system has faced problems with the supply of medicines, thus forcing these uninsured people to buy them at their own expense. On the other hand, private drugstore companies are facing a great amount of competition, especially among the three or four largest drugstore companies in the country, because most of the products they sell are patented, or name brand, drugs. These products cost a whole lot more.

But because the Mexican government has authorized a considerable number of generic drugs, some pharmaceutical companies focus on these kinds of products. The lower costs of these drugs help draw a lot of clients, so some drugstore companies are offering generic products under their own trademark as a way to attract and retain customers.

One Mexican corporation that owns a drugstore company with operations across the entire nation (31 states plus a federal district) decided to embark upon a complete redesign of its distribution network. The changes were to focus on the network’s strategic configuration.

The tactical and operational issues were not considered simultaneously, and members of top management, including the CEO and the vice president of logistics, were interested in a way to configure and evaluate the network’s possible configurations based on the minimum cost.

The actual distribution network was based on the following structure:

- One master distribution center
- Nine regional distribution centers (RDCs)
- 34 local warehouses
- 2,000 drugstores (some owned by the company; others were franchisees)

About 20 percent of the products are manufactured at a facility the corporation owns that is located next to the master distribution center. From there, the products are sent to the RDCs. Regional centers also receive products from external suppliers. In these instances, the distribution cost from suppliers is included in the product’s price. RDCs send products to all drugstores that the corporation owns, as well as to big franchisees and local warehouses located within an RDC’s associated geographical area. Small franchises are not served directly by the corporation. They must buy and pick up their products from local warehouses; therefore, there is no distribution cost associated with them.

RDCs, warehouses and stores request products based on their inventory levels. The safety stock is defined heuristically as 30 days. Distribution is carried out once per week, and a strategic aggregation is based on regions served by each RDC, as shown in Figure 1.

All transportation is performed by an external company that uses different kinds of trucks, except for some specific places, mainly around coastal areas, that are served by ferries. The system includes designed truck routes. Delivery routes span some states and serve a different number of points of sale; therefore it was a good idea to design a specific methodology to assign a unitary transportation cost. Each RDC operates independently from the others with no overlap in

**CURRENT LAYOUT**

Figure 1. The drugstore chain’s distribution network does not include delivery to small franchises or the subsidiaries of big franchises.
operations or transportation between RDCs.

The company was interested in evaluating the suitable number of RDCs that should be included in the system, along with the regions served by each one. Options included creating new RDCs, closing some and merging others. If needed, a second master distribution center could be opened, and the system used to define the safety stock in the inventories through the complete network could be revamped as well.

Two key performance indicators were defined to evaluate the minimum cost desired:

- The total transportation cost of the network
- The total cost of holding inventory in the network

Data from one complete year was available. Some information that related to special demands, such as specific sales for the government or for other companies, were not included in the model because they weren’t common. They also weren’t significant, representing less than 2 percent of the total. Such orders are carried out under a make-to-sell approach.

In order to provide support for the company’s decision making process, a simulation model was designed with a strategic approach.

The simulation model
A simulation model to evaluate the strategy to reconfigure the distribution network was developed under a standardized framework. According to Dayana Cope, Mohamed Sam Fayez, Mansooreh Mollaghasemi and Assem Kaylani in their 2007 Winter Simulation Conference paper “Supply Chain Simulation Modeling Made Easy: An Innovative Approach,” standardized simulation models are those that can be applied to a broad range of systems and, at the same time, be precise enough to be adjusted for different scenarios and performance criteria. Such models become specific when data for a particular system is loaded.

Authors like Guruprasad Pundoor and Jeffrey Hermann in “A Hierarchical Approach to Supply Chain Simulation Modeling Using the Supply Chain Operations Reference Model,” published in the International Journal of Simulation and Process, suggest that there are always some common processes within distribution networks that can be reused. Qing Wang’s “A Discrete Event Modeling Approach for Supply Chain Simulation” in the International Journal of Simulation Modeling suggested that simulation must be focused on the specific elements of the supply chain.

In this drugstore company’s case, the simulators based the distribution operations model on a two-echelon framework for the supply chain where there is a supplier serving “n” number of clients through a matrix of data. This structure will form the basic unit of the model where the complete logic and common processes are carried out, and its replication both forward and backward can create the complete network, just like a series of steps where a supplier becomes a client of another previous supplier, as shown in Figure 2. Furthermore, due to the fact that the distributive processes could yield some subnetworks, the structure also can be replicated in a parallel way, converging in a point-of-origin of the network.

The simulation model considered the code of the basic two-echelon structure, and this logic then can be replicated in a serial way, starting from the final end of the distribution network (the final consumers) and going back up to the main supplier, thus forming the complete network.

