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It may be desirable to order from only a few vendors even if they are not the low bidders on all items. These authors describe a computerized routine for balancing material against purchasing costs in —

ANALYSIS OF COMPETITIVE BIDS

by W. N. Smith and J. R. McCreight

The Dow Chemical Company

WHEN A COMPANY receives bids for one hundred different items from ten bidders it is a relatively simple job to determine the lowest bidder on each item and hence the lowest material cost for the package. Unfortunately, for the purchasing agent life is seldom this simple.

Consider the replenishing of stock for a large corporation's maintenance supply inventory. Inventories containing as many as 20,000 to 30,000 stockkeeping units are not uncommon. At a normal

turnover rate this might require a hundred or so replenishment orders a week. If bids must be taken, the lead time would require a much higher inventory level for the same service level than would be required without bidding. Yet without competitive bids the buyer is at the mercy of the seller. Furthermore, in the case of government agencies competitive bids are usually required by law.

The compromise solution to this problem adopted by many corporations is the use of contract orders

or term contracts. Under this system the bids are for the quantity of a commodity estimated to be required for a period of time, usually one year. The material is shipped and billings are made on the basis of releases issued by the buyer as the need arises. Bids can be taken in advance of the end of the current time period; thus, the need for bids need not affect the normal lead time.

The advantages to both the buyer and seller under the contract order system are obvious. Even

greater benefits accrue to both parties, however, if bids are taken not on individual stockkeeping items but on logical or conventional groupings of these items. For example, alloy pipe fittings are logically categorized as a class by type of fitting, alloy, and pressure rating; the various standard pipe sizes of a given fitting would constitute the members of that class. Thus, it would be reasonable to accept bids for this class of commodity rather than for the individual members of the class.

The class, then, is the smallest unit for which contract orders would be placed. If a logical class grouping has an estimated need too small to warrant the issuance of a contract order, it should be combined with other classes for bidding purposes.

The composition of a class is important. The class should be large enough so that the seller would be willing to accept a contract order for this class alone. In deciding whether to issue a contract order for a single class (or even a combination of classes) the buyer must analyze the potential savings after considering all costs, not just those of the commodity.

Bid analysis routine

To assist our purchasing agents in making these decisions we have developed a bid analysis routine that incorporates a number of useful summaries, tables, and comparisons. Use of the routine requires a computer, since many of the summaries and comparisons would be prohibitively time-consuming if done by hand. With the thought that the routine might be useful to others if adapted to their needs, it is briefly outlined in this article, with a case example illustrated in the exhibits.

In our illustrative example bids were taken on approximately 200 items divided into 15 classes of alloy pipe fittings. Five bidders were furnished with bid information that included a complete description of each item and a statement of our

Class Total Array for Each Bidder

Class	Vendors					Winner
	ABC	DEF	GHI	JKL	MNO	
1	2076.56	2078.83	2099.99	2343.60	2158.80	2076.56
2	2596.78	2407.84	2076.84	2748.66	2977.61	2076.84
3	3813.20	3196.48	3565.23	3918.17	3606.97	3196.48
4	4202.30	4093.12	3286.32	4441.96	4822.39	3286.32
5	4014.11	0.00	3886.08	4242.19	3312.74	3312.74
6	7209.18	6495.39	5825.55	7314.26	11267.91	5825.55
7	809.60	673.60	280.80	237.60	395.20	237.60
8	4716.36	5859.57	4067.89	5518.02	3753.17	3753.17
9	3074.35	0.00	2455.76	3248.33	3526.68	2455.76
10	3696.47	3425.46	3580.53	3917.11	3064.66	3064.66
11	150.95	127.24	162.78	108.10	108.00	108.00
12	491.88	707.30	744.93	737.32	705.86	491.88
13	89.64	75.57	87.85	69.43	80.49	69.43
14	7849.84	7263.14	6269.20	8287.77	9010.56	6269.20
15	6787.73	6279.17	6556.85	7159.95	5612.89	5612.89
	51578.95	42682.71	44946.60	54292.47	54403.93	41837.08

*Lowest Bid for Each Class in Rightmost Column

Following are the Non-Tie Totals for Each Bidder:
 491.88 3196.48 19913.66 307.03 15743.45

Following are the Totals for Each Bidder After Ties Have Been Allocated:
 491.88 5275.30 19913.66 307.03 15851.44

This Would Give A Total Cost of 41839.31

The Total on a Low Item Rather than a Low Class Basis is 41493.31

TABLE I

estimated needs for each item for the coming year (based on the previous year's usage.) They were instructed to enter a unit bid for each item but were told that awards would be made on the basis of class totals obtained by summing the extensions for each item in a class. Each vendor was informed that he might be awarded the order for one or more classes. The vendors were permitted to bid on any number of classes, but if

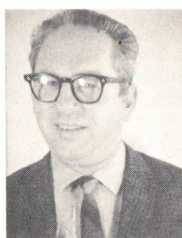
they chose to bid on a class they had to bid on each item within the class.

