Figure 1.5 Chemical complex erected in Katar by UHDE GmbH, Dortmund, Germany. The chemical complex consists of three main plants for the production of 260000 t/a chlorine, 290000 t/a caustic soda, 175000 t/a ethylene dichloride and 230000 t/a vinyl chloride. The order value was approx. 450 million US$.

engineer. In case of a positive career s/he may work his way or her way into the project management, initially starting with rather small or medium-sized projects. Then, with sufficient experience and relevant further education in the field of project management – often within the framework of in-house training courses – s/he may be assigned to the management for a large-scale project..

Nowadays, most different demands are placed on project engineers /1.10, 1.11, 1.12/. Apart from technical qualifications, especially in plant engineering, the so-called "soft skills", i.e. personal characteristics, are demanded more and more. Table 1.1 gives a compilation of some important demands on project engineers.

Depending on company and project, the individual demands are weighted differently. Since medium-sized and large-scale systems are always designed and handled by project teams, the demands on team spirit and communicational abilities are always of the utmost importance.

Within the framework of the contract award negotiations with subcontractors, project engineers not only have to act and negotiate respectively, they are required or assumed to have more and more basic *commercial* knowledge. Meanwhile, at least sound basic knowledge of the English language is a matter of course, since the business of process plant engineering is, to a large extent, internationally oriented. The language of projects carried out abroad is almost always English. Of course, knowledge of the respective native language is always of advantage.

Table 1.1 Job specifications for project engineers.

Technical requirements	*Personal qualifications*
Expert knowledge in the disciplines:	Communication skills
Chemical Process Engineering	Team spirit
Thermal Process Engineering	Interdisciplinarity
Mechanical Process Engineering	Cross communication within the project team
Biological Process Engineering	Appearance
Apparatus and Pipeline Engineering	Stress tolerance and adaptability
Pumps and Compressors	Independence
Materials Science	Loyalty
E/MC-Technology	Readiness to take on responsibility
	Assertiveness
EDP Capabilities:	Negotiating skills
Word Processing	Cost consciousness
Spreadsheet Analysis	Spoken and written English
CAD and CAE in Plant Engineering	Additional foreign language competence
Pipe Stress Analysis	Experience acquired abroad

On the other hand, companies are aware of the fact that project engineers cannot meet all demands. For this reason, the relevant further professional education should not be neglected. Proactively initiated measures like language courses at adult education centres or professional seminars at the Haus der Technik (House of Technology) in Essen, for example, or at the Technischen Akademie of Wuppertal (Technical Academy of Wuppertal) will be appropriate.

In any case, entrants should prepare themselves right from the beginning for lifelong learning and further education that will accompany their entire professional career.

1.4 Overview of activities

Plant design comprises all stages from the product idea to the commissioning and, finally, to the operation of the production facility. This, however, requires a multitude of activities to be carried out. In order to facilitate the way of approaching this matter, the complete project term is being divided into two phases:

Project planning: Within the context of project planning it is to be decided whether – and if so, by whom – a plant will be manufactured. During this phase of planning, cost forecasts and analyses play an important role. To be able to assess the production costs for the manufacturing of a planned product as exactly as possible, so-called *basic engineering* has to be carried out. This includes, inter alia,

