# COMPETITIVE BIDDING

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**SAMEVATTING:**

**'n Tenderaar het nie die versekering dat 'n bieëry om 'n tender suksesvol gaan wees nie. Deur 'n studie van konkurrente se vorige tenderpryse te maak en met behulp van statistiese tegnieke kan 'n tenderaar minstens die kans op sukses teen mededingende tenders bereken. Die tenderaar se eie kostestruktuur en die wins wat beoog word, is twee belangrike faktore by die bepaling van 'n mededingende tenderprys.**

**I shall be talking about the bidding situation where companies submit closed tenders for projects, which are then adjudicated by the buyer. This sort of situation occurs most frequently in the civil, constructional and heavy engineering fields, althuogh it is not restricted to these.**

**As far as one can divine, some considerable success has been achieved by companies (largely in the USA) using these approaches, although one of the immediate things that strikes one about this topic, is the lack of published information on it. This is probably a result of the fact that no-one with a really successful tendering strategy is going to tell the world all about it. On the other hand, papers published in the more theoretical journals are often of little practical merit, as they do not begin to appreciate the difficulties of collecting the data they require.**

I have also discovered a surprinsing reticence on the part of engineers, whose profession is to measure and use numbers, to apply this approach to the commercial aspects of their businesses — even though the benefits to be derived from this in terms of increased profits and better forecasting, seem considerable.

Perhaps this is because no-one has ever shown them what can be done in this field, so in this talk I want to change the situation by taking you through a real life problem, which I spent some eight months working on in the U.K. I should mention at the outset that not enough time has yet elapsed since this investigation closed, for the results to have been proved in practice. For what it's worth, I am satisfied that they should provide the basis for a much improved business future.

I must also point out that it is essential during an investigation of the sort I am going to describe, to have access to a lot of confidential information, which obviously I cannot pass on now. Consequently, although I shall talk in terms of numbers, these bear no relation to the absolute values of the cost structures etc. which I encountered — if you like, the story is true, only the facts have been changed to protect my late employer's profit margins. For the same reason I have had to ignore some commercial practices which could potentially alter the answers

I will derive, but even so, I hope that what I reveal will be enough to light a spark of enthusiasm for applying numbers to commercial situations.

What I shall do for the rest of this talk, is to recount the reasons why we were first called in on this problem, and how we tackled the job of building a simple little model to explain how the bidding situation works. I shall then show how this fell short in practice, and what we had to do to overcome this, ending up with the way in which a working answer was produced and presented for use by tendering engineers.

I shall spend the last few minutes considering the shortcomings of the necessarily crude model we constructed, and discussing how these might be overcome in practice if, say, a computer was available.

To fill in the general picture, the company we are considering sells large complicated pieces of engineering — let us call them Giant Widgets — to a world market. The giant widgets range in value from R100,000 to R4 million, and we were told that the company was better at making the more expensive variety. There were also about 4 radically different design concepts for these things, of which our company specialized in three.

In any one year there were about 300 calls for tenders for these item, from various parts of the world, but each machine had to be designed individually. In nearly all cases, certain manufacturers would be approached by the buyers and asked if they would be prepared to tender, some six months before tenders were officially asked for. Tenders would be called for from those who showed interest, although there was usually nothing to prevent any manufacturer who heard about a job from tendering for it. Tender adjudications took place between one and three months after tenders had been called for, and it would take six months or more for the results to be announced. Unfortunately, all these time estimates were what you might call flexible, and in addition requirement dates given by buyers were usually highly unreliable.

It was against this background that we were called in to the newly appointed General Manager's office, just after he had held his first meeting to attempt to plan out which of the 30 bids he had the manpower to tender for out of the total of 300, he should go ahead and make in the next year. Above his desk he had a large framed quotation reading "it is only by attempting the absurd that one can achieve the impossible" — one could not avoid the feeling that this reasoning had led to our presence there.

They had already realized the difficulties of bid selection, i.e. how to choose the best 30 out of the 300 possibilities, because they had found it impossible to pursue any rational discussion at the meeting beforehand. One of them had developed a "scoring model" which listed 14 different attributes of a bid, such as type of machine, source of contract finance, previous jobs done for the buyer, etc. Each of the bids was given a score by the tenderers — the idea being that one went for the bids with the highest scores. The trouble, as they had realised only too clearly, was that the scores were not based on any physically meaningful model of what actually went on, and consequently they could and did argue for ages about what the various weights and scores should be, without getting anywhere.

So we told them that we would like to start by buiding up a simple model of the bidding process, and go on to see what information about bid selection this would give us

To explain our model, let us have a look at the simplest bidding situation. We are bidding for a job against only one other competitor — one Fred Smith. What is more, we have met him on several previous occasions and in fact, on 10 of these, we were able to find out what his bid price was — these bids are shown in diagram (i), which is self explanatory. It is interesting to note in passing that one bid which Smith made was 4% under our marginal cost. It is quite common to find this in real life situations.

