INNOVATIVE CONTRACTING PRACTICES

TRANSPORTATION RESEARCH BOARD/NATIONAL RESEARCH COUNCIL

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EXECUTIVE SUMMARY

Historically, transportation agencies in the United States have been conservative in their construction contracting practices and have tended to continue the status quo rather than assume the risks associated with change. Innovative contracting techniques have been developed more in foreign countries than in the United States. Before U.S. federal and state agencies can make greater use of these techniques, the issues, options, potential advantages and disadvantages, steps required, and legal and economic impacts must be better understood.

In order to help develop this understanding and facilitate greater innovation in government and industry, TRB formed its Task Force on Innovative Contracting Practices. The task force examined the processes, as they affect quality and cost, under which U.S. and foreign agencies contract for construction. This report summarizes the findings of the task force, as well as some federal and state initiatives that have already taken place as a result of its deliberations.

BACKGROUND

Over the past century, highway agencies have developed a system of contracting practices in which exactly what is built, how it is built, what materials are used, and how traffic is maintained during construction are stipulated. Payment procedures, dispute resolution, and testing methods are specified by traditional contracting practices. A goal of many of these practices is to minimize risk for the public agencies.

Highway agencies rely on the lowest responsible bid system in awarding contracts. Determining the lowest responsible bid requires a complex set of regulations designed to eliminate uncertainties. Unfortunately, the lowest initial cost may not result in the lowest overall cost.

Avoiding risks and minimizing costs are understandable objectives for public agencies, but, in combination, they have produced an even greater risk--the stifling of innovation in construction methods and materials, and the resulting loss of unrealized benefits.

In fact, current contracting practices provide little incentive for industry to be innovative. For example, the specifications that guide highway contracting set out the details of how work should be performed, how it will be evaluated, and who is authorized to approve alterations to the specifications. By their nature, such method-type specifications are not based on performance or desired end results. Performance-based specifications could offer lower life-cycle costs by providing contractors the opportunity to use alternative methods and materials, thus increasing their profits. However, implementation of performance specifications has been stalled by a lack of widely accepted standards and tests for measuring performance and uncertainties associated with performance guarantees.

Various concepts for new contracting practices have been developed over the past decade with the ultimate objective of improving the finished product (e.g., the highway) or reducing total costs, or both, by providing the opportunity for contractors to use more cost-effective ways to accomplish their work. Some concepts that originated in other countries may be adaptable to the United States. However, actual introduction of new practices has been slow, resulting in the need to more clearly identify the potential benefits and to encourage public and private agencies to change their traditional approaches.

MAJOR TOPIC AREAS

The task force addressed four major topic areas: (a) bidding procedures; (b) materials control; (c) quality considerations; and (d) insurance and surety issues. In addressing these areas, the task force evaluated the following:

- Procedures and specifications that stifle initiative and innovations, as well as those that encourage them;
- Ways that current procedures and specifications adversely affect quality or unfairly assign risk;
- Various types of performance-based quality assurance (QA) specifications that have been demonstrated to improve quality and equitably assign risk;
- Effects of penalties and incentives;
- Alternative methods of contract award that have been used successfully; and
- Administrative, legal, and other problems.

Recommendations were made by the task force for each of the four major topic areas.

RECOMMENDATIONS

Contract Bidding Procedures

Short-Term Actions

- A research program should be established through the Legal Resources Group of TRB to determine more

workable assignments of risk between facility owners and contractors.

- The cost-plus-time bidding concept should be considered for wider implementation with the caveat that appropriate controls must be in place. However, careful selection of the types of projects as well as accurate determination of the time value are required. Cost-plustime bidding represents a variation to traditional lowest-initial-cost bidding that can reflect the additional costs to highway users from inconvenience and delay during construction activities.
- The potential for use of warranties or guarantees should be investigated with a goal of delineating standards and procedures for maintaining data on highway segments built with warranties.
- An industry-wide awareness program dealing with warranties or guarantees should be initiated; success obtained in other industries or countries should be publicized.
- Attention should be given to the use of constructability testing throughout the design of projects; this procedure requires close coordination of all aspects of the design with those who will implement the design.
- The agencies should develop contractor responsibility tests that reflect quality and performance factors; these tests should be examined and possible modifications developed.
- The use of alternative bidding, using innovative contracting practices, is an option for public works contracts.
- Additional study should be devoted to improving the alternative dispute resolution processes for use by public agencies.
- Guidelines should be developed for establishing bidding times; these should provide the contractor sufficient opportunity for developing and evaluating innovative recommendations.

Long-Term Actions

- Research, development and implementation programs should be established to investigate the design-build concept, including a study to review the statutory authorization for it in the states that want to use it.
- Research should be started to develop means for compensating a contractor who initiates value engineering concepts that prove applicable to subsequent projects.
- Procedures should be developed to encourage private sector participation in developing and funding demonstration projects.
- Training for specification writers should be developed to identify ways to implement innovative techniques within the restrictions of contract practice and regulations.

Materials Control Enhancements

Short-Term Actions

- A nationwide research and development effort should be initiated to transition from method specifications to performance-related specifications for existing materials and processes.
- A guide to performance-related specifications should be developed and published for use by transportation agencies.
- A contact point for information should be created to publicize the benefits from highway innovations, especially performance-related specifications. Such an information center might make available assistance for those who write specifications to encourage innovation.
- A national clearinghouse or databank should be established for information on new materials and processes to be shared by the public and private sectors.
- A national effort should be encouraged to identify programs and reward those who develop innovative techniques.
- The public and government leaders should be informed of the development of new technologies and advised when they are being implemented on the highway system.
- Channels should be expanded for the review and acceptance of technologies developed in other countries.
- Procedures should be established that would permit participation by the private sector in funding demonstration projects for new and innovative materials and processes.
- Precision and bias statements should be developed expeditiously for all standard test methods not having them.
- Sampling procedures and test methods should be developed that are appropriate to the full range of aggregate sizes.
- Value engineering concepts should be investigated to identify ways to promptly approve successful innovative techniques. Those contractors who develop techniques with applicability to future work should be compensated and rewarded accordingly.
- The use of verifiable automatic records of production processes should be considered for acceptance wherever practical.
- More emphasis should be placed on the use of nondestructive testing for monitoring construction processes and pavement performance.

- Technician certification and laboratory accreditation programs should be developed for public and private sector quality assurance-quality control (QA-QC) in all publicly funded transportation construction.
- Efforts should be taken to develop systems that ensure that materials produced and incorporated into a project are similar in performance to those used in design. For example, the properties of as-built subgrades should be required to be determined before final adjustment of the pavement design.
- The use of computer systems at construction project sites should be actively encouraged.

Long-Term Actions

- National or regional self-sustaining centers for product evaluation should be investigated for potential savings and improved products. These should include private sector participation.
- To encourage innovation, cooperative specification committees with representatives from both the public and private sectors should be considered for state, regional, and national levels.
- The use of contractor-supplier-manufacturer QA-QC should be investigated for product acceptance.
- Performance-related specifications should consider incentive and disincentive provisions formulated to encourage better quality.
- Generic, performance-related specifications should be developed that encourage the introduction of new materials and processes into the transportation construction industry.

Quality Considerations

Short-Term Actions

- An updated and maintained set of working definitions for quality and performance terms is needed.
- Transportation agencies should establish or enhance present internal processes for gathering and disseminating information on new technologies.
- A focal point for R&D, implementation, and experience dealing with performance-related specifications should be considered. Such a center might assist in encouraging innovations from those who write specifications.
- An NCHRP 20-5 Synthesis should be initiated to document the current state-of-the-art regarding the use of incentives and disincentives in contracts.
- Information should be generated to acquaint elected officials and others with the advantages of improving quality and performance in highway construction.
- Research for application of expert systems to QA and performance-related specifications should be considered.
- Research should be initiated to consider ways of offering quality incentive programs to those involved in the design, specifications writing, construction, or construction management of highway projects when innovative construction practices are developed.
- The use of contractor-supplier-manufacturer QA-QC should be considered for product acceptance.
- As new information on quality issues becomes available, assurances must be made that the university technology transfer centers receive it for use by local agencies.
- All segments of the highway industry should work together to identify where rapid tests are needed and to develop them.

Long-Term Actions

- National programs should support the development and use of reliable, performance-related, rapid test methods to replace surrogate tests.
- Programs should be developed to enhance and educate the highway construction work force on the importance and value of quality production.
- Periodic forums should be considered in which users can assemble and share experiences. The breaking down of barriers through communication and a willingness to cooperate are precursors of progress.
- A national conference on life-cycle costing should be considered to establish direction for a course of action. This conference should have input from public agencies, academia, and industry.

Insurance and Surety

Short-Term Actions

- Innovations and concepts that introduce any element other than price into the bid process should be discussed in advance with sureties and their constituent groups.
- Educational materials suitable for use by sureties, insurance companies, and their constituents should be developed for purposes of explaining any proposed

innovation and discussing its ramifications well before their introduction in contract documents.

- A system of monitoring the success, failure, or variations from accepted practice of innovations should be established to maintain a data base of what does and does not work.

Long-Term Actions

- Ongoing relationships with the surety and insurance community should be established by and between state and federal highway officials. These relationships will allow for a continuing dialogue on issues of innovation and a variety of other topics.
- All parties with an interest in advocating the adoption of innovations alien to current contracting and procurement methods should expose their ideas and concepts in the industry with widespread distributions and a solicitation of comments or criticisms.

IMPLEMENTATION AND CALL FOR ACTION

The transportation industry cannot afford not to try new products, processes, or procedures. Someone must pick up on the recommendations of the task force: full implementation requires all elements of the highway community to look for opportunities to use innovations and ultimately have the states modify their standard practices to make use of the most beneficial ones.

The task force encourages the responsible federal and state agencies, as well as industry groups, to review the recommendations individually and in combination, to determine appropriate follow-up actions through their own programs and cooperative efforts. Transportation agencies, especially those of the states, are viewed as the primary agents for innovation. FHWA, AASHTO, and TRB also play important leadership roles in the development of standards and the establishment of a climate that encourages innovation.

The task force feels that the implementation of any innovation will occur only if cooperation, support, and commitment is obtained throughout the industry. If states are not willing to initiate a contract; if consultants, contractors and suppliers are not willing to take a risk and undertake such an effort; and if the insurance and surety industry does not provide the proper bonds, innovation will not happen. The activities of the task force are only the seed for change and innovation. The entire industry needs to carry it further into implementation. By trying, evaluating, documenting, and sharing the results, innovative contracting practices can benefit all involved, and especially the traveling public.

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*Task Force Members serving on more than one subgroup.

Chapter 1

INTRODUCTION

Improvements are always possible. Improvements in highway contracting practices are not only possible but desirable. Improvements that benefit public agencies and private contractors should be sought out and identified. This vision prompted the TRB in 1987 to establish the Task Force on Innovative Contracting Practices (A2T51).

The task force was created for the purpose of identifying promising innovative contracting practices for further evaluation. The members were charged with investigating the state-of-the-art by soliciting, studying, and compiling information, sponsoring annual meeting sessions, and then recommending to the TRB Group 2 Council potential improvements to present contracting practices and future TRB activities, if any, to be pursued in this area.

Innovative contracting practices, as used in this report, include processes that have been developed in other industries, procedures successfully used in other countries, and concepts unproven. Each represents some aspect of highway contracting that is not generally used by agencies responsible for building and maintaining this country's highway network.

