Summary

An everlasting trade-off in many industries is the one between efficiency and flexibility. In this thesis, we investigate how this trade-off is dealt with in the food processing industries. More specifically, we look at the way in which the flexibility of the production system is related to production planning. The research question of this thesis is:

*How can day-to-day planning in the Food Processing Industries contribute to flexibility?*

In Chapter 2, the kinds of companies we look at are explored: small and medium sized food processing industries that produce for consumer markets. Two exemplary case studies provide reference material. The case studies, in combination with literature that deals with the research domain, are used to describe in more detail the organizational and production system characteristics in small and medium sized food processing industries. The background of this is that we expect that the organizational and production system characteristics have an influence on how the planning is and can be performed. This leads to a comprehensive view of the conflicts between the production system requirements and the customer requirements. The role of day-to-day planning in this discrepancy is also investigated. The most significant conclusion of Chapter 2, albeit a rather trivial one, is that the market requirements oppose production system requirements. A somewhat less trivial conclusion is the role of planning in this. We want to find out how the way in which plans are created relates to the flexibility of the production system. Thus, three elements of the research question remain to be tackled: planning, flexibility, and the relation between the two.

According to the research question, planning is used as an instrument to contribute to flexibility. The presumption of this is that the planning can be designed. There are two main research directions that deal with planning. First, the planning problem can be the starting point of the analysis. Planning in the food processing industries can be formulated as a flow shop scheduling problem with sequence dependent setup-times and non pre-emption. The domain characteristics can be analyzed and used to formulate algorithms that can find schedules. Second, the way in which the planning problem is dealt with by the (human) planners in the organization can be the starting point. We choose to apply this latter approach.

Chapter 3 provides a literature overview of planning as a task that has to be performed by a human planner. There, we distinguish two approaches to planning by humans: planning for yourself (for example, making a shopping list) and planning for others (for example, making a plan for a factory). This distinction is important if we look at our research question, because humans appear far more flexible during plan execution than organizations. Possibly, organizational planning can learn from
the way in which humans deal with planning and plan execution. In Chapter 3, we also look at planning support by providing an overview of components that are commonly found in planning systems. As a part of this overview, we discuss the complications of the application of plan generation techniques in a task oriented planning support approach. A conclusion of Chapter 3 is that we need an integrated approach that relates the kinds of entities that are planned (the domain) and the way in which they are planned (the organization of the planning and the planning task) to the way in which planning can be supported. This is taken up in Chapter 4.

The thesis deals with planning in the food processing industries. This demarcation is based on the fact that companies in this domain have many similarities with respect to planning. Still, there are also many differences between companies in the domain. Therefore, as we argue in Chapter 4, the integrated approach that is called for in Chapter 3 needs mechanisms for reuse as well. For that reason, we provide an overview in Chapter 4 of approaches that deal with planning, planning support, and reuse. On the basis of the overview, we conclude that there is no approach that fulfills our requirements of integration and reuse. Consequently, we propose the Scheduling Expertise Concept (SEC) as such an approach. In the SEC, a plan is defined as a set of objects that are assigned to each other, and a planning task is defined as a process of setting constraints on object assignments and assigning the objects to each other. Although the SEC contains (reusable) models to describe planning situations and planning support in an integrated way, it still lacks normative guidelines that can be used to design planning situations. This is the subject of Chapter 5, where we describe (with the use of the SEC) how the planning in food processing industries can contribute to flexibility.

In Chapter 5, we deal with flexibility. Although many things influence the flexibility of production organizations, we focus on the way that the planning relates to flexibility. Most notably, we state that (a) the flexibility of the production system is positively related to the flexibility of the planning, and (b) the more planning decisions can be taken as late as possible, the more flexible the planning is. To be able to describe the flexibility of the planning, we present a framework in which planning events are related to the moment that the events arrive and to the possibilities of the planner to react on such events.

To realize flexibility as defined, we argue against the traditional link between aggregation of time, aggregation of other object types, and the length of the planning horizon. In other words, it must be possible to make or change decisions at a high level of aggregation in a short time horizon. For example, a rush order might result in changes at the level of product families and machine groups in the time frame of the plan that is currently being executed. Decision making at several hierarchical levels in parallel costs more information processing capacity than sequentially building the plan hierarchy. We state that computer support can provide this information processing capacity.

Chapter 5 uses the models from the SEC to describe the planning in food processing industries, and thereby links the task / decision models of the SEC to flexibility. We show that hierarchical decision making opposes flexibility. In this
way, the results from Chapter 2 (Food Processing Industry characteristics), and Chapter 4 (hierarchical view on the planning task) are related to flexibility.

Chapter 3, Chapter 4, and Chapter 5 each pose requirements for planning support from the respective perspectives (task support, reuse, and flexibility). In Chapter 6, we describe a system architecture and a prototype planning support system that enable both flexible planning (a functional requirement) and reusability (a design requirement). The thesis ends with conclusions, our thoughts on generalizations, and directions for further research in Chapter 7.