THE OOPS GAME: HOW MUCH PLANNING IS ENGOUGH?

Gregory Howell[1] **& Min Liu**[2]

ABSTRACT

The future is unknown and unknowable. In the face of this reality, planning tries to assure an outcome certain. The "Oops Simulation" (Oops) models the dilemma experienced by every planner: "Should I spend more (time, money, resources) to improve my plan or go forward with what I have and more likely suffer an "Oops"? This problem is the sort Civil Engineers face when trying to decide how many soil samples to collect to assure the foundation design will be sufficient and most economical. This sort of problem is faced at every level in project planning: "How much effort is it worth to assure weekly work plan is 100% planning reliable? At what level of precision – week, day, hour, minute?" It is unlikely that anyone on the project could answer such a question because there are so many possible immediate and longer-term interactions with unknown consequences. This simple 9-card simulation can be used in research and teaching to study the cost and benefits of planning under uncertainty both in "economic" and human decision making terms. At the extreme, there are two strategies in Oops Game: 1) No planning, the "Guts Ball" approach where the cost of planning is lowest and risk of an "Oops" is highest; and 2) Risk averse where the investment is made in planning until there is no risk of an "Oops." In a third and more realistic approach, "Judgment" the decision to plan rests on an analysis the risks and likely outcomes in the situation at hand. The paper explains the simulation and its application in the classroom and as a platform for research into planning effectiveness, decision-making, and complexity.

KEY WORDS

Lean construction, planning, risk, project management, productivity, reliability.

INTRODUCTION

Projects are conceived, designed and constructed to deliver needed capability in the face of uncertainty. Risk, the possibility of harm (or "the combination of uncertainty and the potential severity of loss that arises"), is at every turn as people establish needed outcomes, plan and organize the necessary means and wherewithal, and take action. Risk is identified and reduced in the course of planning (including design and engineering) as people consider hazards and their consequences, apply discipline-based knowledge and lessons from experience, collect and analyze information, and

[1] President, Lean Construction Institue, Box 1003, Ketchum, Id 83340. +1-208/726-9989; ghowell@leanconstruction.org

[2] Assistant Professor, Department of Civil, Construction, and Environmental Engineering, North Carolina State University, Raleigh, NC 27695-7908. PH (919) 513-7920; E-mail: min_liu@ncsu.edu

decide choosing one alternative over another. But how much planning is enough given the ineffable reality that the future is unknown and unknowable?

Every project manager and planner at every level faces this dilemma as they balance the cost of additional planning against the reduction of risk. While the cost of additional planning is easy to measure, the cost of failures great or small is difficult and often impossible to conceive, predict and estimate. This is the sort of problem posed when deciding on the number of core samples needed to determine the soil conditions prior to foundation design. The "perfect answer" may not be knowable until long after construction is complete. And the strategy might change based on the immediate evidence from any sample.

The paper first reviews literature related to the value of planning and then introduces "The Oops Game" (OOPS), invented by Michael Vorster and Gregory Howell, as a model of the planning dilemma for both teaching and research.

PREVIOUS RESEARCH ON THE VALUE OF PLANNING

The value of planning has been studied in a number of fields such as socio-economics, world development, operation research, corporate management, and business venturing (Blumstein and Cassidy 1973; Brada et al. 1983; Bock and Hoberg 2007; Camillus 1975; Gruber 2007). However, according to our knowledge, little research has been done in quantifying the cost and value of improving the reliability of decision making and planning for construction projects. Austin et al. (1999) studied the value of detailed and reliable planning in design phase. They stated that common planning practice takes little account of the interdisciplinary and iterative nature of the building design process and this leads to a compromised design process containing inevitable cycles of rework. Subsequently they proposed Analytical Design Planning Technique (ADePT) to generate the project-specific models in an acceptable time scale. However, they did not quantify the value of planning in design phase or measure the value of the proposed technique.