We want to move on from diagram (i), to make an estimate of our probability of success at any price we choose to go in at in the current bid. To see how we do this, let us have a look at diagram (ii).

From diagram (i), we can say that if we bid at our Marginal Cost — 5%, Fred Smith has never to our knowledge bid lower than this, so our chance of success is effectively 100%. So we plot this point on diagram (ii). If we bid at our Marginal Cost + 5%, 80% of Smith's bids have been above this, so our chance of success is 80%, and we can plot this point also on diagram (ii). We can proceed in this way for each possible bid price, and end up with the curve shown in diagram (ii), which tells us our chance of success at any price we choose to bid at.

How do we use this knowledge of our probability of success? Say the job we are currently bidding for has an estimated marginal cost of R10,000, then our probability of success at any price we choose to bid is shown in diagram (iii). In addition we can say that if, for example, we bid at R11,000 and win, we will make a contribution to our profits and overheads of R1,000, this being the amount of money which will go into the kitty which must eventually pay for our fixed costs — anything left over being profits. Similarly, if we win with a bid of R12,000, our contribution will be R2,000. We can in fact see what our contribution if we win will be at any bid price, from the broken line also plotted in diagram (iii).

All we have done really is expressed in numbers what every bidder knows, namely that at a low bid price one stands a high chance of succeeding but making little profit. whereas at a high bid price the opposite is true. Having got these numbers, however, we can go one step further, and calculate the exact price at which we should bid if we want to maximize our contribution to profits and overheads. To do this, we take a series of possible bid prices and multiply the contribution if we win at each price by the corresponding probability of winning. This gives us a quantity called an "expected" contribution for each bid price. This quantity for the bid in question is shown plotted in diagram (iv), from which we deduce that we should bid at R11,000 as this is the price at which we achieve maximum expected contribution

It is crucially important that the concept and physical meaning of this quantity I have called "expected contribution" be understood by anyone who wishes to use these methods, so I will explain it in slightly more depth.

Let us suppose that we were going to make a large number of bids identical to the one we have been talking about, and that each time we bid at R11,000. Of course we will win some bids and lose others, but if we were to add up all the contributions from those which we won, and divide this figure by the total number of bids made, we should find that the answer is equal to the expected contribution per bid which we have already calculated, i.e. about R600. If we repeatedly bid at, say R10,500, we would find that over a period of time we were making an average contribution per bid made of only R400. This, or indeed the average contribution we will get from bidding at anywhere but R11,000, will be less than R600, so we have discovered what pricing policy we should adopt to maximise contribution.

The above situation is usually not very real, because one rarely makes more than one identical bid. To get a firmer grasp of the meaning of expected values in a realistic situation, let's see how they are used for business forecasting.

In diagram (v), bids A to J are those we intend to make in the next year, say. We have made a marginal cost estimate for each of these, and have also worked out from graphs our best bid prices, and the probabilities of winning at these prices. You can see that in column 6 we have calculated our expected contributions for each bid, by multiplying column 4 by column 5. We have arrived at an expected order intake by analagous methods.

We see that we can make three forecasts about the results of making these bids. Adding up the probabilities gives us a forecast of the number of bids we shall win. Adding up the expected contributions, we get a forecast of total contribution to profits and overheads resulting from these bids. Adding up expected order intakes, we get a forecast of total order intake. In other words, although an expected order intake for one bid has no physical meaning on its own — one can only win or lose the bid in its entirety — it has a very important physical meaning when totalled up for a list of bids. In general, the longer this list is, the more accurate our forecasts will be. Whatever the length, however, this is still the most meaningful way of forecasting.

I should explain that this approach implies a complete departure from traditional methods of factory accounting, which I will discuss later.

As it happens, we are also in a position to answer the question originally posed. Say we only had enough manpower to make eight out of the ten bids in diagram (v). As we want to cause as little damage to our profits position as possible, the obvious thing to do is to leave out the bids with the lowest expected contributions, i.e. G and D or E. Noticing that our bid price on E represents a 50% markup on marginal cost, whereas that on D is only a 7% markup, we would probably choose to drop the latter. In fact this indicates that it might in some cases be better to compare bids on the basis of expressing the bid price, expected contribution, etc., as a percentage of marginal cost.

There is one factor which must be added to our basic model to make it sufficiently realistic, and that is the way in which we must treat bids with more than one other competitor bidding against us.

