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The Development of an Online Bidding Game as a Learning Tool

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ABSTRACT

Competitive bidding in construction involves high degrees of risk. The nature of the work involved is not certain: the contractor cannot accurately predict all of the factors that are involved such as the weather, soil conditions, labour rates, reliability of plant, the extent of wastage, and productivity. Whilst cost estimates are usually done deterministically, these uncertainties will give effect to some degree of unavoidable error in these estimates. Despite these risks, the mark-ups in this industry are typically relatively small. Given this environment, the lowest bids in any tender may be the cause of comparatively low costs (for reason of some competitive advantage), erroneously low estimates of these costs, low mark-ups, or a combination of these factors. As a result, contractors suffer the risk of the "winner's curse" which is otherwise known as a Pyrrhic victory. A contractor's bid may be the lowest because they made an error under-estimating their costs, causing them to win the tender but make a loss. An online Bidding Game is in development that will facilitate that students will be able to compete against each other in a safe, simulated environment. They will be able to test their skills at deciding strategies as regards selecting projects on which to compete and then decide bid prices that are sufficiently low for them to "win" and yet sufficiently high as to produce profits, given conditions that resemble the real world.

KEYWORDS

bidding, pricing, bidding models, game theory

INTRODUCTION

Research on bidding models was started by Friedman (1956). He proposed a mathematical technique for predicting the bid prices of competitors and hence the determination of an optimum bidding price, given a competitive situation. He formulated models for three different scenarios, namely (a) if a contractor has knowledge of who their competitors are for a given project, or (b) if they only know how many competitors they have, or (c) worst of all, if they don't even know how many bids they will be up

against. Friedman's model provides a basis by which a contractor can analyse the data they have available and decide their best-suited bid.

Around the same time, and independently of Friedman's efforts, Gates (1959) formulated an alternative model. The Gates versus Friedman debate has raged on ever since, with many dozens of researchers falling largely into one or other of these two camps (see, for example, Skitmore 2002). Most bidding models are derived from either Friedman's or Gates' original models. Abdel-Razek (1987) is one of those who have provided a synopsis of the early stages of this conceptual 'battle', Crowley (2000) provides a more recent assessment, and Skitmore (2002) provides a quantitative comparison.

Despite extensive research on bidding models (comprising well over 1000 journal papers) these theories are believed to be seldom applied in the 'real world'.

The role of these bidding models is not to be confused with that of *unbalanced* bidding models (see Cattell et al. 2007), which are aimed at optimizing the pricing of the component items *within* a project (given that the contractor has already decided their bid price for the overall project).

The use of Bidding Models is highly contentious and many practitioners believe that the theory is of no practical use. Some students believe that they can justifiably discard having to study these techniques. It was for this reason that a simulation game was developed for use as a tutorial in the classroom environment, whereby students could try a variety of techniques of their own choice, including those supported by prior research and theory, as well as any other approach that they believe to be more appropriate.

There is now a game in development that is a modern, online version of this early (offline) game. It is suited to being a teaching aide for some users as well as a game of entertainment for others. Both such situations will serve to generate data for academic research.

EARLY DAYS

It was decided by the author in 1984, at the University of the Witwatersrand in Johannesburg, South Africa, that a simulated Bidding Game could serve to give students practice in bidding, and in particular, that it would give them opportunity to test various bidding models in a safe and risk-free environment (Cattell 1985). It was started in a very simple manner, given that these were early days with PCs. The university's department was fortunate to be a beneficiary of an HP mini-computer, donated by Skok Systems (an early pioneer in desktop-based CAD software). The game was put together to simply function as follows:

a) Students were invited to a tutorial in which they competed against each other, by submitting bids in secret, to test their effectiveness at deciding tender prices.

b) Prior to the tutorial, some software was written to run on the computer to randomly generate a series of cost estimates, roughly simulating contractors' inability to be 100% accurate with their deterministic estimates of a project's total cost (see Beeston 1975). The software was given as input a supposed value of a project's final, true cost, and it then randomly generated, using a normal distribution, a series of numbers which were then treated as estimates of this final cost (ignoring the effects of inflation).

c) Sufficient data was generated in advance of the tutorial so as to have simulated cost estimates for several such 'projects'.

d) The tutorial started by giving each student a piece of paper that secretly revealed to them, their (personal) 'cost estimate' for the first 'project'. Each student's estimate was drawn out of a hat so as to be obviously unbiased.

e) The students were given a few minutes to decide their tender price and they then submitted these, written on paper. The bid prices were then announced, together with identifying the students who had submitted them, and the project was 'awarded' to the lowest bidder. This bidder alone was then told of the project's true cost, which was then used to determine if they made a profit – and this information was kept secret from the other competitors.

f) The students then went on to compete for the next project, on the same basis, and repeatedly so until the end of the tutorial. At the end, it was revealed how much profit or loss each student had made over the course of the full session.

Interestingly, the students started this exercise with an attitude of suspicion as regards the theory of bidding models. They appeared to have an attitude that the tutorial would be easy and that the mathematics of bidding models would likely have little to offer them with what seemed to be an 'obviously' easy exercise in which intuition would guide them to making great profits. To their surprise, the tutorial ended with them all having made losses, and seemingly very confused about how to make a profit.

