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SIMULATION TESTBED FOR THE ANALYSIS OF BENEFICIAL BUSINESS STRATEGIES FOR THE AIRBUS A350 PRODUCTION RAMP-UP

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ABSTRACT

The production ramp-up of new aircraft is characterized by high complexity and planning and control challenges caused by complex product design, supply chain and production processes. In the past, this resulted in significant delays and increased costs of the production ramp-up. Novel business strategies and planning and scheduling technologies promise better production control and risk mitigation during the ramp-up phase. The European research project ARUM has developed those business strategies and a new distributed decision support solution based on knowledge processing technologies. A simulation testbed was used to identify the most beneficial business strategies and to evaluate linked control strategies for the industrial use case of the Airbus A350 production ramp-up. This paper discusses the potential of simulations for the business strategy definition and for the validation of linked control strategies from the industrial end-user perspective.

1 MOTIVATION AND PROBLEM DESCRIPTION

Shortened development cycles have increased the number of production ramp-ups in the aeronautic industry. The complexity of the product aircraft, the pressure to introduce novel features and technologies like composite instead of aluminum fuselages and the shortened overall development time have led to a reduction of the design maturity of the aircraft at the beginning of production. The pressure on suppliers – the share of external supply has increased to more than 80 percent for new aircraft programs – has increased the risks for a lack of maturity and supply chain disturbances. In contrast to other industries, e.g., the automotive industry, the production ramp-up for aircrafts starts without a pilot series. All the elements of the production, the tools and jigs, the production processes and the IT tools for the production planning and control, have to be tested and matured in parallel to real production for customers. Based on experience from former production ramp-ups like the Airbus A380 or Boeing B787 programs novel strategies and control solutions were developed and implemented for the Airbus A350 program to handle the resulting risks of disturbances and ramp-up delays.

This paper discusses the process of the definition of beneficial business and control strategies with a particular focus on the use of simulations as part of this process. Along the production ramp-up different strategies have to be applied for different stages of the industrial ramp-up depending on the maturity, amount and quality of the disturbances. The overall goal is to avoid late deliveries of the aircraft to the customers as a result of the late or incomplete supply of assemblies, which results in traveling work to be finished at a later production stage and location. Complex scenarios, a high amount of uncertainties and multiple decision variables within the definition process require the support of simulation techniques , which must be built into the decision support IT solutions.

2 CASE STUDY AIRBUS A350 PRODUCTION RAMP-UP

The solution for the definition of business and control strategies, which has been briefly described above, was developed and finally implemented into IT solutions for the decision support within the production ramp-up within the European research project ARUM (Adaptive Ramp-Up Management, 2012-2015, www.arum-project.eu). One of the industrial use cases in the project was the production ramp-up of the Airbus A350 system installation line in Hamburg. The system installation flow line is composed of six stations and is used for the installation of electrical and hydraulic installations, isolation and side wall panels into the Airbus A350 front section of the aircraft fuselage. The front section is supplied from other Airbus plants to Hamburg and the equipped section will be delivered from Hamburg to the final assembly line (FAL) of the Airbus A350 in Toulouse. Although the sections are all from the same aircraft type, the required workload can vary more than 30 percent depending on the airline customization of the aircraft. For each section, the system installation requires several thousand man hours and around one hundred and fifty qualified workers, approximately thirty to forty workers assigned to each station. The production ramp-up for the system installation flow line starts with a throughput of one to three sections per month in the very early stage and will increase to ten or more sections per month. This means a cycle time reduction for each station from one and a half weeks down to two days. In parallel to this, the amount of unplanned work and other disturbances is expected to be reduced from up to fifty percent down to less than ten percent in the steady state production phase. The performance of the production system is measured by a set of key performance indicators (KPIs). Since the timely delivery of the aircraft to the customer is a top priority for Airbus, the most relevant KPIs are the achievement of the planned lead time and the minimum tardiness of deliveries to the FAL in Toulouse. Additionally, the minimization of traveling work inside the flow line and to the FAL in Toulouse is key for avoiding additional efforts and costs. Furthermore, the resource utilization and balancing across the flow line will be an objective for production control.

3 SIMULATION APPROACH AND RESULTS

The ARUM research project developed beneficial business and control strategies for the production ramp-up and implemented those strategies into novel agent-based planning and scheduling solutions. The validation of those strategies and of the implemented planning and scheduling solution in a real environment and a comparison with today's human based decision making was supported by simulations. This was achieved by simulation of industrial use cases using real data and the developed ARUM planning and scheduling solution and control strategies. The Airbus use case was modelled and simulated in AnyLogic 7, a multi-method simulation tool, that was linked to the ARUM test bed, which was running the IT prototype of the agent-based decision support solution including the planner and schedulers, the knowledge store and transformation and gateway services. The simulation model particularly covers the user and legacy systems emulation of the industrial environment and allows the observation of KPIs to measure the performance of the modeled Airbus A350 system installation line. The AnyLogic 7 simulation uses an agent-based method to model the shop floor elements (stations, buffers), the sections, the work orders, the workers and a process library with queues and linked service elements for modelling the execution of the work orders. A control agent models the complex behavior of human controllers and their reaction to events with the control strategies described in action charts. The ARUM planning and scheduling services are connected by the Enterprise Service Bus (ESB).

Experiments with the ARUM test bed and the AnyLogic 7 simulation model of the Airbus A350 system installation flow line now allows the validation of the control strategies in combination with the novel IT solution for planning and scheduling. For this experiments a set of scenarios and data sets are defined, representing different ramp-up stages and multiple event sets representing different possible disturbances. The results of the study have proven the benefits of the application of optimal production control strategies. For example, throughput improvements by 2-5 percent due to optimized cycle times and lead-time reductions by 5-10 percent due to application of optimized control strategies have been achieved.

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