Because of the somewhat fictitious nature of these bids, fictitious bidder identifications are used in the exhibits, and only class dollar totals—without use quantities—are given.

The first important summary of the results is shown in the upper part of Table 1 on this page. Each column shows the class bids for a vendor. The winner column shows the lowest bid for each class.

Tie bids

Tie bids are not uncommon, and some provision must be made for handling them. Two or more vendors may submit identical bids for a class, and these bids may be lower than all others. Or two or more (low) bids may be so close to each other that the difference is insignificant. These latter we call virtual ties. In our computer program an input variable defines the minimum percentage by which two bids must differ if they are not to be considered virtual ties. In the example of this paper 1 per cent is used for this variable; that is, bids that are



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1 per cent or less than 1 per cent apart are classified as virtual ties.

The winner column total in Table 1 thus indicates the material costs if we are willing to award five contract orders, one to each vendor. This procedure will give the lowest material cost. However, it also results in the highest accounting and record keeping costs for processing the orders. If processing costs are high, it might be more economical to issue fewer contract orders even at the expense of an increase in material cost. How to determine the exact amount of this increase in material cost is illustrated in the various tables.

If processing costs were so high as to make a single contract order desirable, we would refer to the column totals in Table 1, which show each contractor's total bid for the entire fifteen classes. Vendor DEF has the lowest column total, but the zeros for Class 4 and Class 9 indicate that he did not bid on these classes. Hence, if we wanted to award all fifteen classes to a single vendor we would choose GHI, who has the lowest total of those who bid on all classes.

Normally, however, let us assume that a vendor will be awarded an order for each class for which his bid is lower than all the rest. The sum of the dollar value of these classes is called the vendor's non-tie total. (This sum does not include classes for which he may be tied for low.) The larger the vendor's non-tie total the greater the dollar value of class bids in which he outbid all the rest.

Allocation of ties

The non-tie total is the key item used in our bid analysis routine for breaking ties. If two or more vendors submit tying low bids for a class, the bid is awarded to the vendor with the largest non-tie total.

Table 2 on this page shows the results of the tie-breaking routine. A non-zero number indicates that a vendor was tied (virtually or actually) for low with his bid for

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The Following Array Indicates The Classes That Contained Ties, Who The Tie Bidders Were, and Who Was Awarded the Tied Bid. A 1 in a Bidder Column Indicates this Bidder Was One of Those Tied. A 2 Indicates the Bidder Who Received the Bid.

Class	ABC	DEF	GHI	JKL	MNO
1	1	2	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	1	2
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0

TABLE 2

TABLE 3

CLASS	CLASS NAME	CLASS TOTAL
The GHI Company		
2	Coupling, Monel, Standard Duty, 125 Lb.	2076.84
4	Elbow, Monel, 90-Degree, Std. Duty, Scr.	3286.32
6	Nipple, Monel, Standard Duty, Screwed	5825.55
9	Tee, Monel, Screwed, Standard Duty 1/4	2455.76
14	Union, Monel, Standard Duty Screw 1/4 In	6269.20
15 Classes Bid.		
5 Classes Awarded.		
The Dollar Value of All Bids Awarded to This Vendor is		19913.67
The MNO Company		
5	Elbow, Stainless Steel, Screw, Type 304	3312.74
8	Nipple, Stainless Steel, Type 304, Scr.	3753.17
10	Tee, Stainless Steel, Type 304, Standard	3064.66
11	Thred-O-Lets, Monel, 6000 Lb. Bonney 1 In	108.00
15	Union, Stainless Steel, Type 304, Standard	5612.89
15 Classes Bid.		
5 Classes Awarded.		
The Dollar Value of all Bids Awarded to this Vendor is		15851.44
The DEF Company		
1	Bushings, Pipe, Stainless Steel, Type 30	2078.83
3	Coupling, Stainless Steel, Type 304, Std.	3196.48
13 Classes Bid.		
2 Classes Awarded.		
The Dollar Value of all Bids Awarded to this Vendor is		5275.31
The ABC Company		
12	Thred-O-Lets, Nickel, 6000 Lb, Bonney	491.88
15 Classes Bid.		
1 Classes Awarded.		
The Dollar Value of all Bids Awarded to this Vendor is		491.88
The JKL Company		
7	Nipple, Nickel, Sch. 80, Screwed 1/2 In.	237.60
13	Thred-O-Lets, Stainless Steel, Type 304	69.43
15 Classes Bid.		
2 Classes Awarded.		
The Dollar Value of all Bids Awarded to this Vendor is		307.03

