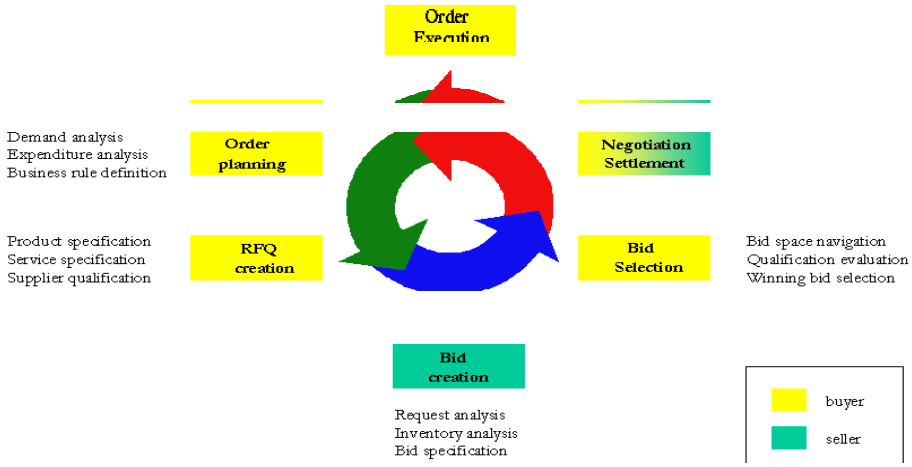
MAP *Intelligent Decision Support for Sourcing*

The Problem

Strategic sourcing is the process of identifying opportunities, evaluating potential sources, negotiating contracts and continually managing supplier relationships to achieve corporate goals. In a recent "e-Sourcing" study by AMR, the companies surveyed reported 10 to 15 percent in direct goods savings costs and 20 to 25 percent in indirect goods and services savings, as well as reductions in sourcing cycle times.



Strategic sourcing requires a holistic process that automates the entire sourcing process, including order planning, RFQ creation, bid evaluation, negotiation, settlement, and order execution. The promise of this process is to reduce total acquisition costs, while improving the total value. The key to realizing cost savings is to aggregate the total procurement spending over the enterprise (through order planning) and leverage the size of this spend to negotiate better pricing (RFQ creation and bid selection). A fundamental shortcoming of sourcing tools today is their inability to allow the creation of complex RFQs that allow for a variety of bid structures that exploit complementarities and economies of scale in cost structures of suppliers.

For example, procurement of direct inputs is usually very large (in total quantity and the dollar value) and requires the use of special price negotiation schemes that incorporate appropriate business practices. Typically, bids (in response to an RFQ) in these settings have the following properties:

- Transaction volume tends to be large and suppliers often provide volume discounts;
- Suppliers often provide all-or-nothing bids on a set of items with a special discounted price; and
- Items may have multiple, non-price attributes need to be traded off against price attributes.

After receiving such bids the buyer needs to identify the set of bids that minimizes total procurement cost subject to business rules such as:

- The number of winning suppliers should be greater than a certain number (to avoid depending too heavily on just a few suppliers), but smaller than a certain number (to avoid too much administrative overhead);
- The maximum amount purchased from each supplier is bounded to a certain limit;
- At least one supplier(s) from a target group (e.g., minority) needs to be chosen; and
- If there are multiple winning bid sets, then one needs to pick the set that arrived first.

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The Solution

Decision support capabilities are essential to facilitate the creation and evaluation of such complex RFQs and bids. Identifying the cost-minimizing bid set subject to these business rules is a hard optimization problem and difficult to do by hand (as is a common practice today). In addition, the buyer is required to specify a scoring function that specifies the tradeoff of the non-price attributes against price. This is difficult to do in a consistent manner without a rational process to elicit the tradeoffs.