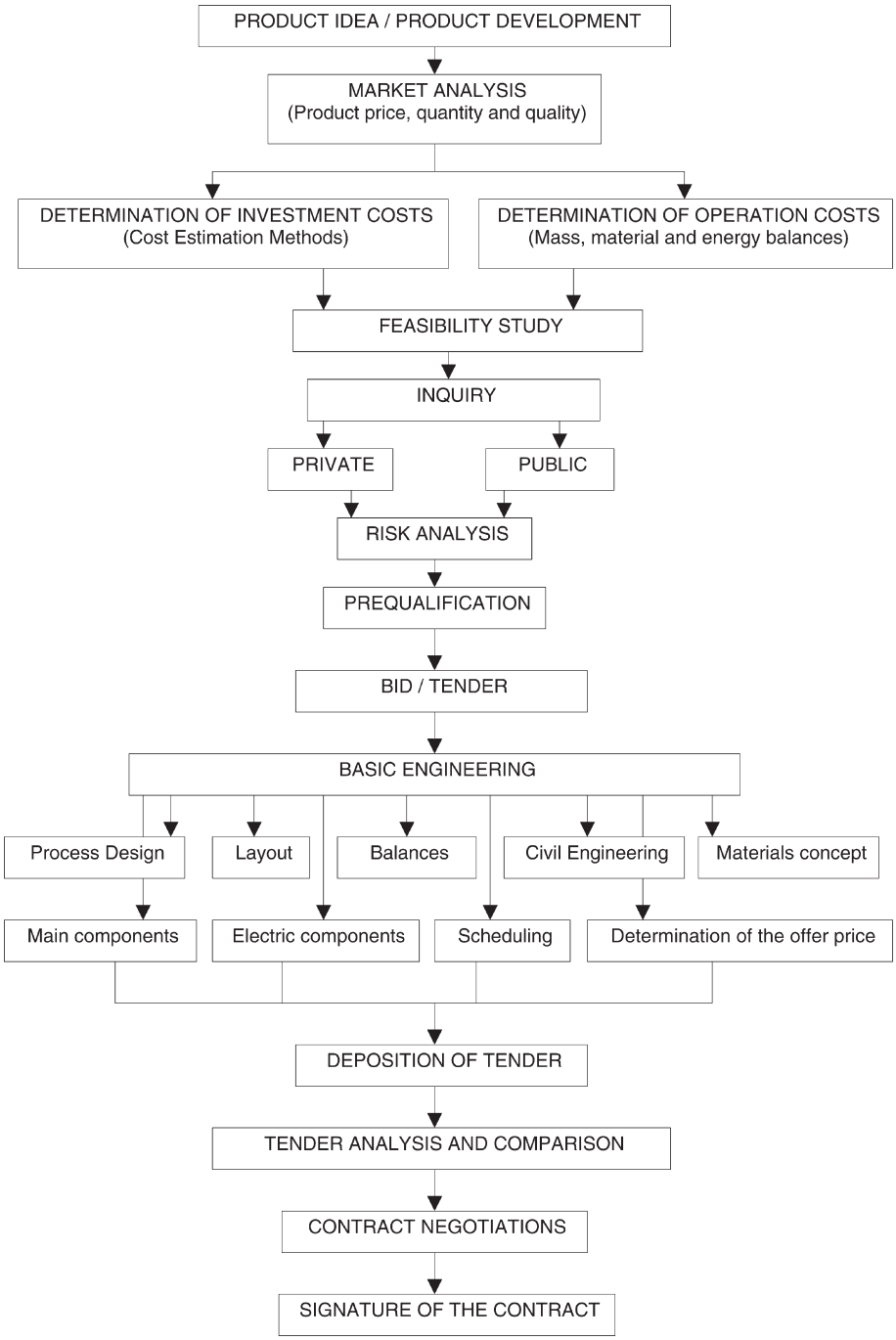

Figure 1.6 Overview of the activities during the project planning phase.

