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THE RELATIONSHIP BETWEEN THE SPECIFICATION, LOW-BID PROCESS AND CONSTRUCTION NONPERFORMANCE

Dean T. Kashiwagi
Director, Performance Based Studies Research Group, Arizona State University, Tempe, Arizona, USA

John Savicky
Researcher, Arizona State University, Tempe, Arizona, USA

ABSTRACT
This article identifies the Specification, Low-Bid Delivery Process as the major cause for construction nonperformance, the eroding of construction quality and craftsperson skill, and identifies the process as expensive and filled with non-value added components. The article discusses the industry structure, problems, and practices, which bring construction nonperformance. It presents an information solution, which will reduce delivery costs and litigation, and at the same time increase construction performance, craftsperson skills, and competition. The solution includes four information filters that minimize risk: an information theory (Information Measurement Theory), a self analysis and identification of performance process (Performance Information Procurement System or PIPS), and a multi-criteria decision making model that forces competition and identifies the "best value." The impact of the process includes contractor self improvement, the understanding of construction risks by the contractors and the users, creative solutions, contractor responsibility and the minimization of construction decisions and inspection by the user's representatives. The solution is tested out in two State of Georgia construction projects. The paper discusses the project solutions.

KEYWORDS
Specifications, Construction Nonperformance, Performance Contracting

1. INTRODUCTION

The construction industry has experienced the following problems in the last ten years (Post, 2001):

1. Low profit margins in a high-risk industry.
2. Reduction of trained craftspeople in the subcontracting areas.
3. Performance issues.
4. Dispute issues.

The specification, low-bid award process has been the traditional construction delivery system. The "lowest bidder" meets minimum performance requirements set forth by specifications. Over the past ten years, this process combined with the worldwide competitive marketplace, has seen a trend of contractors not minimizing the owner's risk (construction on-time, on-budget, and meeting quality expectations.) More and more, contactors provide the

minimal acceptable quality at the lowest price. The low construction performance is a direct result of the owner's desire to cut cost. The vehicle of this movement is the specification, low-bid delivery system.

The price pressure has motivated owners to reduce design fees. The architects and engineers have reacted by transforming their responsibilities to include the management and delivery of construction. However, architects and engineers are not trained in construction. There are several problems caused by this trend (Shearer, 2000.):

1. The design documents, which communicated the requirements of the owner to the contractor, have become regulatory documents instead of documents that communicate intent.
2. The designer becomes responsible for inspection and identification of construction quality.
3. With the regulatory documents, contractors are being directed and controlled to produce quality at a minimal price.
4. Minimum standards are being used, which are subjective and difficult to relate to performance.

The task to produce performing construction has become more complex. With a movement toward low cost in a high risk arena, every party is attempting to minimize their liability. By definition, this complex environment is devoid of performance information (differentiates contractor's ability to minimize risk.) It has the following impact on the industry (Post, 2001; Kashiwagi, 2001.):

1. Minimal training and a lack of trained craftspeople and construction managers.
2. Low quality construction.
3. Low profits and poor work environment (more work for less pay) resulting in construction work being perceived as an unattractive industry.
4. Contractors are forced to leverage volume for price, do more work with minimally trained personnel.
5. Architects and engineers are highly insured due to their "high" risk.
6. Litigation increases due to the lack of information and unwise business practices.
7. Users hire designers, engineers, and consultants, who attempt to regulate the performance of poor performing contractors through construction management.

The above environment describes the current construction industry. Many of the factors have been individually identified. However many designers, engineers, and construction managers, have had difficulty understanding that the specification, "low-bid" award process and accompanying "practices" is the source of construction nonperformance. This misunderstanding is evidenced by the following:

1. Difficulty of federal agencies to move to performance contracting. Federal agencies are still procuring construction that is not on time, not on budget, and not meeting quality expectations.
2. Federal agencies using performance contracting, often pre-qualify based on performance, and then award based on low price.
3. Protests in the State of Hawaii and Utah, claiming that performance contracting was expensive and did not add value.
4. After two high performance based projects were delivered through performance contracting, a State of Hawaii Department of Transportation director took the policy that the "low-bid" was a better system. The previous director had encouraged his staff to move to a performance contracting to relieve the contractors of the "low-bid" low profit environment. He predicted that the two major contractors could not survive the low price competition in the "low-bid" environment. One year later, one of the main companies bought the major competitor, and raised their prices.

