# Auctions within e-Sourcing Events

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**Abstract**

This paper presents a survey of current industry practices in designing and running auctions as part of e-Sourcing events. We report our findings from numerous interviews with auction makers in leading e-Sourcing application vendors. The differences between auction theory and auction practice pose a number of interesting and important research questions for the Operations Management community; we conclude with a discussion of lessons learned and open research questions.

## 1 Introduction

Procurement has been one of the last functional departments within a company to take advantage of the Internet's capabilities to improve processes. The need to standardize the procurement process, reduce transaction costs and overcome fragmented processes and information has forced more companies to examine their procurement strategies and consider moving their sourcing processes online. The most celebrated and publicized use of the Internet for procurement purposes has been the use of *online auctions*.

During the early 1990's, online auctions were viewed as a panacea for sourcing problems. Buyers believed that if they simply invited enough suppliers and had them competitively bid in an online auction, their costs would decrease. In the beginning, almost all the online auctions were conducted as open descending price-only events. This price focus had two effects: (1) the price-only focus alienated and angered suppliers, particularly in those industries where suppliers varied considerably along non-price dimensions such as quality, reliability, terms of delivery, etc., and (2) while the price determined by the auction implied a significant cost savings (in the order of 10%-40%) for the buyer, but in actuality the buyer sometimes experienced an increase in *realized* costs of doing business with the winning supplier. Both buyers and auction software providers quickly saw that a price-only focus limited the potential for growth in the use and applications of auctions to commodity-like settings. Fortunately for the early B2B auction companies such as FreeMarkets, the popular press

reported the cost savings *implied* by the reduced auction price. The fact that online auctions promised sizable cost savings motivated buyers across industries to take a closer look at their sourcing process and ask if online auctions, in some shape or form, could be used within their sourcing process.

Today's landscape of online auctions has evolved to include: (1) a new breed of auction software, (2) a calmed enthusiasm and wiser (more realistic) approach towards the design and use of auctions, (3) the absorption of B2B auction companies into larger e-Sourcing solution vendors (for example, Ariba acquired FreeMarkets in 2004) and (4) the enterprising adoption of auctions for the procurement of services, such as marketing, insurance, legal, information technology, as well as products and goods that possess a strong qualitative dimension, such as food additives and promotional items.

Procurement software vendors such as Ariba, Verticalnet, and Emptoris have developed software tools to aid buyers in various steps of their procurement process. These tools include: Spend Management tools, that identify critical spend categories whose sourcing decisions should be revisited; e-Sourcing tools, that attempt to semi-automate the sourcing process by providing a platform to facilitate buyer-supplier negotiations - online auctions fall within the e-Sourcing toolbox; and Contract management tools, that are used once a set of suppliers has been identified and a contract put in place and assists the buyer in the enforcement of the contracts.

This paper presents a survey of industry practices in designing and running online auctions as part of e-Sourcing events. We report our findings from numerous interviews with auction makers in Ariba, Emptoris, and Verticalnet, as well as former employees of FreeMarkets (ten interviews in total were conducted). We also supplement the practitioners' gained wisdom with relevant academic and industry papers and build upon the survey by Elmaghraby (2004).

In section 2 we provide the reader with an overview of a generic e-sourcing process, as described by our interviewees. It is important to point out that Emptoris, Ariba and Verticalnet are among the leaders in the field of e-Sourcing software. As such, the steps outlined in section 2 characterize the forefront of this software genre (with some exceptions). In sections 3 - 8, we outline and discuss in greater detail the main components in designing and executing a successful sourcing event auction. We conclude with a discussion of lessons learned and open research questions in section 9.

## 2 Designing a Successful Online Auction

*A properly designed and executed online auction constitutes more than collecting a few suppliers, having them bid in an open auction and picking the lowest price. Vogt (2005)*

The initial distrust of online auctions came about due to the early heavy emphasis placed on price competition, at the sacrifice of other supplier attributes. Furthermore, the buyer did not always award business to the lowest-price supplier. In the majority of auction events, suppliers felt that their bidding was in vain, as the buyer would award her business to the incumbent supplier although he was not the lowest bidder.

Buyers have recognized the flaw in a price-only sourcing approach and have adapted their e-Sourcing process to recognize the diversity of suppliers, their relative strengths, and the total cost of ownership associated with any award scenario. Today, the term *online auction* still refers to a price-only bidding event; however, online auctions now constitute only a single phase of the sourcing process. A correctly executed process includes pre-auction exchange of information in order to qualify suppliers, communicate product specifications, and understand supplier capabilities - as well as post-auction negotiations on non-price attributes and the buyer's final award decision. When done properly, online auctions may offer companies increased visibility to market prices, and hence a possibly more competitive price for the defined goods and services being sourced. However, practitioners consistently emphasized that an online auction should be viewed as one tool to enable the price discovery process during negotiations, and should *not* be considered a substitute for the negotiation process itself. That is, in contrast to the meaning of an auction in the literature, in practice an auction serves as a *price-discovery* mechanism, while the entire e-sourcing process constitutes the *allocation* mechanism.

Figures (1) and (2) present the main steps commonly used in an e-sourcing event. In a Request for Information (RFI), the buyer presents suppliers with a list of 10-20 questions that can be used to filter and identify qualified suppliers. Typical questions that arise include a suppliers' location, size of the business, the product lines supported, electronic data information capabilities, available capacity, and other value-adding activities available to the buyer. Based on the RFIs received, the complexity of the product/services to be sourced and willingness of suppliers to participate in an auction, the buyer invites qualified suppliers to participate in the online event. Accompanying this invitation, are the product(s) specifications, a general description of the evaluation criteria the buyer will use to select the winner(s) and an announcement if the auction will be online (open) or

a sealed-bid Request for Proposal (RFP).

If the buyer finds the suppliers willing to participate in an online auction, she may conduct a second round of RFIs, this time eliciting information to help prepare bundles for the auction (described further in section 5.1). After this second round of RFI, the buyer selects the final bundles that will be auctioned. The nature of these bundles can vary: In the simplest setting, the buyer has identified a set of mutually exclusive bundles where each supplier can win at most one bundle. On the other side of the spectrum, suppliers may be asked to submit bids for possibly overlapping bundles and may be awarded more than one (but not all) bundle.

