BY TED GIFFORD

Editor's note: This is another in a series of articles profiling members of the INFORMS Roundtable.

The Schneider Enterprise

FROM ITS BEGINNING IN 1935 WHEN AL SCHNEIDER SOLD THE FAMILY CAR TO BUY HIS FIRST TRUCK, Schneider National, Inc. has grown to become a premier provider of transportation, logistics and intermodal services. With combined revenues of $3.7 billion, the Schneider enterprise portfolio of integrated services includes truckload, intermodal, transportation management, dedicated, bulk, supply chain management, warehousing and international logistics services. Schneider operates more than 14,000 tractors and 48,000 trailers with over 15,000 drivers. Last year, Schneider trucks moved two million loads and drove 2.5 billion miles (Ted: What's your source for these #'s?). Schneider Logistics, a part of the Schneider National enterprise, is an international logistics provider to two-thirds of the FORTUNE 500 companies.

Schneider Logistics helps customers capture strategic business value from their supply chains in the form of lower distribution costs, reduced inventory, improved customer service and increased availability to working capital. Schneider Logistics operates two units in China: Schneider Enterprise Consultancy (Shanghai) Co. Ltd. and Schneider Logistics (Tianjin) Co. Ltd. Services include supply chain consulting, as well as transportation and logistics services for the domestic market. Schneider National conducts business in more than 28 countries in North America, Europe and Asia, and continues to grow its international service offerings.

Operations Research at Schneider

OPERATIONS RESEARCH-INSPIRED work at Schneider has developed along two somewhat distinct threads, both driven by business opportunities and the need to leverage sophisticated mathematics-based approaches to realize these opportunities. Work around the first thread began in 1976, when the Schneider truckload freight network had grown to the point where complex planning models could be easily justified. Initial development began on two applications. The first was a precursor to later revenue management models and was formulated to determine the "optimal" freight mix given a selection of load opportunities and fixed set of assets. The second was a linear programming formulation with a sophisticated pre-processing engine to solve the classic driver-to-load matching problem. To our knowledge, Schneider was the first truckload company to address these problems with modeling and optimization.

With the deregulation of the trucking industry in the early 1980s, Schneider grew from its upper Midwestern base to encompass a national transportation network. To support this growth, engineers at Schneider helped develop plans for a broad network of operating centers using set-covering models in combination with available information on national freight flows. In the late 1980s, O.R. projects included the development of techniques to design dedicated network tours routing of inter-plant movements. This period also fostered the implementation of statistical tools to address a variety of customer-specific analyses.

The second thread of activity began in the early 1990s when Schneider realized the opportunity to expand from an asset-focused transportation provider to a broader offering of freight management and logistics services that were asset-light. In 1993, a separate entity, Schneider Logistics, was incorporated to meet this need; it now provides a broad range of domestic and international logistics services ranging from transportation management to supply chain management and warehousing.

These new service and product offerings generated additional opportunities and demands for O.R.-based projects. For the expanding third-party logistics (3PL) business, shipment planning

and carrier selection tools were developed. A sophisticated shipment planning system included components for mode selection, consolidation and multi-stop routing. The carrier selection module utilized integer programming to model complex carrier commitment constraints. For the truckload business, numerous regression models were developed to better understand the profitability impact of freight flows and characteristics. In support of the information technology infrastructure, fast approximation algorithms and highly efficient data structures were developed for distance and rating engines. The rating engine technology was subsequently patented.

During this period, a supply chain engineering group was commissioned within Schneider Logistics. This group, which developed many of its own tools for facility location and network modeling, was engaged primarily in business development and in fee-based consulting for logistics and 3PL customers. Through the late 1990s and early 2000s, these two spheres of O.R. activity continued to flourish in two separate groups. Enterprise software-based, decision-support systems continued to be developed and enhanced by the Decision Analytics group which was housed within the Application Development arm of the IT organization, while the Supply Chain Engineering group, responsible for both internal and external O.R. consulting, supply chain modeling and business development support, reported directly into the Schneider Logistics business unit.

In 2003, as collaboration and resource-sharing had steadily increased, Schneider decided to merge the two teams into a single Engineering and Research Department headed by a vice president reporting to the CIO, while maintaining close ties to the Logistics business unit. This integration proved to be a precursor to much closer alignment and product integration that soon followed across the company's customer-facing business units.