Taking this problem at the simplest level, statistics tells us that if the chance of beating one Fred Smith is 0.5 (i.e. 50%), then the chance of beating five Fred Smiths in the same bid is $0.5^5$ which = 0.03 or only 3%. Diagrams (vi) and (vii) use this rule to recalculate the probability of success and expected contribution curves used previously. Note in particular the traumatic affect the additional competition has had on our maximum expected contribution — it is down by over 70% — a fact which leads us to suspect immediately that the number of competitors must be a major factor in determining bidding policies.

It is interesting to note in passing, that the number of competitors was not even mentioned explicitly in the original scoring model!

And so we go on to our attempts to apply this model in practice.

I spent the first three weeks of on-site work, talking and working with the design and tendering engineers. I mention this because my experience has shown that unless the technological problems and terminology associated with a product are understood, it is very easy to start producing rubbish when one tries to work out commercial strategies.

We then moved on to the sales engineering section. Here I must retrack slightly, to admit that in explaining the probability calculations in terms of the "ball diagram", I have prejudiced events rather in the interests of clarity. Our original idea was that the bidding habits of competitors would all be roughly the same and could be approximated to by a distribution of the "normal" type.

The parameters of this distribution would have been fixed by asking questions such as "What do you think the most likely price your competitors will bid at is?" "Give the limits which it is 90% certain that your competitors will not step outside" etc. This approach had in fact been suggested in one or two of the papers.

Well, the first thing that became clear, was that even after coaxing with a few pints of beer at the local pub — an institution, I might mention, sadly not availabe to investigators in this country — sales staff could not begin to estimate the likelihood of their various competitors bidding various prices in even the vaguest terms.

In addition to this, although one or two people vaguely remembered hearing the word marginal cost somewhere, none had the faintest idea what their marginal cost structure was.

So it was all off to the dungeons to extract for ourselves as much information on cost structures and competitor policies as possible.

The results in the latter field were rather shattering. Suitably falsified, they are shown in diagram (viii). It appeared that from the sample of bid prices we were able to obtain (representing all prices bid on about ⅓ of the contracts they had tried for over the last five years), even after the usual corrections for price inflation and engineering differences had been made, it was quite normal to encounter bids from 60% above to 40% below our cost estimates.

We showed these results to everyone we could lay our hands on, and tried to find the reasons why. Was it simply a difference in pricing policies (but surely no one would deliberately go in at 60% above us?)' was it a difference in costs, (but surely not by ± 50%?), or was it just that people couldn't estimate their costs? The data available was not much help in resolving this problem, nor were some statistical analyses we tried. Eventually we had to accept the spread as part and parcel of being in the giant widget business, although we did help to devise some better approaches to costing, which I won't have time to tell you about unfortunately.

Having accepted these variations, we then had to decide whether it was reasonable to assume that all competitors bid in the same way — i.e. whether their ball diagrams were the same roughly. This problem was accentuated by tariff barriers, which lowered the effective price of an American bidding in America say, and the untimely decision of the British Government to devalue in the middle of the data collection period.

Eventually, we isolated 8 different classes of bidders/machine types, between which one could reasonably expect the pattern of bidding to differ. Bids falling within each of these classes were collected in diagrams similar to (i). With the help of some coarse statistics, we reduced these eight groups to two — basically these consisted of Japanese competitors and non-Japanese competitors.

So we ended up with two probability charts like diagram (ii). One gave the chance of beating any one Japanese, and the other gave the chance of beating a competitor from anywhere else. When more than one competitor was faced, then these probabilities could be compounded as shown before.

We tested these graphs and the model by taking all the bids which had been made by our company in the last five years, and finding what probability of success we would have given ourselves in each, had we known the number of competitors. We then made estimates of the total expected order intake, and the total expected number of wins, in the same way as was shown in diagram (v). The answers agreed remarkably well with what had actually happened, and we concluded that the model was a reasonable one.

There remained the problem of finding marginal costs. We defined a marginal or variable cost as any cost we would incur because we won a bid, which we would not have incurred had we lost. A fixed cost was defined as expenses we would incur whether or not we won a specific contract, but assuming that the factory throughout remained at the same order of magnitude as before. This last condition is essential as even a fixed cost is only meaningful in terms of some sort of turnover which it has to support.

Armed with these qualitative definitions, I spent the most exhausting month of my life wading through piles and piles of accounting figures, eventually to emerge with two answers. One was that on average their variable cost was x% of their total cost estimate — pursuing our fictitious way let us call it 55%. The other answer was a method by which they could calculate this figure more accurately after detailed cost estimate sheets for a bid were worked out.

Having got our basic data, we decided to attempt to formulate some simple rules such as "only bid for type A machines" or "if there are more than two Japanese competing don't bid, otherwise go in at total cost plus 10%" etc. We wanted to do this by taking all the bids awarded in the world in the last year or two, postulating rules like the above from our knowledge of the system, and following this by a simulation to see what effect the rules would have had on total contribution, order intake, etc.