They couldn't seem to escape the wrath of Pyrrhic victories: where their (winning) mark-ups regularly proved to be insufficient to overcome their higher probability of winning whenever they were assigned an under-estimated cost. Those who drew high cost estimates had little chance of winning, regardless of their mark-ups, whilst those who drew low cost estimates fell foul of having chosen a mark-up that would, typically, be insufficient to yield a profit.

The course then went on to teach them about the mathematics of bidding models, by which time this subject had become more meaningful to them. The tutorial was then repeated on the same basis as the first session. This time, the students were noticed to be adopting more formal strategies and the session ended with many of them having made

profits. Overall, the exercise proved useful at illustrating the practical need for the theory of bidding models. It proved the merit of a mathematical approach, albeit that, given that the students had discretion on their individual strategies, this brief exercise didn't provide any assessment of any particular bidding model.

MERIT GAME

Loughborough University ran their first, paper-based MERIT game in 1988 (Loughborough 2011). Since then they have run the game for more than 20,000 contestants. Their game has a wide agenda: aimed as functioning as a teaching tool for most of the management skills involved in construction, and not merely that of bidding. It is also designed around an annual schedule, which builds up to a final round in which the teams of contestants gather together in a physical location to compete. The system is largely dependent on being administered by software that has been developed especially for this purpose.

THE NEW BIDDING GAME

A new bidding game is now in development that has been patented. It will be solely Internet based and is being designed to be freely available to be played, in some modes, throughout the year, by anyone who has web access. Access will also be given to some mobile devices, such as Android- and Apple's iOS-based smartphones and tablets. Some gaming sessions will be 'closed' and restricted to use only by groups of students, and more particularly, set up to assist universities as the basis of tutorials, to be administered (online) by the respective lecturer / tutor.

Players will be able to compete against each other, else against simulated players that will implement bidding strategies that have been proposed by various researchers over the past 50 years.

Players will start with an assigned profile, describing their work in progress, location, reputation, skills set, amongst other characteristics and resources. These will be adjusted (enhanced or depleted) as the game progresses based on the players' performance. Each project will be announced with some description of the project and the requirements that the players will have to be measured against in order to qualify to tender. Of those projects for which a player is qualified to tender, they will be able to select the projects on which they wish to compete. This will give them the facility to employ a strategy as regards which nature of work they wish to pursue, as well as the level of bid to submit in each instance. Their strategy could include the submission of non-competitive 'cover prices'.

As a further consideration, there are times when some contractors will enjoy a competitive advantage on a project whereby their costs will be lower than their competitors. This may be because of their location, prior experience of similar work, exclusive access to some resources, or by way of having the benefit of some proprietary knowledge or skill that will ensure comparatively better productivity in some manner.

Different projects will have different degrees of information published as regards which players have chosen to submit bids. Players will be able to adapt their bidding strategies accordingly, to take advantage of whatever information is available to them in each instance.

Players' success at the game will be measured according to their long-term ability to survive the perilous conditions typically prevalent within the construction industry, inclusive of the varying conditions arising from business cycles. By comparison, players' short-term successes or failures will be, more so, determined as a function of random 'luck'.

Players will be encouraged to adopt a systemized approach in which their pricing on individual projects will be governed by their own algorithms that they will have to set up in advance. They will be able to tweak these and refine them as they progress. Players will be able to input these in the manner of macros as has become popular in application software such as MS-Word and Excel.

The game is also being designed to serve to gather data on bidding behaviour for the purposes of making this available for academic research. Researchers will have data on the relative success of different bidding strategies, under a variety of conditions and in competition with a variety of other strategies.

The game is also being designed to appeal to players with skills that would traditionally fall outside of the discipline of construction management. It should, hopefully, for instance, serve to interest those with applied mathematics and operations research skills. This multi-disciplinary environment should service to cross-pollinate skills besides serving to test the practical efficacy of various theoretical approaches on an even playing field.

ADMINISTRATION

In the academic environment, lecturers / tutors will be able to administrate the games that their students will play under their control. This administrative role will give them the ability to set the accuracy of the cost estimates as well as the variance between contractors as regards their real costs. For instance, if a lecturer wants to simulate an environment in which contractors are all identical as regards incurring equal actual costs and, also, if they wish to empower their students with a super-human ability by which

they can be 100% accurate when estimating these costs, then the players of the games that they administrate will all be given the same cost estimate. Whilst this scenario does not represent the real world, the administrator will be given control of their games to this extent that they can create such an environment for their students to play in, for whatever reason they may want to test this.

CONCLUSIONS

The new bidding game should complement the MERIT game. It will address a far-wider audience and could even interest people from outside the industry, in the same manner as the game of Monopoly (Hasbro 2011) is not only of appeal to property developers. It will, on the other hand, by comparison to the MERIT game, have a more narrow focus on project procurement by way of bidding. Its primary purpose will be to serve as a teaching aide whilst further academic benefits will include the data that will be generated as regards players' bidding behaviour.

The game will not require the use of bidding models or any mathematical technique or strategy, nor does it advocate that any methodology is preferable or necessary for success. Instead, it will present a safe, simulated environment in which students, academics and other players can apply their own strategies. They may choose their approach to be a derivative of an established bidding model or to be a novel mathematical technique of their own. Alternatively, they may wish to try an approach that has little or no mathematical sophistication. In this context, it should prove to be interesting for both students and their teachers to test the effectiveness of this variety of strategies, recorded over multiple projects and in laboratory conditions where any noise from extraneous factors can be excluded.

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