Online auctions generally have an open descending price-only format; they begin at a pre-specified time and typically conclude in under an hour. The duration of the auction depends on the number of lots being auctioned, with each lot usually allotted 10-15 minutes before it closes. During the auction, suppliers have the opportunity to successively lower their asking price in response to market feedback.

If the buyer finds the suppliers unwilling to participate in an online auction, or the complexity of the products and diversity of suppliers is too large to effectively create competitive bundles, the buyer uses an RFP. In an RFP, the suppliers submit a single bid at a specified time/date, where the bid indicates both a set of bundle of goods/services the supplier is willing to supply as well as a price for each bundle - that is, the suppliers propose potential award scenarios.

As is clear from Figures (1) and (2), the breadth of communication between suppliers and the buyer during the sourcing process has expanded to recognize and accommodate suppliers' diversity. Despite the considerable progress in the information flowing from suppliers *to* the buyer, there has been less progress on the information going *from* the buyer to suppliers: The exact manner in which the buyer makes her final selection still remains unclear. With either an online auction or a RFP, the buyer may still leave some terms of trade unspecified. The buyer then uses optimization-based tools to identify potential final award scenarios, and may do a final round of negotiations on non-price factors with the lowest $m$ bidders before deciding upon the final awards. This stage allows the buyer to assess the total cost of ownership (TCO) for different award scenarios by incorporating all elements of cost related to a supplier's offer. This includes not just pricing but additional out-of-pocket costs related to shipping, taxes, tariffs, financing, warranty and maintenance, and includes for costs and opportunity costs related to delivery, availability, and harder-to-measure quality and performance (Emptoris (2005)). While suppliers may know some (or all) of the attributes that will be weighed in the final award selection, they do not know how the buyer makes trade-offs across

the multiple attribute dimensions.

Another, more formal way to incorporate non-price attributes into the negotiation process that has been studied in the literature but is seldomly used in practice is a *multi-attribute* auction. In an online multi-attribute auction, suppliers compete on price as well as other attributes, such as lead time, warranties, inventory stocking policies, non-defective parts-per-million, and discounts over accompanying basket of goods or discounts of future years, to name a few. For example, in a recent auction for the procurement of laptop computers and related services run by The Sourcing Authority, the buyer inserted line items that asked the computer vendors if they would offer (1) 4 hour repair service in certain locations, (2) price discounts for year 2 and 3 of the contract, respectively, and (3) the maximum number of days after invoice that payment is due. The price for the specified quantity of laptops was bid in an open descending auction format; the ability to offer 4 hour repair service was the bid as a binary variable (1=Yes, 0=No), while price discounts and days until payment were bid in an open ascending format. The buyer then took all of these attributes into account during her final award scenario (accordingly to an unspecified award rule).

It is expected that multi-attribute auctions of this sort will increase overall value in the supply chain and allow both suppliers and the buyer to mutually benefit by reducing the lead time between initial RFQ and final selection of the winner. Recent experimental work on multi-attribute auctions has demonstrated its potential for increasing the buyer's utility without posing too complex a bidding problem for suppliers, e.g. Koppius and van Heck (2003) and Chen-Ritzo et al. (2005). While Jap (2002), Teich et al. (2004) and Bichler and Kalagnanam (2005) note that there are a growing number of companies who are currently developing multi-attribute auctions, the vendors whom we interviewed were not currently offering such capabilities, primarily as a result of their clients not requesting them to support such services. Our understanding from these practitioners is that while the technology exists to support multi-attribute auctions, the infrequent use of these tools may be explained by the reluctance on both sides of the market to relinquish more control to the auction event itself, whereby more of the relationships' terms are identified within the auction (and its implied short window) rather than outside during a more leisurely and exploratory information exchange. As a result, we do not cover the use of multi-attribute auctions in further detail here and referred interested readers to Teich et al. (2004) and Bichler and Kalagnanam (2005).

We leave the topic of multi-attribute auctions with one interesting observation: Some companies that position themselves as multi-attribute or multi-parameter auction vendors, such as NegoMetrix of the Netherlands, do not actually have suppliers bid on both price and non-price attributes online.

Rather, the procurement is done in a multi-stage manner, similar to the one outlined in this paper. Initially, invited suppliers respond to a RFI and indicate their capabilities along possibly multiple non-price dimensions. The buyer then articulates to the suppliers her weights for price and non-price attributes, and assigns to each supplier a bid transformation factor. Finally the suppliers participate in a price-only auction, whereby their bids are translated by their individual transformation factor. Hence, while not conducting an online multi-attribute auction, these companies are differentiating themselves from the ones interviewed here by successfully persuading buyers to clearly articulate a scoring rule and selecting the winning supplier(s) according to the pre-specified transformation factors in the majority of the auction events.

# 3 Qualifying Suppliers

*The advice that most often comes about when asking experts how to hold successful e-sourcing events: make sure that the bidders invited are qualified and ready for the event. As important as this advice is in the offline sourcing world, it's even more important in the much-compressed online bidding process. Hannon (2005)*

When asked what is the most frequent cause of failure in an auction, practitioners consistently cited skipping the qualification stage. The buyer puts qualified suppliers in a very difficult situation when she asks them to compete against potentially unqualified suppliers. Qualified suppliers do not know if the current winning bid (or lower ranked bids) come from competitors who are capable of delivering the serives/goods or from unqualified suppliers. This complicates the bid submission process and can be compared to the existence of 'false' bids used purely to excite competition. The end effect for qualified suppliers is an increase in the number of uncertain factors they must take into account when determining their optimal bid, and can potentially lead more cautious bidding behavior. Furthermore, the buyer's reputation suffers and suppliers may choose not to invest in order to submit a serious bid in future auction events.

In their role as auction consultants, e-Sourcing vendors consistently advise their clients to screen suppliers and sample their products *before* the online auction event. In this, and many other ways, software application vendors and third-party service providers have played a central role in creating effective auction events and delivering results. With few exceptions, in the early years of e-sourcing adoption all companies employed these third-party service providers. Over time there has been a clear pattern of shift towards self-service. One of the fears raised from this shift 'in-house' is that

buyers will skip the critical qualification stage, in the hopes of reaching the auction bidding stage more quickly, without giving adequate thought to the negative consequences of doing so.

