be included as basic services if they are specifically listed in a schedule of services. This will negate some of the limitations in the standard list of basic services.
* Setting up a detailed area-by-area specification in the form of a room schedule to serve as a basis for a description of materials, areas and volumes, duties and programme of works
* Setting up a detailed specification in the form of a bill of quantities to serve as a basis for a description of materials, duties and programme of works
* Inspection of the contractors' and sub-contractors' specialist design input developed on the basis of the specification and programme of works, to check that it accords with the overall design planning
* Production of scale models of details and prototypes
* Inspection and approval of design drawings produced by organisations outside the design team, testing that they accord with the overall design planning (e.g., fabrication drawings from specialist manufacturers and contractors, setting-up and foundation drawings from machine manufacturers), in such as their contracts do not form a part of the main contract sum (upon which the professional fees have been calculated)

1.2 Aims/risks of construction planning

Construction planning aims to ensure a trouble- and fault-free execution of the works. This requires a complete and detailed establishment of the formal and technical requirements, and their compliance with formal, legal, technical and economic matters.
* Legal basis: planning and building regulations, and other regulations such as safety guidelines, e.g. for places of assembly
* Technical basis: established standards and techniques of construction and materials, e.g. building standards, consultation/agreement with specialists and specialist contractors
* Economic basis: cost control techniques, e.g. cost estimates/calculations, and consultation/agreement with specialists in this field

Insufficient construction planning results in – among other things – wastage of materials (correction of errors, breakages and decay), waste of productive time (time wasting, duplicated work), and persistent loss of value (planning mistakes/construction faults)

1.3 Means and tools for construction management

Construction drawings contain all the necessary information and dimensions for construction purposes: normal scale is 1:50.

Sectional drawings (component drawings, junction drawings), expand on the construction drawings with additional information on parts of the building works, normal scale is 1:20, 1:10, 1:5 or 1:1.

Special drawings are tailored to the specific requirements of elements of the work (e.g. reinforced concrete work, steelwork or timber structural work) and show only the essential aspects of the other building features which relate to that particular specific element of work: normal scale is 1:50, depending on the particular needs. National standards and conventions govern the
drawing modes which, ideally, should be compatible with CAD (computer aided design) and the standard methods of specification and measurement of quantities and pricing. Suitable software packages are available.

Area/room/component schedules, specifications, bills of quantities contain full information — in the form of lists and tables — about the sizes (e.g. length, width, height, area and volume), the materials (e.g. wall coverings and floor finishes), and equipment (e.g. heating, ventilation, sanitary, electrics, windows and doors) of which make up the building, building elements, rooms or other areas. They serve as a basis for a full specification of materials and workmanship. Bills of quantities are commonly used in the UK and for large contracts in other countries.

2.0 Tender action and letting of contracts

i.e. the preparation/co-operation during tender action and letting of contracts

2.1 Definition of duties and outputs/contents

i.e. stages G + H in RIBA Plan of Work, and 6 + 7 in HOAI

Basic services
* Production and collation of quantities as a basis for setting up specifications, using information from other members of the design team
* Preparation of specifications with schedules according to trades
* Co-ordination and harmonisation of specifications prepared by other members of the design team
* Compiling the preambles of the specifications for all the trades
* Issuing the tender documents and receiving tenders
* Inspection and evaluation of the tenders, including preparation of a cost breakdown by element, in cooperation with the rest of the design team engaged in these stages
* Harmonisation and collation of the services of the design team engaged in tender action
* Negotiation with tenderers
* Setting up of cost predictions, including the fixed price and variable price elements of the tenders
* Co-operation during the granting of contracts

Additional services
* Setting up specifications and bills on the basis of area schedules and building schedules
* Setting up alternative specifications for additional or specific works
* Compiling comparative cost estimates for the evaluation and/or appraisal of the contributions of other members of the design team
* Inspection and evaluation of the tenders based on specifications of materials and workmanship, including a cost breakdown
* Setting up, inspecting and valuing cost breakdowns according to special conditions

2.2 Aims/risks of tender action and letting of contracts

The tender action aims to formulate contract documents which will enable the construction work of a project to be carried out within the civil legal framework, thus affording the relevant structure of regulation and guarantees. Tenders can be sought when all the relevant information is available for costing. Tender documents consist of: schedule of conditions (e.g. specifications and contractual obligations) plus clauses with descriptions (e.g. possibilities for inspecting the details of the conditions / location, date of the project commencement and completion / limits to time and additional costs).