All About the Roundtable

INFORMS has two types of members: individual and institutional. The latter (usually a company) joins by joining the INFORMS Roundtable and appointing as its representative the person in overall charge of O.R.

The Roundtable has been very active since its founding in 1982, with three meetings each year and much communication in between. It, its member institutions and its member representatives take a strong interest in how INFORMS serves the needs of practitioners, and have undertaken many initiatives and provided many services toward this end. These involve, for example, public awareness of O.R., both of the annual INFORMS conferences, continuing professional education, one of the prizes and various committees.

In addition, the Roundtable has an advisory responsibility to INFORMS. One bylaw states that it "... shall regularly share with INFORMS leadership its views, its suggested initiatives and its implementation plans on the important problems and opportunities facing operations research and the management sciences as a profession and on the ways in which INFORMS can deal proactively with those problems and opportunities ..." By tradition, it meets with the newly elected INFORMS president-elect each spring to discuss practice-related topics of interest to him or her, and with the entire INFORMS Board each fall to discuss topics of mutual concern.

The Roundtable membership comprises about 50 organizations. Further information is available at http://roundtable.informs.org.

This series of articles aims to share with the INFORMS membership at large some information and insights into how O.R. is carried on in practice today.

Business Development: Design and operational planning for dedicated fleet networks, modeling to support feasibility studies, analysis for new business proposals, international logistic support. Primarily supporting internal business units and key sole-source customer accounts.

Supply Chain Engineering: Development of solutions for route design, scheduling and facility location problems. Primarily serving after-market parts distribution systems for heavy equipment, automotive manufacturers and tier one suppliers.

Team members bring significant prior transportation operations experience, which helps ensure that the department pursues solutions that are relevant, practical and credible.

Today, the Engineering and Research Department is comprised of 44 professionals with varied academic backgrounds and industry experience. The group's academic backgrounds range across not only operations research, but also industrial engineering, mathematics, computer science, finance and business administration, with a combination of bachelor's master's and Ph.D. degrees. A number of team members bring significant prior transportation operations experience, which helps ensure that the department pursues solutions that are relevant, practical and credible. The group is organized into four activity-specific teams, each lead by a director with accountability to deliver business value to a corresponding constituency. With overlapping skill sets, cross-training and resource sharing, these groups are able to both maintain specific focus as outlined below, as well as to flex in size to support changing business needs.

Research: Development of algorithms and optimization models that form the basis for decision support engines embedded in corporate-wide operational planning and execution systems. Development and execution of off-line simulation and optimization models to support strategic and tactical planning and policy development.

Consulting: Statistics and data mining, industrial engineering analysis, business process simulations, general consulting and problem analysis using a wide-range of O.R. techniques. Development of productivity tools to support the work of the E&R group.

A Diverse Spectrum of Opportunities

SCHNEIDER APPLIES O.R. in a comprehensive array of decision-making contexts. The following examples will serve to illustrate the breadth of application areas and the variety of skills and methodologies represented by the organization.

Network Value Engine: Schneider has created a number of proprietary applications to institute revenue management principles in its truckload and intermodal lines of business. Chief among these applications is Network Value Engine (NVE), which estimates the profitability of individual loads. NVE estimates these network-related profit impacts of loads using marginal values produced by solving a large, complex math programming model. While NVE was originally developed to support load acceptance decisions, network value has become central to the mindset of decision-makers in other contexts including load solicitation, asset repositioning, and spot pricing.

Tactical Planning Simulator: TPS is a large-scale modeling environment that is particularly effective for analyzing problems and policies which are sensitive to micro-level details and, therefore, not addressable via more traditional aggregated-flow, min-cost type models. Developed jointly with CASTLE Laboratory at Princeton University, TPS uses approximate dynamic programming in conjunction with mathematical optimization at sub-problem nodes and sophisticated pattern-matching techniques to enforce operational policy adherence. The system has been used to improve business decisions related to the geography of driver hiring, driver work-rule impacts, driver time-at-home policies, new business profitability analysis and other areas.