## 4 Product Specification and Evaluation Criteria

The importance of the product specification stage is highlighted if the buyer decides to run an online auction. Online auctions allow suppliers to bid in real-time and respond to their competitors; however, they are still only bidding on price. The other attributes that are of interest to the buyer must be either pre-specified before the auction, and hence are 'locked-in' during the bidding phase, or negotiated after the auction. If the buyer chooses to postpone specifying the product attributes until after the auction, this lack of commitment causes suppliers to not have a clear understanding of what goods/services they will be supplying. As a result, they may either bid overly cautiously-uncertainty in terms of trade will result in a more complex and often less competitive bidding behavior, or bid too aggressively, effectively lowering the quality they are willing to supply.

Beall et al. (2003) have found evidence that the process of preparing for an online auction (whereby the buyer clearly defines the goods/services specifications and identifies a sufficient number of qualified suppliers who are willing to participate in the auction) has actually helped build and sustain long-term relationships between buyers and suppliers. The perceived fairness and clarity of the decision process - as well as the reduced 'element of surprise' when the contract has been awarded and the buyer and supplier embark fulfilling their terms of the contract - has helped define sustainable relationships.

Along with a clear statement of the products' specifications, practitioners also note that the process of putting an auction event online and specifying the general rules by which the final supplier(s) will be selected can more than offset the loss of flexibility and richness of communication offered by sequential bilateral negotiations. Practitioners concur that buyers almost never report to suppliers an exact scoring function. Rather, they tell suppliers that they will be judged along a certain number of dimensions, but leave the exact trade-offs between dimensions unclear. The reason for this is two-fold: (1) buyers themselves do not always have a clear understanding of their weights and do not want to be locked-in *a priori* to a scoring rule and (2) practitioners observed that suppliers are satisfied when buyers outline the general criteria, and do not request more detailed information.

What is not clear is if suppliers would know how to incorporate more detailed scoring rules

into their bidding strategies. We asked each of the practitioners if they know of suppliers using game-theoretic based tools, that incorporate the strategic behavior of competitors, to help them formulate their bids; the resounding answer was no - a concern voiced by Rothkopf and Harstad (1994) when discussing the relevance of game-theoretic auction papers on industry practices. There are some decision support tools companies, such as Manugistics NetWORKS Target Pricing$^{TM}$ software (Elmaghraby (2004) and Philips (2005)), that aid suppliers to formulate a bid for an auction. These tools typically take into consideration the specific buyer, the bundle of goods to be auctioned, the suppliers history with the buyer, and the supplier's winning record when calculating an appropriate bid (Agarwal and Ferguson (2006) provide a nice overview of customized pricing bid response models, as well as test two common bid response models against industry data.). However, practitioners frequently pointed out that the use of these tools is more the exception than the rule. Quite often, suppliers sometimes do not even know their own costs for the products being auctioned. Therefore, it is not clear whether the buyer will receive more competitive bids if she commits to and announces an exact scoring rules, or if the exact scoring rule will merely serve to confuse suppliers and further complicate the bidding process.

# 5 Online Auction Formats

Once a buyer has decided to use an online auction, she must decide on the auction format. When asked which auction design parameters had the greatest impact on the performance of an online auction, the practitioners repeatedly cited: (1) how to *bundle* the buyer's demand and construct bidding lots, (2) how to *sequence* the lots' auctions, (3) what type of feedback to provide to bidders during the auction, referred to as *feedback to the marketplace*, and (4) what type of bid format to use.

## 5.1 Bundling

If the buyer believes that the market can support an online auction, then she must identify the bundles of goods/services or lots that she will put out to auction. Given the multi-unit/product nature of most B2B transactions, a buyer must decide which units/products to bundle together and have suppliers bid on as an entire package, or lot. In the traditional bilateral negotiation process, bundling was done in an informal manner as the buyer and suppliers exchange information on the buyer's needs and suppliers' capabilities. In an online auction, the determination of the bundles

must happen *before* the auction, as opposed to alongside the negotiation of prices.

The reasons most commonly cited for bundling objects together included: (1) the items experience synergies in production, (2) packaging allows a desirable job to be bundled with an undesirable one, (3) the buyer wants a group of items to be awarded the to same supplier, and (4) the individual items represent a small spend category. From their interviews with 30 U.S. companies, Schoenherr and Mabert (2006) found *increased bargaining power, more competitive bidding and increased simplicity and decreased administrative complexity* be the top four reasons cited by buyers for bundling.

It is important to note that once the buyer has defined the bundles of goods that will be auctioned, she has essentially created a zero-sum game. From that point onwards, the auction and subsequent negotiation determine the division of this gain amongst the players. Frightened with the prospect of selecting the 'incorrect' bundles, buyers typically precede an auction with a second round of Request For Information (RFI) from suppliers. In these RFIs, the buyer will indicate the specific goods/services she wishes to procure. She then invites suppliers to suggest possible bundles of goods/services that would be attractive to them and best reflect their capabilities. These bundles could include different grouping of goods, or could consist of varying terms for delivery, quantity discounts, etc. Based on the information collected from the suppliers, and the number of suppliers who express an interest and expertise in a particular grouping of products, the buyer then selects the final bundles that go to auction. The importance of this second round of RFIs is particularly high if the suppliers differ in their production capabilities and/or cost structures and if the buyer does not have adequate knowledge of these differences. In this case, a buyer who designs the bundles without supplier input may be unnecessarily crippling the competition in the auction and limiting the potential gains from trade. Once the bundles are defined, they are generally opened for auction at the same time and have staggered closing times.