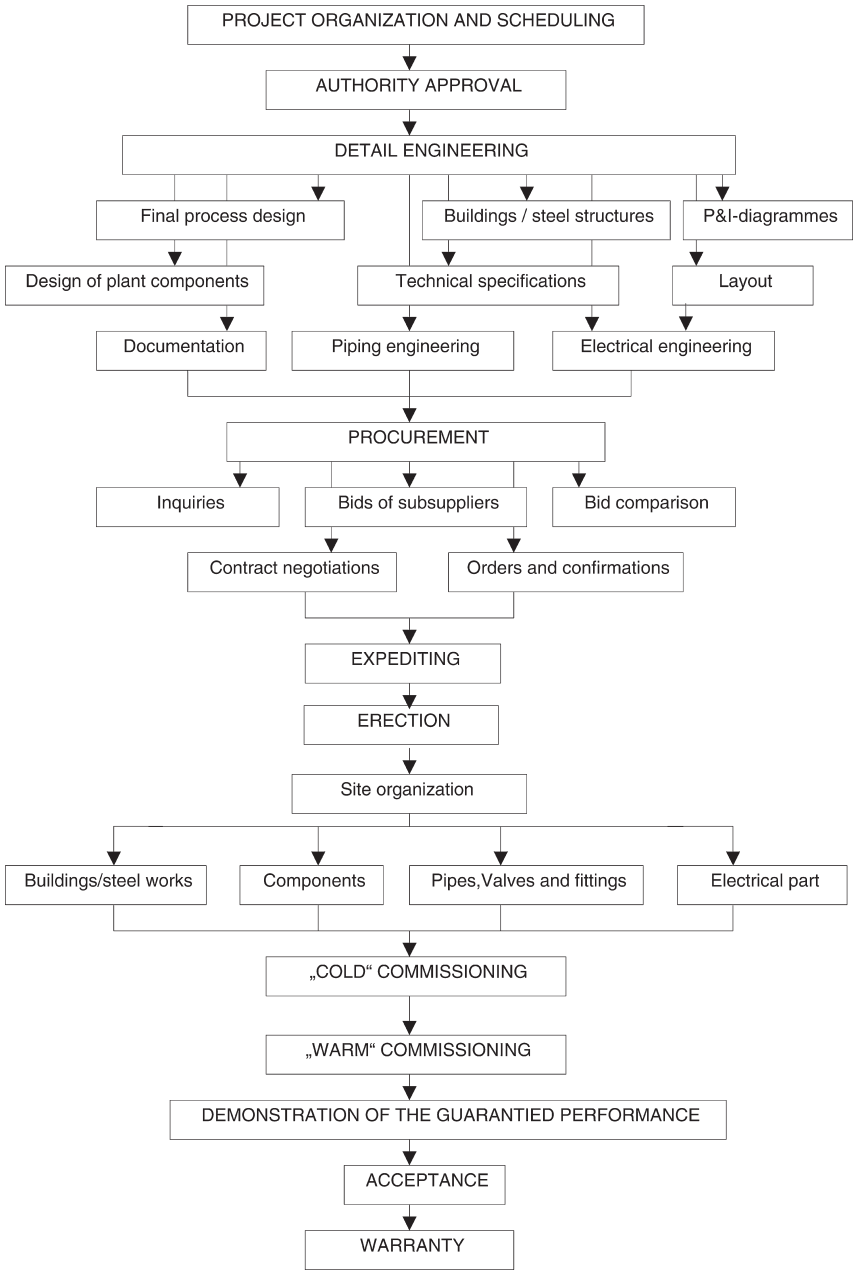

Figure 1.7 Overview of the activities during the execution phase.

the determination and optimization of the process concept with the required balancing regarding material and energy, as well as the implementation of an at least rough component and installation plan (layout). Another essential component of project planning is the *tender* and *contract award* for the procurement of the designed plant.

Project execution: Usually, the execution of a process plant project seamlessly follows the project planning, i.e. after the starting signal for the construction has been given by the competent authority. The planning activity necessary for the project execution is known as *detail engineering*. Apart from the planning steps, further activities such as *procurement* and *assembly* of the equipment as well as *commissioning* of the plant have to be carried out. With acceptance after the successful test, the project is completed. This is where the actual operation of the plant is going to start.

The interface between project planning and project execution is the *conclusion of the contract*. This means the signing of the contract worked out by the plant operator and the plant constructor stipulating all commercial and technical project matters in detail.

The most important activities during the phase of planning and execution are shown in Figures 1.6 and 1.7. The project development phase comprising the period from the idea for the project to the invitation to tender usually requires one to three years. Owing to difficulties in the field of research and development or problems arising from political arguments, to mention only two possible reasons, the phase of project development may, in individual cases, span up to ten years.

Even the phase of the contract awarding, which begins with pre-qualification and ends with the conclusion of the contract, may extend over several years, especially due to lengthy contract negotiations.

The actual phase of realization, which is equivalent to project execution, comprises two to four years and depends essentially on the scope of the project. Of course, considerable delays may also arise owing to climatic (violent storms etc.) or political difficulties (military conflicts etc.).

The operating phase of the erected and running plant ranges from 5 to 30 years, depending on the operator's philosophy.

The following chapters will describe chronologically the most important activities in carrying out medium-sized projects.