IBM Research has developed a suite of decision support tools, called MAP (Multidimensional Analysis Platform) that consists of:

- Tools to elicit a buyer's preferences for multi-attribute bid evaluation based on conjoint analysis and advanced decision analysis techniques;
- A visualization tool to compare multiple bids across different attributes;
- A bid evaluation engine that uses optimization techniques to identify a cost minimizing bid set subject to various business rules; and
- A set of tools for spending analysis including commodity mapping and price estimation.

Additionally, the engine can be coupled with an existing auction platform to conduct complex auctions to implement iterative price negotiations for the aforementioned real-world business practices. Such an implementation is available on a procurement auction platform called ezMarket built on IBM's WebSphere Commerce Suite.

Complex RFQs and Bids

There are a variety of bid types communicated in real-world procurement. The simplest case is a price negotiation is for a single commodity. This is appropriate when the commodity is standardized in terms of its attributes and cannot be differentiated across suppliers except for price. In procurement the RFQs are seldom this straightforward. MAP provides decision support for bid evaluation and supports a large variety of different bid types and constraints, some of which are summarized in the following table, and also described in the following sections:

Bid Types	Description
Simple multi-line bids	A bid includes multiple items, and specifies the unit price for each item.
Multi-attribute bids	A bid includes multiple items, and specifies various relevant attributes for each item, including unit price.
Bundled bids	A bid includes multiple items, specifies the quantity of each item, and provides a total bid price for all the items.
Volume discount bids	A bid includes multiple items, and specifies the price curve of each item.

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Multi-Attribute Bids

Most procurement negotiations include non-price attributes over and above price. A typical RFQ for office chairs is shown in Figure 1.

		Buyer Specifications	Bids from Suppliers		
Office Chairs	Price	Reservation Price ($50/unit)	$54/unit	$36/unit	$45/unit
	Quantity	500	500	350	500
	Delivery	7-10 days	7 days	10 days	8 days
	Reliability	> 70% (Probability On-time)	100%	Unknown	80%
	Quality	Med – High (Ergonomics)	Hi	Med	Med

Figure 1: RFQ for a Multi-Attribute Negotiation

When evaluating and selecting bids, buyers need to take a number of different factors into account. For example, there may be factors related to the *product specification* such as price, material quality and properties, color and size. In addition, there may be factors related to the *service specification* such as delivery time and cost, and warranty. Furthermore, there may be *supplier qualification* factors such as trading history, experience and reputation.