The goal of the task force was to identify ways to reduce life-cycle costs in highway construction and to improve the quality of highways while providing appropriate attention to contractor profitability. The task force examined: (a) the effect of current contracting practices and requirements; (b) the experiences related to material specifications and newer techniques such as performance- and incentive-based specifications; (c) the potential of quality assurance (QA) efforts; and (d) the administrative, legal, and other issues that might arise in conjunction with any alternative procurement procedures.

Four major topics were identified that deal with the public-private sector relationships that exist among owner, designer, contractor, and user. The topics are bidding, materials control, quality, and insurance-assurance. Each topic is the subject of a chapter in this report and was the attention of a subgroup.

This report documents the primary findings of the TRB Task Force on Innovative Contracting Practices. The materials found in Chapters 5 through 8 include some overlap as different subgroups of the task force investigated areas independently. In looking at the recommendations, the task force saw some as short term, i.e., concepts and practices that can be undertaken in weeks or months. Others are long term and will require several years before they can be realized. However, the task force does not encourage delay in any recommended innovation. The major theme is that, within the bounds of competitive bidding, innovation should be encouraged.

Chapter 2

TASK FORCE ACTIVITIES

In addition to the deliberations and observations of the task force, information used in this report has come from a TRB annual meeting conference session, a questionnaire to all state highway and transportation agencies, and a workshop.

TASK FORCE MEETINGS

The task force initiated its efforts in August, 1988, holding a meeting in Denver, Colorado. At this meeting, a series of presentations was made to provide background information relative to the objectives of the task forces. Key presentations from this meeting are included in Appendix A. The presentations provided a stimulus for the task force to establish direction and to identify topics on which to focus attention.

Subsequent open meetings were held in conjunction with the TRB annual meetings in January 1989, 1990, and 1991.

At the 1990 annual meeting, the task force sponsored a conference session on innovative contracting practices, containing six presentations. These discussed innovative bidding procedures, the design-build concept, ways to identify and overcome barriers to innovative practices related to highway materials, the enhancement of quality in construction, the influence of insurance and bonding on construction, and the toll road alternative.

QUESTIONNAIRE

A significant phase in the task force operation was to establish a base of information from which recommendations could be made. A questionnaire was designed to obtain current state-of-the-art practices as well as practices that would be considered in the near future. The four topic areas were addressed. Highway agency representatives from research, design, materials, construction, and administration were assembled to develop the questionnaire, which dealt with construction management and operations issues.

The responses and findings from the questionnaire on the state-of-the-art practice are discussed in the next chapter.

WORKSHOP

The task force held a workshop in Fort Worth, Texas, in September 1989. Over 50 national and international experts on contracting practices from both the public and private sectors attended a series of sessions and four working meetings. The general sessions consisted of 17 formal presentations. The working sessions provided the participants with the opportunity to discuss and debate the relevant issues associated with the four major topic areas. The workshop program and a list of the invited participants are contained in Appendix B.

The attendees felt that if innovation is to be realized changes must be made in the present contracting process, which uses method specifications, rewards the status quo, and penalizes risk taking. Because of the interest shown by the attendees, considerable input was obtained by the four working groups. This information, together with the results of the questionnaires, forms the basis of the findings covered in subsequent sections of this report.

Chapter 3

STATE OF THE PRACTICE

The questionnaire on the topic of contracting practices was used to determine the state-of-the-practice used by state highway and transportation agencies across the country. Twenty-six contracting methods thought to be most widely used, or being considered for use, by state agencies were included on the questionnaire. No definition was provided for the topics identified, thus leaving to the states the liberty to interpret the contracting method using their local experiences. The states were asked to indicate if they had previously considered each topic, if it is a current practice, if it was currently being considered, if it might be considered in the future, or if it was of no interest to the state. A sample questionnaire is included in Appendix C.

The questionnaire was sent to the staff construction engineer in each of the 50 states in early 1989. In addition, members of the task force were asked to respond to the questionnaire if they had direct input to the subject.

This chapter discusses the contracting practices by the state highway and transportation agencies and others responding to the questionnaire.

RESPONSE

Forty-one responses were received, which included 38 states and 3 private-sector task force members. Table 1 summarizes the responses for each area of interest.

Overall, the responses indicate that those construction practices currently accepted and encouraged by the FHWA are the most frequently used. As expected, practices dealing with QC-QA, contractor surveying, value engineering, off-peak time incentives, and alternate bidding on structures are the most popular with the states.

On the other hand, those topics with administrative or legal barriers are obviously not being practiced. However, there was an indication of interest if some of these barriers could be overcome. These include the elimination of wage scales, risk management assurance, incentives on material quality, and guarantees and warranties in bid items.

Several topics were of no interest to many of the responding states. These topics frequently dealt with features unique to special projects and were unfamiliar to the respondents. In many cases, it was felt that if a state agency was familiar with a procedure and could rely on the training and experience of others, it could use them in appropriate circumstances. Topics that fall into this category include; design-build or turnkey projects; no-claim clauses, bid averaging or bracketing; and the build-own-operate-transfer concept.

FINDINGS

The following is a brief discussion of each of the topics presented for response in the questionnaire and the task force's interpretation of the general attitude of the responses.

End Result Specifications

Some FHWA restrictions (e.g., QC, a contractor's responsibility, and QA, the agency's or owner's responsibility) on end-result specifications are reflected in the current practice of highway agencies. Some agencies are using end-result specifications, others are considering their use, and still others are considering future implementation. There is the indication that many states prefer to avoid direct specifications on the construction process and are slowly working towards specifications that address the final product. The greater acceptance by the FHWA of end-result specifications appears to have generated a broader acceptance of the practice by the states.

QC-QA

The mood appears to favor increasing the contractor's responsibility for QC and letting him be responsible for the product. QA would be retained by the agency or owner; however, in situations with personnel restrictions, a third-party contractor frequently provides the necessary assurances. This topic is one of the more popular topics for innovation and may indicate the wave of the future.

Contract Administration

The indication is that states do not want to turn contract control over to the contractor unless there is an overload on the state agency caused by a shortage of personnel. Again, third-party contract administration is an alternative.

TABLE 1 SUMMARY OF QUESTIONNAIRE FINDINGS*

Topics	Previously Considered	Current Practice	Now Being Considered	Consider in Future	Not Interested
End result specifications	2	13	9	10	6
QA-QC	2	27	7	4	1
Contractor administration	1	11	4	5	20
Contractor surveying	0	30	4	5	2
Value engineering					
Design phase	3	22	8	3	2
Construction phase	2	27	5	2	5
Design-build (turnkey)	2	2	4	7	26
Cost-plus-time bidding	3	2	3	12	20
No-claim clause	1	0	0	14	25
Bid averaging and bracketing	0	0	0	11	27
Contractor qualifications		16	9	7	8
Build-own-operate-transfer	0	1	3	8	27
Bid item consolidation	1	3	2	15	18
Night and weekend work	0	30	3	6	2
Reimbursement for engineering cost	3	11	0	11	13
Pre-bid conferences	1	35	2	1	2
Elimination of wage scales	0	1	1	25	10
Risk management-assurance	1	3	2	18	12
Incentives-disincentives					
Time	3	28	3	4	1
Pavement smoothness	1	20	7	7	3
Material quality	1	13	5	15	3
Alternate bids					
Pavements	6	16	2	8	6
Structures	3	28	2	4	3
Guarantee-warranty bid clause in					
Workmanship	1	8	3	18	7
Materials	2	10	3	16	5
Time limits	1	4	2	19	9

*Not all agencies and contractors responded to all questions.

Contractor Surveying

This popular practice transfers the responsibility of performing the engineering surveying from the owner to the contractor. Responses indicate general acceptance of this practice.

Value Engineering

The process of developing alternative designs or procedures to establish relative as well as absolute values for each alternative is an accepted practice. More emphasis is currently placed at the design phase. There is some resistance to using value engineering at the construction phase.

Design-Build (Turnkey)

The construction of structures appears to be the only area in which a contractor designing and building a project as a single entity is being considered. The concept does show some potential for more widespread use.

Cost-Plus-Time Bidding

Although not in widespread practice, cost-plus-time bidding has been authorized by the FHWA on an experimental basis. Interest is expressed in this technique once procedures are established to include user cost in the contractor's bid methodology. Thus, this process needs to be better defined and developed to avoid the existing fear of uncertainty as to the consequences. It is expected that this concept is most appropriate in congested areas.

No-Claim Clause

This concept has been used in some states on small construction contracts that specify that no claims will be made on given bid items. One of the least popular concepts, this topic may not be realistic for widespread use. It appears appropriate only for small jobs, certain activities, or types of claims. Again, this topic needs further development before gaining widespread acceptance.

Bid Averaging and Bracketing

Under these concepts, certain countries use a process that eliminates high and low bids; the bidder closest to the average cost is awarded the work. These concepts are not accepted in the United States under current philosophies. This topic was the least popular topic addressed by the questionnaire.

Contractor Qualifications

Prequalification or rating of contractors on the basis of past performance appears to be used on major or specialized contracts. For this concept to become more widely accepted, procedures need to be better established and tested. With overall knowledge and experience, this concept may grow in popularity by the industry, resulting in a better overall product.

Build-Own-Operate-Transfer

Build-own-operate-Transfer (BOOT) is a European concept used on major toll facilities such as the Channel Tunnel between England and France. Here the contractor's risk is maximized, not only taking on the physical and financial risk of construction, but also the risk related to the marketing of the end product. The survey indicated some degree of interest. This concept is currently being considered for several projects in the United States including the Dulles Toll Road extension in Fairfax County, Virginia.

Bid Item Consolidation

Variations exist on this job-specific concept, which is designed to combine bid items similar in constructability and payment schedule. It has a potential for reducing engineering cost. Many agencies are not interested in this concept. Perhaps through education and training, a gradual approach to its use could become acceptable.

Night and Weekend Work

Off-peak-hour construction is especially popular in congested areas. Over 70 percent of the states use this feature, indicating that the logistic and cost problems have been solved. Concepts such as lane rental and fast-tracking projects may further encourage this topic.

Reimbursement for Engineering Costs

A diversified response was received on this topic indicating a degree of variability in implementation. The practice

of charging the contractor for engineering cost incurred beyond core hours has provided a major budget benefit to the owner. This concept also encourages better administrative practices by the contractor and discourages overtime work, which helps to reduce the number of construction-related problems, such as work-zone accidents or unsafe conditions.

Pre-Bid Conferences

This concept was the most popular, receiving a positive response from over 85 percent of the states participating in the survey. Better understanding of the scope of work, reduction in unanticipated construction conflicts, plan revisions, and other value engineering benefits can result from such conferences. Specialty jobs, especially fast-track projects, are most appropriate for this process.

Elimination of Wage Scales

Experience on non-federal-aid projects has demonstrated the usefulness of this concept to contractors and highway agencies. Although it is unpopular and there are barriers (e.g., federal Davis-Bacon Law) in federal programs and opposition from worker organizations, this topic has the potential for increased usage.

Risk Management and Assurance

End-result specifications and a determination of QA enter into this issue. Although not currently being practiced, many agencies are considering this concept for future application.

Incentives and Disincentives

Incentives and disincentives have been used routinely on major projects with high pay-back for project time and pavement smoothness. Future consideration for material quality indicates considerable promise, especially using selected pay items with high benefit-cost ratios.

Alternate Bids

Although the FHWA has set up criteria for bidding pavements using life cycle costing, more development is needed. Life cycle costing procedures need to be demonstrated in order to gain confidence in this practice, and the incorporation of long-term cost as a construction bid item needs to be addressed. Alternate bids for highway structure work is a state-of-the-practice concept. Minor structures and retaining walls are areas in which this concept could readily be expanded.