It must be remembered that the model is based on a strategic approach; however, some tactical issues must be included to evaluate the network based on key performance indicators. The main characteristics of the model are:

- Aggregation: An aggregate approach has been included, adding all the pieces and products to be demanded in a single aggregated demand without making a distinction among individual items. This approach
provides an insight to the total items in inventory through the whole system; however, the model standardization allows an easy way to be modified to include families of items or individual products in a tactical manner.

- Unitary transportation cost: There are several delivery routes spanning several states, and even the types of vehicles vary. Trucks are the main delivery vehicles, but ferries serve some coastal regions. Therefore, a methodology to integrate the unitary transportation cost for each region has been developed and included as an input data to the model.

- Discrete operation: Because most events occurring during normal operation of the distribution network occur at a specific point in time, discrete operation is used. This approach leads to the fact that all variables are considered as discrete, allowing for a fast execution of the model. The model is based on a single entity flowing through the model and executing the common logic previously stated.

- Time framework: Considering the strategic approach and the aggregation, the model does not consider small gaps of time, so the entire cycle of operations are carried out in a discrete time scope, which can be one week, one month, etc.

- Simulation language: In order to achieve a standard model and its recursion both in serial and parallel, a typical graphical simulator was not used because of the restrictions for handling these kinds of models. A simulation language was used to prepare this logic and provide an encapsulated model, where all the information is included without using any external references to databases, spreadsheets or any other software.

Operating the model and getting results
First, the standardized simulation model was validated by simulating the actual distribution network against one year of historical data. Then, the validated model was used to evaluate different scenarios for the new configuration of the network.

Simulation was carried out based on a steady-state analysis, and the differences in the total inventory level were about 2.7 percent versus historical data. In the case of transportation costs, the difference of the simulation versus historical data was about 3.2 percent.

Considering these differences and a target error of 5 percent, results from the simulation model were within tolerances. Therefore, the researchers decided that they could use the model with confidence to evaluate new alternatives to inventory policies and other aspects of the distribution network. Some scenarios were designed to improve the distribution network, and several options were considered, including:

- Opening, closing and/or merging regional development centers
- Reassigning regions to different RDCs
- Increasing delivery frequencies
- Opening a second, new master distribution center

All improvement scenarios also considered a new calculation of safety stocks using a multiechelon inventory system. More than 20 scenarios were designed and tested.

The model only required the recalculation of input data and the activation, via a simple logical switch, of the multiechelon system. No more changes to the model were required, and the scenarios were evaluated in a simpler and faster way.

Some alternatives were considered promising, but according to results from the simulation, these options provided no improvements to the total cost of operating the distribution system. Once all the alternatives were analyzed, the best distribution network was defined as one having eight RDCs and one master distribution center, shown in Figure 3. The new distribution system merged four of the original RDCs into two new ones and kept five of the original RDCs in the network. These five are to use the new safety stock levels. One new RDC was opened to absorb part

NEW LAYOUT

Figure 3. The simulation results recommended merging some regional distribution centers and opening a new one.
of the regions previously served by other RDCs.

The entire new configuration is based on increasing the frequency of delivery to twice per week in the metro areas where RDCs are located, along with using multiechelon inventories. Increasing deliveries might increase costs while reducing inventories, so the trade-off suggested by Porter’s Harvard Business Review article was considered. However, by reassigning the various regions, the new distribution system will lead to reduced transportation costs.

The suggested distribution network would reduce the total system cost by about 20 percent, as shown in Figure 4.

Not too good to be true
Using a simulation model provided insights about the distribution network and allowed the integration of stochastic conditions occurring in the real operation of the network. Furthermore, the design of the model, based on the input-data matrix, boosted the design and evaluation of the scenarios. This was possible because some of the scenarios were similar, involving identical regions and/or regional development centers, while others just merged the data. Therefore, some information was reused.

The nature of the standardized model supported the fast execution of the analysis. Although any scenario had its own structure, the main logic was identical, and the only parameter required was the number of areas and/or RDCs to be considered. So depending upon the scenario to be run, the researchers just had to adjust the matrix input data.

The final savings of 19.3 percent of the total cost is important for the company. Once translated into U.S. dollars, this money can be used to reinforce the corporation’s competitive position through a small reduction in prices and expanded marketing to get more clients.

Finally, the risk associated with configuring a new network was reduced drastically. Corporate officers were worried about the suggested cuts in inventory level, fearing that the comparison versus the actual heuristic method was looking “too good to be true.” So the reductions were implemented gradually in one of the regional development centers. However, after it was demonstrated that the new way to calculate inventories was providing the same service level to its customers, the company deployed the new inventory levels to its complete network.

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<tr>
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