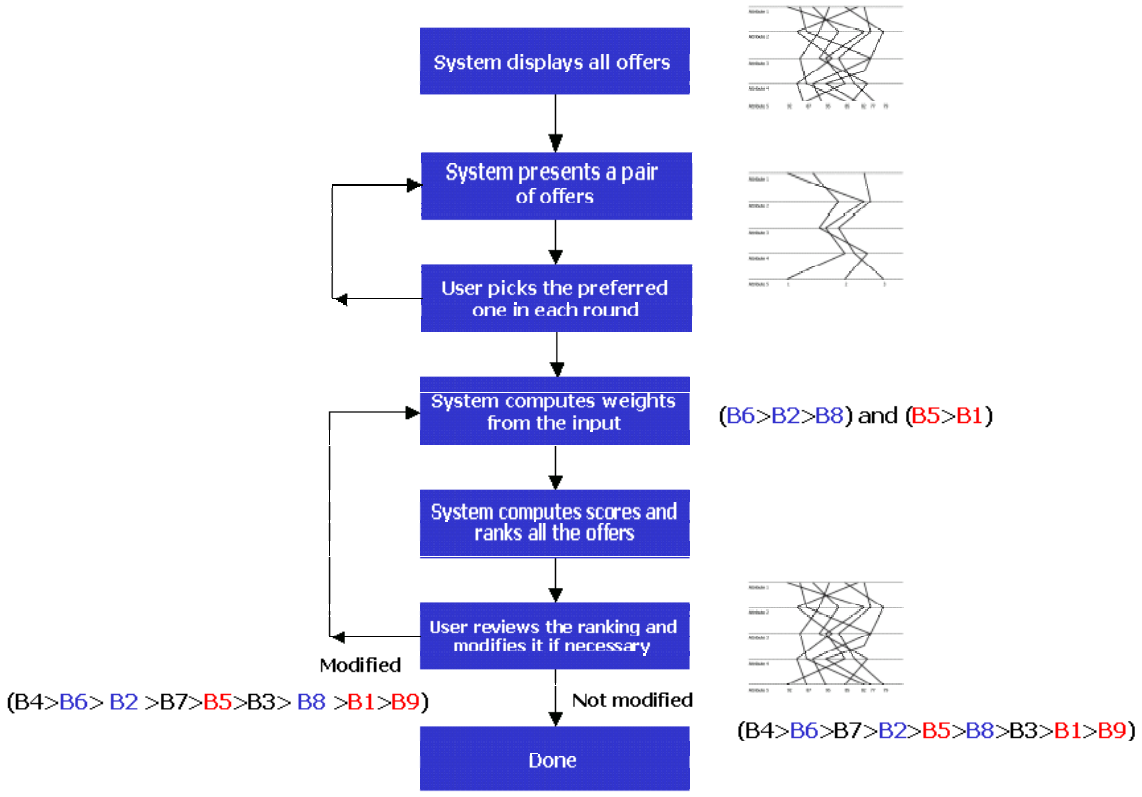

Figure 2: Eliciting Tradeoffs between Non-Price and Price Attributes

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MAP provides unrivaled buyer side decision support by evaluating and scoring weighted preferences of multiple attributes. Besides traditional scoring mechanisms, MAP allows users to interact with the system to determine weights of multiple attributes from ordinal rankings of subsets of submitted bids. The bidders are not only allowed to describe their multi-attribute bids as a set of attribute values, but they can also specify complex pricing rules for product configurations. Also, it provides an advanced interactive visual analysis capability that allows buyers to view, explore, navigate, search, compare and classify submitted bids.

Bundled "All-or-Nothing" Bids

While negotiating prices for procuring, say, weekly demand, it is advantageous to aggregate demand over several locations and plants, because this leads to a larger transaction. An additional advantage is that suppliers can provide a discounted bid on a bundle (e.g., a demand for sugar in New York and in New Jersey) because they might have excess inventory in a local warehouse or spare capacity in the carrier and hence can reduce transportation costs. However, the discounted bid price is valid, only if the entire bundle bid is accepted.