Work on the value of planning in construction phase is mainly done in the field of Lean Construction. Ballard and Howell (1998) gathered over 450 weeks of Percent Plan Completed (PPC) data from seven different companies and found they had an average PPC of 54%; thus illustrated the lack of reliability in the construction industry. As a result, Ballard (1994) created the Last Planner System® (LPS), in which the Last Planner (typically a foreman) develops the weekly work plan by using a 6 week look-ahead process to ensure constraints on successful task execution are identified and removed, and limiting work assigned to ready work within the capacity of the crew. The benefits of using LPS® have been mainly investigated in terms of improving PPC (Ballard 2000, Ballard et al. 1996, Ballard and Howell 1998, Kim and Jang 2005). Howell et al. (2001) suggested that improving planning reliability from 50% to 70% improves productivity by a significant amount between 10 & 30%. But to our knowledge little work has been done to understand and quantify the relationship between the investment in planning and the return in improved performance using empirical project safety, duration and cost data.

PLAYING RULES FOR OOPS GAME

OOPS can be managed by one person and it is easier with three. When roles are assigned, one player, the "Project Manager" announces the choice for each card. The

Superintendent handles the cards moving them as directed. “Project Controls” assures the rules are followed and keeps score. All participants should watch for errors. The aim of the simulation is to complete a nine-card project as shown in the Figure 1.

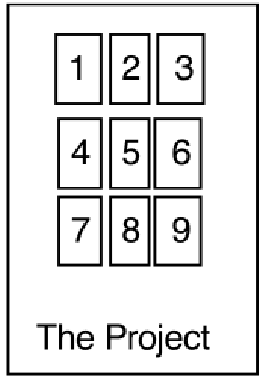

Figure 1: A Nine-Card Project

Figure 2 shows the locations for cards and the cost to move a card from one location to the next. The cost of each move is recorded on the score sheet. Play begins with all cards shuffled and face down in the “Yard”.

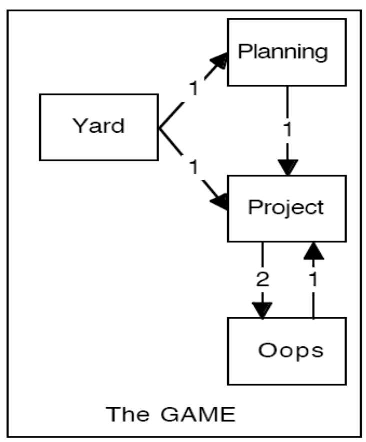

Figure 2: Configuration and Scoring

1. The top card is turned face up and placed in its position on the project and a mark placed in the “Build” column on the score sheet.
2. The next and all subsequent cards may only be added to the project if they share an adjacent edge with a card already on the project. Corner to corner connections are not allowed. For example, if the first card was the 3, then only cards 2 and 6 may be placed directly on the project.
3. Before each of the remaining cards is revealed, the Project Manager makes the decision either to “Build” or “Plan” and announces it.
   - If “Plan” is announced, the top card is turned over and placed in “Planning” and a mark is made in the “Planning” column on the score sheet. The cards

face up in “Planning” are moved to the project when it shares an adjacent edge with a card already on the project. In the example above, if the 3 was drawn first and the 2 second, then the 2 should then be immediately placed on the project.

- If “Build” is announced the top card is turned over and a mark is placed in build on the score sheet. If the card turned over shares an adjacent edge with a card already on the project - the 2 or 6 as in the example above. Then place the card on the project.
- If the card turned over does not share an adjacent edge with a card already on the project, place the card on in Oops, and a mark in the “Oops” column on the score sheet. The card remains face up in Oops until a card on the project shares an adjacent edge. Then it is brought on to the project.

4. Before making and announcing the next choice, review the situation to assure any cards “Planning” or “Oops” that share an adjacent edge have been added to the project.
5. The simulation is complete when all 9 cards are on the project.
6. “Project Control” assures that cards are placed only when they meet the shared-edge criteria and are placed in the correct location. The “Superintendent” assures the score is correctly recorded. Table 1 shows a completed score sheet. Figure 3 and 4 show the process for “Plan” and “Build”.

Table 1 Sample Completed Score Sheet

Week	Build	Plan	Oops
1	1		
2	1		1
3		1	
4	1		
5		1	
6	1		
7	1		
8	1		
9	1		
Sum	7	2	1
Outcome Cost	1	2	3
Extension	7	4	3
TOTAL COST			14

CLASSROOM SIMULATION AND DISCUSSION

Once the class understands the OOPs simulation, it can be used to explore a variety of issues related to planning and strategy. Demonstrate the management of the simulation and rules to the class by playing a few rounds in public. Once the rules are well established, have each three-person team complete the simulation 10 times with the no planning “Guts ball” strategy. Collect and post the scores in a simple histogram to display the range of outcomes, the frequency of each outcome and the average performance.