In the infancy of B2B auctions, many buyers succumbed to the temptation of having suppliers bid on every possible combination of goods/services. Buyers viewed auctions as an opportunity to not only identify a good supplier, but also as an opportunity to gain as much information about their suppliers' costs as possible. Not surprisingly, many of these auctions backfired on the buyers; their 'fishing expedition' for prices had created an auction that was too burdensome and complex for suppliers. Suppliers did not have a clear understanding as to which were the viable award scenarios the buyer would seriously consider. For example, Millet et al. (2004) found that auctions events with greater than eight bundles experienced decreased bid activity and competition. Furthermore, the

suppliers were understandably overwhelmed when presented with a multitude of possible bundles and reflected their confusion in cautious (unaggressive) bids. From these experiences, practitioners have learned to strongly dissuade their clients from putting too many bundles out for auction in an event. They quickly point out that a buyer would rarely walk into a face-to-face negotiation and ask a potential supplier to comment on 50+ award scenarios, but rather would present a supplier with three to four award scenarios that reflect the buyer's priorities in sourcing. Schoenherr and Mabert (2006) echo this advice by saying '...great care must be taken to design bundles that do not strain suppliers' capabilities and/or capacities, requiring thorough supplier identification and analysis.'

That said, the RFI process is not always sufficient to determine a set of bundles that are mutually exclusive and will induce the most competitive bidding behavior. Therefore, it is a common practice to create relatively *few* bundles that have *some* overlap, and as a result, make the final award scenario uncertain. For example, a company may bundle transportation services at a national, regional and local level, knowing that these different sized bundles contain the same lanes and hence at most one can be awarded. The overlap in the bundles' contents combined with the fact that the final award decisions are made after *all* of the bundles have been auctioned implies that suppliers often will not know whether or not it has won previous bundles when submitting a bid. In these settings, practitioners believe that the buyer's benefits of flexibility to select the 'best' bundles after bids are submitted outweighs the increased bid complexity suppliers face due to uncertainty in final award scenarios.

An alternative to the buyer predefining the bundles is a combinatorial auction, whereby suppliers can simultaneously submit prices as well as propose bundles that best reflect their competitive advantage. A combinatorial auction is an attractive mechanisms when there exist strong complementarities over several goods and the source of those complementarities *varies* across suppliers; thereby complicating the bundling stage for the buyer. Combinatorial auctions have enjoyed great success in the procurement of transportation services (Cramton et al. 2006). It is interesting to note that online combinatorial auctions, like multi-attribute auctions, offer a theoretically attractive way to accommodate supplier diversity and elicit competitive prices in an auction framework. Despite this, their application has been limited to a handful of industry sectors, such as transportation. Practitioners frequently steer their customers away from combinatorial auctions unless the complexity of the market necessitates it; they have found that suppliers are often confused and learn slowly about how to bid in a combinatorial auction, which translates into a diminished

competitive environment in the auction. Instead, they encourage the buyer to keep the auction as simple as possible so as to promote supplier involvement and competitive bidding. Readers interested in learning more about combinatorial auctions, their use and design challenges are referred to the book (Combinatorial Auctions) edited by Cramton et al. (2006).

A key recommendation repeated in all of our interviews, as well as in the empirical papers (Carter et al. (2004), Schoenherr and Mabert (2006) and Millet et al. (2004)) is that the value of a bundle (the buyer's dollar spend) must be large enough to attract a sufficient number of suppliers to participate seriously in the auction. From their survey, Schoenherr and Mabert (2006) found that the bundle spend ranged anywhere from $5,000 to $70,000,000, with a mean of about $6,300,000 (they interviewed 30 companies, both private and public. The companies came from diverse market settings, and ranged in sales from $5.2 million to $213 billion with an average of $25 billion for the set of firms (based on 2002 sales)). Carter et al. (2004) report an average bundle spend of $2,200,000 from the companies in their survey (their survey included 31 companies across a broad spectrum of industries - they were generally large firms (Fortune 500) that regularly participate with CAPS Research and were identified as having conducted more than 20 online auctions in 2001).

### 5.2 Sequencing of the lots

Once the bundle selection is completed, the buyer must decide in which order to stagger the bundles' closing times. We found the following guidelines to be the most common when structuring an auction event: (1) Escalate bundle value throughout the order to increase bidding intensity and maximize savings and (2) Order bundles so as to maximize the number of suppliers bidding on consecutive groups.

Practitioners agree that the buyer should try to build up bidding competition as the auction progresses by putting higher dollar-spend bundles towards the end of the auction. Both recommendations speak to cultivating and maintaining a level of bidder excitement. Although it seems to fall outside the bounds of what is traditionally modeled in the auction literature, the practitioners have often noticed that suppliers experience a 'warm-up' period in their bidding behavior within an auction, and that their aggressiveness is directly impacted by whether or not they participated in the previous auction in the event. Furthermore, both anecdotal evidence, as well as an empirical study by Carter et al. (2004) indicate that suppliers bid more aggressively for higher spend volume lots. In the event that a buyer may have multiple high spend lots, practitioners advise clients to

place several near the event beginning to spark supplier competition among the low value groups, and conclude by placing the largest value groups with the greatest expected savings last in the order.

Two recent academic papers speak to the sequencing design question and their conclusions contradict the practitioners'. Chakraborty et al. (2006) question whether a seller who is auctioning off two goods should adhere to the common wisdom of 'best foot forward' or 'save the best for last' - that is, they address the issue of whether a buyer, who is believed to be following a particular sequencing strategy, should auction the best (highest valuation) good first or last.

The authors consider a setting where a seller wishes to auction two goods; each good can either be a High quality item or a Low quality item. The seller observes a private signal as to the goods' quality, and then decides on which order to auction them. There are $n > 1$ bidders in the market, each of whom also observes a private signal as to the quality of the good. The value of good $k$ to buyer $i$ is assumed to be non-decreasing in the (private) signals of the bidders and strictly increasing in the seller's signal. The seller's and bidders' signals are assumed to be independently and identically distributed across both goods. It is important to note that the authors assume that two *different* groups of buyers participate in each auction.

The authors find that, although the values of the two goods are independent distributed, if information is released about the value of the first period good after the first auction, then endogenous correlation occurs. In other words, the first period information is a public signal that, on average, increases the second period price in accordance with the linkage principle. This implies that it is dynamically consistent for the seller to auction the higher valuation item first. It is important to note that restricting the valuation signals to a set of two elements (high and low) permits tractable and intuitive sequencing strategies. If the valuation signals were drawn from a larger set, then the optimal sequencing strategy could include strategies of the form 'sell the better good first only if the gap between signals is *sufficiently* large', where *sufficiently* is defined by increasingly complicated relationships. Furthermore, the authors' results rests squarely on information being (credibly) released after the sale of the first good. While such an assumption is credible if the times between successive auctions is long, it is not a plausible assumption within a single auction *event*, where the final award is not decided by the outcome of the auction and/or the bundles may overlap.