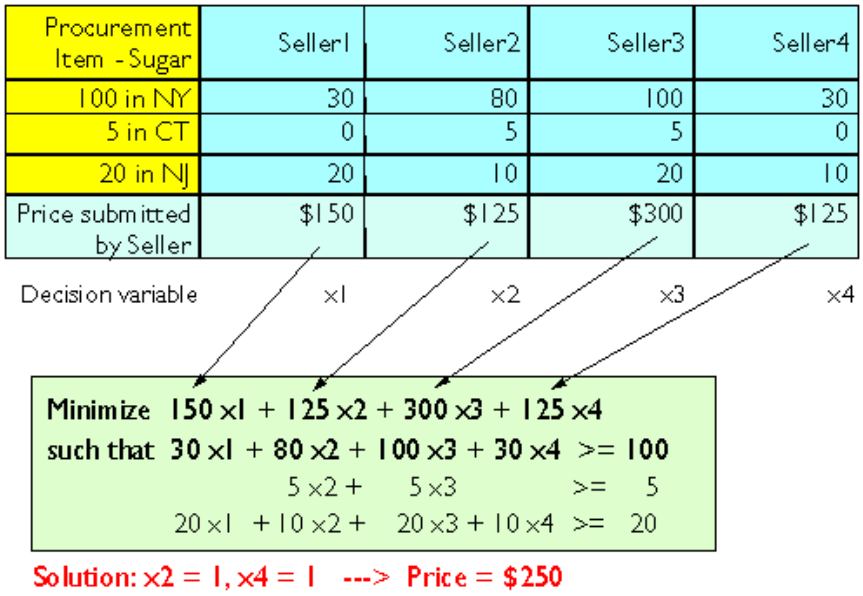

Figure 2: Example of Bundled Bids and Resulting Optimization Problem

In such settings, finding the cost-minimizing bid set ensuring that the demand for each item is satisfied can be a very hard problem as the number of bids begins to get large. (Notice that each supplier is usually allowed more than one bid and as the number of items increases the number of bids can get quite large. Also, notice that the optimal supply may over-satisfy demand.) In the MAP system, IBM Research brings expertise from combinatorial optimization to solve this problem by modeling it as an integer program.

Volume Discount Bids

Volume discount bids allow the seller to specify the price they charge for an item as a function of quantity that is being purchased. For instance, a computer manufacturer may charge $1000 per computer for up to 100 computers, but for more than 100 computers would charge $750 per computer. Bids take the form of *supply curves*, specifying the price that is to be charged per unit of item when the quantity of items being purchased lies within a particular quantity interval.

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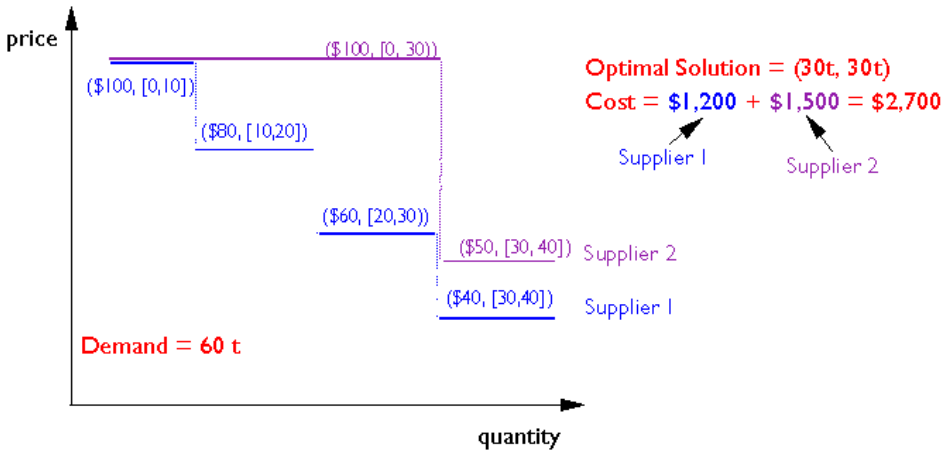

Figure 3: Example of Volume Discount Bids with 2 Suppliers

When there are multiple suppliers providing such volume discount bids, the choice of the winning bids and the amount to be procured from each supplier is a difficult optimization problem that is modeled as an integer program. In addition, the various business rules are captured as side constraints within the mathematical formulation. In the MAP system, once again, we bring expertise in optimization to solve this problem by modeling it as an integer program.

Business Intelligence for Pricing

Providing a buyer with good market intelligence based on past transactions with various suppliers is very important for effective negotiations. Transaction data can be used to provide sound estimates on expected prices for commodity types. MAP provides tools for clustering suppliers into groups based on past transaction prices, and calculating statistical moments such as means and variances, and recommending optimal reserve prices. Such information can be used for two purposes:

- Setting reservation prices for auctions, and
- Setting expectations about fair value for a commodity in negotiations.

For repeated auctions, setting reservation prices optimally can lead to large expected savings over longer periods.

In addition, it allows analyzing the impact of qualitative attributes on price in existing transaction data. For both, reverse auctions and RFQ's it is also important to rank and score suppliers on various dimensions such as reliability, quality and price. Decision analysis and supplier scorecards are excellent tools that are supported within MAP.