1.1 Information Measurement Theory

Information Measurement Theory (IMT) is a deductive logic, which gives some insights into the relationships of factors based on factor's level of information. IMT has the following theoretical foundation:

1. Everything is cause and effect (previous state affects the next state.)
2. All factors are related and relative.
3. Information is relative data and laws of physics that predicts the future outcome and minimizes uncertainty.

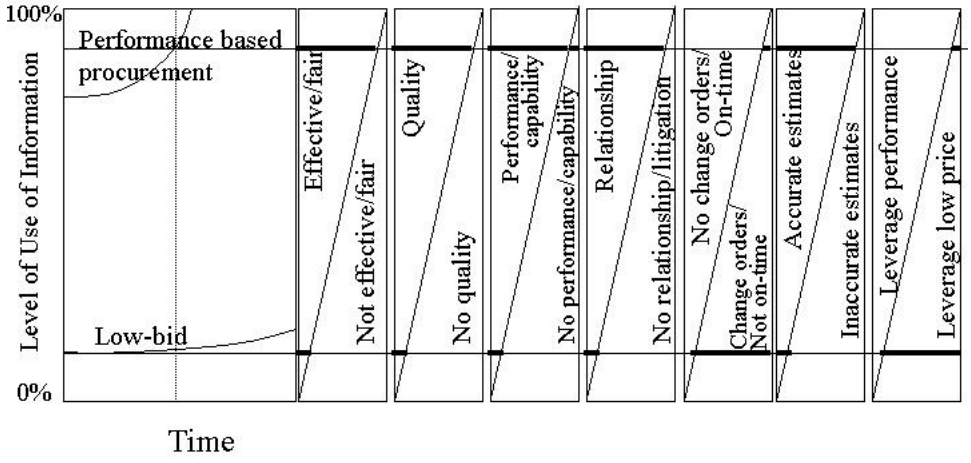

Figure 1: Characteristics Associated with "Low-Bid" and Performance Contracting

The results show that the influx of performance information results in high performance, agreeing with the results of Figure 1.

1.2 Industry Structure

The construction industry can be graphed using two major components: competition and performance (Figure 2). The industry is divided into four quadrants:

Quadrant I. High competition, low performance. This is where the award is based on price. A minimum performance (low performance) is required. The contractors force the owner to identify when the performance does not meet minimum standards. The award is based on price. The lowest price is usually awarded the contract. In many instances the low bid may also go to contractors who forget to include activities, force subcontractors and manufacturers to lower their price, and employ the "least expensive" management and craftspeople. Survey results show that the contractors agree with the identification of Quadrant I as the existing construction environment. In this Quadrant, construction management and inspection are key components.

Quadrant II. High competition, high performance. This is the "best value" or performance-contracting quadrant. Users consider both performance and price. It differs from both Quadrants I and III in that it requires performance information that minimizes risk (not being on-time, on-budget, and meeting quality expectations) and does not require "means and methods" specifications, construction management, or owner driven inspection. Performance contracting has the following characteristics:

1. Performance information (past performance, current capability, and risk minimization) is used to select the contractor. Many performance contracting procurements pre-qualify by performance, than select the low-bidder. This is not true performance contracting. Anytime price is used as the sole selection criteria, it is a Quadrant I low bid award.
2. The user allow the contractor to dictate "means and methods," control the construction, set the schedule, and inspect their own project minimizing the inspection by the owner's representative during the project. The owner's representative would inspect at the end of the project to determine if the contractor met the requirements.
3. The user would minimize decision making. In the case of the Georgia tests discussed below, the Performance Information Procurement System (PIPS), which uses an artificial intelligent processor, was used to prioritize and select the "best value." The process uses past performance and current capability factors while minimizing the subjective translation of the numbers.

