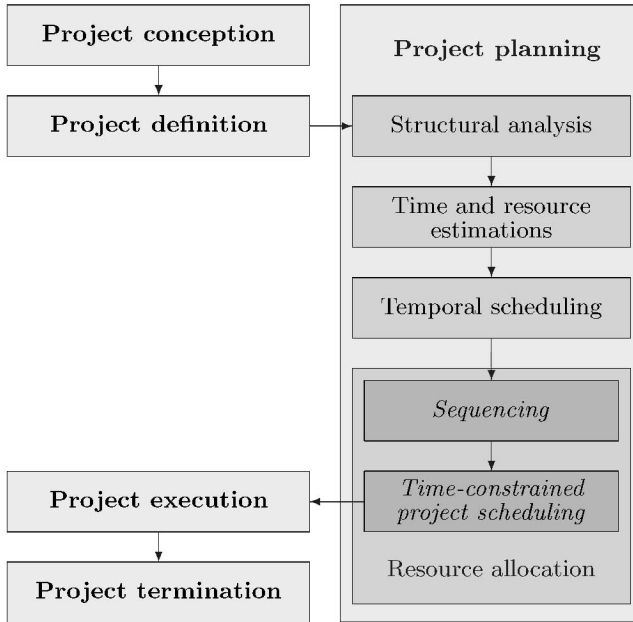

Introduction

Project management and resource allocation. A project is a major one-time undertaking dedicated to some well-defined objective and involving considerable money, personnel, and equipment. It is usually initiated either by some need of the parent organization or by a customer request. The life cycle of a project can be structured into five consecutive phases involving specific managerial tasks (cf. Klein 2000, Section 1.2). Starting with some proposal, several preliminary studies such as a feasibility study, an economic analysis, or a risk analysis are conducted in the *project conception phase* in order to decide whether or not a corresponding project will be performed. In the *project definition phase*, the objectives of the project are formulated, the type of project organization is selected, resources are assigned to the project, and different tasks with associated milestones are identified. Subsequently, the *project planning phase* at first decomposes each task into precedence-related activities by means of a structural analysis of the project. The time and resource estimations then provide the duration and resource requirements for each activity as well as temporal constraints between activities that are connected by precedence relationships. The result of the structural analysis and the time and resource estimations is the representation of the project as a network modelling the activities and the prescribed precedence relationships among them. Next, the temporal scheduling of the project provides the earliest and latest start times as well as the slack times of the activities, limitations with respect to resource availability yet being disregarded. The last and most complex issue of project planning consists in allocating the scarce resources over time to the execution of the activities. During the *project execution phase*, the implementation of the project is controlled by monitoring the project progress against the schedule which has been established in the project planning phase. In case of significant deviations from schedule, the resource allocation has to be performed again. The final *project termination phase* evaluates and documents the project after its completion to facilitate the management of future projects.

Each phase in the project life cycle requires specific project management techniques. Several recent textbooks on project management are devoted to the managerial and behavioral aspects of project conception, project definition, project planning, project execution, and project termination (see, e.g., Lewis 1998, Pinto 1998, Turner 1999, Keeling 2000, Meredith and Mantel 2002, or Kerzner 2003). This book is concerned with quantitative methods for the project planning phase and, more specifically, with the problem of optimally allocating resources over time.



Project planning within the life cycle of a project

The complexity of resource allocation arises from the interaction between the activities of a project by explicit and implicit dependencies, which may be subject to some degree of uncertainty. Explicit dependencies are given by the precedence relationships between activities emanating from technological or organizational requirements. In the course of time estimation, those dependencies are transformed into temporal constraints between activities. The scarcity of the resources used establishes an implicit dependency between activities, which can be formulated as resource constraints referring to sets of activities competing for the same resources or in terms of an objective function penalizing excessive resource requirements. The *resource allocation* problem consists in assigning time intervals to the execution of the activities while taking into account the prescribed temporal constraints and resource scarcity. If