Our investigations to get this data revealed some completely unexpected and rather nightmarish gaps in the data gathering system. This included the fact that we, despite our position as one of the oldest giant widget makers in the world, were probably not even getting to know about some very lucrative contracts.

This lack of data precluded us from going ahead with the simulation, but resulted in several good ideas to radically improve the information system, which may in temselves have justified the cost of the whole exercise — which was about R6,000.

After this failure, the only course left open, was to let people work out for themselves the optimum bids etc. in each case. In *theory* they could have done this manually in the way we have already described, but this would have involved a lot of computational work that was unlikely to be done. As no computer was available at the time, we decided to present them with what we called bidding tables, which were sets of tables in which answers were already tabulated.

I do not have time to go into the computation of these tables, but the derivation of the basic differential equation used in the analysis is shown in diagram (ix), and diagram (x) sketches out how we plotted the solutions to these graphically. The full set of computations took about two weeks with the aid of an electronic calculating machine.

The tables were set out as in diagram (xi). The book in which they were published contained detailed instructions for use, of which the following are the salient features.

At the stage of bid selection, bidders used curves based on engineering features, to establish the likely total cost of the machine in question. We also suggested various methods by which they could estimate competition at this early stage, (several factors like size of machine, source of finance for the project, etc. affected this).

Having got these two factors, bidders were told to turn to a table marked 'typical variable cost' and look up the bid's maximum contribution to profits and overheads.

In fact, displaying a streak of Irish logic, we gave them two typical tables. This was because in any bid we usually had the option of making the machine entirely in our own factory, or subcontracting some of it to a works in the country of destination — a policy which usually resulted in lower total costs, but proportionally higher marginal ones. One was therefore faced with a make in or buy out decision. Our approach resolved this problem quite simply, because one merely has to find the maximum expected contribution from each alternative, and use the one with the highest. It is interesting to note that we gave them a rough rule based on a few generalisations, which said "make in unless your factory price is more than x% above the subcontractors one, otherwise you are losing contributions". This went some way towards ending years of strife between the manufacturing and engineering divisions.

Anyway, having worked out all the expected contributions, the bidder selects the bids with the highest values for these and goes for these. Note again that it is not clear whether one even needs to have an absolute value of total cost at this stage, as it is arguably better to choose bids on their expected margin of contribution. In other words it may be better to do 2 small bids at 120% of total cost, than one large one at 110%, even though the absolute value of contribution generated by the latter is higher.

Forecasts of order intake etc., are made as in diagram (v).

Bidders then instructed their commercial office to go all out to find accurate information on numbers and types of competitors, etc. for the bids they had decided to make. In this respect, we made suggestions as to the redesign of their intelligence system, which was completely inadequate for this task.

Another interesting problem which can crop up at this stage, is the possibility of joining forces with another company or consortium. Such a decision will lower the number of competitors at the expense of some contribution. It may also alter the total bidding capacity. The methods outlined above make a quantitative evaluation of the worthwhileness of this strategy quite easy.

As the bid date draws nearer, more information becomes available. The final decision on pricing can also be made from the tables, using the latest estimates of competition and variable cost. Forecasts are updated all the time.

So we now have a practical system for bid selection and pricing, and we can also make forecasts of order intake and profits from the same data. The remaining question is how many bids we should make. To answer this, we have to work out what the marginal cost of making a bid is, and then arrange our bidding capacity so that we are roughly able to bid for all jobs where the marginal cost of bidding is less than the maximum expected contribution from the bid. Actually this sum is rather difficult, and it is probably reasonable to err on the high side.

However, the intuitive feeling that it is better to bid for everything is not usually true: Considerations of capacity restrictions which I shall touch on later, often restrict the number of bids. It is also worthwhile considering whether one or two bidders should not be transferred full time to collecting and collating commercial intelligence.

We have now found practical solutions to all the problems, and more, that were originally posed. These differ from what went on before mainly in that they enable decisions to be made on the basis of logical and quantitative analysis, rather than blind guesswork.

Perhaps the biggest difference between the new system and the one it replaced, was the flexible attitude to bid pricing. Before this, the company pursued a fairly rigid x% on total cost policy being constant, irrespective of the particular bid it was making. They now had a realistic policy which was a living thing, in that it took account all the time of the changing commercial environment they operated in.

In this respect, it is interesting to note that in one of the rare results published in this field, it is shown that by following a variable pricing policy evaluated on the above lines, a certain contractor gained at least 14% more than he could have done by using ANY fixed pricing policy.