Guarantee-Warranty Clause

Current practice is limited primarily to highway hardware and related items. The survey indicated that nearly half of the states are considering this topic for the future, indicating the need for significant development. However, federal restrictions and other legal barriers need to be addressed and overcome. The incorporation into end-result specifications of proof of responsibility procedures and other owner-builder responsibilities are areas for development before implementation. In addition, improved and well-understood performance-related test methods are needed that reflect the quality of the items covered in the guarantee and warranty clause. These then become the responsibility of the contractor.

SUMMARY

The questionnaire indicated that significant progress is taking place regarding innovation in selected topic areas. Many agencies are implementing QA-QC philosophies, contractor surveying, value engineering, off-peak time incentives, alternative bidding on structures, and other concepts. Additionally, many cost-saving and profitable concepts are being considered for future use and in need of further development. However, many agencies expressed interest in receiving guidelines on other concepts that were not well understood.

Chapter 4

BARRIERS TO INNOVATION

The dominant goal that guides the awarding of public highway contracts today is to minimize risk and costs. Specifications must protect agencies against poor performance. Risks of delay, increased costs, public criticism, and contractor controversy can be avoided. Initial construction costs are minimized in an effort to increase the number of projects that can be produced each year. Together, these risk and cost reduction goals have historically limited the discretion of the public servants responsible for recommending and awarding public contracts.

Three major barriers must be recognized in evaluating the potential for innovation in construction contracting practice: (a) resistance to change, (b) risk potential, and (c) cost factors. The members of the task force recognize these as barriers to be considered by any agency contemplating new contracting procedures.

RESISTANCE TO CHANGE

Transportation contracting officials acquire their skills and methods of operation by learning from their agency predecessors. Each agency has its own techniques and standards set within a guiding legal framework. Engineers and specification writers generally follow past practice in developing their contract specifications.

Adherence to past practice by the highway contracting community has produced predictable results that translate into predictable products. Improvement in contracting, leading to a better product, occurs when a climate is created that encourages true innovation. Contract writers understand that the safest guide for present and future contract decisions is to observe past practice. There is little incentive for innovation and even less for making significant changes in contracting procedures. The contract professionals look to organizations that set national standards, to federal agencies, and to local legislation for signals of approval to try new techniques. The lack of incentive for change results in retaining of past practices.

The specifications that guide highway contracting vary from state to state and may even vary from agency to agency within a state. Such specifications set out the details of how work should be performed, how it will be evaluated, and who is authorized to approve alterations to the specifications. By their nature, such specifications are based on construction methods rather than on performance or desired end results. These method-type specifications prescribe conformance with current practices, having been developed over many years of contracting practice. Thus, they usually are subject to detailed scrutiny before they are changed.

Reluctance to vary from method-type specifications or to alter them is promoted by several factors, including the lack of widely accepted standards and tests to measure performance and the uncertainties associated with guarantees.

RISK POTENTIAL

Public sector contracts are designed to minimize risk, whether of a financial or fiscal nature, or of a physical or political nature. For example, factors like avoidance of adverse publicity or political criticism directed at poor performance or unacceptable practices, reductions in safety, construction delays, and legal or other liabilities all influence public contracting practice. Laws governing such contracts that limit the freedom of contracting agencies have often been adopted in response to these risk issues. Such laws seek to balance actual and perceived public interests, cost considerations, and the avoidance of future risk.

The use of accepted, known standards comfortably minimizes risk, whereas innovation does not lend the same level of comfort. Although legal restrictions tend to reinforce reliance on known standards, proposed new contracting practices must recognize the restrictions.

The contracting community is also concerned that risks inherent in new contracting practices may create resistance from contractors who conclude that the equities they see in current contracting procedures will be disturbed. The contractors understand what is accepted today; changing practices must be accompanied by a demonstration of benefits to be derived from change so that the practices do not represent an unreasonable business risk to contractors.

COST FACTORS

The demands on highway agencies are greater than what the resources at their disposal can accomplish. Therefore, the need to keep initial costs as low as possible always affects decisions on highway contracting practices. Unfortunately, the lowest initial cost may not translate into

a realization of the lowest overall cost in the context of a completed project.

Funding for highway projects almost always separates new construction and maintenance into distinct programs with separate funding streams for each, complicating the way costs are considered and allocated. Public highway contracting agencies traditionally view the structure of funding programs as their guide when evaluating costs. Thus, although the design process and design system are intended to balance long-term maintenance requirements with the features of initial design, contracting practice and procedures do not accommodate proposals that offer that same balance because contracting, unlike design, is driven by available funding.

In addition to their focus on achieving the lowest initial costs, public agencies are also reluctant to invest in innovation without the prospect or promise of a significant return. The prospect of a payoff in savings must be sufficient to justify the risk of innovation and the consequent development of new performance measures. This issue influences the entire contracting business community. The potential benefits, especially the potential for greater profits, must exist before the use of new techniques is encouraged. Current bidding practices give contractors a sense of comfort. They find a level playing field where bids are awarded on the basis of predictable and widely understood procedures and standards. Altering the procedures involves risk. Only when the risk is balanced by a demonstration of potential savings are government agencies and the contractors who bid for their work encouraged to produce a better, more efficient highway system that uses new contracting techniques.

Chapter 5

ENHANCEMENTS IN THE BIDDING PROCEDURE

The task force recognized that public bidding is an essential part of highway construction contracting practice. After reviewing and evaluating materials presented in the workshops and set forth in background papers, the members concluded that bidding procedures can be enhanced to improve contracting practice.

Darrell Harp pointed out saliently, "Our forefathers bestowed the competitive bidding concept on us in order to curb corruption, inefficiency, and mismanagement by government officials." (see Appendix A.) That concept, rooted in concern for public integrity and efficiency, has become the predominant factor in establishing highway construction contract standards.

The task force recognizes that these procedures, particularly controlling laws, rules, and regulations, may cause stagnation in the competitive bidding process. Nevertheless, the members recommend that the lowest responsible bidder concept be retained. However, the task force addressed issues and innovative contracting practices within the framework of the lowest responsible bid process.

ISSUES

The task force identified the fundamental issues influencing bidding procedures as the need to

- Avoid risks,
- Evaluate bid prices,
- Ensure selection of a competent contractor,
- Guarantee a quality product, and
- Meet federal and state regulations.

The task force examined each issue and identified specific areas of concern that presented opportunities for innovative contracting practices.

Risk Avoidance

Innovation involves risk. Government contracts are intended to avoid risk. The inherent conflict between risk taking and risk avoidance affects every aspect of highway contracting. Over the past century, highway agencies have developed a system of contracting practices that specifies and stipulates exactly what is built, how it is built, what materials are used, and how traffic is maintained during construction. Other details, such as payment procedures, dispute resolution, and testing methods are similarly specified by traditional contracting practices. All traditional practices are intended to minimize the risks of the private contractor who is building a public project.

The task force members identified the difficulties in attempting to balance risk and risk assignment. The difficulties are in determining what risks are acceptable, who should bear risks, and how risk can be moderated by identification of compensating benefits. Goals of innovation must include increased efficiency and effective delivery of a better product. To achieve these goals, those seeking to use innovative techniques in highway contracting need to understand how to assign risks between facility owners and contractors.

Evaluating Bids

Public agencies rely on the low-bid system to award contracts. The process for determining which bid is lowest has generated a complex set of regulations intended to eliminate uncertainties. The most common procedures require bidders to assign unit prices to estimated activities and material quantities needed for a project. The process requires that the public agency define the work as completely as possible. When work changes are called for or disputes arise, there are separate procedures to authorize additional work or to settle disputes. Contractors who assume that they can substitute a procedure or material that is different from contract specifications risk being required to follow original specifications at the bid price in the event their recommended substitutions are rejected as failing to meet original plans.

The process requires that nearly identical assumptions be made by all contractors. The differences in the prices contractors bid should reflect their willingness to limit costs, their skill in interpreting plans, and their ability to avoid delays.

Selecting Competent Contractors

Highway contracting practice is not absolutely based on a flat determination of the low bid. Rather it requires identification of the lowest responsible bidder. The

variation in terms reflects a dual need to determine that the bidder can and will do the job promised and will be able to comply with the stated procedures. The most common procedure for evaluating responsibility, as it is meant to be understood in the term "responsible bidder," is to prequalify potential bidders on the basis of their past performance, avoidance of error (that is, avoidance of items in the category of things "the contractor shall not do"), and ability to obtain bonding.

Prequalification of bidders restricts the entry of new firms into public works construction, and thus results in restricting the number of contractors available to agencies. More important, it limits the flexibility of agencies and contractors in using new techniques in highway projects.

Ensuring Quality of Products

Over the years, contracting has evolved a system of tests and procedures for guaranteeing that highway projects meet design specifications. These tests maintain quality control over the contractor's product and may in themselves limit innovation. Where specific systems or equipment are required, such testing tends to set limits. Further, the process focuses on the quality of specific elements of the product, rather than on the quality of the entire product.

Contractors and designers do not always speak the same language. Tests that have evolved over the years are intended to assure highway agencies that quality levels required by the designers are fulfilled in the product.

Regulatory Requirements

Ruling all contracting practices are the applicable federal, state, and, at times, local regulatory requirements. These regulatory factors influence every contracting procedure. They range from many of the processes discussed earlier to restrictions on alternative bidding procedures and to limiting opportunities for using innovative construction methods.

The regulatory climate has matured over the years to protect the public interest, while at the same time offering contractors opportunities to bid effectively. However, highway regulatory requirements themselves have become one of the forces that restrict the consideration of innovative methods.

INNOVATIVE PRACTICES

The highway construction contracting field has not been void of innovation. In each of the areas discussed earlier, an agency somewhere has developed or tried new techniques to improve the bidding process. Several of these techniques are examined to increase understanding of important factors that must be considered when using new bidding procedures. The following list relates the more significant factors to the fundamental bidding issues.

Issues	Innovative Practices
Risk avoidance	Equitable risk assignment; alternate dispute resolution process
Evaluating bids	Cost-plus-time bidding; guarantees and warranties
Selecting competent contractors	Quality and performance prequalification
Ensuring quality products	Constructability testing; end result Specifications
Regulatory requirements	Alternative bidding

Equitable Risk Assignment

"The optimal contract trades off giving the chosen agent an incentive to limit costs against stimulating bidding competition and sharing risks.[1]

The University of Manchester Institute of Science and Technology (UMIST) in England has been studying this issue and has presented ways for government to properly define the risks in contract plans, and procedures to pay for the effects of such risk that go beyond the initial bid price.[2]

Another key aspect of risk assignment is affected by contract language. By relying on technical language in contracts that is understood by only a small segment of society, potential bidders are virtually compelled to rely on personnel who are familiar with the nuances of the contract terms. Otherwise, they take on the additional risk that others may have overlooked in the plans. Development of simpler contract language, which clearly identifies risks, has been suggested by groups such as the Federation International des Ingenieurs-Conseils (FIDIC) as a way to share risk more equitably.

Target contracts are used for large high-risk projects such as tunnel construction. Here the fee is established by assuming completion within the window of estimate.

Adjustments in the fee award cost savings and penalize cost increases. However, actual expenses are paid by the agency.

The goal of each innovation is to avoid as many risks as possible and balance those of the agency with those of the contractor.

Alternate Dispute Resolution Processes

A well thought out and smooth-functioning process to resolve disputed work should be considered part of innovative contracting.