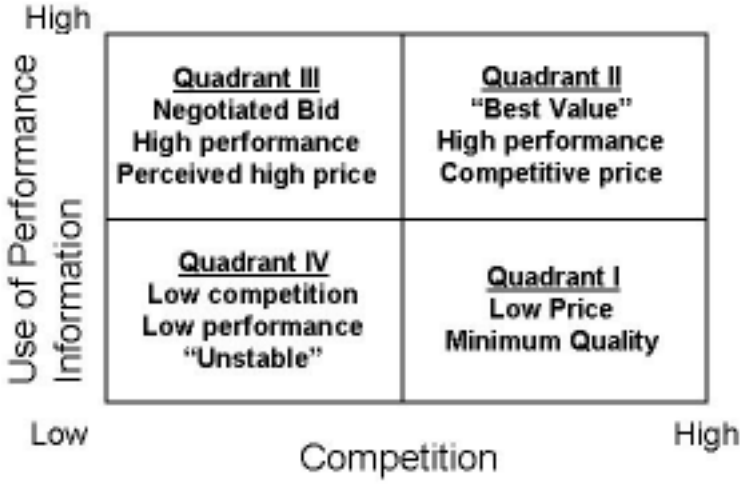

Figure 2: Construction Industry Structure

Quadrant III. High performance and low competition. This is the negotiated contract. Users usually pre-qualify contractors, and subjectively select the best value. There is no way to identify the value of construction unless more than one contractor is employed. This quadrant will also become unstable. Owners looking to reduce cost will seek competitive bids.

Quadrant IV. Low competition and low performance. This quadrant is unstable and cannot maintain itself. If a contractor has no competition, and cannot perform, they will not remain in business for a prolonged period of time. When a performer appears, the nonperformers will disappear. If competition appears, the noncompetitive will disappear. An industry requires performance, competition, or both to maintain it self.

It is interesting to note that designers, engineers, and construction managers control Quadrant I due to the minimum specified requirements (Figure 2.) Performing contractors control Quadrant II. Movement to Quadrant II from I has brought resistance from the design community in both the states of Hawaii and Utah.

1.3 Performance Based Contracting Implementations

The Performance Based Studies Research Group (PBSRG) located at Arizona State University has been performing research on an information based Performance Information Procurement System (PIPS) for the past seven years. An artificial intelligent processor is used to transform performance data into information, minimizing the subjectivity of decision makers. The following are test results over the last seven years (Kashiwagi, PMI presentation, 2001.):

1. 300 tests on $167M of construction procurement.
2. General and specialty construction, design-build, new, and retrofit construction.
3. States of Wyoming, Utah, Georgia, and Hawaii, Dallas Independent School District, Federal Aviation Administration, Honeywell, Motorola, Intel, IBM, and Boeing.
4. The project results are 99% on time; no "identifiable" contractor generated cost change orders.
5. Reduction of construction management by 75%.

Information filters are used to force contractor self evaluation and self elimination. The following filters are used:

1. Understanding that owner wants performance and that all contractors will compete on performance. This eliminates all contractors who compete only on price and who cannot verify their performance.
2. Identification of owner risk (not on time, budget, meeting quality). This eliminates all contractors who cannot owner identify and cannot minimize risk because they do not have the experience.

3. Contractors compete on performance and price. An artificial intelligent model does this. With minimized biased decision making, the highest performance will always be prioritized best.

4. Top prioritized contractor takes responsibility for design intent, means and methods, and schedule. There are no contractor generated cost change orders.
5. Contractor performance directly impacts the contractor's future chance of getting more work. Their rating on the project count 25% toward their future performance line.

Risk is minimized not by construction management, but by the best performing contractor available. The award process forces the performance within the budget, instead of forcing contractors to lower their price to get the project under the low-bid system. This principle has been well documented by Deming in the manufacturing sector.