Despite all this, it must be realised that our model is still a crude one, and I shall briefly discuss its major short-comings just now. I think it only fair to warn do-it-yourself bidders, that it could be dangerous to apply the simple model and completely ignore these other factors. During the course of the investigation I have been talking about, we were continuously checking to make sure that the variables we were ignoring did not radically alter the policies we recommended. Even so, we realised that situations would occur where management would quite rightly want to use different policies to the ones we recommended, and we went so far as to suggest what these situations might be, and how the basic answers might be altered. It should also be obvious that it is still necessary to apply every possible commercial pressure on the buyers, after the decision to bid has been made. In the extreme, this may result in discovering other people's prices, in which case our model ceases to be useful.

The first point I would like to touch on concerns what quantity we are trying to maximise as a result of our policies. We aimed to maximise contribution to profits and overheads, which seemed to us the most logical approach. I suspected, however, that some of the people we talked to were confusing maximising profits with maximising order intake. A real life example of the dangers of this policy is shown in diagram (xii). We see that by lowering our bid price below that needed to achieve maximum contribution, we can in the extreme double our order intake. To do this, however, we must bid at a price lower than our marginal cost — usually not a very intelligent commercial practice. Incidentally, in practice expected contribution curves drop off more sharply to left than right so if in doubt bid higher.

Another point is that I have not yet mentioned turnover, but talked only in terms of order intake.

To forecast turnovers, the order intake (if the bid is won), should be split into turnovers in each production period that the contract lasts for. These can then be multiplied by the respective probabilities of success, to get expected order intakes. We encountered extreme practical difficulties in attempting this, because of long production cycles and uncertainties in timings. Incidentally there is an argument for using some sort of discounted cash flow analysis on expected contributions, when these are going to come in over a long time interval. If turnover forecasting is practicable, it may also be possible to use a much more sophisticated approach to bid selection than ours.

A whole series of intriguing possibilities arise when one tries to delve more deeply into the fact that certain parameters are themselves subject to a probability distribution. The most obvious of these are cost and number of competitors, although another interesting and important problem which can be approached from the same angle is the fact that the lowest bid does not necessarily win, (this happened about 15% of the time in our exercise). All this family of difficulties require the employment of conditional probabilities. For example, in the last case, the probability of winning becomes: (the probability of being lowest) × (the probability of winning if we are lowest) PLUS (the probability of being second lowest) × ( the probability of winning if we are second lowest) PLUS etc. We showed in the exercise in question that the existance of customer bias (as we called it), did not alter optimum bids significantly, but could reduce forecast contributions etc. by as much as 25%.

Only a computer could provide an acceptable means of dealing with this family of difficulties, and it was our opinion that the model we had produced would have to be developed along these lines as soon as enough data had been collected. It would also normally be true to say that only a computer based system could keep track of shifts in the relationship between bid prices and our costs.

No mention has yet been made of the relationship between a company's bidding policies, and how they should relate to its physical capacity for work. In our exercise we could afford to ignore this interaction as the works in question had a very flexible capacity because of its ability to subcontract. This problem is very complex, and one cannot usually ignore it like this. This would be particularly true in the sort of case I was discussing with a member of one of the mining houses the other day, where the number of competitors is fairly constant, and consequently this factor recedes in importance as the dominant variable determining bidding policies.

In the simplest case, one approaches this problem by working out total expected turnover, (at cost) in each forward production period. When this equals capacity in any period, one does not bid for any more jobs for that period .

Life being what it is, it is necessary to delve a bit more deeply than this, because the costs of exceeding capacity are often radically different from the loss of profits associated with not achieving it. As our expected turnover is a statistical average, we are going to run into each of these circumstances fairly frequently.

The problem is solved by computing a bidding limit. The calculation of this is complex, and although again it is possible to produce tables, the job is probably better done by a computer. One aims to compute the bidding limit which gives the minimum expected loss — note that this is the first time that we have used the negative strategy of minimising loss rather than maximising profit!

Another problem is that of lack of data on competitors' bid prices. This can usually be overcome but the methods used will depend on what data is available, and I do not intend to propose a general remedy.

Finally, you will recall that I said earlier that the methods I have been talking about imply a complete departure from traditional methods of factory costing. I would like te spend the last couple of minutes explaining what I meant by this.

Traditional costing methods start by making some forecast of turnover at cost for, say, the next year. The fixed costs of supporting this turnover are then estimated, and divided by the turnover at cost to give a recovery rate. When a bid is costed, one first works out the marginal cost, then adds this recovery rate to it to arrive at something called total cost, (or some similar term). Bids are then often made at some fixed percentage above total cost, say total cost plus 5%. The mechanics of this operation are usually more complex than this, but essentially this is what is happening.

The fallacy of this approach will be immediately apparent, because it is your bid prices which determine what turnover you will get, and hence what recoveries or contributions to profits and overheads you will make. Hence, to protect turnover, and then to use this prediction to give an arbitary (and often constant) mark up on marginal cost for your bid prices, is physically meaningless and can lead to disastrous results.

