Volkswagen Saves Millions on Delivery Using Simulation

ProModel
VISUALIZE ANALYZE OPTIMIZE VAO

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Genre Case Study | Project Review: | White Paper | Technology Overview

Client **Volkswagen**

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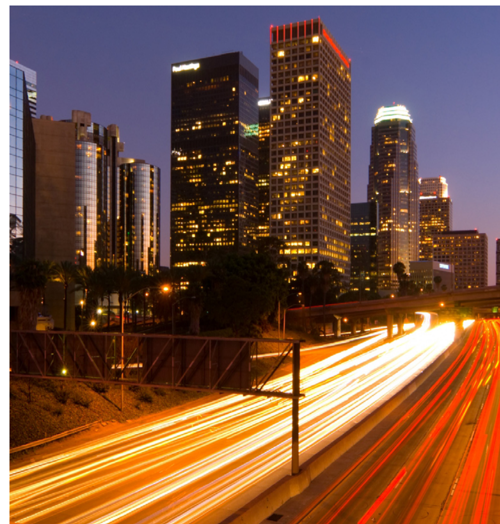


Volkswagen (VW) manufactures the vehicles marketed in North America at two plants, one in Germany and the other in Mexico. Vehicles are first shipped to one of the five U.S. ports that act like distribution centers (DCs). They are then transported to the dealerships at major market areas, mainly by trucks. The company aims to improve its vehicle distribution network with two major objectives: 1) to improve customer service, vehicle delivery times, and market responsiveness, and 2) to reduce the total distribution and inventory holding costs.

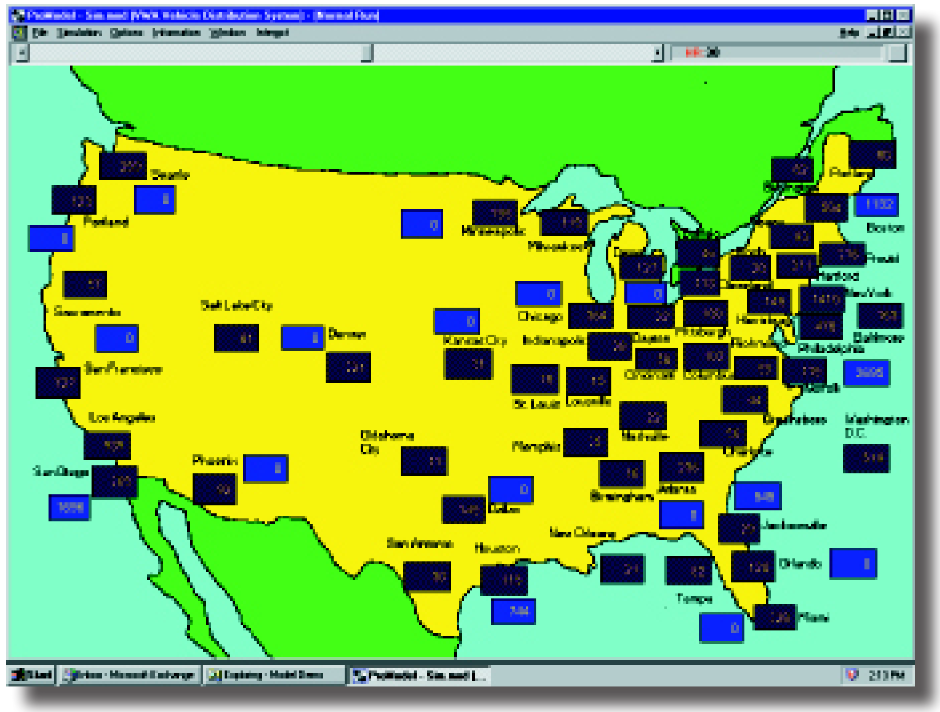
Production Modeling Corporation (PMC) was brought on to model the delivery system. PMC's approach to improving the vehicle flow was the establishment of more DCs closer to metro markets so that the following benefits could be realized: a)part of the current expensive truck routes could be replaced by cheaper rail of sea routes, b) the chance of meeting a customer's first choice vehicle increases with combined dealer and a DC inventory, and c) customers' first choice vehicles are delivered with shorter lead times. Clearly, the number and location of DCs are major factors that affect both customer service and distribution cost measures. Moreover, there is a choice for the type of facility to be installed at each DC location. Type I facilities are smaller in capacity and cheaper. Type II facilities are larger, but the increase in operating expense is nonlinear and allows us to consider economies of scale in locating DCs in certain high-demand areas. This simulation effort has the potential of saving the company $20 million a year.

Modeling Approach

Given a location scenario (i.e. number and location of DCs), realistic computation of the performance measures (cost and customer service) requires explicit consideration of the dynamic and stochastic elements include the inventory control policies (both quantity and mix) at dealers, truck load factors, and demand seasonality. Stochastic elements include customer demand, customer choice, and transportation delays. A simulation model was appropriate for the consideration of both elements. Once the model was developed, a few location scenarios were generated "by eye" as input to the model. It became quickly apparent, however, that a systematic way of generating location scenarios was needed because of the tremendous number of alternatives. In an attempt to reduce the number of alternatives, a Mixed Integer Program (MIP) was formulated that generates a reasonable number of "good" scenarios. The MIP minimizes a cost function that approximates the distribution cost of the actual system by ignoring the stochastic and dynamic aspects. The variables consist of shipment quantities and whether DCs are to be installed on potential locations (binary variables). The output of the MIP is a location scenario as input to simulation. (Note: This solution was designed prior to the release of Simrunner) The MIP objective function consists of two components: 1) total transportation costs, which depend on mileage between locations as well as the modes of transportation, and 2) fixed facility installation costs at DCs, which depend on location capacities. Inventory holding costs are ignored. Constraints are specified to assure that a) market demands are satisfied, b) incremental capacity limitations for facility types are not violated, c) market orders can be shipped within a pre-specified time window, and d) maximum number of DCs to install is not exceeded.

Two major input parameters to the MIP are market demands and truck load factors, which, in fact, are both functions of the location policy. (Truck load factors are used to calculate the shipment costs.) We resolve this problem with a heuristic iterative procedure. We start with solving the MIP assuming that 1) all market demands match the planning sales volume exactly, and 2) all load factors are 10 (i.e. full-load trucks). The resulting location scenario is given as input to the simulation model. Considering the dynamic and stochastic elements, the simulation run produces better estimates of the sales and load factors as a result of implementing this particular location scenario. Now, we give these better estimates back to the

MIP, and solve it. If the output location policy is changed, we proceed with running the simulation using the new location scenario as input. Otherwise, the most recent estimates are not different enough than the previous ones, and both the MIP and simulation agrees on a particular solution. Although there is no guarantee of convergence, this procedure proved satisfactory in our experiments.



Using ProModel, Volkswagen establishes and tests a completely revised distribution system.

Implementation

To solve the MIP, AMPL PLUS with CPLEX as the solver was used. It proved convenient in implementing the above iterative procedure. Communication between AMPL PLUS and ProModel was handled (semi-automated) by an Excel spreadsheet with macros that read the output files created by one program and generated appropriate input files for the other program.

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Conclusions

The quantitative analysis based on the combined optimization and simulation modeling yielded many interesting results. Since railroad transportation is cheaper than trucks, a cost-optimal policy includes far more DCs that the current one. Under certain circumstances, an optimal solution has the potential of saving over $20 million per year in transportation costs.

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