Then have teams complete 10 rounds using a “Risk-averse” strategy and collecting the same data. (People using simulations play a form of OOPS too. Take the time to assure students know how to manage the simulation each time the situation changes.) In the Risk-averse strategy, “Plan” is chosen until there is no risk of “Oops” because all remaining unused cards will share an adjacent edge with cards already in place. For example, there is no risk of an Oops if the 2, 5 and 8 cards are in place. Check on each team during the simulation to assure they are following instructions.

When all teams have completed their play, post results and have the teams compare the results from risk averse with those from “Guts ball.” Then open the discussion to the larger group and discuss both their analysis of the results, and the implications for real life.

- Students learn more when they discover the patterns and issues raised by OOPS. A carefully designed post simulation conversation is useful but it should not prevent or limit open discussion. Begin by asking what patterns are apparent both in data and what they have learned about the simulation. The data will reveal that the range of outcomes is narrower under the risk-averse strategy and average performance is better than that produced by “Guts ball” given the cost of planning and consequences of an Oops established at the outset.
- “Guts ball” will usually produce both the best and worst outcomes. Ask why they might choose one or the other. Then shift to discovering what they have learned about the simulation itself and its management. Listen for any observation about the patterns they see related the first card revealed. If not raised by participants, the instructor should be prepared to direct their attention to the importance of early cards. When a corner card is drawn first, only 2 cards out of 8 will share an adjacent edge. By contrast, 4 cards of 8 will share an edge if the center card, the “5” is chosen first. The instructor should also consider using these questions to shape the discussion: Which strategy in average results in lower cost of completion for the project? Does it match their anticipation?
- Which strategy has a more predictable outcome? Which strategy has lower variance in outcomes?
- Which factors can change the lower costing strategy from one to another?
- How would changing the cost of Planning, Building and Oops impact the results? For example if the cost of an Oops were very low or on average 3 but randomly varied.

INJECTING COMPETITION: A FIRST STEP TOWARD REAL LIFE PROJECT MANAGEMENT

Real managers bring their experience, history and backgrounds to bear as they manage projects. In real life, managers may be both courageous and risk averse but to neither of the extremes experienced in OOPS. Use this first step toward real life to explore the behavior and results of decisions made by managers in a competitive environment. Give each team $10 as capital and then challenge them to increase it by their management skill. (It is usually better to not use real money as most colleges and universities have restrictions on gambling.) Explain that all teams interested in bidding must pay a dollar to bid, a sort of an ante, and only the team with the low bid will be allowed to play. Allow time for the teams to decide what they will bid and to submit their “sealed” bids in writing along with the dollar for the costs expended in bid preparation. The team will make money if they deliver the project for less than bid and will have to pay for any overruns. Flip a coin to choose the low bidder in case of a tie. Turnover the first card and ask for their choice and record the results. Repeat the bidding and performance process several times until it is clear that the competitive environment is provoking them to take risks that compromise their ability to survive. Stop when this point is obvious and shift the conversation to explore the potential consequences of resource or financial constraints on decision making in general and safety in particular (Dekker 2011).

Shift the conversation to explore how the simulation is and is not like real life. Certainly, an Oops is always possible and risk can be reduced by gathering more information and sometimes by waiting until more information is available. But unlike real life, the probability of Oops is rarely known with any precision and the relationship between the investment and cost of its reduction is neither known nor fixed. Turn the discussion to focus on the process and practice of risk reduction. Ask questions about what they could do in real life to learn more before deciding. Real life rarely gives firm statistics for failure or the nature and magnitude of the consequences. Rather, people make assessments, that is, they shape and ground their opinions more or less well. Explore how changing the probability of a failure and the magnitude of the consequences might change their choices. The aim here is to bring consideration of probability and consequences to the surface in order to develop their ability to ground their assessments with the best information available. How they might discover information about the probability and consequences in various circumstances. How they might make their choices if the consequences of an Oops was doubled or the cost of information reduced by a factor of 10.

