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Implementation of a Comprehensive Production Planning Approach in Special Purpose Vehicle Production

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Abstract

The European vehicle industry employs a cascading planning process, for medium-term sales and operations and medium- to short-term production planning. Due to a lack of coordination and feedback between the different planning phases, costly problems in production arise. This paper describes an integrated planning solution for the harmonisation of sales, purchasing, supply chain and production planning along the planning cascade. By harmonizing long-, medium- and short-term planning, cost savings and additional value potential can be realized. The basic approach for harmonized planning is illustrated with a case study from special purpose vehicle production.

Keywords: Planning; Sequencing; Automotive

1. Introduction

Expensive production infrastructure and volatile customer demand make sales, operations and production planning key functions, particularly in special vehicle production. The industry employs cascading planning for medium-term sales and operations and medium/ short-term production planning.

A major problem is a lack of coordination and feedback between planning phases, causing costly troubles, from unfeasible production programs requiring permanent ad-hoc troubleshooting caused by unavailable resources or limited supplier capacities. Such problems could be avoided, if bottlenecks were discovered during long-term planning, since this would leave time to build up the necessary resources. Such a fragmented planning cascade often manifests itself in disjointed IT-systems. Since they often correspond to existing organisational structures changes to the overall planning procedure come slowly. This is especially true for the automotive and special purpose vehicle industry, but can also be found in other industrial sectors. These problems were the trigger for a project that intends to develop a solution that assists in overcoming this chasm.

This paper discusses planning restrictions, their originators and connections between single planning tasks and the correlation of restrictions between different planning horizons. An integral planning approach serves as the basis of a software tool that harmonizes the planning tasks over the different planning horizons. The case study investigates the approach for special purpose vehicle production and covers the entire analysis and implementation process. It is the result of a project called Harmonised Planning of Sales, Purchasing, Supply Chain and Production (HarmoPlan), which developed an integral planning solution for the harmonisation of sales, purchasing, supply chain and production planning along the planning cascade from long-, medium to short-term planning, resulting in the realisation of cost savings and additional value potential. The project focuses on the planning process of the final assembly in vehicle and component manufactories where variant flow production with low automation and high labour intensity exists [1].

When it comes to lead time and productivity the

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special vehicle sector lags behind the automotive industry. Differences are caused by variations in product structure and range. Further potential for optimization stemming from the overall organization of production and especially due to planning consistency and transparency is not utilized. Major car manufacturers have very high standards concerning organization of production and work on the optimized use of IT for the harmonization of long, medium and short term planning.

Special purpose vehicles are often produced in a site assembly or semi-series assembly setting without a fixed production cycle, due to a low degree of transparency of parts availability and use of personnel in the planning process. The spread of required times for assembly in a line for special purpose vehicles is a multiple of that of an assembly line for passenger cars due to option-related work content. This is especially a problem for short-term production planning to find the correct sequence order and the appropriate use of personnel.

Today, large components are sourced from Asia for cost reasons resulting in very high replacement times, i.e. for special drive chains for construction machines it is between six months and one year. With such extended delivery times transport times by ship and truck of about 2 months are a considerable delay, and require careful planning. Hence, harmonized planning of special vehicle production holds enormous potential for performance improvements and cost savings.

2. Planning approach for special vehicle production

As mentioned above, in the automotive industry and particularly in special purpose vehicle production a cascading planning process is prevalent. Although each company has its own peculiarities, such a cascading planning process follows a pretty similar pattern. Figure 1 describes a generic planning process that illustrates the "common ground" of a possible harmonized planning process for sequenced, automotive production in Europe.

Based on a continuous market analysis the company decides, which brands are to be produced. The results will be put in the brand strategy, which subsequently will trigger the annual and budget planning resulting in a sales forecast. The sales forecast has a rolling horizon with a planning period of about seven to ten years.

Next sales planning specifies the models by their main criteria (engine type, auto body, gear box, no. of axles for truck assemblies, etc.) and assigns potential production sites to models and production volumes. The particular production site is decided on location-specific costs and other conditions (i.e. planned or existing production sites, available suppliers, local labour market, site-specific strength and weaknesses, etc.).

Input data for production program planning usually are sales forecasts broken down into monthly sales quantities and production rates. Restrictions are minimum line load levels resulting from the model mix problem (provision of the production factor resources), the capacity of plants (annual working hours of workforce), technical solutions in the line (equipment) and potential bottlenecks on the supplier side (material).

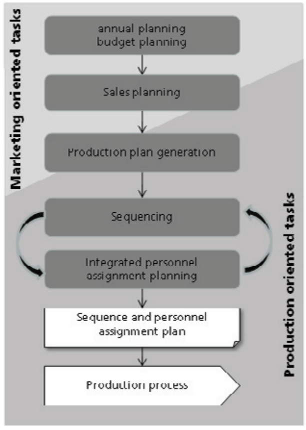

Fig. 1. Generic planning process

Production program planning is usually done continuously and the production program is split up into daily or weekly order pools. The allocation of orders to weeks, days or shifts is dubbed *slotting* and order pools are calculated using an average process time per vehicle. At this point planned or real customer orders have been placed, although sometimes the orders in daily or weekly order pools are not fully specified dummy orders. Specifications include only items as engine type or number of axles for truck assemblies. If a real customer order is placed an eligible dummy order is removed and will turn into a fully specified customer order [2].

After slotting the planning continues until a sequence is found, that does not violate any capacity or material restrictions. This is done by moving individual orders within the sequence to a different time period in order to accommodate the restrictions mentioned above.

The shifting of orders is called balancing. To increase the level of detail, attributes such as transmission, colour, sunroof, etc. are added. This enables a detailed analysis of work content per vehicle and generation of balanced sub-order pools based on days or shifts.

At last, all planned orders have to be substituted by actual customer orders. If this is not possible, it has to be decided, if a planned order is removed or if a vehicle is produced on stock. For order sequence planning the vehicle has to be fully specified. In principle three different sequencing methods can be distinguished:

- level-scheduling,
- mixed-model sequencing and
- car-sequencing [3].

Derived from the Toyota-Production-System, level scheduling aims at achieving a level spread of material demand [4]. In contrast mixed-model sequencing intends to reduce resource overload within the system resulting in an exact schedule for each type and station under