Big data is generating a powerful buzz. For firms that know how to harness it, big data can offer a significant competitive advantage. However, much of the ongoing hype has been focused on gaining insights from these vast amounts of accumulated information while a more intriguing question lingers outside of the spotlight: How can these insights be translated into powerful business decisions?

So far, big data alone has not been developed into anything near its touted value, primarily because there is a disconnect between the vast volume of data and the managers who make and implement business decisions. Analytics can bridge this gap by applying algorithms, generating and presenting recommendations for optimal, practical and achievable business decisions in a user-friendly format.

Operations research – the scientific discipline of using analytical methods to
make better decisions – encapsulates these analytical techniques, applicable at all stages of a company’s operations, to help improve overall profitability given particular business objectives and constraints. In turn, a variety of user-friendly visualization tools and techniques can help management focus on their most important key performance indicators (KPIs).

This article explores some of the most common applications for analytical and visualization techniques and highlights the benefits that can be achieved.

THE POWER OF OPTIMAL DECISIONS

Analytical techniques allow us to understand and stimulate demand, develop an efficient production plan, effectively source and allocate production resources, and lower distribution costs. Across all industries, many companies are excelling at applying these techniques, recognizing them as necessary to maintain a competitive advantage. Analytics can have a sizable impact across all areas of operations (see Figure 1).

SALES AND MARKETING

Demand forecasting. Being customer-oriented and demand-driven are modern business prerequisites. Although demand sensing and predicting future behavior are crucial activities that directly influence sales, required inventory levels and customer service,
Many companies still use the wrong tools, including spreadsheets and black-box enterprise resource planning (ERP) algorithms, which are not necessarily fine-tuned for individual SKUs and may be especially ill-suited for slow-moving items with no sales in some periods. Forecasting is also often ignored at the point-of-sale level, which is harder to do but can be used to improve distribution-center forecasts and cross-department collaboration.

Choosing right-time series models, tightening modeling parameters using mathematical optimization and adjusting processes to become demand-driven can result in substantial operational improvements. More accurate forecasting, supported by collaborative silo-penetrating processes, can reduce working capital up to 20 percent and reduce out-of-stock events by up to 6 percent.

**Marketing optimization.** Demand can be stimulated by driving up sales with brand-recognition campaigns or by promoting individual goods and services. Sometimes, these promotional campaigns are either too broad or poorly timed and very often offer higher discounts than necessary to achieve extra sales volumes. Marketing optimization approaches maximize the effectiveness of these campaigns within marketing budget constraints. Alternatively, they can inform decision-makers about the right budget level to achieve a certain sales volume. These techniques routinely improve the marketing budget by 10 percent while allowing for achieving the business objectives.
Optimal pricing. Once the desired level of demand is attracted, it can be further managed through optimal pricing. Optimal pricing balances both margin and volume so that transaction profitability is maximized amid business constraints such as production and distribution limitations. Determining the optimal pricing level requires a good understanding and quantification of the underlying demand for goods and services and of the profitability of any given transaction. At the portfolio level, optimal pricing, implemented based on multivariate constraint optimization techniques, allows driving some segments for volume and others for margin growth, aligned with the business strategy. Profitability improvements as a result of applying these techniques can reach 2 percent to 5 percent of revenue.

Once demand is understood and the right level to maximize the profitability of sales transactions is attracted, it is time to analyze how demand triggers other activities in the company. In traditional systems, demand only affects decisions at the nearest stock locations and their replenishment through outbound logistics. However, demand signals from the point of sale can also be taken into account on upstream stages of the supply chain to more accurately decide how to allocate stock across the system, which needs to be modeled holistically.

SUPPLY CHAIN

Strategic network. Whether it is after inorganic growth, mergers and acquisitions, moving sourcing to low-cost countries or resourcing transport providers, footprint and flow path restructuring is a crucial activity for supply chain managers. The most common optimization applications are establishing where to get raw materials, what to produce where, how much and where to store it, who to deliver to, and what assets are required across the whole network. However, real life presents interesting modeling and implementation challenges.

Examples of these include convincing stakeholders of the need to holistically optimize the end-to-end supply chain, considerations for production scheduling, demand sensing across all network tiers, non-linear costs for warehousing and transport, non-linear relationships between the quality of raw materials and the quality of finished goods, the integration of less quantifiable and known elements such as competition into models, and the double objectives of costs and CO2 emissions. Typical network optimization projects save 5 percent to 10 percent, but higher benefits – up to 20 percent – are not unprecedented.

