

# Yutong Group

Gurobi solves a challenging multi-objective production planning problem for the largest bus manufacturing company in China

## The Challenge: Optimize the production of 100 individually customized bus models across 10 production lines

Headquartered at Zhengzhou City in Henan Province, the Yutong Group is the largest bus maker in China. In 2011, with sales of 45,895 buses, Yutong's production ranked #1 among all major bus manufacturers worldwide.

Unlike family-owned vehicles, a bus is a highly customized product, especially for the use of city metros or for carrying local commuters. As a result, most customer orders consist of only 1 to 2 buses. At Yutong's main manufacturing site in Zhengzhou, an average of 170~180 buses are put into production a day and about 100 different models are in process & assembly at any given time. Each day, planners need to allocate customer orders into 10 production lines that have four primary processing steps (welding, painting, assembly, and testing) while taking into account many additional factors. These factors include due dates and priorities of orders, material constraints of key components, reducing expensive component inventory, capacity constraints, working calendars, overtime work regulations, workload balancing among the production lines, production line preference by product, minimizing product change over in a line, increasing resource utilization, and so on.

## The Solution: Build a custom planning system to do what commercial Advanced Planning and Scheduling software packages could not do

To automate the planning task and to improve the quality of the production plans, the Yutong Group had conducted a survey of several world-leading commercial APS (Advanced Planning & Scheduling) software packages, as well as built prototype models. Unfortunately the results were disappointing. Due to the diversity of Yutong's bus products and the capability of manufacturing highly customized products, multiple business objectives and constraints need to be considered in the planning process, and commercial APS software could not meet the functions required by Yutong planners. As a result, the idea of building a tailor-made planning system using an optimization solver was suggested to Yutong executives and was adopted.

Firsttech, as a Gurobi partner and also a leading company in the application of optimization technology to resolve planning & scheduling problems in Greater China, was appointed to build the Yutong Bus Production Planning System.

## The Results: A nine-hour manual planning process requiring five people replaced by Gurobi solutions in only 45 minutes

Firsttech optimization specialists built a network flow model to address the multi-objective planning problem, and Gurobi was used to solve a sequence of MIP problems generated from the network flow model. The resulting system plans 1500~2000 customer orders a day across a 30-day planning horizon. Depending on various business scenarios, six to eight different business objectives (including soft constraints such as "minimize the violation of production line preference by product") are used in each planning process. Six to ten MIP problems are resolved by Gurobi solver in

sequence, and each MIP problem consists of about 100K rows of constraints, 60K variables, and 260K nonzero parameters. The performance is much better than what was expected going into the effort. Gurobi solves the sequence of MIP problems within 45 minutes, which is significantly reduced from a 9-hour manual planning process using a 5 person team.

As a result, Yutong Bus has significantly improved corporate operational efficiency through the successful application of optimization technology. Yutong top management is pleased to see that their production planning process has become much more efficient and, as a result, further increased Yutong Bus' advantage over its competitors. the largest bus builder worldwide in terms of sales volume.

At present, Yutong has established a complete 6m-25m product lineup consisting of ordinary, medium-level and high-level products, covering various segment markets including highway passenger transit, tourism, and public transport.



## Zhengzhou Yutong Group Co. Ltd.

Headquartered in Zhengzhou of central China's Henan Province, Zhengzhou Yutong Group Co., Ltd. (hereinafter referred to as "Yutong Group") is a large-scale industrial group mainly specialized in bus business, also covering some other strategic businesses such as construction machinery, automotive parts and components, real estate, etc. It is also one of China's top 500 enterprises.

Zhengzhou Yutong Bus Co., Ltd. (hereinafter referred to as "Yutong Bus"), the core enterprise of Yutong Group, was established in 1963 whose predecessor is Zhengzhou Bus Repairing Factory. In 1993, it was renamed as Zhengzhou Yutong Bus Co., Ltd. Located in Zhengzhou Yutong Industrial Park, it covers an area of 1.12 million sq m with a daily capacity of over 210 unit buses. Till now, it has grown up into the largest and the most technologically advanced manufacturing base of large and medium-sized buses around the world and become the largest bus builder worldwide in terms of sales volume.

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