Showing Elimination of Vendor JKL

The Following Array Gives The Class Totals for Each Bidder. The Lowest Bid is Shown in the Last Column.

Class	ABC	DEF	GHI	JKL	MNO	Winner
1	2076.56	2078.83	2099.99	0.00	2158.80	2076.56
2	2596.78	2407.84	2076.84	0.00	2977.61	2076.84
3	3813.20	3196.48	3565.23	0.00	3606.97	3196.48
4	4202.30	4093.12	3286.32	0.00	4822.39	3286.32
5	4014.11	0.00	3886.08	0.00	3312.74	3312.74
6	7209.18	6495.39	5825.55	0.00	11267.91	5825.55
7	809.60	673.60	280.80	0.00	395.20	280.80
8	4716.36	5859.57	4067.89	0.00	3753.17	3753.17
9	3074.35	0.00	2455.76	0.00	3526.68	2455.76
10	3696.47	3425.46	3580.53	0.00	3064.66	3064.66
11	150.95	127.24	162.78	0.00	108.00	108.00
12	491.88	707.30	744.93	0.00	705.86	491.88
13	89.64	75.57	87.85	0.00	80.49	75.57
14	7849.84	7263.14	6269.20	0.00	9010.56	6269.20
15	6787.73	6279.17	6556.85	0.00	5612.89	5612.89
	51578.95	42682.71	44946.60	0.00	54403.93	41837.08
Following are the Non-Tie Totals for Each Bidder:						
	491.88	3272.05	20194.47	0.00	15851.46	
Following are the Totals for Each Bidder After Ties Have Been Allocated:						
	491.88	5350.88	20194.47	0.00	15851.46	
This Would Give a Total Cost of						41888.69
The Total on a Low Item Rather than a Low Class Basis is						41493.31

TABLE 4

TABLE 5

Showing the Results of Eliminating Three Vendors

The Following Array Gives the Class Totals for Each Bidder. The Lowest Bid is Shown in the Last Column.

Class	ABC	DEF	GHI	JKL	MNO	Winner
1	0.00	0.00	2099.99	0.00	2158.80	2099.99
2	0.00	0.00	2076.84	0.00	2977.61	2076.84
3	0.00	0.00	3565.23	0.00	3606.97	3565.23
4	0.00	0.00	3286.32	0.00	4822.39	3286.32
5	0.00	0.00	3886.08	0.00	3312.74	3312.74
6	0.00	0.00	5825.55	0.00	11267.91	5825.55
7	0.00	0.00	280.80	0.00	395.20	280.80
8	0.00	0.00	4067.89	0.00	3753.17	3753.17
9	0.00	0.00	2455.76	0.00	3526.68	2455.76
10	0.00	0.00	3580.53	0.00	3064.66	3064.66
11	0.00	0.00	162.78	0.00	108.00	108.00
12	0.00	0.00	744.93	0.00	705.86	705.86
13	0.00	0.00	87.85	0.00	80.49	80.49
14	0.00	0.00	6269.20	0.00	9010.56	6269.20
15	0.00	0.00	6556.85	0.00	5612.89	5612.89
	0.00	0.00	44946.60	0.00	54403.93	42497.50
Following are the Non-Tie Totals for Each Bidder:						
	0.00	0.00	25859.69	0.00	16637.81	
Following are the Totals for Each Bidder After Ties have Been Allocated:						
	0.00	0.00	25859.69	0.00	16637.81	
This Would Give a Total Cost of						42497.50
The Total on a Low Item Rather than a Low Class Basis is						41493.31

that class. A figure 2 indicates the vendor who was awarded the bid on the basis of the tie-breaking routine just described. (A figure 1 indicates the losing tie bidder.)

