OR/MS at Ford Motor Company

veterans from the Statistical Control Command, an operations management group that coordinated material and troop logistics and in the course invented new ways to approach massive logistics problems. The “Whiz Kids,” as this group came to be known, modernized the Ford Motor Company’s management practices. Since then, O.R. practice in Ford has tracked the ebb and flow of O.R. practice throughout industry and business. Over the years, many organizations within Ford’s different operating units created groups that today we would recognize as O.R., although they were not necessarily named O.R., and these organizations also dropped O.R. when they fulfilled their missions, business needs changed or they failed to deliver on expectations.

The Ford Motor Company does not now have an organization named O.R., although individuals with undergraduate or graduate O.R. degrees (the kind earned in engineering colleges) are scattered throughout the operations. Today, many Ford operations in need of O.R. (for example, supply-chain, outbound logistics, plant-floor production scheduling) use outside O.R. suppliers because operational organizations cannot maintain an O.R. staff to solve problems as they arise. Unfortunately, while outside O.R. providers solve many problems, they sometimes fail for various reasons: the provider didn’t understand the business and local conditions; data did not exist because they were never collected or the information systems could not be accessed; and occasionally the business did not adequately specify the problem.

Individual O.R.-trained internal staff working with the suppliers might help to avoid these failures, but there is a class of fundamental failures that arise when the complexity of the problems in combination with Ford-specific circumstances put the problem beyond the capabilities of off-the-shelf solutions of typical providers. This is especially true today when the complexity of the business combined with rapidly changing technology creates problems not previously encountered. Despite occasional failures, Ford has incorporated many O.R.-based solutions that are running invisibly in the background of Ford’s daily operations.

The highly visible business challenges facing Ford, and generally the entire automobile industry, are well described in the popular business press. Less well described are challenges arising from extremely fast changes in all kinds of technologies, especially those driven by advances in computers and computing. These advances
are happening at rates far faster than the automotive business can
digest or comprehend, and they affect the products, the business
and manufacturing operations, and policy and strategy. From an
O.R. practitioner’s perspective these challenges are opportunities,
made possible by the computational horsepower now available
from laptop to supercomputer, to solve problems of extraordinary
depth and complexity. Equally important as raw computational
horsepower has been the rapid growth through the 1990s in the
availability of cheap data storage, which has driven the astonishing
growth of transactional, observational and experimental data in vol-
umes unimaginable 10 years ago. The availability of all of these
data and computational capability raises the question of what to do with
it? The answers lie in the interface between research and practice.
Therein lie opportunities for O.R. practitioners to contribute in new
ways to business success.

Research and Advanced Engineering

THE FORD MOTOR COMPANY’S organization that works in
the research-practice boundary is its Research and Advanced Engi-
neering, a 2001 merger of its former Research Laboratory with
Advanced Engineering. Ford established a Scientific Research Lab-
oratory in the 1950s for the purpose of understanding the busi-
ness implications of new science and technology. At various times
in its history, the “Lab” engaged in selected, specialized applied
mathematics problems that today’s INFORMS community, look-
ing back, would recognize as classical O.R. In response to the rapid
technological advances in computers and computing, the Research
Lab in the mid-1990s gathered a small group of physicists and
engineers to explore business applications of advanced mathe-
matical modeling, especially the then nascent field of data-mining
and the growth of data-intensive simulation methods (e.g., agent-
based methods and neural networks) applied to complex systems.
This small group was the nucleus for what became in the late
1990s a 25-person department in the “Lab” devoted to business
modeling and O.R. Today, this group, the Business Systems Ana-
lytics Group, is the one organization in Ford that comes closest to
an O.R. activity with a broad enterprise perspective, including sup-
ply chain, plant floor logistics, purchasing, marketing and sales,
wartiness and product development.

In addition, Marketing and Sales has a 20-person O.R.-like group
devoted to specific functional needs. The technical foundations of
this Marketing and Sales Group partly stem from a collaboration
began in the late 1990s between Research and Marketing, and that
collaboration continues today. Finally, Ford Credit, run as a separate
business from the Motor Company, has had for many years an O.R.
activity related to financing of vehicle sales to customers through its
dealer network.

In addition to applications of explicit O.R.-related methods to
business problems, we should point out that many engineering pro-
jects within the Research and Advanced Engineering organization
use optimization, simulation and other mathematical methods
found in the O.R. toolkit. Of particular note is an especially strong
Research and Engineering group in applied control theory; O.R. his-
torians know the strong connection between control theory and
modern optimization problems taught in O.R.

O.R. officially came to Ford with the arrival
of a group of 10 U.S. Army Air Force
veterans from the Statistical Control Command.