Supply chain operations. Supply chains are inherently dynamic because of the uncertainties of customer demand,
lead times and other unforeseen events. Simulation is the best way to model dynamic operations to improve business policies that balance customer service levels, multi-echelon inventories, and the use of transport and production assets while keeping costs under control. Because company operations is an area where the devil is in the details and multiple trade-offs exist, much effort goes into modeling to capture this complexity on the required level of detail. Benefits include overall service-level improvements and 20 percent to 30 percent inventory reductions.

**Holistic supply chain.** When overhauling the supply chain, strategic and lower-detail operations designs are both beneficial because they leave no stone unturned. Operational design also helps to show the customer how a redesigned network will work in real life. Although there are many ways to make the optimization and simulation methods work together, a model with two feedback loops is ideal (see Figure 2). Optimized flow path design is fed into a dynamic simulation model, which is then tightened with a simulation-optimization loop. If an adjustment is needed to the high-level network
design, the outcome from operational testing is passed back into strategic optimization.

Once the structural backbone of the supply chain and product flow is modeled, the next step is to improve operational complexity and distribution.

**OPERATIONS**

*Production scheduling.* In many production processes, setup times are conditional on the sequence in which operations are performed on a single machine. Batch size is therefore a crucial decision because it determines how often changeovers need to be done and determines product availability in the warehouse, which affects dispatch to customers. Scheduling problems become even more complex when the same job can be performed on different machines with varying degrees of efficiency. Using complex combinatorial math optimization with column generation to optimize production schedules, product throughput and asset utilization can be improved by up to 5 percent.

*Site design.* Simulation is again an ideal tool when production, transport or other capabilities need to be designed or redesigned to support operational changes, including increased throughput, alternative job-shop configurations and production scheduling. Flexible and detailed models can be built to simulate many scenarios to determine the most suitable configurations, especially if optimization add-ons are used. For example, if production capacity will increase significantly, a simulation can quickly find the most feasible logistics and warehouse layouts to cope with this expansion.

*Asset management and failure prediction.* Modern operations are characterized by a vast and complex assets base. When an asset fails, the operating routine can be significantly disrupted, which can deal a big blow to revenue. Methods that can predict an asset failure and then plan and schedule the corresponding maintenance can lower the risk of failure and improve the return on assets. Approaches that use predictive analytics can lower maintenance and repair costs by 10 percent.

Because production and operations decisions lead directly to dispatching goods and services to points of sale and end customers, distribution is the next area to consider.

**DISTRIBUTION**

*Transport routing.* The traveling salesman problem is one of the most notorious optimization tasks when a vehicle needs to visit numerous geographically distributed locations. However,
optimization can help plan this task. Several constraints need to be taken into account to reflect operational reality – including terminal handling capacities, demand availabilities and sequence priorities – to represent operations with terminal networks that use less-than-full-truckload shipments. Within a few hours, a huge number of alternatives can be evaluated to identify the best schedule, resulting in asset utilization improvements of 2 percent to 5 percent.

Transport loading. Transport loading is another interesting application of math optimization that belongs to the family of knapsack problems, where different loading setups are possible. This gets even trickier if every load is unique; for example, if the problem needs to be solved on a daily basis because customer orders change or if loading sequence matters because some items can be transported on top of others but some cannot. Typical project benefits are 2 percent to 4 percent of increased vehicle space usage.

Many companies’ operations are executed by external service providers, and this is where efficient procurement becomes essential. Procurement cuts...
across all business functions and, if executed well, can significantly improve the bottom line.

**PROCUREMENT**

**Sourcing.** For many sourcing events, optimization can help match expressive or non-standard offers with the business requirements. Potential suppliers often come up with volume or package discounts, step-change pricing, alternative offers, capacity constraints or other ways to showcase their strengths. However, these complex offers cannot be taken at face value, and optimization is required to assemble the puzzle pieces into a coherent picture that covers business requirements and minimizes purchasing costs.