1.4 State of Georgia Performance Contracting Case Studies

The State of Georgia is in the process of two performance-contracting tests. The first was a $45M construction of a Environmental Engineering Wet Laboratory at Georgia Tech, and the second was a $18M technical education building at Savannah Technical College. The first test was unsuccessful. The second test is in the construction phase and on schedule.

The first test was unsuccessful due to the over design of the project by the designer. As in other locations, the misperception that performance-contracting drives up the cost of the project was also brought up. The critical subcontractors on the project were the mechanical, plumbing, and electrical contractors due to the nature of the environmental laboratory. The highest performing subcontractors qualified for the project. When the bids came in at $56M, $54M, and $52M, the designer and the user's representatives charged that the project cost was being increased due to high cost union contractors. However, this contention could not be supported due to the following:

1. A similar facility (not as complicated) was constructed two years earlier next to the new construction site. The cost per square foot was more than the estimated cost of the new facility. If the same cost with no cost accelerations due to the increase in construction cost, the budget for the new facility should have been $52M.
2. After agreeing with the user to reprocure the construction using the low-bid award system, the State of Georgia facility group, redesigned about $4.5M out of the project. The lowest bidder was at $46.5M. The low-bidder used the low-bid subcontractors. Of the performing mechanical contractors, the subcontractor selected was the lowest rated mechanical subcontractor in the performance-rating scheme. The project is currently behind schedule and the budget is up to $48M.
3. All three bidders stated that the budget was impossible to meet. All bidders gave various value engineering proposals which brought the price of the facility down to or close to the budgeted amount. The majority of the items were rejected.

After an analysis was done of two of the bids and the designer' project estimate, a difference of $4M was identified in the mechanical construction area. After these findings, the State of Georgia decided that the project was over designed. The performing contractors were asked if there value engineering ideas could be used to reduce the scope of the project. All the contractors agreed, with two of them rebidding with the rescoping of the project under the low-bid system. The Board of Regents at Georgia Tech claimed that the performance contracting drove up the price of the project and directed that the project be awarded through the low-bid process. The bidders who rebid were still substantially higher than the budget. The low-bidder was at $46.5M.

It is significant that when analyzing the general contractors and the critical subcontractors, the general contractor had the lowest past performance and did not participate in the performance contracting bid, and only one of the twelve critical mechanical and electrical subcontractors who had submitted past performance references was used by the low bidder the second time around. The contractor had the lowest performance score of all the critical subcontractors in their area.

The performance contracting process had the following differences from the low-bid award:

1. The contractor submitted their own schedule and identified how they were going to do the project.
2. The contractor and critical subcontractors who won the project, were required to review and coordinate the design, get clarification on anything that could not be built, and sign a contract taking responsibility for the intent of the design.
3. There would be no cost increase change orders awarded on the project.

An observation made by contractor and labor trade organizations was that the process identified the top mechanical and electrical contractors in the Atlanta area. Some contractors were inquiring how the subcontractors were selected and were amazed to find out that the performance contracting process of allowing all participants and allowing the subcontractors to identify their own performance had been effective. The first test case did show that high performance critical subcontractors do not inflate prices. This has been seen by the other performance contracting tests, which show that prices do not rise substantially. Tests also show that change orders decrease dramatically.

One of the problems encountered on this project was the amount of over design or the large amount of the performance based prices over the budget (15 to 25%). This was the first occurrence of 200 tests at that time, to have this problem. In the philosophy of minimizing decision making, the following award process was identified to solve this problem in future performance contracts:

1. If the project was within the budget, the highest performing contractor would be prioritized first and awarded the contract if they accepted to take full responsibility of the project.
2. If the project was over the budget, the user would subjectively pick the best value, depending on the various levels of performance, the prices, and the additional amount of funding that could be secured.

This award process would put the contractors at risk for inflating the price, and encourage contractors to stay within the budget if they were close to the budget. The budget should be given to the contractors ahead of time, allowing them to identify the risk on not being within budget, time, or quality.