There is no hard evidence to prove that contract claims are excessive or that they are increasing in number. On the other hand, there is ample concern among highway contracting officials that claims represent a potential threat to control of an agency budget. Various groups have worked on the claims administration processes as a way to minimize this potential problem.

Resolving disputes quickly and efficiently allows attention to focus on the product rather than processes. A claims procedure that is acceptable to both government and the public works contracting community and that is efficiently implemented should be considered part of innovative contracting.

Cost-Plus-Time Bidding

A variation to traditional lowest-initial-cost bidding is to factor in the costs associated with inconvenience during construction.[3] The public is the ultimate sponsor for highway projects. The public's extra travel time, additional distance, and lost opportunities during construction, are hidden costs added to the actual award price.

In bid price evaluation, this is done by adding a time-cost factor to the bid amount. The latter assigns a value to the inconvenience. For example, if one day's inconvenience is valued at $25,000, then the total time specified in the bid would be multiplied by the assigned value. This total would be added to the construction price to give a total bid price. The lowest responsible bidder would be the contractor with the lowest combined price. In concept, this process could be further modified by considering life-cycle costs to determine the overall lowest price.

This aspect of the bidding process has been used successfully in some parts of the country. In using it, particular attention must be given in determining a realistic time value because this value should also be used in connection with incentive-disincentive clauses. For example, if a contractor completes the project in 20 days less than bid, an incentive-disincentive clause in a contract might provide for a bonus equal to those 20 days times the daily savings. A $25,000 time value would then equate to a $500,000 bonus for completing the project 20 days under the bid. Conversely, if the contractor was 10 days late, he would lose $250,000 from the bid amount as a disincentive.

Guarantees and Warranties

Traditionally, federal highway policies state that guarantees or warranties pertain to maintenance programs and therefore cannot be funded as federal aid capital costs. This policy inhibits the use of this technique. There has been some indication that these policies may be relaxed. Capital projects with guarantees and warranties have the potential for producing a better life-cycle cost product.

Highway agencies are responsible for construction, operation, and maintenance of their systems. The argument can be made that a project that offers the lowest life-cycle cost is the best bid. However, a proposal for life-cycle cost bids would require a new process for evaluating bids.

Agencies considering the use of warranty clauses require well-defined criteria to define expectations, and detailed data on actual experiences. Factors such as traffic volumes and loadings, the degree of regular maintenance, materials used for control of weather conditions, etc., all affect performance. Where warranties are sought, the agency must be able to assure that the conditions will be well-defined and monitored.

Guarantee-warranty contracting shifts the responsibilities for the ultimate project from the governmental agency to the private contractor. If the contractor does not have the opportunity to define the specifications, material, and equipment for the project, such a shift in responsibilities is unlikely. The question of whether the owner would have to guarantee the design criteria and how this could be done without excessive litigation is unresolved.

Quality and Performance Prequalification

The public sector relies on the contractor responsibility test (prequalification) as a punishment rather than a tool to rank the quality of performance of the contractors. In many cases, this tool relies primarily on the financial stability of the contractor. The proper use of prequalification or similar methods of measuring the contractor's past performance should involve quality factors and performance factors.

A potential innovation is the use of prequalification using a measure of the contractor's past performance. If carried out uniformly at all levels of government, and applied to quality and performance factors, a prequalifi-

cation system could assist in evaluating the bidders on a project.

Contractibility Testing

Traditional highway project design and construction activities are separated. Those who design rarely supervise construction, and vice versa. As a result, designers are not always familiar with new construction techniques and equipment. Contractors are not always aware of the intent of designers and therefore make their own assumptions.

Developing open lines of communication between designers and constructors, while not innovative in itself, offers ways to improve the final product and to discover innovations.

End Result Specifications

The goal of all specifications is a facility that operates according to plan, withstands the use expected, and can be maintained properly. Designing a project with the focus on the end product may prove cost effective and may also encourage new construction techniques. The use of end result specifications requires a change in the relationship between the project owner, designer, and contracting community.

Some European countries use a process of selecting the contractors who will build the projects early in the design process. These contractors have the opportunity to recommend the equipment, materials, and workmanship to be incorporated into the end result specifications. In this process, clear parameters for how the highway will be used and for the responsibilities of the contractor in maintaining the highway must be established.

Alternative Bidding

Traditional specification bidding for highway projects assumes full design, operations, and funding by the public agency. Programs that stray from that formula are not easily accommodated in this process.

Among the innovative practices being considered and used are the following: design-build projects; design-build-operate projects, and public-private partnership projects. Each of these practices involves considerations well beyond the scope of the task force. However, each offers some opportunity for improving the product or reducing the public risks, or both, and is thus noted and offered for future consideration.

These techniques represent forms of turnkey construction. The contractor accepts responsibility for the quality of design, and often takes on a financial risk. The past application of these techniques has generally been limited to projects involving some form of service concession such as bridges, tunnels, or railways. They tap the unused capacity and skill among contractors to assist owners in the management of the contracts.

Other forms of alternative bidding include negotiated competitive bidding such as used by the Army Corps of Engineers or the acceptance of bids for several design concepts at one time. In the former, the agency may select the lowest responsible bidder and then negotiate specific items for a better product or price. In the latter, the agency reserves final decision on the design to be used until the bids have been received. This encourages contractors who can offer unique packages to bid on projects that might otherwise be closed to them. This technique is used for certain bridge projects but has not received wider acceptance.

Encouraging innovation includes allowing contractors sufficient time in preparing bid packages to adequately develop alternative materials or techniques. Responsible bids, carefully developed, can result in lower prices and higher quality.

RECOMMENDATIONS

Short-Term Actions

- A research program should be established through the Legal Resources Group of TRB to determine a more workable assignment of risks between facility owners and contractors.
- The cost-plus-time bidding concept should be considered for wider implementation with the caveat that appropriate controls must be in place. However, careful selection of the types of projects as well as accurate determination of the time value is required. The cost--plus-time bidding, which represents a variation to traditional lowest-initial-cost bidding, reflects the additional costs to highway users from inconvenience and delay during construction activities.
- The potential for use of warranties or guarantees should be investigated with the goal of delineating standards and procedures for maintaining data on highway segments built with warranties.
- An industry-wide awareness program dealing with warranties or guarantees should be initiated; success observed in other industries or countries should be publicized.
- Attention should be given to the use of construct-

ability testing throughout the design of projects; this requires close coordination of all aspects of the design with those who will implement the design.

- The agencies should develop contractor responsibility tests that reflect quality and performance factors; these tests should be examined and possible modifications should be developed.
- The use of alternative bidding, using innovative contracting practices, is an option for public works contracts.
- Additional study should be devoted to improving the alternative dispute resolution processes for use by public agencies.
- Guidelines should be developed for establishing bidding times; these should provide contractors sufficient opportunity for developing and evaluating innovative recommendations.

Long-Term Actions

- Research, development, and implementation programs should be established to investigate the design-build concept, including a study to review the statutory authorization for it in the states that want to use it.
- Research should be started to develop means for compensating a contractor who initiates value engineering concepts that prove applicable to subsequent projects.
- Procedures should be developed to encourage private sector participation in developing and funding demonstration projects.
- Training for specification writers should be developed to identify ways to implement innovative techniques within the restrictions of contract practice and regulations.

ENDNOTES

1. Darrell W. Harp, "Historical Background--Low Bid Concept," Appendix A of this Report.
2. R. W. Hayes, J. G. Parry, P. A. Thompson, and G. Willmer, "Risk Management in Engineering Construction," UMIST, Dec. 1986.
3. Ralph D. Ellis, Jr. and Zohar J. Herbsman, "Cost-Time Bidding Concept: An Innovative Approach," In *Transportation Research Record 1282, 1990.*

Chapter 6

ENHANCEMENTS TO MATERIALS CONTROL

Materials used for highway construction have evolved over the last 100 years. Even so, the lack of effective quality control and acceptance tests today leave agencies at risk when rejecting work as inadequate or unsatisfactory. Using newer materials or methods is more difficult. The lack of data from past construction performance hampers attempts to even try less-documented approaches. Rapid tests, essential for use of performance standards, require data on the significance of the test results for indicating success or failure to meet the standards. Recent efforts of the Strategic Highway Research Program (SHRP) and similar programs in other countries are beginning to provide the data needed, but these programs are far from complete.

ISSUES

The task force identified the procedures for materials control as a potential beneficiary of innovative contracting practices. In particular, four major areas were identified: (a) institutional issues and controls; (b) testing equipment and procedures; (c) construction equipment and procedures; and (d) evaluating and marketing new materials and procedures. In many of these areas, research is already underway to develop new products and procedures. The SHRP has several of these areas targeted for special investigation.

Institutional Issues and Controls

The institutional issues and controls identified by the task force centered on the type and quality of specifications, the flexibility of the agencies in encouraging and implementing innovations and the sharing of information on new techniques in contracting practices and materials control. The most significant issues were raised at a task force-sponsored workshop in Fort Worth, Texas, during September 1989. These issues included the following:

- Method-type specifications and manuals now used inhibit innovation. They frequently require specific construction equipment or techniques and fail to recognize the capabilities of contractors to evaluate and select the most appropriate equipment and procedures.
- End result specifications that offer sufficient flexibility to facilitate innovation deserve encouragement.
- Generic specifications are needed to permit new technologies and techniques to compete in the marketplace. The replacement of method-type specifications with performance-related specifications will encourage innovation. It is important that those responsible for updating specifications and manuals understand the state of the art; to this end a guide to performance-related specifications is needed.
- Wide variations exist among the specifications used by state transportation agencies and others, and these variations even exist at the regional level. Because many contractors work in more than one state, they find themselves using different equipment, materials, and procedures for essentially the same activity. This process results in inefficiencies and increased costs. Although there may be reasons for some differences, regional efforts to coordinate specifications should be encouraged.
- The current procedures for establishing and adopting existing specifications and changes to those specifications are too slow to permit significant innovation. Today, specifications developed in some states limit the involvement of contractors and suppliers. This circumscribes the breadth of knowledge available and restricts innovation. When AASHTO develops national standards, consultants are used and funded by the members. This procedure limits the potential for additional standard-setting. Cooperative specification committees are valuable at all levels. Further, funding, from whatever sources, should be available to develop new standards or revise existing ones.
- Research and development activities that can encourage innovations in highway contracting and materials control do not attract public attention and lack the visibility needed to generate public support. Government tends to view the risks involved in testing new methods or technologies as limiting the visibility available for these programs. This attitude limits the potential for strong public support. This trend should be recognized as limiting innovation and should be reversed.
- Innovative techniques and materials require talented, innovative professionals and strong, committed leadership. The highway community needs to encourage talented professionals to join their ranks and to continue educating and rewarding those within their organizations who can provide the innovation and leadership required.
- Innovative practices developed outside the United States should be examined promptly for applications here. This procedure may require new or expanded channels of

communication to identify successful techniques developed elsewhere.

- Industry and government should be encouraged to develop new technologies and given the incentives and protection that their importance justifies, including national recognition. Proprietary products are frequently rejected as incompatible with the competitive bidding process. Some way should be developed, incorporating value engineering, to accommodate technological advances developed by private interests. This procedure should include financial compensation at the time the techniques are initially used.
- The current climate of tort law limits innovation and risk taking.
- The exchange of information within and among agencies should encourage the development of innovative practices and the understanding of emerging technologies. Unless the information on innovative technologies reaches the right people in an agency, it will not be used. Information dissemination should be encouraged.