Another benefit of this approach is that a sensitivity analysis can be used to estimate the costs of business constraints and challenge business stakeholders on the ones that are less crucial to business (see Figure 3). For example, typical sourcing events for transport services result in an 8 percent to 12 percent cost reduction.

**Sourcing with strategic network design.** Sourcing optimization conducted jointly with strategic network design can be especially beneficial. In
this case, network optimization uses true market quotes rather than approximated lane and warehousing costs. In many cases, it uncovers hidden market potential (see Figure 4). The benefits for sourcing transport and warehousing together with simultaneous supply network optimization are often in the range of 10 percent to 15 percent.

**Component choice.** When the production process is flexible, such as if raw materials vary or different formulations can be used to arrive at the same result, optimization can help determine the most cost-efficient way to make products. This is especially useful if costs for raw components are volatile, and different vendors can supply materials of various quality and resulting costs. Optimization projects that explore production flexibility can minimize total costs of goods sold by 1 percent to 3 percent on raw material purchasing.

**WEAVING ANALYTICS INTO THE FABRIC OF BUSINESS**

Developing sophisticated models is impractical if business stakeholders don’t use them. Gaining their buy-in is vital. To capture incremental business benefits on a regular basis, analytical solutions must be institutionalized and incorporated into daily decision-making.

Visualization is one way to help stakeholders focus on their KPIs by presenting information in a user-friendly format. Every analytics project needs a visualization component that reflects insights, complexities and interdependencies so that the advanced analytical algorithms are not perceived as black boxes (see accompanying sidebar story, pages 43-44). This, in turn, increases trust in the results.

Regardless of market conditions, forward-thinking players that use analytics perform better than their competitors. They know that capturing a competitive advantage requires going beyond ERP upgrades. By bridging the gap between decision-makers and the vast volume of data, an analytics-driven business transformation can ensure that optimal decisions are an integral part of every business unit.

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**Alex Romanenko** (alex.romanenko@atkearney.com) leads A.T. Kearney’s Analytics Practice in London, which develops and delivers analytics-based solutions in the United Kingdom and around the world.

**Alex Artamonov** (alex.artamonov@atkearney.com), a manager with A.T. Kearney, leads supply chain transformation projects that use analytics to support strategic and operational decision-making.

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Transforming data into graphics to gain buy-in

The most sophisticated analytical models are meaningless if business stakeholders avoid using them when making strategic decisions. Turning data into a more aesthetic, user-friendly format builds trust in complex analytical results.

An array of visualization tools can transform advanced algorithms into easily understandable graphics. For example, Tableau Software’s (tableausoftware.com) interactive dashboard can present footprint optimization results and compare scenarios to help stakeholders make informed decisions (see Figure 5-1).

**Figure 5-1: Info graphic view of analytics jobs.**

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**Client’s preference 1**

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Client’s Preference 1</th>
<th>Client’s Preference 2</th>
<th>Unconstrained</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual Costs (€) &amp; Savings</strong></td>
<td>259M</td>
<td>215M</td>
<td>228M</td>
<td>186M</td>
</tr>
<tr>
<td><strong>Savings:</strong></td>
<td></td>
<td><strong>15%</strong></td>
<td><strong>10%</strong></td>
<td><strong>24%</strong></td>
</tr>
</tbody>
</table>

**Storage & Distribution to POS**

- **Warehouses:**
  - Berlin
  - Bremen
  - Dresden+Leipzig
  - Essen
  - Frankfurt
  - Hamburg
  - Hanover
  - Nuremberg
  - Poznan
  - Prague
  - Rostock

**Delivery points (by warehouse):**

- **Storage volume (by warehouse):**
  - Dresden-Leipzig: 60M
  - Berlin: 57M
  - Frankfurt: 54M
  - Hanover: 23M
  - Essen: 37M
  - Rostock: 33M
  - Nuremberg: 15M
  - Prague: 15M
  - Hamburg: 26M
  - Bremen: 26M
  - Poznan: 26M
Circos (circos.ca), which takes data from a table and converts it into a circular layout, can show the links between three types of blending products and their components to come up with the most economical component purchases (see Figure 5-3).

Gephi (gephi.org), an open-source graph visualization and manipulation software program, can be used to highlight complexity and interlinks between supply chain tiers to derive a cost-efficient and sustainable setup (see Figure 5-2).

**Figure 5-2**

**Figure 5-3**