Ask students for examples from their lives where they play OOPS every day – where do they take steps of one sort or another to reduce risk? They might leave early for the bus, keep extra cash on hand, keep their cell phone fully charged etc. Return to the simulation; How much would they be willing to play to select the first three cards in the deck, or to order the cards? What would they pay at the beginning of the game for a cards that could be placed anywhere on the matrix/

Real Life Reflections and Implications:

- How does this game relate to reality? Provide examples of causes in construction that may prevent timely execution of activities.
- How do you interpret the following statistics?
    1. Maximum cost for each strategy? The difference between the maximum cost and the average cost for the strategies represent the amount of possible cost overruns.

2. The average cost of strategies? In the long run, the difference between the two cost averages is the amount of savings that one can gain using the lower average cost strategy.
3. The standard deviation of the results? A lower standard deviation in cost shows a more predictable performance. This reliability in performance will result in more reliable bid estimates and subsequently will help reduce the contingency cost that is considered in the estimates.
4. What activities would you consider as examples for a 4-card game (predictable probability of Oops)? Also provide examples for 9 and 16 card games (higher probabilities of Oops).
5. In real life what factors impact the cost of Planning, Building and Oops?
6. If you are in a decision making position for a project how might you think about the choice between planning and building in a variety of circumstances? What factors will you consider in your decision?

CONCLUSIONS

The Oops simulation raises a fundamental question in project management: how much planning is an enough? The answer always starts with "it depends". It depends on how much an Oops will cost, who will pay, and how much the risk can be reduced by more planning. The choice to "plan" vs "build" depends on the probability of having an Oops given the amount of planning that we can afford. It gets harder for us to answer the question in the very real uncertain world. We can never know for certain of the costs and probabilities of failure. The Oops simulation provides us a platform to capture those elusive concepts and relationships.

There are many remaining questions can lead to very interesting and useful future research. The directions for the future research include: 1) Human reaction to fixed and variable consequences with the same consequences on average, changing the cost of information – it would be interesting to test decreasing information cost and increasing consequences on each draw; 2) OOPS could be used to explore how people act differently in the face of an risk. The simulation could be played where people know there is a fixed cost of an Oops such as two dollars more than planning, and an average cost of an Oops of two dollars but a range of outcomes from 0 cost to four dollars. In this situation people who suffer an Oops would spin an arrow with equally probable out comes of 0, 1, 2, 3, and 4. The hypothesis would be that people are more risk averse in the face an uncertain outcome than a fixed outcome of the same average amount; and 3) Explore the effect of competition and cooperation by having 2 or more teams playing separately or combining and allowing cards from one to fit on another project.

REFERENCES

Austin, S., Baldwin, A., Li, B., and Waskett, P. (1999). "Analytical design planning technique: a model of the detailed building design process." *Design Studies*, 20 (3) 279-296.

Ballard, G. (1994). "The Last Planner." *Proc. of Conference of the Northern California Construction Institute,* Lean Construction Institute, Monterey, CA, 1-8.

Ballard, G. (2000). “The last planner system of production control.”. *PhD thesis*, Dept. of Civil Engineering, University of Birmingham, Birmingham, U.K.

Ballard, G., Casten, M., Howell, G. (1996). “PARC: a case study.” *Proc. IGLC-4*, Birmingham, UK.

Ballard, G., and Howell, G. (1998). “Shielding production: Essential step in production control.” *J. Constr. Engrg. And Mgmt.*, ASCE, New York, NY, 124(1) 11-17.

Blumstein, A., and Cassidy, R. G. (1973). “Benefit-cost analysis of family planning.” *Socio-Econ. Plan. Sci.*, 7 (1) 151-160.

Bock, S., and Hoberg, K. (2007). “Detailed layout planning for irregularly-shaped machines with transportation path design.” *European Journal of Operation Research*, 177 (2) 693-718.

Brada, J. C., King, A. E., and Schlagenhauf, D. E. (1983). “The benefits of long-term developmental planning: an estimate.” *World Development*, 11(11) 971-979.

Camillus, J. C. (1975). ”Evaluating the benefits of formal planning systems.” Indian Institute of Management, Ahmedabad.

Dekker, S. (2011). “Drift into failure.” *Ashgate*, Surrey, United Kingdom.

Gruber, M. (2007). “Uncovering the value of planning in new venture creation: A process and contingency perspective.” *J. of Business Venturing*, 22 (6) 782-807.

Kim, Y., and Jang, J. (2005). “Case Study: An application of Last P lanner to heavy civil construction in Korea.” *Proc. IGLC-13*, Sydney, Australia, 405-411.