Testing Equipment and Procedures

The task force identified potential areas for innovation in the way highway construction tests are developed, conducted, measured and evaluated. The principal concerns were the need to develop new methods for testing construction elements quickly, efficiently, and uniformly and to ensure that the most qualified personnel conduct the tests. Significant observations include the following:

- There is a lack of precision statements for acceptance testing. Because product acceptance, and correspondingly disincentives for poor products, depend on laboratory tests, the precision of the results becomes an issue in testing. Today there is a lack of appropriate precision and bias statements for these tests, leaving agencies in a perilous position when determining penalties or rejection of work. This deficiency should be corrected for all standard test methods not now having precision statements.
- There is a need for performance-related tests. These tests should be rapid and reliable, and should keep pace with production. A national research program should support the development and use of these performance tests.
- Test methods should be appropriate to the materials being tested. Current tests do not always distinguish among the different characteristics of possible materials. For example, aggregates of different sizes may all be tested with the same-diameter mold, regardless of the stone size. Test methods should be appropriate to the material being tested and accommodate new materials that may not have the same test characteristics traditionally evaluated.
- Automatic record keeping of test results should be encouraged. Technology is progressing to the point where systems can continuously control and monitor the manufacturing process. This progress has not yet received widespread acceptance in the highway construction industry. The potential for quickly identifying diversions from accepted products and for retrieving information needed for acceptance purposes suggests that these systems should be developed and applied wherever practical.
- Nondestructive testing (NDT) has increased applicability in highway construction. Both during and after construction, agencies can use NDT to monitor the performance and quality of their facilities. Tests that avoid coring are effective and less disruptive. Additional NDT systems are needed for control and acceptance applications such as for density, thickness, surface profile, and entrained air measurement systems.
- Certification for laboratories and personnel are needed to ensure QC of the testing procedures. Using accredited laboratories and certified technicians may be a necessary option as technology expands and agency human resources decline. Systems for providing accreditation and certification should be developed and applied to both public and private sector QA-QC activities.

Construction Equipment and Procedures

The procedures for building highways offer the potential for innovation in the areas of QA-QC, especially for materials. The significant observations include the following:

- Automated record systems at construction job sites offer improved quality control and reduced paperwork. Although computers have become standard in office settings, they are just now finding their way into construction field offices. These systems offer the potential for improved efficiency and accuracy. They also offer the potential to develop the data needed for evaluating construction materials. With the appropriate computer systems, the field units can also better verify the level of success in meeting design standards.
- Alternative bids and performance guarantees offer the potential for an improved product. As discussed in Chapter 5, alternative bidding is seen as a significant benefit to innovative contracting.
- The most effective and efficient QA-QC systems for product acceptance should be developed and used. This may involve systems implemented by contractors, suppliers, or manufacturers, especially if undertaken in an accredited laboratory with certified technicians. At the

same time, suppliers should ensure that their systems are compatible with the agency requirements and should avoid the requirement for duplicative control techniques.

- Materials verification should be viewed as part of the QA process. On many projects there is no verification that the materials produced or used are similar in performance to those used in design. This appears especially in subgrades where the product is not continuously observed. FHWA has a demonstration trailer program on mix verification that helps to focus attention on the need for materials verification. This type of educational process and the development of additional verification control measures should be encouraged.

Evaluating and Marketing New Procedures

The task force identified a need to develop a structured process for evaluating new technologies and sharing that evaluation. This process can include private sector efforts in demonstrating new materials or methods and in providing guarantees on new products. The task force cautioned that public agencies must evaluate new procedures and should consider in those evaluations various societal needs that might be met by the proposed material or process. Significant observations are the following:

- Innovation requires new products. There should be a structured process for evaluating these new technologies and products. Under ideal conditions, there would be a national or regional system for introduction of new technologies and materials. This system would include test centers, it would have the facilities to inform the highway community about new products and techniques, and it would provide an unbiased evaluation of the products.
- Information dissemination would be improved with a national clearinghouse or data bank. Although state agencies have vehicles established to share some information among themselves, these are not available to the private sector. A national clearinghouse, available to both public and private sectors, would improve communication and facilitate innovation.
- Innovation benefits from real-life demonstrations of a product, technology, or material. The private sector should be encouraged to participate in these demonstrations. Limited public budgets frequently limit the potential to test and demonstrate innovative techniques. At the same time, regulations frequently limit the financial participation of the private sector in demonstration programs. The benefits accrue to both the public and private sector. Procedures that encourage participation in demonstrations by all who would benefit would also encourage innovation.
- Societal needs to recycle materials offers an opportunity for innovation in highway contracting. Waste products and recycled materials have been suggested for inclusion in highway materials. These should be evaluated and where information is developed it should be made available to the broadest possible audience. Opportunities to meet these needs through innovative construction practices are considered as possible by the task force.

MEASURABLE RESULTS

The highway agency expends considerable public monies to build long-term projects. In the process, the agency needs to assure public officials, area residents, and highway users that the road is both safe and enduring. Designers have developed techniques that ensure a safe highway and one that will have a minimal life of 20 years. More important, they know that if built as designed, and reasonably maintained, the roadway will last for generations.

Ensuring that the highway that is built is the same one that the engineers designed requires quantitative procedures. Because most agencies cannot afford to wait 20 years to see if the constructed highway lasted as designed, they must rely on tests to indicate that the construction will provide the promised results. Historically, these tests have focused on the specific materials used and the procedures for installing these materials. Recently, there has been more attention given to looking at tests that evaluate the quality and anticipate the performance of the installed materials. The goal of these tests is to determine whether the construction meets standards that equate to the designer's specifications.

The concept behind performance rather than materials specifications is that the builder has more flexibility in defining the construction materials and methods under performance standards. Allowing this flexibility, while ensuring a final product that is equal to or better than the designer's requirements, could encourage innovation, higher productivity, and, in the end, better highways.

Specifying agencies that continue to use specifications of traditional method or recipe type have to approve or prespecify the use of innovative equipment before a contractor can bid a job using that machine. Even where the equipment has proven elsewhere to successfully deliver the required performance, preapproval is demanded.

The concern that must be accommodated is that the measurable results need to correspond directly to the known materials performance results, at least until such time as the performance standards themselves become the designer's basis for performance, durability, and safety.

Availability and acceptance of performance standards

therefore become essential to their broad applicability. However, without research and innovation, it is unlikely that these standards can be accepted.

RECOMMENDATIONS

Short-Term Actions

- A nationwide research and development effort should be initiated to effect a transition from method specifications to performance-related specifications for existing materials and processes. Differences in specifications should be resolved on a regional basis.
- A guide to performance-related specifications should be developed and published for use by transportation agencies.
- A contact point for information should be created to publicize the benefits from highway innovations, especially performance-related specifications. Such a center might make available assistance for those who write specifications to encourage innovation.
- A national clearinghouse or databank should be established for information, new materials, and processes to be shared by the public and private sectors.
- A national effort should be encouraged to identify programs and reward those who develop innovative techniques.
- The public and government leaders should be informed of the development of new technologies and advised when they are being implemented on the highway system.
- Channels should be expanded for the review and acceptance of technologies developed in other countries.
- Procedures should be established that would permit participation by the private sector in funding demonstration projects for new and innovative materials and processes.
- Precision and bias statements should be developed expeditiously for all standard test methods not having them.
- Sampling procedures and test methods should be developed that are appropriate to the full range of aggregate sizes.
- Value engineering concepts should be investigated to identify ways to promptly approve successful innovative techniques. Those contractors who develop techniques with applicability to future work should be compensated and rewarded accordingly.
- The use of verifiable automatic records of production processes should be considered for acceptance wherever practical.
- More emphasis should be placed on the use of NDT for monitoring construction processes and pavement performance.
- Technician certification and laboratory accreditation programs should be developed for public and private sector quality assurance/control in all publicly funded transportation construction.
- Efforts should be taken to develop systems that ensure that materials produced and incorporated into a project are similar in performance to those used in design. For example, the properties of as-built subgrades should be required to be determined before final adjustment of the pavement design.
- The use of computer systems at construction project sites should be actively encouraged.

Long-Term Actions

- National or regional self-sustaining centers for product evaluation should be investigated for potential savings and improved products. These should include private sector participation.
- To encourage innovation, cooperative specification committees with representatives from both the public and private sectors should be considered at state, regional, and national levels.
- The use of contractor-supplier-manufacturer QA-QC should be investigated for product acceptance.
- Performance-related specifications should consider incentive and disincentive provisions formulated to encourage better quality.
- Generic, performance-related specifications should be developed that encourage the introduction of new materials and processes into the transportation construction industry.

Chapter 7

QUALITY CONSIDERATIONS

"Quality is never an accident. It is always the result of high intention and sincere effort, intelligent direction, and skilled execution. It represents the wise choice of many alternatives."[1]

The highway user looks at the quality of construction in terms of a smooth ride, a maintenance-free facility, reduced inconvenience or delays because of reconstruction, and the most cost-effective miles for the tax dollar. The engineer who designs or builds the highway recognizes that quality is tied to performance, incentives, user delays, and life-cycle costs. Quality does not guarantee performance, but performance is affected by the quality of the construction.

The task force has defined quality as "substantial conformance to a standard for a specified period of time." This process involves the agency that controls the highway, the engineers who design and supervise its construction, and the contractor who builds the facility. Together they ensure the overall quality, i.e., they define how the highway should work, for how long it should survive, the level of maintenance that should be required, and the levels of and type of traffic it should serve.

Quality takes teamwork. It takes the public and private sector working together towards a common goal. It takes an open mind. It takes an appreciation of the other's point of view. It takes a well-trained work force. Quality is not an accident. It happens because people work to make it happen.

"Providing quality in the design, construction and operation of a project costs less, it is safer for the public and site personnel, and minimizes disagreements and subsequent litigation. Quality in design and construction results in significant benefits for the owner, the design and construction professional, and the contractor."[2]

During the deliberations of the task force several other developments related to highway quality were evolving (see Chapter 9).

ISSUES

The potential innovations in contracting practices must ensure the quality of the finished product. End result specifications are the most likely way of achieving improved quality in highway construction. This requires the identification of standards to be used in the specifications. In looking at how this can best be accomplished, several fundamental issues arise:

- Standards of performance should be defined;
- Operating procedures should encourage innovation while ensuring quality; and
- Industry information must be shared.

Defining Standards of Performance

There are many design parameters that influence quality and performance. Their definition and identification of how they prescribe the anticipated quality of the final system support innovative practices by letting all involved know what is expected. The identification of these parameters and the impact they have on performance is an area of study that warrants consideration. Changing quality standards and environmental rules impacts the costs of construction. The tradeoffs involved in achieving higher quality should be understood by those making the critical decisions on a project.

The efficacy of performance-related specifications must receive additional attention in highway construction. Today the overall perception of highway construction procedures is one of transition. The engineer-driven process is giving way to a contractor-produced product. This involves three steps: (a) QA-QC; (b) statistically based end result specifications; and (c) performance-related specifications.

Public highway contracting agencies generally accept some form of contractor QC or QA. About half are currently using statistically based end-result specifications for at least a portion of their contracted work. However, performance-related specifications are not widely used.

There are few true performance-related specifications available. Not enough is known about those factors that affect the durability and performance of a highway. This void needs to be filled.

The specifications used today frequently do not measure up to the quality of the design plans. The latter have become sophisticated and direct. The specifications all too often are ambiguous or even misleading. This hinders quality control and limits opportunities for innovation.

Encouraging Innovation

Several concepts to encourage innovation have developed

during the past several years. Life-cycle costing is now encouraged by the FHWA and recognized by AASHTO. Acceptance by specifying agencies has not been widespread. Full adoption requires an understanding of the appropriate calculations and acceptance of reasonable discount rates.