The second test at Georgia was a technology educational facility at Savannah Technical School. The project was an $8M new facility. The difference of location from the first project brought the challenge of getting enough qualified contractors who would do performance work in the relatively (when compared to Atlanta) rural area of Savannah.

The concerns were confirmed when the process failed to identify any new contractors. There were concerns that some of the smaller general contractors would not be able to handle the scope of the project. However, in keeping with the performance contracting philosophy of allowing the contractors to self eliminate themselves, the process was continued.

For the second time, the project was over designed. This is despite a direction to the designer from the State of Georgia to not over design. The State's opinion was that this was one of the better designers, and would not over design. The construction was relatively simple, and the competing contractors were past "low-bidders" known for bidding low, and proposing change orders for additional funds and time extensions. The budget was $7.8M, and all the bids were around $10M. It exposed a serious problem in construction delivery, the accurate estimating of construction costs. The State of Georgia requires the designer to use an independent cost controller/estimator. Despite the independent cost control, both projects were over designed. This can have a negative impact on the contractor, because the owner is expecting a value that is overstated.

However, after the conversation between the designer and the contractors along with analyzing the bids, realized that the project was over designed. Deductive alternatives were identified, bringing the contractors closer to the budget. Table 1 shows the relative performance distance numbers from the Displaced Ideal Model (DIM) (Zeleny, 1985). These distances are between zero and one, the greater the distance, the greater the relative nonperformance. The following conclusions were made by the State of Georgia:

1. Contractor #1 has the best past performance, the best management plan that identified and minimized risk, a relative performing site superintendent, and performing subcontractors.
2. There were concerns that Contractor #2 did not have the capability to finish the project. The process minimized their chances of winning the project.
3. The low-bidder, Contractor #4, showed characteristics of a low bidder: low bid, poor management plan, less performing site superintendent, and didn't know much about the project.
4. Because Contractor #1 was the second low bidder, and there was only $70K (less than 1%) differential between the two, the best value is Contractor #1. The performance based process identified Contractor #1 as the only contractor the State could have hired to perform. The difference in expected performance from the performance based contractor and the low-bid contractor is predictable.

Table 1: Total Points and Ranking

OVERALL BEST VALUE			PERFORMANCE		PRICE	
Rank	**Contractor**	**Total Points**	**Relative Distance**	**Distance Points**	**Price**	**Price Points**
1st	**Contractor #1**	**9.96**	0.0500	5.30	$ 8,104,000.00	4.66
2nd	**Contractor #2**	**5.65**	0.2321	1.14	$ 8,371,723.00	4.51
3rd	**Contractor #3**	**5.09**	0.3899	0.68	$ 8,561,000.00	4.41
4th	**Contractor #4**	**5.04**	0.7784	0.34	$ 8,033,645.00	4.70
			Maximum performance: 5.3 points		*Maximum price points: 4.7 points*	

The project is currently on schedule, on budget, and without any quality issues. One of the problems that persist is the issue of control by the State and the designer. In a performance-based contract, the contractor has control and responsibility to finish on-time, on-budget. However, designers are used to demanding detailed critical path printouts to control the contractor. These activities are being minimized on the project.

2. CONCLUSION

The majority of the current construction industry is based on high competition and low price in Quadrant I. Designers, construction managers, and inspectors using the specification, low-bid delivery system that puts the owner at risk of nonperformance construction, are controlling the industry. The system uses no performance information and gives no credit to construction management skill or craftsperson skill. A move to Quadrant II by using performance information, and allowing contractors to be liable for their work will result in performance. Both State of Georgia tests show that construction performance does not increase costs substantially. As shown in the KSMs, an environment with specifications directing means and methods, construction management and inspection is associated with all the characteristics of nonperformance, and when directed to provide the minimum quality, contractors cannot be blamed for nonperformance. As seen in the State of Georgia tests, the major problems are caused by the scope, cost estimation, and over design, all tasks of the designer. The current business process of low bid construction and control by managers and inspectors is inefficient, has never worked in other industries, and makes it impossible to create a sustainable performing industry.

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