Our remedy to this problem is not to spread overheads at all, but rather to consider them in the light of the approach shown in diagram (v). In other words, we estimate the direct costs for each of the bids we intend to make, work out an optimum bid for each case, and then forecast the total contribution to profits and overheads (and the turnover), which will result from this strategy. This figure is then compared to the total fixed cost which the predicted turnover requires to support it. If the comparison is unfavourable, (i.e. fixed costs are more than total contribution), we have several major options open to us. Firstly we can shorten or lengthen our bid list: secondly we can see if we can alter our direct and/or fixed cost levels and thirdly we can manipulate the market forces, (i.e. by bribery or making consortium arrangements). We must study the feasibility of all of them, and make new forecasts after we decide what it is possible to do. If, even after this the fixed cost level is still higher than the total expected contribution, we must seriously consider whether it is worthwhile being in the business.

It seems patently obvious to me, and I hope to you, that this approach is incomparably better than the previous one. On the other hand, it is true to say that I and others have encountered considerable hostility towards using it. Inasmuch as this is because people don't understand what we are trying to do, we must accept the blame and continue to try and find new methods of getting our ideas across. For some reason people seem to think that the new method leaves them with less control than before, but this is the opposite of the truth. Control of marginal costs remains as before. Spreading fixed costs is no more a method of controlling them than it is of making cheese, but the method I have outlined gives us control of fixed costs, (and direct ones for that matter), taking market forces into account. What is more, control is up-to-date as forecasts are being updated regularly, whereas recovery rates sometimes remain fixed for long periods of time.

Lord Kelvin said: "When you can measure what you are speaking of, and express it in numbers, you know that on which you are discoursing. But when you cannot measure it and express it in numbers, your knowledge is of a very meagre and unsatisfactory kind." Your knowledge of this commercial field is probably anything but a meagre and unsatisfactory, but nevertheless, I hope that the little I have had time to say, has given you some additional vision into what can be done with numbers in the commercial policy field.

DIAGRAM (iii)

OUR CHANCE OF BEATING FRED SMITH AND THE CONTRIBUTION WE WILL MAKE IF WE DO.

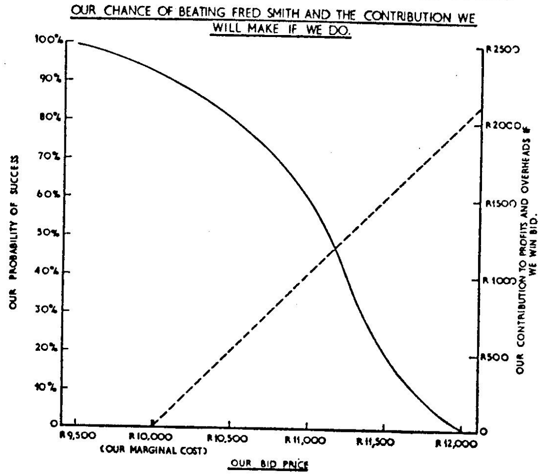



DIAGRAM (i)

FRED SMITH'S LAST 10 BIDS

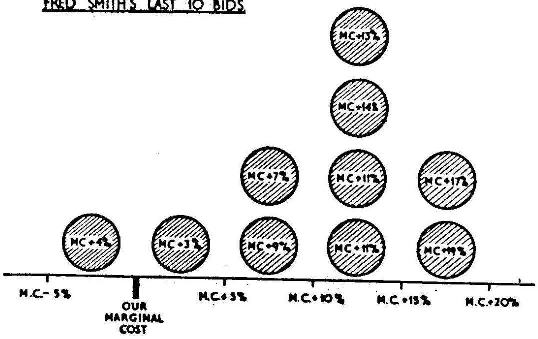
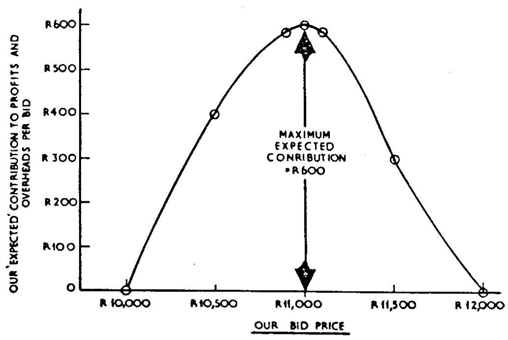



DIAGRAM (iv)

