

Revenue Management in a Make-to-Order Environment

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Abstract. Manufacturing companies in a make-to-order environment sell customer specific products. Usually, a company offers more than one product, faces a stochastic demand, and a time-varying product price. The latter cannot entirely be set autonomously by the company due to competitors. The decision the company has to make for an incoming order is whether to accept or reject the order, depending on the remaining capacity, the contribution margin of the order and the orders expected for the future. In our contribution we will discuss if the methods for the airline revenue management are applicable to the described problem. After giving an overview about the requirements a decision support system ought to fulfill to improve the order selection process in a make-to-order environment, we will discuss the differences of such a system to existing revenue management approaches in service industries. Subsequently, we give a mathematical formulation for the described problem and apply it to a simplified practical example.

1 Make-to-Order Manufacturing, Introduction and Problem Definition

Manufacturing companies in a make-to-order environment sell products specific to consumer requirements. In general, an incoming order initiates the production process, i.e. the procurement of specialized materials and component parts, the in-house fabrication of parts, the production of subassemblies and the final assembly. Often the product itself or a variant of the product has been manufactured before, and hence, the bill of materials as well as measures for the expected processing time of the order at the resources are available [4].

We will focus in our contribution on the production processes in the iron and steel industry as an example of a make-to-order production process. Our reference production structure originates from the production structure of the Salzgitter AG, Germany. The steel making process [10] in general starts with the pretreatment of iron ores in a sintering plant which agglomerates the fine iron ores to sinter. In a blast furnace, the next production step, the ore is reduced to hot metal by adding

coke, coal, oil or gas. The hot metal is then refined in a converter to liquid steel by an oxygen top-blowing process, subsequently ready to be cast and rolled. Nowadays, post-treatment is generally applied after refining, as an increasing demand in terms of quality and the ongoing development and diversity of steel grades produced do not allow sufficient accuracy when melting the steel in the refining vessel. This so-called secondary metallurgy aims at enhancing the quality of the metal by precisely alloying and lowering undesired elements or compounds. After this process liquid steel with the desired grade is available for transforming through a continuous casting process to solid cuboid-shaped slabs. The slabs are customized (in terms of steel grade and dimensions) semi-finished products and are the starting product for further processing in different types of rolling mills. Moreover they are tradable products with a market existing between different steel companies. Hence there is a possibility to procure additional slabs in order to increase production capacity. The finished products which are produced through different rolling processes are classified according to the shape of their cross-sections as long products and flat products. The long products being produced in our reference production structure are sectional steel products and steel beams with different geometry and application areas. The flat products produced by two different hot and one cold rolling mill are consequently subdivided into a hot-rolled and a cold-rolled fraction. The hot wide strip as a hot-rolled finished product marks the input for the cold rolling mill and the spiral tube welding plant. Some of the cold strip gets further refinement in the metallic and non-metallic coating plants to obtain corrosion-resistant and surface protected steel strips and sheets.

As a result of the analysis of the reference production structure we have found the following conclusions:

- The produced slabs are make-to-order semi-finished products in terms of steel grade and dimensions.
- There are multiple finished products produced from slabs, themselves constituting raw material for different industries (car industry, building industry, etc.).
- The processing times of orders at certain resources depend on specific order characteristics (steel grade and dimensions) and are known (as an average) before start of production.
- The company cannot entirely set prices autonomously because of competition.

The problem arising for the company is which orders to accept and which orders to reject in order to maximize profit or contribution margin respectively. Therefore we see a practical need to develop a decision support system with the purpose of improving mid-term sales planning and primarily short-term sales planning in advanced planning concepts [7]. This decision support system ought to improve sales planning thereby explicitly considering interdependencies of dif-