Performance-related specifications require testing and decision-making systems that can evolve with the technology. The constant improvements in technology suggest that tests may change frequently, with each improvement offering further opportunities for improving the highways.

Incentives that reward outstanding ride quality have been used in highway contracting. A smooth-riding pavement is in the public interest both in terms of life-cycle and public relations. Wherever the public interest is served, the competitive bidding process benefits. The problem for agencies is how to pay for the improvements and added value within that competitive bidding process.

Informing the Industry

Clear and current definitions of terms are necessary to achieve broad-based understanding and industry support for innovations. There needs to be a clear distinction as to the level of quality required for a project versus the performance to be evaluated. Definitions that are widely accepted would benefit the entire industry. However, acceptance requires information. It is not enough for the agencies or standards setters to develop performance-related specifications. The contractors who build the highways need to understand how these standards will be applied. An overall information-sharing program must be undertaken.

More attention needs to be focused on enhancing quality by linking construction procedures to performance. Users that share experiences on effecting change better understand the respective responsibilities of all involved.

Employees of the agencies, their consultants, and contractors must have incentives for using the standards to develop new and better techniques. The actual innovations often are the result of a single employee or group recognizing that there is a better way to do the job. This process should be encouraged. When innovations are successful, the industry should recognize and reward those who have initiated the improvements.

The university technology transfer centers established throughout the country provide vital communication links with local highway agencies. They offer a potential channel for defining the responsibilities in ensuring quality construction.

There should be a wide realization that the quality of the finished highway product eventually comes down to the workman on the asphalt roller or the concrete screed control, or their counterparts. Efforts to help the individuals understand and appreciate quality parameters and to motivate them to enhance overall quality are essential for innovation and improved quality in our highway construction.

The decisions to allow innovation are not only technical. The political climate that surrounds highway construction requires a comfort level for the policy makers who approve new techniques. The assurance that a specified quality level will be maintained offers that comfort. Beyond that, the decision makers need a general understanding of the benefits and potential problems associated with the more significant innovations.

RECOMMENDATIONS

Short-Term Actions

- An updated and maintained set of working definitions for high-quality performance terms is needed.
- Transportation agencies should establish or enhance present internal processes for gathering and disseminating information on new technologies.
- A focal point for R&D, implementation, and experience dealing with performance-related specifications should be considered. Such a center might assist in encouraging innovations from those who write specifications.
- An NCHRP 20-5 Synthesis should be initiated to document the current state-of-the-art regarding the use of incentives and disincentives in contracts.
- Information should be generated to acquaint elected officials and others with the advantages of improving quality and performance in highway construction.
- Research for application of expert systems to QA and performance-related specifications should be considered.
- Research should be initiated to consider ways of offering quality incentive programs to those involved in the design, specifications writing, construction, or construction management of highway projects when innovative construction practices are developed.
- The use of contractor-supplier-manufacturer QA-QC should be considered for product acceptance.
- As new information on quality issues becomes available, assurances must be made that the university technology transfer centers receive it for use by local agencies.
- All segments of the highway industry should work together to identify where rapid tests are needed and to develop them.

Long-Term Actions

- National programs should support the development and use of reliable, performance-related, rapid test methods to replace surrogate tests.
- Programs should be developed to enhance and educate the highway construction workforce on the importance and value of quality production.
- Periodic forums should be considered where users can assemble and share experiences. The breaking down of barriers through communication and a willingness to cooperate are precursors of progress.
- A national conference on life-cycle costing should be considered to establish direction for a course of action. This conference should have input from public agencies, academia, and industry.

ENDNOTES

1. *Quality in the Construction Project Manual*, Vol. 1, American Society of Civil Engineers.
2. *Ibid.*

Chapter 8

INSURANCE AND SURETY

To the insurance and surety communities, all discussions regarding innovations in products, processes, or procedures are abstractions until they are brought to an underwriter or analyst in either discipline. At that point they become either opportunities or problems. Innovations are opportunities in the sense that they tend to represent new markets from which revenues can be derived. They become problems when they represent risks that are incalculable or that defy known analytical techniques. They also become problems to the extent that they require pricing beyond what the market segment they represent either contemplated or is capable of bearing. This result creates economic as well as social problems.

Consider the myriad discussions regarding the emphasis in Japan and Europe on R&D. The popular perception is that much more money is spent by both on R&D, thereby giving both communities a competitive edge on United States industry in the development and marketing of technologically advanced products. Consider in that context the prevailing thought that insurance is an impediment to product development because of the high cost and limited availability of product liability insurance. This scenario lays part of the blame for limited R&D in the United States on the insurance industry.

With those thoughts in mind, the representatives of the insurance and surety communities who have been involved with the TRB Task Force on Innovative Contracting Practices attempted to ensure consideration of those realistic constraints that must accompany innovation. This involved the generation of a fundamental understanding of what the respective roles of surety and insurance are in the construction process. The purpose of that approach was to provide a rational context in which innovations could be discussed, with the hope that the recommendations of the task force would fall into the realm of the achievable from the viewpoint of surety and insurance.

Insurance and surety are mandated by law and dictated by prudent practice throughout all phases of the construction process. Therefore, if innovative ideas are going to be put forth, it would appear reasonable that those that are insurable or assurable by insurance and surety underwriters are the ones that will have the best prospects for implementation. Logic would also dictate that an understanding of the basic precepts of insurance and surety by those proposing innovation would allow for rational and reasonable dialogue with insurance and surety practitioners. This procedure would be invaluable to all parties and would be preferable to cumbersome and lengthy legislative proposals designed to skirt, avoid or eliminate the vital and traditional roles of surety and insurance in the field of publicly funded construction.

ISSUES

The task force identified the fundamental issues influencing insurance and surety for highway construction as

- Risks;
- Responsibilities of the various parties;
- Role of the surety and the limits those needs impose;
- Role of prequalification;
- Role of insurance; and
- Limits on innovation imposed by insurance and surety.

Risks

In examining the question of innovative contracting practices, there must be a fundamental understanding that any innovation entails risk. In the context of public construction, the definition of risk bearer becomes the overriding consideration. Does the public assume the risk of innovation or does public policy dictate that the risk be transferred in whole or in part to those given the responsibility for executing the innovation? The answer to this question must be sought in a societal context wherein no matter how well intentioned any party may be, responsibility for failure, damage, or partial fulfillment of stated intentions is translated into blame, generally after litigation, and with blame goes some assessment of monetary penalties. The public elects officials who promise to deliver services. The political officials instruct their bureaucracies to implement plans for the delivery of such services. The bureaucracy plans the services and contracts with private enterprise to execute the plans. All of this process must be done conceptually, at least, to the highest standards, and failure (or the inevitable human error) is not excusable. Thus, all parties must insulate themselves from blame, ensure that some other party can be held responsible, and ensure that there is an adequate source of funds

available to pay whatever compensation may be required as a result of a failure or an error.

Responsibilities

As the transportation community stands today, the mechanisms that are in place to satisfy the need to reduce risks and insulate each party from blame in a construction environment are well defined, tried, and tested. First, there is the designer. Second, there is the administrator. Third, there is the contractor.

The designer must formulate a plan that will accomplish the desired end, e.g., construction of a road from point A to point B. The designer must understand the ground over which his design will be executed. The designer must provide a clear, detailed plan demonstrating how to execute his design. The designer must choose the materials that will be used in the execution of his plan as well as the methods by which they will be applied. Any deficiency in the designer's plan will result in either a change in materials, quantities of materials, or method of delivery, which will inevitably lead to deviation in the cost of execution of the original plan. The designer bears the ultimate responsibility for his plan, unless he can demonstrate clearly that his plan was sound but poorly executed.

The designer must, therefore, assume the added burden of monitoring the execution of his plan and provide periodic assurance that it is in fact being done properly. The degree of insulation from the penalties of the failure of the design are almost directly related to the independence of the designer. If he has independently contracted to provide his services to a public body, he will bear a higher degree of exposure to the consequences of failure than if he is a direct employee of that same public entity. The laws of the land diminish the risk assumed by a public employee vis-a-vis a private contractor. Conversely, the private sector provides a higher degree of monetary reward than does the public sector. Theoretically at least, this leads to the assumption that talent demands reward. Therefore, talent is more likely to accept risk in order to achieve reward. If the reward is higher in the private sector, talent will be more readily drawn to it and talent may be subject to a higher standard of performance and accountability. The primary vehicle available to the private designer to isolate that which he owns from the consequences of this failure, is errors and omissions insurance.

After reviewing the designer's qualifications, an insurance company charges him a premium to indemnify him against any penalties or judgments for which he may be liable as a result of an error, be it one of omission or commission. Thus, as long as such insurance exists and is available at a reasonable or at least affordable cost, the designer may go forward with some degree of impunity. However, such insurance is not available or affordable should the designer attempt anything considered excessively innovative or radical. The provider of insurance will only accept his risk if he can understand it and quantify the reward commensurate with it. He must understand what constitutes an error, where it is likely to occur and how capable the designer is of avoiding it. Any design that deviates from a range of norms or involves new technologies or untried methods will be deemed by the insurer an unacceptable risk or, depending on the degree of innovation involved, will demand a higher premium for the insurer for accepting the risk.

The alternative to seeking innovation from the segment of the private sector unable to bear the consequences of accepting high risk of failure may logically be sought by using public sector designs. This alternative may require a greater range of talent than currently exists in the agency. Assuming the expense of talent, attention is inevitably drawn to the availability of funds to compensate talent. Because public budgets are constrained by a variety of factors, the employment of adequate full-time design talent may be precluded by available funds.

The role of the administrator bears the lowest level of risk in the process. As neither designer nor executor, this role is that of the mediator. The drawer of contracts has a basic role to assure that the interests of the public are protected. The administrator must acknowledge the role of the public to provide both the land over which the project will be built and the funding necessary to compensate those designing and building the project. The administrator must provide the basic terms and conditions for the contract and make sure there is a clear delineation of responsibility among all parties to the contract and also ensure that public funds will be disbursed only to those capable of using them properly. The public must be protected against the actions of the designer and contractor and all parties must comply with all applicable statutes. The administrator must see to payment for performance, ensure that performance is in accordance with the design, that the quality of work is acceptable, and that it is being done on time and within budget. The administrator must also make decisions where necessary when the design proves to be less than adequate, or when circumstances conspire to alter the scope of the work, the funds available, or the time allowed. Available for guidance in this role are statutes and the contracts entered into by those responsible for their execution. In the absence of clear guides to decision making in either of these, the administrator may use intermediaries in the form of a panel of arbiters or the courts.

The administrator is the ultimate keeper of precedent. The administrator has available language, systems, and

procedures that have stood the test of time. Innovation is constrained because any failure will be publicly visible with consequent political ramifications. The monetary result of failure will be felt by the public treasury and this means that political will is required if innovation is to take place. The exercise of that political will must be manifest in statutory language that will allow for deviations from established practices and procedures as well as a commitment of funds. If those prerequisites are in place, the administrator must seek out those qualified to provide innovative design and those capable of executing it. This procedure requires assurance that the public interest is protected from actions that may damage the public or its employees. It also requires recourse for failure on the part of those executing the project. For these purposes, the administrator turns to surety and insurance, two separate and distinct mechanisms designed to aid him in providing the public with the recourse it requires.

Surety

Surety is as much a process as it is a product. The products of surety are bid, performance, and payment bonds, each designed to provide a benefit to the public.