Driver recruiting: Recruiting and training drivers represent significant costs for the trucking industry. Schneider has developed several data-mining approaches (regression trees, cluster analysis, etc.) to improve its understanding of relationships between applicant characteristics and measures of driver effectiveness, including time-to-hire, productivity, retention and safety.

Forecasting: Utilizing the tool set of a third-party forecasting package, the group has refined and extended statistical techniques to generate impressive improvements in forecast accuracy for monthly load volume (1.7 percent error enterprise-wide over the second half of 2005). The group is now working on new operational (0-7 day) forecasting models to better predict network flow imbalances so such situations can be addressed proactively rather than reactively.

Dedicated fleet analysis: Dedicated networks operate semi-autonomously within the Schneider One-way truckload network. Using both third-party and internally developed optimization software, Engineering and Research sizes and designs these sub-networks to minimize operating costs, maximize synergy with the broader network, and reduce the impact of freight surges and flow imbalance. In 2005, incremental revenue for Schneider from designed networks accounted for more than 6 percent of total dedicated revenue.

Customer service: Over the past five years, Schneider has embarked on a pervasive process redesign journey. Industrial engineers within the Analytics group have played a key role in this work. Using statistical process control methodologies adapted from manufacturing (e.g., Six Sigma and control charting), the group has been instrumental in facilitating, understanding and improving work flow, customer service representative productivity, on-time performance and other areas. The group has developed simulation models to evaluate alternative workflows for newly structured call center operations.

Shipment consolidation: Schneider's internally developed optimization engine for shipment planning, consolidation and routing has been continually upgraded over the last 10 years as software and hardware capabilities have advanced. As originally conceived, the system relied primarily on simulated annealing and a palette of local search heuristics. The current version uses a novel combination of constraint programming and integer programming to provide optimal solutions for most problems and near-optimal solutions for the remaining, largest problems.

Partnerships

A KEY COMPONENT in the success of O.R. at Schneider has been an organizational willingness to invest in applied research, as

well as projects specifically focused on delivering near-term business benefits. In addition to internally staffed activities, the group is actively engaged in joint projects with several leading universities and with domain-specific external consultants. Among current academic relationships are projects to improve inter-modal scheduling and dray optimization (University of Wisconsin-Madison), to explore the use of control-theory techniques to better understand and address network stability and flow balance (Michigan Technological Institute), and the development of a large-scale transportation network simulator, based on approximate dynamic programming, to evaluate the effect of operating policies, resource allocation models and revenue management strategies (Princeton University). Recently completed projects include development of a short-haul schedule and route optimizer utilizing column-generation schemes (Georgia Institute of Technology) and studies of driver behavior and preferences (University of Minnesota-Morris).

Perspectives on Success

SCHNEIDER'S USE OF O.R. began more than 25 years ago. Over the subsequent decades, Schneider's O.R. applications have grown more sophisticated and diverse, taking advantage of technological advances and responding to growth and expansion of Schneider's business portfolio. In addition to providing the organization and its customers with a competitive edge through well-informed decision-making, the use of O.R. has made positive contributions to Schneider's bottom line: Annual earnings have increased by more than $10 million.

Success through O.R. does not come overnight, nor does it occur in a vacuum. Keys to the the long-running success of the O.R. effort at Schneider are:

- Commitment of time, resources and leadership to mentoring and training, both technical and soft skills.
- Commitment of dedicated resources to the development and maintenance of productivity tools.
- Adopting a philosophy of high bandwidth interaction with customers. This takes two forms: enabling non-engineering business associates to take on lower-level engineering tasks and moving engineers into business leadership roles.
- The vigilant search for new opportunities and application areas for O.R. This helps keep the staff fresh and motivated and helps condition the business to realize the broad range of areas where O.R. can deliver value. The complexities of moving and managing freight throughout an international supply chain continue to surface in today's global economy. For global supply chain service providers like Schneider National, O.R. will continue to play a significant and lasting role in managing those complexities, mitigating risks and ultimately delivering the type of service, visibility and reliability customers require. **IORMS**

Ted Gifford *(giffordt@schneider.com) is the vice president of Engineering and Research at Schneider National. Schneider won the 2006 INFORMS Prize for its "effective integration of operations research into organizational decision-making."*