Elmaghraby (2003) considers the sequential auctioning of two heterogenous lots. For the purposes of this discussion, we can view each lot as being comprised of the same products - the lots

merely differ in size, whereby lot $A$ has $a$ units of the good and lot $B$ has b units, $a < b$. The buyer faces a set of suppliers who can supply either $A$ or $B$ but not both, and experience differing degrees of economies of scale in production. The suppliers are characterized by a single type, and their types are independently and identically distributed. Elmaghraby examines the equilibrium and performance of sequential $2^{nd}$ price auctions, when the ordering of the lots is first $A \rightarrow B$, and then $B \rightarrow A$.

A procurement auction is said to be efficient if it awards the buyers business to the set of suppliers with the lowest (total) production costs. The design of an efficient auction has theoretical appeal (and practical appeal in certain environments); however, buyers are typically more concerned with the impact of an auction design on their procurement costs. While a definitive link between efficiency and revenue has yet to be established in multi-unit auction settings, it is generally accepted that the seller faces an inherent tradeoff between payments and efficiency. Elmaghraby demonstrates that this does not appear to be the case when selecting the ordering of auctions for certain cost structures: She finds that it is optimal from an efficiency as well as a minimizing cost viewpoint to auction the larger lot first, i.e., lot B, thereby contradicting the wisdom from practice.

### 5.3 Rank vs. Full Disclosure Feedback

The majority of online auctions are conducted under either rank or full disclosure feedback rules. Interestingly, we learned that the use of rank feedback is increasing and now overshadows the use of full disclosure feedback.

The early preference for open/iterative auctions stemmed from the belief that the psychology of an open auction induces suppliers to bid more aggressively. As auctions began to expand outside of commodity products into services and customized products, the wisdom of this belief came into question. Practitioners cite three main reasons why rank feedback is increasingly being used: (1) the final award decision will depend only in part on price, (2) when there is a cost-diverse supplier base, and (3) suppliers are sensitive to information being disclosed and are choosing to not participate in auctions that do not adequately respect this concern.

*Wong (program manager, online bidding for Sun) says, unlike many of companies, Sun does not do reverse auctions for spot buys. Rather it uses them to award annual contracts. "We see reverse auctions as a strategic sourcing tool," says Wong. "We do them with our approved suppliers with whom we have long-term relationships." Business isn't awarded to low bidders in nine of 10*

*reverse auctions, adds Wong. Price is an important part of the equation, but Sun takes into account suppliers' previous overall performance before awarding business. Carbone (2003)*

As described above, running a successful online auction involves much more than identifying a need to purchase and inviting suppliers to bid; pre-qualifying suppliers, identifying the appropriate bundles to put in the auction, and determining the optimal sequencing all require critical thought and resources from the buyer. Despite all of this prepatory work, the online auction is frequently *not* the final determinant of the winning supplier(s). More often than not, the buyer reserves the right to award business to another (set of) supplier(s). After conducting interviews with companies that had used online auctions, Carter et al. (2004) propose that a rank-visible auction might be advantageous when the buyer intends to conduct further, negotiations offline. In these settings, the auction event is a means by which to identify the lowest $m$ bidders and the final winner will be determined after a round of negotiations after the auction. The fact that suppliers would expose themselves in a full disclosure auction, only to not be awarded the business created unease and ill-will with suppliers. Rank feedback is increasingly being used in settings where buyers are using auctions to develop and sustain strategic alliances with (a group of) suppliers.

*...the lowest bidder does not necessarily win the event, but being in the ballpark is important. Hannon (2005)*

The fact that a supplier does not have to be the least cost supplier, but merely *one of* the least cost bidders may explain why rank feedback is gaining in popularity. Practitioners have found that rank feedback stimulates more aggressive behavior from suppliers, particularly those that are in second or third place. Carter et al. (2004) found that a full disclosure auction could be unsuccessful if the initial bid was sufficiently low to stifle competitive bidding by the other suppliers. Their suppliers inability to see their opponents' exact bids makes them more willing to iteratively lower their bid. As a result, rank tends to be used when suppliers costs are expected to be far apart, as is frequently the case when domestic suppliers compete against foreign suppliers from Asia, and the preferred supplier(s) are not expected to be the lowest cost suppliers.

Finally, if the supply base is sensitive to information being disclosed, then a rank feedback may be the only way to get sufficient supplier participation in the auction. Suppliers cite wariness about revealing to their competitors what payment terms or interest rates they will accept. They also fear that full disclosure of prices will lead to a downward spiral of prices that will lead to more competitive behavior in the future and/or retaliatory behavior as supplier's compete for their

incumbent business. As the balance of power shifts between buyer and suppliers - a phenomenon that is beginning to happen in electronics as we shift to a tight supply market - we may expect to see the use of rank feedback increase further.

In an exploratory data set, Jap (2002) considers whether the price information feedback has an impact on how winning and losing suppliers perceive the auction event, thereby influencing their willingness to participate in future events. In her study, she compares a full-disclosure format with a sealed-bid format and finds that there is a marginally significant difference across price formats. Suppliers who lost in an full-disclosure auction indicated a lower willingness to work with the buyer in the future. We might extrapolate from this information effect and conjecture that a rank feedback form (which reveals less information) would better serve to attract both winning and losing suppliers to future auctions.

Another interesting (and potentially attractive) aspect to rank auctions is the need for fewer suppliers to achieve the most competitive environment. Based on empirical observations, Millet et al. (2004) find that a rank auction's success (the maximum price-reduction achieved) increases up to a local optimum of six invited suppliers, and then declines. This is good news for buyers who feel obliged by their supplier base to use rank auctions; the supplier qualification process is a less onerous since qualifying more than five or six suppliers may reduce the competition in the auction.