The bid bond serves as an instrument of prequalification. It certifies to the public that the contractor proposing to do the work is indeed qualified to do it and that he will provide an assurance of performance as well as an assurance that he will pay for his labor, materials, and subcontracts should he be chosen to perform the work. The bid bond then is a key, in that it is the end product of the process of prequalification. It is also a reaffirmation of the prequalification done by administrators as required in 38 states and the District of Columbia. In those 38 states, administrators are required to perform some level of investigation into a contractor's background and finances. The end product of this exercise is to determine at what level the contractor is qualified to operate.

Prequalification

In some states, the administrative prequalification process is fundamentally an exercise in quantification. The finances and equipment of a contractor are reviewed, weighted, and the sum of the positives versus the negatives are multiplied by a factor to produce the level of aggregate work a contractor may undertake. In other states, a similar mathematical formula may be supplemented by size of largest previous work completed, experience of staff, previous failure to perform, and qualitative factors assessed by administrators at the conclusion of a contractual exercise. The public process of prequalification is of necessity more mathematically oriented so as to insulate the administrator from challenges by those whose qualification score indicates less than what they may deem themselves capable of executing.

The fundamental difference between public prequalification and private prequalification lies in the penalty for error. An error in public prequalification may cause embarrassment to the administrator and a degree of inconvenience but he pays no penalty. The administrator can cite his mathematical model as being sound but may excuse its failure on the basis of unforeseen factors not contemplated by the model. No such excuse is available to the private prequalifier.

The independent surety prequalification is a function of a free market economy, is therefore prone to a higher degree of subjectivity and may be subject to more variables, judgments, and market forces. The private prequalifier will examine the same data available to his public counterpart. He will supplement the data with references, an investigation of bank credit available, a knowledge of the ramifications of tax and audit policy on the figures presented, and analytical skills that allow understanding of the status of work underway and its future impact on the subject under scrutiny. All of these factors are combined with a personal understanding of the character, business philosophy, planning, adequacy of record keeping, problem-solving ability, secondary assets, and the quality of personnel and professional advice available to the contractor. The sum and substance of the private prequalifier's efforts is a judgment rendered on the contractor's qualifications. The quality of the judgment is then dependent on the quality and depth of the prequalifier's knowledge of his business and the business of his client, and his ability to correlate his intellect and experience meaningfully. The penalty he pays for the rendering of a bad or faulty judgment is the payment by him for the performance of the work and any of the unpaid obligations of his client. The private prequalifier is rewarded for his efforts but the risk inherent in them is significantly disproportionate to the reward he receives. Therefore, he can rarely afford to err.

The reliance on the private prequalifier and his written assurances of performance and payment is the cornerstone of the administrator's ability to provide the public with recourse against the contractor who for whatever reason, other then those clearly spelled out in his contract as valid and excusable, fails to perform his contractual obligations or execute the design for which he is responsible.

The effect of prequalification on innovation is profound and creates a dichotomy for all parties. Because innovation represents something new or unknown, it presents the ultimate paradox. How can one qualify someone to do

something that has never been done before? The only measure that can be applied in seeking that answer is to examine how much risk the innovator can reasonably bear without being financially crippled. The finite ability to absorb risk is a function of available capital, the nature of the risk, its transferability, and the reward to be derived from having accepted it. All of these factors can be evaluated on the basis of the nature of the risk, be it technological, procedural, or contractual. The surety in any of its aspects is not providing a transfer of risk except on behalf of the public for whom the surety has both prequalified the contractor and provided assurance of his ability to perform and to pay. The risk, however, is borne by both the contractor and his surety with the wherewithal of the latter providing credibility for the former. The assets of the contractor remain always at risk and will be depleted in their entirety in the event of his failure either before the assets of the surety are used or afterwards as repayment to the surety. The contractor, therefore, does not transfer risk to the surety. He joins with his surety in providing credible assurances.

The technological risk in the context of innovations in highway construction would be generally limited to new materials. The materials would, at least conceptually, provide a more durable end product, would require less maintenance, or would bear up better under the elements. They may also be conducive to easier, less costly installation. The extent of the unique properties of technologically advanced materials would bear heavily on their source of supply, which would be one of the first things a contractor and his surety would have to evaluate. A single source of supply exposes both to the risk of the cessation of the source or a disruption in the flow of materials. The costing of technologically advanced materials and their application is the next element of risk that would have to be evaluated. The warranty required in the event of improper installation as well as the failure of the material to provide the benefits or durability sought by its use are the final elements of risk.

The procedural risk would involve a new installation technique or the acquisition of technologically advanced equipment to implement installation. Because installation is a function of labor and time as well as equipment, the pioneering contractor again bears the risk of determining the cost of installation. Failure of the process or machinery would require reversion to traditional techniques and processes if such were feasible, with consequent escalations in cost, resulting in an erosion of profit or catastrophic loss.

The contractual risk would be created by absence of clearly defined responsibility for failure, particularly if the failure was the fault of someone not a party to the contract. Further contractual risks could entail bearing responsibility for financing the project, inadequate payment terms, the absence of contingency plans, implied as well as stated warranties of a punitive nature or of unreasonable duration, lack of recourse for relief from poor administration or faulty design, or any of a myriad of factors expressed or implied.

The entrepreneurial contractor seeing disproportionate reward or not seeing disproportionate risk may be inclined to accept the challenge presented by any innovative technology, procedure, or contract. However, his prequalifier cannot render judgment on that about which he is ignorant. He is left therefore with three options. He can determine that while the risk may not be fully known it may fall within parameters bearable by his client. He and his client can reduce their risk by whatever means available be they monetary or contractual. He may gamble, but because the essence of surety is to be sure before providing assurance, the likelihood of a gamble by the surety is remote to nonexistent. Either of the other alternatives is a business judgment that must be made. In none of these scenarios, however, is the surety fulfilling its prequalification function. It is only providing assurance and then only to the extent that it will be able to recuperate that which it may lose.

Insurance

The majority of the recourse the administrator seeks for the public he serves rests with the surety. The remainder rests with insurance. In seeking recourse from insurance, the administrator looks first to a source of recovery in the event of an error or omission of the designer. Next, the administrator seeks protection for the work from a variety of natural or man-made hazards so that the public will not have to bear the expense of rebuilding or replacing that which has been damaged or destroyed by the perils against which insurance is purchased, generally through the contractor. Third, the administrator seeks protection for individual members of the public or their property should either be damaged or destroyed as a result of the work or anything and anyone engaged in it. Additional insurance may be specified or purchased to protect that same public and its property from damage or destruction occasioned by the failure of the final product to do that for which it was intended or its failure because faulty or negligent installation. Finally, the administrator must see to the protection of the workers on the project in accordance with applicable statutes.

Insurance is a risk transfer device. The perils anticipated as well as the probability of loss can be reasonably defined and quantified as to what it will cost to assume those risks. A low incidence of risk within reasonably

predictable parameters will bear a lower cost than will unknown risks or probabilities or contractual terms that purport to transfer disproportionate risk to the contractor or his insurer.

Insurance and Innovation

Innovative technologies, procedures, and contracts are less inhibited when considering insurance because the mechanism of price for risk acceptance affords the insurer greater flexibility in what risk level he can tolerate.

Unlike surety, which is averse to risk and not driven by pricing considerations, insurers can negotiate levels of risk, terms and conditions, as well as price, to render a decision on the acceptability of a risk. Insurers become inhibited when they lose their ability to forecast the probability of their loss or when the magnitude of their exposure indicates a significant threat to their capital base and hence their survival or acceptability by those who regulate them and determine their fitness as insurers.

A new material may present no more hazard or risk to an insurer than an old material unless, for instance, it involves toxicity or contains pollutants. New procedures or machinery may present no inherently higher damage of harming the public but may present undue hazards to those using them. Finally, reasonable contract terms can generally be negotiated unless it is the intent of the drafting or offering party to transfer excess risk to the contractor.

In summary then, innovation entails risk to all. Risk must be identified, quantified, accepted, or willingly transferred if it is to be controlled so that those accepting risk have a reasonable opportunity to garner reward.

Innovation Versus the Status Quo

Because there is no progress without innovation, a brief discussion of alternatives to the status quo may be warranted.

- The low-bid system is felt by many to represent the essence of the status quo, be less than efficient, and inhibit alternatives to what was proposed without guaranteeing the delivery of a high-quality product within the time required. Yet, the low-bid system is considered to be the fairest method of procuring services at an economic price from the largest number of vendors. Any alternative to it would be perceived as limiting competition by anyone excluded from the procurement process by whatever alternative was required. That is a political problem on which neither surety nor insurance have any inherent effect.
- The introduction of time as a companion element with price would not deter prequalification by a surety provided that the surety was fully cognizant of, and satisfied with, the contractor's strategy for being able to execute the contract within the time and for the price. The use of incentives for early completion would at least negate the effect of penalties and would give the surety and the contractor a measure of superior performance.
- The bidding on a QA specification for which the contractor was to be paid on a ratio consistent with the measure of the quality of the materials put in place to what was required would also not necessarily pose an undue impediment to prequalification. The ramifications of pricing such a contract would have to be understood as would the contingencies represented by it. But, again a measure of superior performance could be established. The measures of superior performance would provide guideposts for the prequalifier as projects become larger and more complex.
- Construction management contracts would only prove problematic to surety if they purported to place undue management or financing responsibilities on a contractor. Similarly, fast tract contracts could lend themselves to prequalification and assurance provided that the complexity of the project was within the scope of the contractor's proven ability.
- Design-build contracts would pose the most unacceptable risks to contractors, sureties, and insurers.

The ability to design anything but the most rudimentary roadway is considered by sureties to be beyond the capabilities of most contractors. Even granting some capability or the acquisition of a design from a design professional, the contractor is still left with the contractual responsibility for the performance of the design and the consequences of an error or omission. Insurance for a contractor doing his own design would not, in all likelihood, be available because the capability of the contractor as a designer would be suspect. In addition, the absence of a division of responsibility for the design or its execution would remove the ability of the insurer to defend a claim for design deficiency on the basis of faulty execution. Similarly, surety bonds for a guarantee of performance contemplate that a contractor render his price on the basis of the plans and specifications rendered by the designer. This places the contractor in a position to argue that any deficiency in those plans that causes his price to be deficient is compensable. If a contractor is precluded from performance by an inadequate design, he is generally not culpable, nor is his surety. The surety generally will not agree to provide bonds on a design-build project without at least having in hand evidence that the design-build contractor possesses adequate error and omissions insurance.

Although design-build contracts are not uncommon in private building construction and in some public construction, their introduction into highway construction would require that contractors, sureties, and insurers were fully aware of the risks and their implications.

- Long-term warranties, maintenance requirements, or performance specifications are viewed with disfavor by sureties. Primary to the surety's view is the fact that a long term (2 years or longer) requires the assurance that the principal will survive as a viable entity capable of honoring the warranty, doing the maintenance, or remedying whatever deficiency caused the product not to last or perform as anticipated. Such a judgment cannot be made rationally with a high degree of certainty. This leaves the surety dependent on luck and the absence of adverse unforeseen conditions and events as much as it does rational judgment. This poses a dilemma for the administrator who wishes a long-term bond or insurance policy because the best he may be able to obtain is one containing a cancellation clause. The cancelability of such policies diminishes their value as instruments of recourse for the public.
- Surety and insurance as manifest by their bonds and policies are highly dependent on case law and precedent. The terms of both are conjured and changed on the basis of law as it exists and as it is interpreted. Knowing how the law is read allows sureties and insurers some insight for judging what rights, duties, obligations, and defenses may be available to all parties to a dispute. It is that same knowledge that is the basis for an insurance company's evaluations of its risk and its probability of loss. These two items then, case law and its interpretation, form the basis of the company's acceptability and pricing of the risk. Any change or alteration in a legal precedent of any standing or duration as well as any alteration of the language of a contract, bond or insurance policy that leaves these documents open to anything but a clear interpretation, consistent with law or precedent, leads to judgments or assumptions of risk based on unknowns. The fear of the unknown is the biggest barrier to innovation by surety or insurer.
- If innovation in construction practices is to take place, it must be done with a clear understanding by all parties as to exactly the extent of the risk inherent in it and who must bear that risk. Clear definitions and divisions of responsibility must be made so that risk can be evaluated and accepted. In a perfect world, one party, having accepted a risk, would not then attempt to blame another party if he lost his reward or was placed in jeopardy by having the risk become reality. If everyone contemplates that all problems will ultimately end up in front of a judge, innovation is stifled.