Advanced Auctions for Direct Procurement

RFQs are often used in a single round process that is similar to a one shot sealed bid auction where the winners are selected (based on the recommendations of the bid evaluation engine) once all the bids are in. However, in a price negotiation context, it is often desirable to have a multi-round process where after each round the suppliers are allowed to reformulate their bids based on information about the winning bids (more like based on feedback from the auctioneer). Such a multi-round process is illustrated in Figure 4. The bid evaluation engine provides the decision support for all the three functions required for multi-round negotiations and iterative auctions. Winner determination identifies the winning bids from a given set of bids to minimize the total procurement cost, the pricing module prescribes the payment to be made by each winner (this could be in general different form bid price to promote efficiency in the market), and signaling provides a "market

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clearing" price for bid reformulation. This iterative process continues until there are no new bids or closing time.

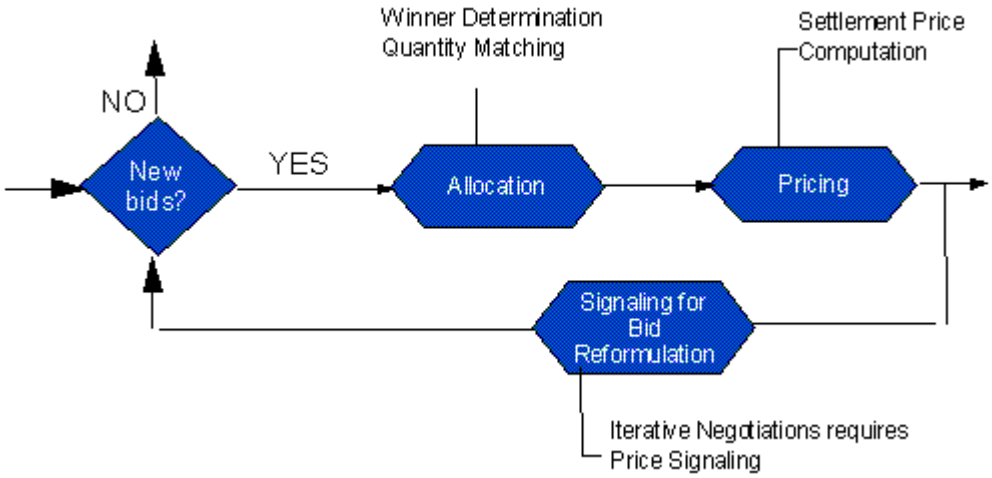

Figure 4: Process Flow for Iterative Auctions

Deployment Model

The Multidimensional Analysis Platform is a set of software modules for providing intelligent decision support for e-Sourcing. MAP features several Java packages related to bid evaluation, preference elicitation, and the analysis of transaction data. The core allocation package provides an object framework with various kinds of bid evaluation algorithms.

MAP has been integrated into the ezMarket procurement platform of Digital Union, Ltd. EzMarket is based on WebSphere Commerce, IBM's e-Commerce flagship product. WebSphere Commerce is built on J2EE architecture delivering unparalleled scalability, and performance. WebSphere Commerce is available on all major platforms and runs many of the world's largest, busiest e-Commerce Web sites including IBM's ShopIBM Web site. The IBM/ezMarket offering is currently being integrated with WWRE, the premier Internet-based business-to-business (B2B) exchange in the retail e-marketplace.

Key Features and Functions

Decision Support for Bid Evaluation

- Multi-attribute auctions
- Combinatorial auctions
- Multi-unit auctions
- Volume discount auctions
- Evaluation of BOMs (Bill-Of-Materials)
- Analysis of the impact of qualitative attributes on price in RFQs

Decision Support for RFQ Creation

- Recommendation of optimal reserve prices for auctions
- Clustering of suppliers into groups based on transaction prices
- Preference elicitation using conjoint analysis
- Selection of suppliers based on multiple attributes

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