# 6 Request for Proposals (RFP)

Practitioners have remarked that the advantages of an online auction format are secondary to the more critical issue of getting suppliers to participate in the online auction. They note that suppliers are resistant to the process of bidding dynamically with real-time competitive feedback. Interestingly, practitioners note that RFPs experience very little resistance from suppliers, and as a result about 75% of the procurement auctions that they run are sealed-bid. By putting RFPs online, buyers can make fully informed and analytically-enabled decisions without the time pressure and ill-will that online auctions create.

An online RFP mimics what buyers traditionally did offline. Previously, buyers who solicited bids from multiple suppliers would negotiate on all contract dimensions simultaneously. The time between when an RFP was announced to when RFPs were received (by fax or shipping), recorded, analyzed, and competing offers compared and then finally awarded would take up to four months. In an *online* RFP, interested suppliers are notified that they must submit their bids by a specific time,

e.g., noon on Monday. In their bid, price is bid alongside other contractual parameters, for example, the length of the contract, volume of commitments, and payment terms. Relaxing the specific demand parameters allows suppliers to create alternative package offerings and simultaneously price them.

After the bids are submitted, the buyer may conduct a few follow-up rounds of bidding; in each round, the suppliers are given feedback on their standing and allowed to resubmit a bid. The form of the feedback ranges from the supplier's current rank/score, the winning score, to information on what the supplier would have to bid in order to achieve the highest score (for example, the supplier must bid these three items together with a price of $X to be in the lead). To the best of our knowledge, Emptoris is the only company that is offering the more advanced form of feedback information with alternative scenario suggestions. The time between rounds is on the order of a day, and the auction typically concludes after two to three rounds.

Interestingly, suppliers prefer the seemingly more complicated RFP to a price-only online auction with well-defined bundles. The key message that we take away from this is that *time* is of the essence. The suppliers derive a large disutility from being forced to respond to price in real-time over a 10-15 time window.

# 7 Post auction negotiations

One message that reverberated with all of the practitioners was that buyers are unwilling to allow the auction to be the determining last factor in selecting suppliers. After either an online auction or RFP, the buyer will frequently do a round of negotiations. While the buyer does not revisit the prices that a supplier can offer, she may negotiate certain terms of the contract that were strategically left vague before the auction. The reasons for this generally fall into two categories: (1) there are additional non-price attributes that must be considered and could not or were not captured during the RFI process and (2) the existence of non-firm business rules.

If run properly, the initial RFI process should identify suppliers that are qualified to meet the products' specifications and weed out all others. These qualifications are 'show-stoppers' whereby failure to meet any one of them results in exclusion from the auction event. In addition to these 'show-stopper' criteria, there are often additional criteria that can affect the buyer-supplier relationship. For example, a suppliers' implementation program (how quickly a supplier can transition and be up and running to supply the buyer) may fall under this category. Given the non-criticality of

these attributes, buyers prefer to evaluate their relative importance after suppliers have concluded the auction.

Aided by optimization based decision tools, buyers explore different award scenarios. This 'what-if' analysis after the auction allows buyers to better understand the cost of various business rules and enables them to change business practices that can now be quantified as 'too costly'. The sophistication of the optimization tool varies based on the user, the overlap in the bundles under consideration, the number of non-price attributes that the buyer negotiates after the auction with a few selected suppliers and the number of 'soft' and 'hard' business constraints that exist. In general, the level of sophistication that is required and used by buyers is modest. Most of the optimization based 'what-if' analysis is handled by Excel spreadsheets and Solver add-in. More complex analysis is done with the aid of mixed integer programming (MIP) software; while Emptoris and the others have the MIP software to perform complex award analysis, they report that this feature of their software package is seldom used (and generally takes place in specialized markets such as transportation with specialized software vendors such as CombineNet).

## 8 And the winner is...the incumbent

Snir and Hitt (2003) note that, despite the flexibility and ample opportunity to exchange information over multiple time epochs, many online auctions do not result in a contract being awarded. (It is interesting to note that this is not a general problem with RFPs.) The most common explanation for this 'failure' of online auctions is that the buyer used the information gathered in the online auction to renegotiate with her incumbent supplier. Jap (2002) notes that the suppliers in the US automotive industry have collected data supporting the claim that many online auctions (we conjecture that these auctions were conducted on the buyer-owned Covisint B2B exchange) did not result in an award. These suppliers' experiences and collected data has further fueled their beliefs that buyers are merely using auctions to survey market prices and that qualified suppliers are being asked to unfairly compete against unqualified lower-cost suppliers. Jap (2002) defends the buyers in the automotive industry, explaining that the buyers with whom she spoke did not try to use auctions in this manner. We extrapolate from her discussions that the suppliers' perceptions of unfair play resulted in non-aggressive bidding behavior, and the high prices in the auction made it unattractive for the buyer to switch to a new supplier in some auctions. Essentially, the suppliers' beliefs led to a self-fulfilling prophecy. It is worth noting that practitioners believe that

the presence of third party solution providers such as Emptoris, Ariba or Verticalnet (a presence that is guaranteed if a third party provider hosts the sourcing event) is increasing the credibility of the sourcing event, and alongside it the fraction of times a non-incumbent is awarded a contract.

Snir and Hitt (2003) and Carr (2003) offer costly bid evaluation as an additional explanation for the failure to award contracts. The richness of the information accrued during the sourcing and auction event poses for the buyer a complex and costly award problem. Rather than take the time to analyze all bids and their potential optimality, the buyer choose to not evaluate the submitted bids if the costs of bid evaluation outweighs the benefits of doing so. Carr (2003) explains that there will be a range of bidders for which bid evaluation is cost-effective; if fewer bids are submitted or more bids are submitted, the buyer may walk away without evaluating the bids. Given our understanding of pricing structures for these auction tools (they can either be hosted by the third party provider or purchased and internally managed) and the tools' robustness and optimization capabilities, we believe that the decision support tools have reached a level of sophistication and robustness to make bid evaluation a low-cost activity once the tool has been purchased. That is, the main cost is incurred when purchasing the right to use the software, while the variable cost of bids evaluation is relatively small. Therefore we may expect to see the sourcing process halt *before* the auction if an insufficient number of suppliers are willing to participate, but rarely *after* the bids have been submitted.