The 25 people in the Research and Advanced Engineering’s
Business Systems Analytics group have degrees (about half with
Ph.D.s) in physics, theoretical chemistry, computer science, data-
mining, AI, O.R., mechanical engineering, mathematics and sta-
tistics, electrical engineering and library science. Several also hold
MBA degrees.

About a third of the group’s projects are related to marketing
questions, for example, econometric and economics models for
consumer demand, understanding consumer preferences through
the analysis of transactional data, understanding the chain of events
from dealer-orders to manufacturing scheduling, and determining
vehicle configurations that best match consumer demand and man-
ufacturing constraints.

Other projects include models for commodities pricing, supply-
chain and supplier contracts, factory-floor layout, factory-floor
information systems and manufacturing scheduling, risk and uncertainty management in volume forecasting and product decision-making, analysis of warranty data and data-base search technologies. A guiding principle is to view all of these problems from a systems-perspective (enterprise view) and engage business-partners across organizational boundaries. For example: marketing questions are tightly coupled to manufacturing and supply-chain problems; business risks and uncertainties propagate across the business because of these couplings; IT owns and provides data and ultimately administers computer-based computational “tools” that emerge from the solutions; operational solutions across systems have to be compatible with financial systems; and so forth.

The Group’s Deliverables

A FREQUENTLY ASKED QUESTION IS: What are the deliverables from this work? Often the deliverable is a “tool,” ideally a desktop (laptop) or server-based tool that the business can apply routinely. Usually, these tools are custom-written solutions linked to commercially available programs, such as optimization or statistical packages. These “tools,” however, usually arise from a novel framing of the business problem. For example, certain aspects of daily sales rates have the characteristics of a Poisson process, a feature not readily apparent from sales data. By formulating sales as a random process and carrying out Poisson regression, it was possible to gain insights into the implications of fluctuations in sales rates.

Another example has been the framing of consumer-demand and manufacturing supply, taking into account the spectrum of competitive effects, in order to better understand the properties of dynamic pricing and their effects on distribution channels (retail sales, retail leases, rental car sales). A third example was a factory-floor scheduling problem and its dependence on the management of information flow in the manufacturing scheduling system. A fourth example was a systems-dynamics model for steel prices to understand how China’s infrastructure construction affected steel demand. This model in combination with an econometric time-series analysis of historical steel prices to estimate mean-reversion tendencies provided a statistical forecast of future steel prices.

The Business Systems Analytics Group also investigates evolving new methods. A notable recent example is the exploration of advances from experimental and behavioral economics. About five years ago, the group was working with the Marketing activity responsible for auctioning cars returned to the company at the expiration of retail leases or bought back from rental companies. The Marketing organization knew that under some circumstances the receiving dealer could avoid transportation and auction trans-

The question was, how much to charge the dealer – too much and the dealer would prefer auctions; too little and Ford lost revenue.
understand the business problems as well as they thought. In other cases, the costs of changing business practice would be too high to justify. But, when results eventually were implemented, the improved revenues or avoided costs have been in the tens of millions of dollars or more. Importantly, the successful implementations were often built upon the lessons learned from projects that did not directly result in implementation.

In the internal consulting mode, someone in the business requests help. These requests come about largely by internal networking: someone in the business, often at an executive level, knows someone who knows the Business Systems Analytics Group. In many cases, projects are funded by the business as an internal budget transfer. The hard part of these problems is usually to render them tractable from both O.R. and relevant business perspectives. This is a more or less standard challenge in the O.R. consulting business. The only advantages our internal Group has as a “consultant” compared with an external consultant, are usually better understanding of the business, better knowledge of and access to internal data systems, a closer ownership of the problem and motivation to solve it, and in some cases possibly lower cost to the business.

The core problem for practitioners of O.R. in a large, complex business such as Ford is that O.R. is a service to the business. The practitioner’s main challenge is to gain the confidence and trust of the business; only rarely will someone in the business share the technical enthusiasms of the O.R. practitioner. For practitioners in a business of selling O.R. solutions or “tools” (e.g. SAP or IBM Business Services), their business necessarily supports the O.R. technical personnel with sales support personnel to search out customers. In contrast, for practitioners employed within a business, O.R. services and “tools” are not usually the mainstream interests of the business, even though the internal O.R. practitioners may produce a path to improved profitability.

Consequently, internal technical practitioners must be their own salesmen, and they must invest in understanding the business and building relationships that lead to trust and implementation of their work. In the end, however, the business, not the O.R. practitioner, will be rewarded for the improvements, which is reasonable because the business decision-makers bear the responsibility for profit and loss. In some respects, there are similarities between O.R. practitioners working inside a company and other professional staffs such as legal staff or IT. The traditional business paradigm is to answer the questions: Who are our customers, what will we make, how will we sell it, how will we profit? Internal practitioners need a dual view of these questions – from their company’s perspective and from their own professional perspective.

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