OUR 'EXPECTED' CONTRIBUTION AT DIFFERENT BID PRICES



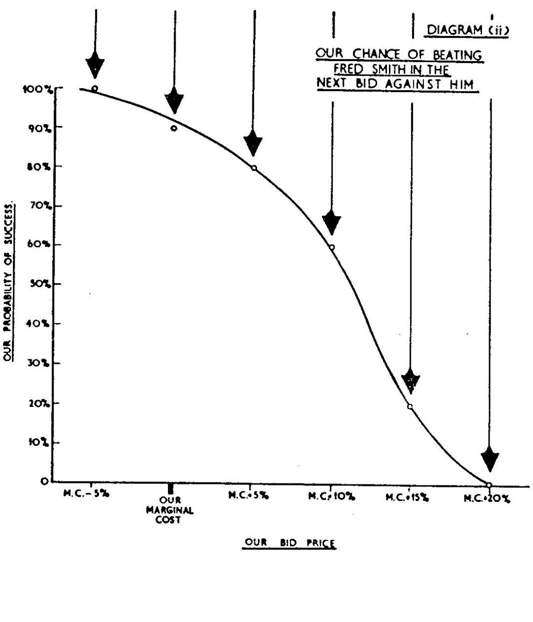




DIAGRAM (vi)

THE AFFECT OF COMPETITION ON PROBABILITY OF SUCCESS.

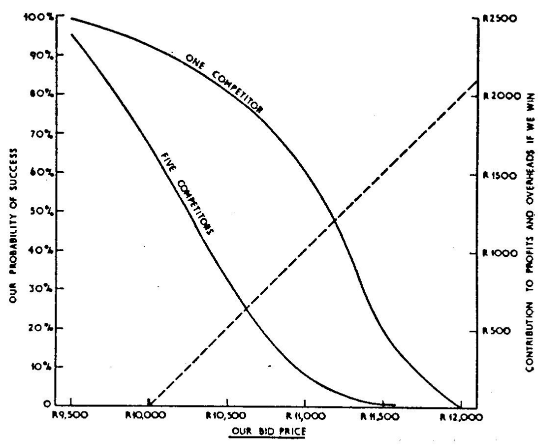


DIAGRAM (vii)

THE AFFECT OF COMPETITION ON OPTIMUM BID PRICE AND 'EXPECTED' CONTRIBUTION

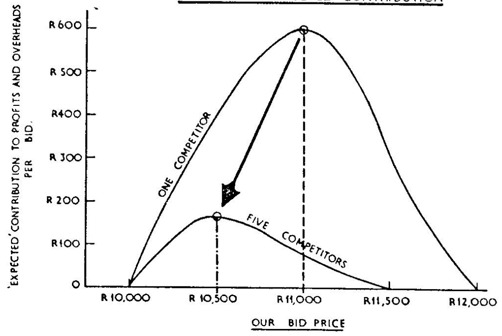



DIAGRAM (viii)

AN ANALYSIS OF OUR COMPETITORS' BID PRICES.

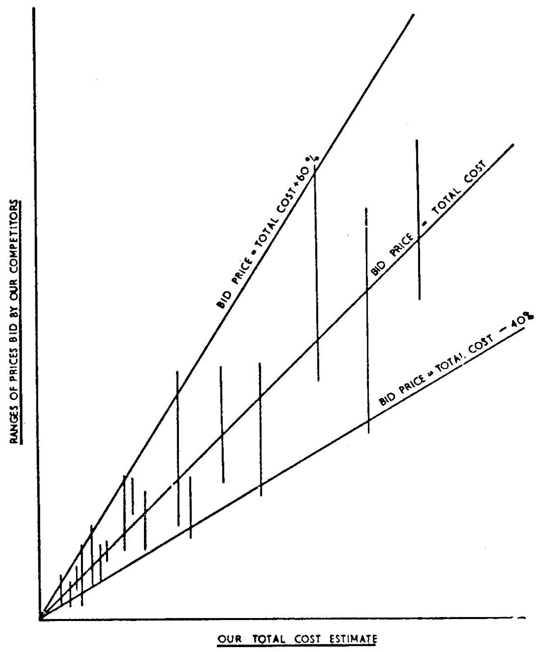



*Diagram (ix):*

## DEFINITIONS AND SIMPLE THEORY

DEFINE:

| | | |
|---|---|---|
| TC | = | Our Total Cost Estimate |
| b × (TC) | = | Our Bid Price |
| v × (TC) | = | Our Variable Cost |
| E | = | Our Expected Contribution |
| p(b) | = | Probability Distribution of Competitor Bid Price |
| F(b) | = | $\int_O^B p(b)\, db$ |
| N | = | Number of Competitors |

CONDITION FOR OPTIMUM BID IS:

$$\frac{db}{dE} = O$$

but:

$$E = (1 - F(b))^N (b-v)TC$$

so

$$\frac{dE}{db} = -N\,(1-F(b))^{N-1}\,\frac{dF(b)}{db}\,(b-v)TC + (1-F(b))^N\, TC = O$$

or

$$\frac{1}{(b-v)} = \frac{N.p(b)}{(1-F(b))}$$

say

$$\alpha\,(b, v) = \beta\,(N, b)$$

DIAGRAM (x)

