By James T. Williams

Advanced analytics at Land O'Lakes

LAND O'LAKES, INC., A FOOD AND AGRICULTURAL COOPERATIVE with 2010 sales of $11 billion, is composed of three primary business units: dairy foods, animal feed and crop inputs (seed and crop protection products). Since 1921 the company has focused on providing agricultural inputs to its producer-members, as well as providing market access and adding value to their production output.

Land O'Lakes' advanced analytics team has provided consulting services since 1974 to managers across the business units. Over that period, we have had various homes within the evolving organizational structure, from centralized locations such as corporate planning, to decentralized locations such as an individual business unit supply chain. Land O'Lakes has recently organized around an operating company strategy, combining shared services across business units. A key

Land O'Lakes uses advanced analytics to help optimize value added to its producer-members' output.

element in that strategy is the establishment of a common Supply Chain organization. As part of Supply Chain, our team has access and accountability to senior managers across the functional units of planning, sourcing, manufacturing, logistics and quality assurance.

Our team's mission is to provide analytic insight and support to help managers solve difficult business problems. This involves framing the business problem, building quantitative models that provide problem insight, providing practical decision options, recommending courses of action and partnering to deliver sustainable savings. A few of the strategic, tactical and operational contributions are described below.

Locating Strategic Assets

LAND O'LAKES' supply chain network consists of raw material sources, conversion facilities, intermediate and finished product warehouses and customer delivery points. The key operating decisions center on whether we have the right:
- raw materials sourced,
- conversion and storage capabilities across 200 facilities,
- inventories staged, and
- mix of customers served.

We use a mix of linear programming, mixed-integer programming, heuristic and portfolio models to help support these decisions. Where the problem structure is more generic, commercially available network modeling frameworks save us project cycle time. As needed, we also develop custom models to reflect the unique characteristics of a particular business unit. One of our recent models has driven strategic changes in sourcing, conversion, inventory management, distribution and customer mix, representing a 50 percent increase in profitability for a major product line.

Synchronizing the Supply Chain

OUR DAIRY FOODS UNIT is a good example where several analytic models work together to help synchronize operations over a rolling tactical planning horizon. Milk is a complex food with opportunities to extract and blend the various fat, protein and carbohydrate fractions for specific functional uses. Within the industry, it is rare for supply and demand of these ingredients or products to be in balance for long. Disruptions occur due to many factors, including weather, cow-breeding cycles, school starts and stops, capacity adjustments and customer marketing campaigns. These result in one company's long inventory position being potentially available to satisfy another's short position. The key is to have an effective sense-and-respond process to capture the appropriate opportunities within short time windows, and effective internal and external trading networks to cover the open positions.

The analytic models working together are:
- A time-series statistical model that helps forecast underlying commodity trading markets that determine

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both raw material costs and finished product reference prices.

- A pair of linear programming models that help manage product-specific sourcing and inventory strategies. Over the past 17 years, they have helped reduce inventories by up to 30 percent and reduce budget preparation cycle time from weeks to days.

- A linear programming model that helps orchestrate milk utilization. This model evaluates the financial opportunity to buy, sell or convert any milk source into any relevant set of products. It also provides a profiled understanding of where our margin opportunities and bottlenecks occur.

Optimizing the Plant Floor

WITH RAW MATERIALS representing over 90 percent of the company's cost of product, conversion efficiency is a key performance metric. A recent opportunity in one of our largest cheese plants underscores the problem-centric approach to our work. Consistent composition control through a multi-stage manufacturing process involving time, temperature, surface area and culture activity is a key driver of the plant's profitability.

Our challenge was to make the product composition more predictable so we could aim the process closer to the profitable edges of the specification space. Although this had a clear Six-Sigma flavor, early in the discovery phase we identified a more basic barrier to overcome.

The plant had a complete history of each product lot's process parameters, composition results and performance tests, but it was a paper-based method that was fragmented, slow and difficult to correlate relationships over time. So we spent time to design a simple system to capture the key information in a database, with abilities to detect process drift and correlated root causes. We could then apply the Six-Sigma define-measure-analyze-improve-control methodology. Through a series of designed experiments, we helped isolate the key process parameters, tightened up their variation and adjusted the process aim. The sustainable savings dropped straight to the bottom line.

Accelerating Product Development

PROCESS SPEED is often an overlooked performance metric. We recently helped streamline the linkage of our cheese formula development and manufacturing processes. The business problem is to blend dairy ingredients with varying compositions and market values into a consistent finished product with the desired flavor, texture, color and melting characteristics, all at best cost. One part of "best cost" is day-to-day materials; the other is one-time development cost (time).

The good news was that we had been using simple optimization models to design and manufacture best-cost ingredient blends toward capable product performance. The bad news was that the fragmented set of two R&D models used different operating assumptions and ingredient specifications than did the three manufacturing models. This caused multiple rework loops resulting from R&D design proposals being rejected by the plant due to execution difficulties. The rework loops extended the development process, reducing our continuous improvement capacity.

Our lean solution approach dovetailed with the concurrent installation of a common specification system. Working with R&D, operations and information systems, we combined the R&D and manufacturing models into a single common system. Using a practical approach to solve a more complete nonlinear mixed-integer blending and batch-sizing problem, the scientists now develop formulas with a much better chance of plant floor feasibility in the first pass. The hard formula savings are complemented by releasing bottleneck R&D and plant resources to tackle further continuous improvement initiatives.

Lessons Learned

OVER THE YEARS, key operating principles help our team forge good working relationships with our management customer base. A few are noted below:

- "Link to strategy": Our team balances the "three Rs" with our project pipeline: "Relevance, Responsiveness and Real Savings." Relevance means staying close to key customers to provide consistent contact, assistance and linkage to strategy. To avoid a Type III error (solving the wrong problem), we make sure that every project has a direct connection to the long-range business plan.

  Responsiveness means being able to help when windows of opportunity are short and closing, even if

close-enough methods need to suffice given the time available. Both hard and soft savings are monitored versus expectations as part of our cross-functional team environment.

- "Live close to the customer": Spending time next to a customer as they do their job provides an invaluable lens to properly frame the problem and builds trust and mutual understanding in the solution design. Living within earshot provides awareness beyond meeting-only discussions. When possible, being the customer (actually doing the job over an extended period) is even better. It clearly demonstrates that the helpful analyst is willing to walk a mile in the customer's shoes and does wonders for acute problem understanding.

- "Problem first, methods as needed": Customers want, above all else, a better solution that they understand sufficiently. The underlying methods may help frame the problem and deliver the solution but need to put the point of pain in primary focus. Any combination of analytical methods (lean, Six-Sigma, theory of constraints, operations research, statistics or computer science) is fair game. First-cut solutions that get used sooner are often appreciated, while we develop the replacement in the background.

- "Vary analyst exposure": Variety is the spice that keeps curious, innovative analysts on their edge. Key dimensions that we have found useful to provide this variety include business units, functions, customers, project roles, degree of ambiguity or political difficulty and likely solution methods. The goal is to provide opportunities for personal growth and career development.

- "Cultivate internal relationships": Our cross-functional team environment works best when members have productive relationships already in place. Whether with supply chain, finance, sales, marketing, information systems or R&D, we encourage networking early and often, digging the well before we're thirsty.

The Challenge Ahead

ADVANCED ANALYTICS continues to play an important role at Land O'Lakes as we help move the organization ahead. The confluence of a company culture geared for continuous improvement, a growing infrastructure to enable data collection and the availability of ever-stronger modeling tools provides an exciting environment. With no shortage of business problems to tackle, we look forward to the challenge. **❚OR**MS

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