Although the incumbent wins in a large percentage of the auctions, participating in an auction is changing the information the incumbent supplier has and his behavior towards the buyer. This change in behavior can be both for the better or for the worse. For example, many U.S. suppliers' resistance to online auctions is that it pits them against a lower cost Asian supply base. Practitioners have noted that an online auction gives U.S. suppliers real-time feedback that is an eye-opening experience: The foreign suppliers no longer pose a potential threat, but become a real threat. That knowledge positively effects the incumbent's willingness to work with the buyer, provided that the incumbent knows that he is the buyer's preferred supplier, and that preference will be duly reflected in the post-auction award process.

Although incumbents win the majority of the time, all interviewees (and empirical papers) confirm that incumbent suppliers are most opposed to participating in auctions. They cite instances of incumbents refusing to participate or offering the buyer changes in both price and non-price factors in order to avoid an auction. If the auction takes place, they found that the incumbent harbors resentment towards the buyer. While frequent auctions would allow the buyer more snapshots to

sources of supply in the market, this increase in information must be weighed against any negative impacts a contractually short relationship may have on supplier quality improvements, exchange of information, and buyer's leverage over the supplier. Practitioners advise that it is not worth jeopardizing the buyer-supplier relationship by repeatedly requesting the incumbent to participate in an auction; they advise that auctions should be used sparingly and primarily as a check that the incumbent supplier(s) costs are not significantly above market prices, and/or learn about a new supplier in the marketplace.

## 9 Lessons Learned...and Research Questions Posed

Given the initial excitement surrounding B2B auctions in the 1990's followed by the realization that auctions are not the panacea for every procurement setting, one is led to contemplate the future of online auctions. In a world where there is an increased reliance on outside suppliers for integral inputs into the production process, it is not clear what role online auctions can have.

What we have learned is this: The mere exercise of examining more closely the sourcing process has proven invaluable to procurement practices - independent of whether or not the eventual decision resulted in the use of an online auction. Holding a successful auction event requires more than just inviting suppliers to make a bid; it requires significant preparation from the buyer. The buyer must understand the supplier market, identify potential suppliers, assess their capabilities and the total cost of doing business with them, present suppliers with a complete set of prints, specifications and requirements, and honestly communicating the way in which competing suppliers will be judged and selected (i.e., whether the buyer will commit to selecting the lowest price supplier, or if she will consider some non-price attributes in making her final selection after the bids have been submitted). If the buyer believes that the state of the supplier market and characteristics of her own demand are conducive to holding an online auction, then she can append the auction near the end process in order to identify supplier prices. Viewed in this light, it is clear that an auction is but *one component* of the sourcing process. However, if she does not find the market to be receptive to a online auction, then the information gathered up to that point can still help her in whichever subsequent procurement pricing strategy she selects.

When the process is executed properly, both online auctions and RFPs have demonstrated that they can help buyers procure more efficiently, and can bring about significant cost savings. The natural follow-up question is, if a buyer has used an auction once with success, should she

continue to use it regularly, or should auctions be used infrequently and in combination with other procurement mechanisms? Practitioners believe that auctions have demonstrated their effectiveness in procuring commodities or near-commodities; hence we should expect to see their adoption in these markets grow with time.

Practitioners also believe that auctions are actually allowing buyers of non-commodity products to move beyond price considerations to service and risk management concerns; this occurs because auctions assure buyers that they are paying reasonable market prices for the goods/services. While at first we found this suggestion to be paradoxical, we have come to understand its logic as follows. Traditionally, barriers to information would create rigidity in the way a company built its supply chain. With online tools, a company can provide almost full transparency throughout the supply chain. Viewed as an information enabler, auctions are a technological platform that provide real-time market feedback on prices. This feedback enables a buyer to identify a small number of qualified suppliers beyond her incumbent and potentially build substitute or parallel strategic relationships as the need arises. With this core supplier group, the focus on supplier selection can then move from pricing considerations to service and risk management concerns, for example the suppliers' inventory control policies, service and response times.

While we may see auctions used less frequently when sourcing strategic goods, we cannot expect auctions to disappear from the sourcing toolbox for these markets. The relatively quick access to the market provided by auctions allows a buyer to react and take advantage of shifts in the marketplace and supply base. This flexibility is particularly valuable when there are shifts in demand and the buyer is in need of spot purchases. This unique advantage of auctions will earn it a permanent place in many company's sourcing toolbox. In addition, the intermittent use of auctions will allow buyers to check and make sure that the prices that they are paying are not far from current market prices. Finally, as buyers become more comfortable with auctions and take advantage of the flexibility embedded in much of the e-Sourcing software to tailor the auction event to their market's particulars, we should expect to see the adoption of auctions in a wider variety of markets for an increasing spectrum of goods.

Currently, the success of an auction is measured by the total price reduction that it delivers to the buyer. However, most procurement managers will agree that price is only one dimension in a buyer-supplier relationship. As a result, there is a need to not only formally incorporate non-price attributes into the supplier selection process, but also into the *assessment* of an auction's success. Auction analytics (Mohara et al. (2005)) is the systematic formal analysis of auctions that entails

(1) the development of standardized metrics to communicate information before, during and after the bidding event and (2) the use of data mining techniques to learn from previous auction events the suitability of various auction formats under different market settings. These metrics will aid buyers to communicate their qualification attributes to potential suppliers. In addition it will serve as a means to properly evaluate the impact and success of an auction. We are unaware of any third party solution providers that are developing or offer auction analytics tools, and believe it to be an important direction for future tools.

We conclude our lessons learned with an obvious fact: A critical component to a successful auction is a dedicated buyer who is willing to allot sufficient resources to design a equitable and well-specified auction event. Surprising, we learned from our interviews that procurement practices often suffer from neglect in companies. While some buyers have recognized early on the importance of a well thought-out and executed procurement process to the total success and health of their businesses (e.g., General Electric, Dell, Coca-Cola, United Technology, Proctor and Gamble, to name a few), many buyers have a lackadaisical approach to procurement and have failed to do some (if not all) of the steps outlined above. Why some buyers place more emphasis (and resources) in their procurement process is beyond the scope of this paper. We bring up and conclude this paper with this point to emphasize that a buyer's neglect of the due-diligence process is not a by-product of an online auctions, but is rather a reflection of an individual buyer's business philosophy. That said, online auctions have served as enablers of procurement process improvement for all buyer types. The attention that auctions has brought to these traditionally neglected company departments has served as a catalyst to reanalyze how procurement is done, and will continue to increase the role and recognition that procurement departments have within a company.