FINDING OPTIMUM BID PRICES

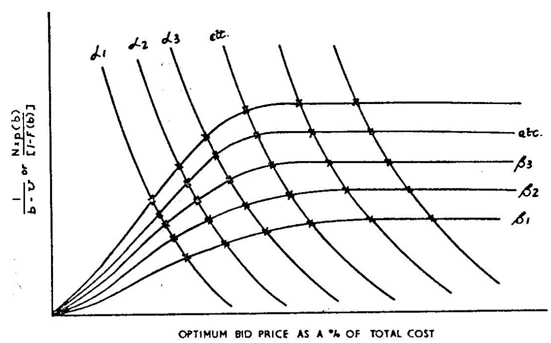


DIAGRAM (xi)

EXAMPLE OF A BIDDING TABLE

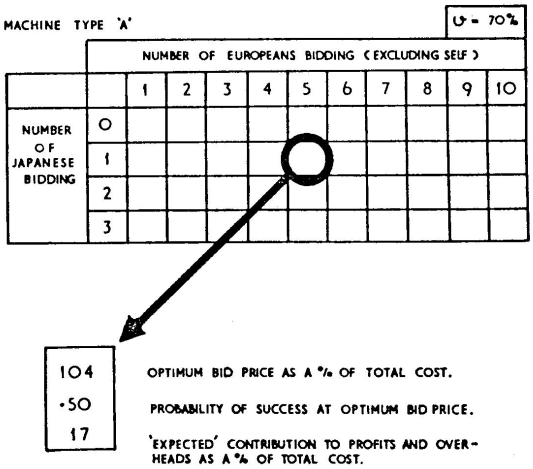
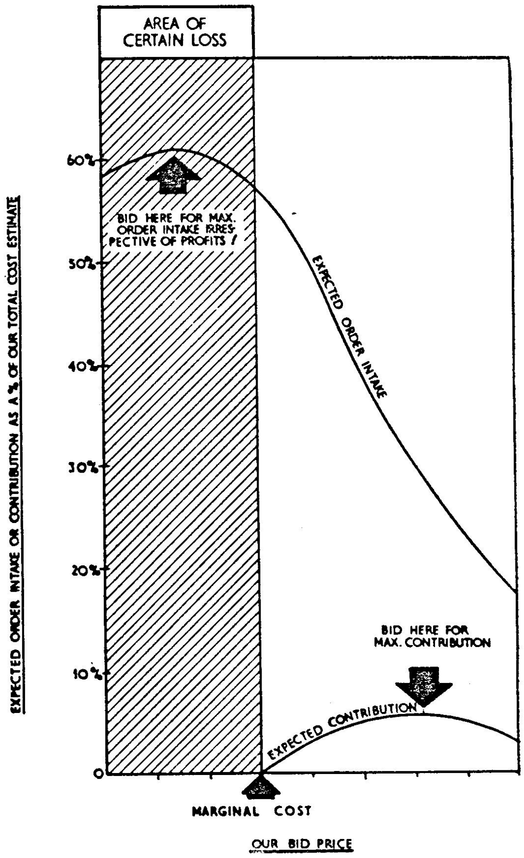



DIAGRAM (xii)

THE DIFFERENCE BETWEEN MAXIMIZING ORDER INTAKE & CONTRIBUTION




## EXAMPLE OF A BUSINESS FORECAST (ALL VALUES IN R1,000's).

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Bid | Our Marginal Cost | Our Best Bid Cost | Our Contrib. to P & O if won (3 - 2) | Our Prob. of Winning | Our "Expected" Contrib. (4 × 5) | Our "Expected" Order Intake (3 × 5) |
| A | 42 | 49 | 7 | .5 | 3.5 | 24.5 |
| B | 96 | 100 | 4 | .4 | 1.6 | 40.0 |
| C | 100 | 110 | 10 | .5 | 5.0 | 55.0 |
| D | 70 | 75 | 5 | .3 | 1.5 | 22.5 |
| E | 10 | 15 | 5 | .3 | 1.5 | 4.5 |
| F | 55 | 62 | 7 | .5 | 3.5 | 31.0 |
| G | 55 | 58 | 3 | .4 | 1.2 | 23.2 |
| H | 64 | 70 | 6 | .6 | 3.6 | 42.0 |
| I | 81 | 87 | 6 | .5 | 3.0 | 43.5 |
| J | 76 | 85 | 9 | .6 | 5.4 | 51.0 |
| | TOTALS | | | 4.6 | 29.8 | 337.2 |

i.e. From making Bids A to J, one forecasts:

1. About 5 wins (approx. = 4.6).
2. At total contribution to Profits & Overheads of R29,800.
3. A total order intake of R337,200.