In our example, Vendor ABC was low bidder for Class 1. However, since Vendor DEF's bid was within 1 per cent of Vendor ABC's, these bids were considered tied.

The bid for this class was awarded to Vendor ABC. Vendor ABC had a larger non-tie total than ABC. The non-tie totals are shown on Table 1.

After all ties have been allocated, new totals for each vendor are calculated and shown on Table 1. Three grand totals are also shown in Table 1. Under the winner column is the cost if awards are made by class by absolute low bids. The next to last line shows the total if ties are allocated. The last line shows what the total would be if the lowest bid per item rather than per class were used as a basis of awards. This can be thought of as an absolutely low bid. By comparing it with the other totals we can see the apparent cost of classifying items. (We say apparent because there is no adjustment for the increase in processing cost if a per item basis is used.)

Table 3 on page 42 is a partial listing of the actual bid awards to be made if we are willing to process five contract orders. We can see from Table 1 that the material cost will increase \$3,107.25 if we award all classes to Vendor GHI, who submitted the lowest grand total. (Vendor DEF did not bid on all classes.) The purchasing agent must determine whether the additional purchasing costs of processing five contract orders are greater than this added material cost.*

Vendor elimination

As the number of vendors to whom contract orders are written decreases, the cost of the material

* In the tables that illustrate this article only the material costs under the various purchasing alternatives are tabulated; no effort has been made to calculate the associated purchasing costs with which they are to be compared. The cost of processing a contract purchase order might vary considerably from one company to another. In addition, this information is generally considered confidential. Therefore, we preferred to take the other approach and point out the maximum amount that purchasing costs would have to be to prevent one from adding an additional contract to supply the material needed.

increases but the clerical costs go down. The more vendors the less the paperwork. It is important to know what the material cost is for five vendors, four vendors, and so on down to one vendor. The remainder of the computer program is devoted to this analysis.

In the analysis, each vendor is omitted, one at a time, and a new winner total is calculated. First is the case in which one vendor is eliminated. The four vendors giving the smallest winner total are selected, and the complete bid analysis is then repeated with only these four vendors. The summary results for this case appear in Table 4 on page 43. This table shows the effect of eliminating one bidder, the one that would have the least effect on the winner total.

Next, each possible pair of vendors is eliminated one by one, and new winner totals are determined. The three vendors whose combined bids result in the smallest winner total are identified.

This procedure is continued until a single vendor is left or until no more vendors can be eliminated. (If a vendor is the only one to bid on a certain class, he cannot be eliminated if we are to order that class. However, this may be the only class awarded to him.)

Table 5 on page 43 shows the results after eliminating three vendors. The bids of the two remaining produce a lower winner total than the bids of any other pair. Table 6 on this page presents a final

summary. It spells out the step-by-step change in material cost as we change from awarding five orders to awarding a single order.

Optimum cost combination

Now the purchasing agent is in a position to compare changes in material costs with changes in purchasing costs as the number of vendors is varied and find the optimum cost combination. Purchasing costs are not tabulated here because the cost of processing a contract order may vary considerably from one company to another, depending, among other things, upon accounting procedures, inventory policy, and statistical records of vendor performance obtained for the purchasing agent.

From these tables, however, the purchasing agent who knows what it costs to process each additional purchase order can easily identify the least-cost alternative. In our example, Table 6 tells us that we can expect to save \$2,449.11 per year in material costs by issuing two contracts instead of one. If the processing cost of the additional contract will exceed this amount, the purchasing agent should stick to the single contract. If not, he is justified in issuing two orders.

We can see from Table 6 that the expected incremental savings in material costs become much smaller as we consider more than two contracts. It is unlikely that these savings would offset processing costs in most companies.

With this computer routine the purchasing agent can compare changes in material costs with changes in purchasing costs as the number of vendors is varied and find the optimum cost combination.

TABLE 6

Summary of Bid Analysis (Family for which Bid Analysis was Run: Alloy Pipe Fittings)				
Number of Vendors Considered	Estimated Total Cost	Change in Total Cost	Cum Change in Total Cost	Vendors Considered with Listing in Decreasing Order of Total Awarded
5	41839.31	0.00	0.00	3, 5, 2, 1, 4,
4	41888.65	49.34	49.34	3, 5, 2, 1,
3	42102.62	213.98	263.32	3, 5, 2,
2	42497.45	394.83	658.14	3, 5,
1	44946.56	2449.11	3107.25	3,