Tender documents that include the price of the work and signature of the contractor (or his rightful representative) become an offer, which can be negotiated or accepted unchanged, resulting in the formulation of a contract, governing everything necessary for the carrying out of the works (e.g. type and extent of the work, amount and manner of payment, timetable and deadlines, and responsibilities).

To prevent, from the outset, differences of understanding and opinion between the members of the contract — and to make clear their mutual responsibilities — contract documents (and hence also the tender documents) must be comprehensive and complete.

Unclear, incomplete tender documents lead to poor building contracts, which provoke conflict, time overruns, defects, loss of value and additional costs.

2.3 Means and tools of tender action and letting of contracts

Contract laws and regulations depend on the country and local situation, and regulate, through the building contract, the legal relationship between the client and the contractor. They generally determine what constitutes a valid contract, how long the liabilities of the contract are valid, recourse to damages, dispute settlement, professional responsibilities and liabilities, and other aspects with regard to contractual relationships.

Contract conditions and articles of agreement are specific to the particular form of contract being used. Because there are many types of standard contract document, it is important that a suitable contract type is chosen to meet the needs of the particular project. Typical headings of clauses of a contract for larger works are listed here:

* Identification of the different members mentioned in the contract, and a description of their role and duties, e.g. employer, contractor, sub-contractors or architect
* Interpretation, definitions, etc.
* Contractor's obligations
* The contract sum, additions or deductions, adjustments and interim certificates for partial completion of work
* Architect's instructions, form and timing of instructions during the contract
* Contract and other documents, and issues of certificates for completions
* Statutory obligations, notices, fees and charges
* Levels and setting out of the works
* Materials, goods and workmanship to conform to description, testing and inspection
* Royalties and patent rights
* Identification of the person in charge of the works
* Access for architect to the works
* Clerk of works or client's representative on site
* Details and procedure in the event of variations and provisional sums
* Definition of the contract sum
* Value added tax (VAT) and other taxes
* Materials and goods unfixed off or on site, ownership, responsibilities incurred
* Practical completion of the contract and liability in the case of defects
* Partial possession by employer
* Assignment of sub-contracts and fair wages
* Insurance against injury to persons and property, and employer's indemnity
* Insurance of the works against perils
* Date of possession, completion and postponement
* Damages for non-completion
* Extension of time
* Loss and expenses cause by matters materially affecting regular progress of the works
* Determination (pulling out of contract) by contractor or employer
* Works by employer or persons employed or engaged by employer, part of, or not part of, the contract
* Measurement of work and certificates for completed work and payment
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appointment agreed by the architect with the client, and the
- type of contract agreed between the employer and
contractor. The list of basic services will also vary from
country to country, depending on the local professional
norms. Typical services are listed below.
- Inspection during the progress of the building works
to check compliance with the planning approval, the
contract drawings and the specifications, as well as
with generally accepted qualities of workmanship and
adherence to safety regulations and other relevant
- Inspection and correction of details of prefabricated
- components
- Setting up and supervision of a time plan (bar chart)
- Writing of a contract diary
- Combined measuring up of work with the building
contractor
- Measuring up and calculating the value of completed
work with the co-operation of other members of the
design and supervision team while establishing
defects and shortcomings, and issuing of certificates
- Inspection of invoices
- Establishing final cost estimates according to the
local or regulated method of calculation
- Application to the authorities for grants or
subventions according to local and specific
- Handing over of the building, together with compiling
and issuing the necessary documents, e.g. equipment
- instruction manuals
- Testing protocol
- Listing the guarantee periods
- Supervising the making good of defects listed at
holding over
- Ongoing cost control
- Inspection of the project for defects before the end of
the guarantee periods of the various sub-contractors
and contractor
- Supervision of the making good of defects detected in
the inspections before the end of the guarantee periods
- Depending on local laws, inspections for up to five
years after completion
- Systematic compilation of the drawings and
calculations related to the project

Additional services
- Setting up, supervision and implementation of a
payment plan
- Setting up, supervision and implementation of
comparative time, cost or capacity plans
- Acting as the agent responsible for the works, as far
as these duties go beyond the responsibilities listed
as basic services
- Setting up of progress plans
- Setting up of equipment and material inventories
- Setting up of security and care instructions
- Site security duties
- Site organisation duties
- Patrol of the project after handover
- Supervision of the security and care tasks
- Preparation of the measurement data for an object
inventory
- Enquiries and calculation of costs for standard cost
evaluations
- Checking the building and business cost-use analysis

3.2 Aims/risks of construction supervision

Construction supervision consists of two major elements:
- Control, measurement, accounting in relation to the
contract conditions and plan of work, and building
programme planning through the use of project
management techniques (availability of people, machines,
material at the right time, in the right amount, at the right
place). Important aids include operation planning
techniques and time planning techniques using various recognised methods.