**Burgeoning Research Questions**

It is interesting to point out that McAfee and McMillan (1987) define an auction to be " a market institution with an explicitly set of rules determining resource allocation and prices on the basis of bids from the market participants." Given their well-accepted definition, the use of the term 'online auction' in this paper is a misnomer. A recurring theme in the preceding sections was buyers' preferences for leaving themselves flexibility in the way business is awarded, and their reluctance to put forth an *explicit* set of rules determining resource allocation and prices.

While buyers believe that they are improving their situation by not committing upfront to a specific award mechanism, the reality of this may be far from the truth. As was frequently pointed out, ambiguity in the selection criteria, goods being procured and terms and conditions of trade

cause suppliers to feel anxious when submitting a bid, and may result in less aggressive bidding. Hence, the lack of commitment may actually be resulting in higher procurement prices. What is needed is a formal analysis to measure the costs/benefits of commitment under various market settings. For example, should the buyer award business at the close of each auction, or is she better off waiting until bidding has concluded on all auctions before making her final award decision? The difference between these two rules is important when suppliers cannot win on all of their active bids, due to capacity constraints or buyer rules such as maximum percent of business award to any one supplier. Awarding business at the close of each auction allows suppliers to know whether or not they are eligible to bid (and win) subsequent auctions: Postponing the award decision until the conclusion of all auctions allows the buyer to see a supplier's bids on all desired lots and select the best allocation *ex post*.

Another string of questions relates to how much of her selection method the buyer should convey to the suppliers. Should she commit to selecting the lowest price supplier(s) or reserve the right to make her award decision based on non-price attributes the suppliers communicated to the buyer before the auction and during the RFI process? Via a series of experiments, Engelbrecht-Wiggans et al. (2006) find that either method may prove to be superior. They found that committing to the lowest-price supplier is best if the number of suppliers is small, while making the award based on non-price attributes is best if there are a large number of suppliers. The authors consider a stylized setting where a supplier's non-price attribute is common knowledge to the buyer, but not rival suppliers, and hence is not actively bid upon during the auction. The natural and necessary next step is to extend this line of questioning to a setting where these non-price attributes are not known to the buyer, and hence the buyer must rely on the information given to her from each supplier during the RFI process.

Closely related to this commitment issue is the critical step of qualifying suppliers. As noted in section 3, the buyer may allow unqualified suppliers to participate in an auction, in the hope of inducing more aggressive bidding on the part of qualified suppliers. The puzzling fact behind this practice is that suppliers often know that there are non-credible bids being made - which makes them question the reality of the current lowest price or their reported ranking in the auction (it is common practice to hide the identity of the bidders, and hence a supplier is unable to judge with certainty if a bid is from a qualified or unqualified supplier). It is not clear if this uncertainty related to the credibility of a bid results in higher or lower prices in the end. If research could shed light on this and demonstrate to buyers that an unlevel playing field actually hurts rather than helps

them, much progress could be made towards improving suppliers' attitudes towards participation in auctions.

To answer these and other questions related to the value of commitment, we must understand how suppliers behave in each environment. Tools from game-theory, as well as experimental and empirical research is much needed to address these pertinent business questions.

In addition to evaluating the need for transparency in the award decision, there is also a need to understand *which* auction format is best for different market settings. For example, how should the buyer *bundle* multiple objects together when constructing bidding lots? Should she create smaller bundles so as to maximize the number of suppliers who can participate in each auction, or should she create larger bundles so as to capture the economies of scale in production of her larger bidders, at the expense of fewer eligible participants. Practitioners reported the need to make the volume of the bundles large enough to attract suppliers to participate. If a buyer has a (relatively) fixed demand for goods/services over the course of a year, this implies that she should decrease the frequency of auctions so as to increase the portion of her business awarded in each auction. If each auction represents a snapshot of the current market setting, then the buyer must trade-off achieving a competitive price with attracting a sufficient number of desirable suppliers.

Given the selected bundles, how should she *sequence* auctioning the bundles? Practitioners have developed a set of rules that they believe work well given supplier behavioral dynamics (for example, building up excitement for an auction) and supply constraints. One of these rules is to auction larger bundles (higher dollar-spend lots) *last*; however preliminary work by Elmaghraby (2003) would indicate that the larger bundle(s) should be auctioned *first* when suppliers costs are characterized by economies of scale in production. Greater investigation of this design dimensions is needed to explain these two contradicting recommendations.

A surprising lesson learned from our interviews was that rank ordering is by far the most common feedback form used in procurement auctions. Reasons for this varied from suppliers believing it to be less invasive (and hence harder for their competitors to correctly guess their actual bids and requested profit levels) to the fact that rank bidding can help create the illusion of competition when suppliers' costs may in fact be very far apart. Interestingly, we are unaware of any literature on the behavioral and revenue differences under rank versus full disclosure feedback. It would be particularly useful to compare game theoretic predictions about suppliers' bidding behavior with behavior observed in a controlled experimental setting. It may be that the standard rationality assumptions implicit in game theoretic tools will be too strong to correctly predict

differences in supplier bidding behavior across the two feedback rules. Hence, we believe that contrasting analytical results with observations from experiments will be particularly useful in this research area.

All of these questions arose from the disparity between the assumptions that are standard in the literature on auctions (e.g., buyer commitment to an allocation mechanism) and those actually used in practice (e.g., the buyer strategically leaving her allocation mechanism ambiguous). It is not clear whether the differences between these two worlds is due to poor communication and education (on both sides!), or whether the differences stem from a more fundamental contradiction and/or omission between how we model a buyer's and supplier's decision process (e.g., rational and profit maximizing) and what the reality truly is. Hopefully, academic contributions crossing the disciplines of operations management, marketing, economics and psychology will help close the gap and hence further the intelligent and effective use of auctions for procurement.

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