Poor building supervision and insufficient control lead, among other things, to unsatisfactory execution of the works, faults (obvious or hidden), faulty measurements and payments for work, additional costs, and danger to operatives (accidents) and materials. Unsatisfactory project management and poor co-ordination normally lead to building delays and extra costs.

3.3 Means and tools of construction supervision

Standard procedures vary according to the country and profession. Together with techniques/instruments for project management, Supervision of the works, measurement of works and accounting is based on the drawings (production drawings, detail drawings, special drawings), specifications, schedules, possibly a bill of quantities, and the contract conditions.

The techniques of operation and time planning make use of various common methods: bar charts, line diagrams and networks.

Bar charts (according to Gantt, bar drawings), show the work stages/trade duties on the vertical (Y) axis, and the accompanying building duration or time duration (estimated by experience or calculation) on the horizontal (X) axis. The duration of the various stages/duties are shown by the length of the particular bars (shown running horizontally).

Building stages which follow on from another should be depicted as such on the chart. The description of the building stages and trade categories help in the setting up of the bar chart, and make possible the comparison of the planned programme and the actual progress of the work.

- Advantages: provides a good overall view; clarity; ease of interpretation (type of presentation shows time scales)
- Disadvantages: strict separation of work tasks; no identification of sub-tasks; difficult to show connections and dependence relationships of the work stages (thus critical and non-critical sequences are not identified, and if altering the time duration of one stage will result in the alteration of the duration of the whole project)
- Context of use: illustration of straightforward, self-contained building projects which have a simple sequence of tasks and no directional element (e.g. as in road construction), planning of individual tasks, resource planning (staffing programme/equipment and plant planning)

Line diagrams - speed-time distance-time (or quantities-time diagrams) - show measures of time (selected on the one axis (which ones depending on the building task), and measures of length (or, less frequently, building quantities) on the other axis. The speed of the production process (the slope of the line), and the division (in terms of time and space between tasks) are clearly portrayed.

- Advantages: clear presentation of speed of progress and critical separations
- Disadvantages: poor portrayal of parallel and layered task sequences (spacing and timing of tasks which have no directional element)

Networks resulting from network planning techniques (as part of operational research) - help in the analysis, presentation, planning, directing and control of tasks. The relationships between different operations show how they are influenced by many possible factors (e.g. time, costs and resources).

To calculate the overall project duration, assume a project starting point at time PTc and show (calculating forward) the earliest point in time ET (earliest time of start event EST/earliest time of finish event EFT) for each task (D = duration, time span, beginning/finish of the task). The overall project duration is the duration of project path (critical path)/project finish time ETc. Incorporating estimated delays (buffer time) elements (added together) produces the given project finish time point PTc. To determine the latest project start time, perform a backward pass (from right to left), taking the latest time point LT (latest time of start event LST, latest time of finish event LFT) for each task (calculating backwards), and hence the latest project start time for the project PTc respectively the total float TF of the individual tasks = latest time point LT - latest start/finish LST/LFT - (earliest time point - earliest start/finish EST/EFT).

The critical path method (CPM) puts task arrows into order. Nodes show the start or finish events of the tasks. The fundamental arrangement of relationships (dependence between tasks, quantifiable) in CPM is the normal sequence (order relationship from the finish of the previous to the beginning of the following: finish event of task A = start event of task B). The time frame is determined (i.e. the task is allotted a definite estimated duration time). Tasks which are running parallel and are dependent on each other, dependencies of parts of tasks with each other which are conditional for the progress of a further task, are displayed as dummy arrows (dummy arrows) or relationships in the network with time interval of 0.

The content of the critical path chart mirrors the list of tasks (list of individual activities together with timing estimates).

The meta-potential method (MPM) orders the task nodes. Arrows display the order relationships. The fundamental arrangement of relationships with MPM is the order of starts (order relationship between the start of the previous task to the start of the following task; start event of task A = start event of task B). The time frame is determined (as with CPM). The content of the task node network mirrors the list of tasks (compare with CPM).

The programme evaluation and review technique (PERT) orders the task nodes. Arrows display the order relationships. The time model is normally stochastic (i.e. the determination of the time intervals between the events is by probability calculations). Geometric models of PERT + CPM can be combined in a mixed presentation (tasks as arrows, and events as nodes). Theoretically, an event arrow-network plan is feasible; however, no practical method is available.

Advantages/disadvantages/appropriate applications of the various network planning methods:

- Pre-organised networks with deterministic time model (CPM/MPM) are the most suitable for detailed direction/control of building operations (emphasis on individual tasks).
- Event-orientated networks (PERT) are more suitable for strategic planning and overview of the project (events = milestones).
- Task node networks (MPM) are easier to set up and alter (consistent separation of tasks planning time planning), and reproduce a greater number of conditions than task arrow networks (CPM; however, CPM is more widely used in practice, being older, more developed, and because 70-80% of ordering relationships which occur in network plans are standard sequences).

Networks are primarily very detailed but are difficult to read, so additional presentation of the results as barchart/diagram is necessary. Computers are predestined to be an aid, particularly in setting up large networks (resulting from entries of relevant data from the list of tasks). Suitable software is available (the majority being for CPM).
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ARTICLES OF AGREEMENT
1 contractor’s obligations
2 contract sum
3 architect
4 quantity surveyor
5 settlement of disputes

Conditions: Part 1: General
1 interpretation, definitions, etc.
2 contractor’s obligations
3 contract sum – additions or deductions - adjustment - interim certificates
4 architect’s instructions
5 contract documents – other documents – issue of certificates
6 statutory obligations, notices, fees and charges
7 levels and setting out of works
8 materials, goods and workmanship to conform to description, testing and inspection
9 royalties and patent rights
10 person-in-charge
11 access for architect to the works
12 clerk of works
13 variations and provisional sums
14 contract sum
15 VAT – supplemental provisions
16 materials and goods unfixed or off-site
17 practical completion and defects liability
18 partial possession by employer
19 assignment and subcontracts, fair wages
20 injury to persons and property, and employer’s indemnity
21 insurance against injury to persons and property
22 insurance of the works against perils
23 date of possession, completion and postponement
24 damages for non-completion
25 extension of time
26 lost expense caused by matters materially affecting regular progress of the works
27 determination by employer
28 determination by contractor
29 works by employer or persons employed by employer
30 certificates and payment
31 finance – statutory tax deduction scheme
32 outbreak of hostilities
33 war damages
34 antiquities

Conditions: Part 2: Nominated subcontractors and nominated suppliers
35 nominated subcontractors – general, procedure for nomination, payment, extension of period for completion of works, failure to complete works, practical completion, final payment, position of employer in relation to subcontractor, etc.
36 nominated suppliers

Conditions: Part 3: Fluctuations
37 choice of fluctuations conditions
38 contribution, levy and tax fluctuations
39 labour and material cost, and tax fluctuations
40 use of price adjustment formulae

6 Typical headings for contract clauses

building contract
the works
the payment

6.1 General contract conditions

groundworks
excavations
boreholes
diversion of springs
retaining walls
bored piling
water retention works
land drainage
underground gas and water mains
underground drainage
consolidation
remaining works on water courses, ditches and embankments
underwater excavation, dredging
underpinning
sheet piling
sprayed concrete work

construction work
brickwork
concrete and reinforced concrete work
stonework
blockwork
carpetry work
steelwork
waterproofing work
roofing and tiling work
plumbing work

finishing work
plastering and rendering
floor and wall tilting, and paving work
screening work
asphalt laying
joinery work
floor laying and finishing work

5 Typical division of the work into sections

A2 room description

A2 room description

A2 room dimensions

B4 service connections for

B5 values

Example of a room schedule (Raumbücher in Germany) (abbreviated version)
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48 (a) (d) PIPework 16.50 M + 16.49 M = 33.02 M

(b) Extract from a specification of piped services

- Architect's Instruction

- Extract from a bill of quantities

- Example of architect's valuation

- An architect's record of a communication
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1. Check list for measured work

2. Building time plan

3. Network

4. Network calculation

5. Network orientation and precedence
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### Task list (CPM) cf. 1

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<th>Task</th>
<th>Description of Task</th>
<th>Duration</th>
<th>Preceding Task</th>
<th>Earliest Finish</th>
<th>Latest Finish</th>
<th>Total Float</th>
<th>Time</th>
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</tr>
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<td>excavation P1</td>
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<td>4</td>
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<td>2</td>
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<td>0</td>
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<td>1</td>
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<td>5</td>
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</table>

(1) added up

### Network plan (CPM)

#### Comparison of the display forms of different process diagrams

![Diagram showing different process flow diagrams]

#### Process list (MPM) cf. 4

1. excavation P2
2. excavation W1
3. piling
4. foundations P1
5. foundations W1
6. concrete columns P1
7. concrete columns W1
8. beams P1-W1
9. beams P1-W2
10. beams P2-W1
11. beams P2-W2

(2) added up