The primary recommendation for implementation of the concepts and procedures suggested by this study group falls within the framework of several cliches or business axioms: "Forewarned is forearmed. You cannot solve a problem if you cannot define it. Luck is the meeting of opportunity and preparation."

What these cliches all suggest is that discussions should be for the purpose of mutual education and should be undertaken within the framework of the antitrust constraints imposed on the insurance and surety industries. The mutual edification of both sides to such discussions should result in the advancement of a specific innovation in such a way as to create an opportunity for insurers and sureties and not a problem. Insurance and surety principles can aid in the refinement of innovative documents and procedures in such a way as to define or quantify risks as well as providing for rational defenses when and if the innovations are unreasonably subject to court action or unintended interpretation.

These discussions will foster further dialogue between the risk transferrers, risk sharers and their primary constituent groups, designers, and implementors, i.e., contractors. Once what is being suggested is analyzed, digested, and refined into terms and conditions that provide the necessary comfort levels to all parties at interest, the innovation may proceed to the implementation stage.

RECOMMENDATIONS

Short-Term Actions

- Innovations and concepts that introduce any element other than price into the bid process should be discussed in advance with sureties and their constituent groups.
- Educational materials suitable for use by sureties, insurance companies, and their constituents should be developed for purposes of explaining any proposed innovation and discussing its ramifications well before its introduction into contract documents.
- A system of monitoring the success, failure, or variations from accepted practice of innovations should be established to maintain a data base of what does or does not work.

Long-Term Actions

- Ongoing relationships with the surety and insurance community should be established by and between state and federal highway officials. These relationships will allow

for a continuing dialogue on issues of innovation and a variety of other topics.

- All parties with an interest in advocating the adoption of innovations alien to current contracting and procurement methods should expose their ideas and concepts in the industry with widespread distributions and a solicitation of comments or criticisms.

Chapter 9

IMPLEMENTATION

The task force was created for the purpose of identifying promising innovative contracting practices for further evaluation. Innovative ideas, as defined here, are not necessarily new or untried. They are outside the generally accepted highway contracting and construction practices. If the transportation industry is to keep pace with the rest of the world, there will be a continuing need to identify new ideas.

The transportation industry cannot afford not to try new products, processes, or procedures. Someone must pick up on the recommendations of the task force, implementing and evaluating the suggestions and recommendations. Full implementation requires all elements of the highway community to look for opportunities to use innovations and ultimately have the states modify their standard practices to make use of the most beneficial ones.

Throughout the preceding chapters, the task force offered opportunities for innovation. Some of the recommendations anticipate that the TRB could act as an agent for implementation. Many of the opportunities require the cooperation of numerous agencies, both public and private, if they are to be realized.

CURRENT INNOVATIVE ACTIVITY

The task force has recognized and was encouraged by the innovative activity currently being pursued in the industry, and it suggests that it continue.

While the task force was deliberating, several external activities that complement the study were initiated by others. The most notable are the following:

- The FHWA released a report from a TRB project titled "Research and Development Program for Highway Construction Engineering Management," dated February 1990.
- The TRB steering committee responsible for the R&D report recommended a priority program of 16 needs with the highest priorities being the development of performance-related specifications for highway construction, the development of effective rapid test methods and procedures, and development of a program for identifying responsibility for quality management.
- The FHWA's High-Priority National Program Areas (HPNPA) moved ahead with its efforts on performance-related specifications (PRS) for highway construction. PRSs have been developed for portland cement concrete (PCC) pavement construction and are now under development for
  - -- Hot-mix asphalt concrete,
  - -- Asphalt concrete (Phase II), and
  - -- PCC pavement (Phase II).
- The FHWA-HPNPA program has identified six areas for future activity:
  - -- Accelerated field tests,
  - -- Development of new test procedures,
  - -- Program for optimizing cost effectiveness of materials and construction test programs,
  - -- Long-term field test of PRS,
  - -- Field testing new equipment and procedures, and
  - -- Guide specifications for long-term pavement performance.

Potential benefits from this program are:

  - -- Reduced use of nonessential tests,
  - -- Maximized effectiveness of limited agency staff,
  - -- Rationales for pay incentive-disincentive plans, and
  - -- Reduction in premature pavement distress.
- The Western Association of State Highway and Transportation Officials (WASHTO) began to develop model specifications for QA.
- The AASHTO Subcommittee on Construction established a task force for construction quality in 1989. This task force is working towards inclusion of QA specifications in the AASHTO Guide Specifications.

ORGANIZATIONS FOR IMPLEMENTATION

The following list identifies some of the parties who will determine the final success of the task force's deliberations. The identified organizations, as well as other agencies, as appropriate, are encouraged to review the recommendations individually and in combination, to determine appropriate follow-up actions through their own programs and cooperative efforts.

FHWA

The existing operating structure of the FHWA allows it to address innovative ideas. FHWA's Experimental Projects

Program evaluates and documents the in-service performance of promising technology, and shares the results with other agencies. Using this program, the FHWA has the ability to truly test new or innovative materials, equipment, processes, or concepts, and evaluate their in-service performance.

If an experimental project proves itself and has national applications for improved performance or substantial cost savings, FHWA moves it into an effort called a demonstration project; as such it is actively promoted around the country on an experimental basis.

Special Experimental Project (SEP) No. 14, "Innovative Contracting Practices," has been established by FHWA to implement (for evaluation on an experimental basis) applicable task force recommendations and other innovative contracting practices that state highway agencies (SHAs) may propose to undertake and are subsequently approved by the FHWA. The objective of SEP No. 14 is to identify for trial evaluation and documentation innovative contracting practices that have the potential to reduce life-cycle costs to SHAs while maintaining product quality and an acceptable level of contractor profitability. A number of states have submitted innovative proposals for consideration and as of September 1991, seven have been accepted. These include the following:

- Michigan Department of Transportation--a proposal for requiring a 2-year warranty on a select number of bridge painting contracts.
- Missouri Highway and Transportation Department--a proposal to use a 3-year warranty for a test section of asphalt rubber concrete pavement.
- California Department of Transportation--a proposal to use a design-build concept for several federal-aid toll road contracts.
- Iowa Department of Transportation--a proposal to use the design-build concept with a warranty requirement and to develop and use an incentive specification for increased quality of work.
- Kansas Department of Transportation--a proposal to use warranties on a traffic signal system and to develop and use an incentive specification for improved quality of asphalt pavement smoothness.
- New Jersey Department of Transportation--several proposals to include the factoring of time with costs to determine the low bidder.
- Washington State Department of Transportation--a proposal to use time with cost to determine the low bidder for a large floating bridge project.

AASHTO

AASHTO, in conjunction with affiliated regional organizations, Northeastern Association of State Highway Transportation Officials (NASHTO), Southeastern Association of State Highway Transportation Officials (SASHTO), Western Association of State Highway Transportation Officials (WASHTO), and Mississippi Valley Conference of State Highway Transportation Officials (MVCSHTO), is also pursuing innovative practices. As the standard-setting organization of state highway agencies, AASHTO plays a unique role in future highway contracting practices.

As mentioned earlier, AASHTO established a subcommittee on construction task force for construction quality in 1989. This task force is working towards inclusion of QA specifications in the AASHTO Guide Specifications. WASHTO is developing model specifications for QA.

TRB

The task force was established by TRB in recognition of the importance that innovation should have in highway contracting practices. TRB is the recipient of these recommendations, suggestions, and considerations. The various committees within TRB offer the forum for continuing many of the discussions initiated here and identifying specific opportunities to implement these ideas.

OTHERS

The task force feels that the implementation of any innovation will occur only if cooperation, support, and commitment is obtained throughout the industry. If states are not willing to initiate a contract; if consultants, contractors, and suppliers are not willing to take a risk and undertake such an effort, and if the insurance and surety industry do not provide the proper bonds, innovation will not happen. Advice, support, and active participation of all parties involved are needed. The activities of the task force are only the seed for change and innovation. The entire industry needs to carry it further into implementation. By trying, evaluating, documenting, and sharing the results, innovative contracting practices can be advanced to the benefits of all parties involved, and especially the traveling public.

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APPENDIX A

BACKGROUND PAPERS AND

PRESENTATIONS

PRESENTED TO THE
TASK FORCE ON INNOVATIVE
CONTRACTING PRACTICES (A2T51)
OF THE TRANSPORTATION RESEARCH BOARD

Denver, Colorado
August 1988

HISTORICAL BACKGROUND - LOW BID CONCEPT

Darrell W. Harp

NEW YORK STATE'S EXPERIENCE WITH COMPETITIVE BIDDING

About 150 years ago, our forefathers bestowed the competitive bidding concept on us in order to curb corruption, inefficiency, and mismanagement by government officials. In New York, for example, the competitive bidding requirements of Canal Law, Sec. 30, appear to date back to legislation enacted in 1847. The principal statute that the New York State Department of Transportation now uses to bid and award highway and bridge contracts, Highway Law, Section 38, is derived from legislation enacted in 1898.[1] Through social and economic pressures, the additional terms of lowest "responsible" bidder and "public interest" determinations have also been added over the years to statutes that control the authority to let and award public works contracts.

Rational for the Lowest Bidder Concept

The statutory requirements are often considered to protect the taxpayer from extravagance, corruption, and other improper practices by public officials emerging in public works contracts, with the side effect of protecting the public official from the demands of those who seek political favors by obtaining such contracts. The bidding requirements are also intended to provide the taxpayers with the benefits of America's free enterprise system by delivering adequate, safe, and efficient transportation facilities at the lowest price that responsible, competitive bidders can offer. For an overview of these concepts, see Henry A. Cohen's 1961 treatise, *Public Construction Contracts and the Law*, and the excellent 1978 study by Ross D. Netherton of the FHWA Office of Research in *Selected Studies In Highway Law, Vol. 3.*

As Netherton observes, the public policy objectives to be promoted by competitive bidding statutes include concerns for administrative efficiency, protection of moral values, and promotion of socioeconomic goals. The policies serve to prevent favoritism in spending public funds while stimulating competition in the construction industry. The central object of the process for awarding contracts is the full and fair return for expenditure of public funds. This public interest is best served by opening bids on an equal basis to all persons able and willing to perform. A real and honest cost basis will best emerge when there is full competition among the parties.

The major objectives of competitive bidding have not changed much since *Wester v. Belote*, a case decided in Florida more than 50 years ago: to protect the public against collusive contracts, to secure fair competition on equal terms to all bidders, to remove not only collusion but temptation for collusion and opportunity for gain at public expense, to close all avenues of favoritism and fraud, to secure the best values for the public at the lowest possible expense, and to provide opportunity for exact comparison of bids in order to give equal advantage to all desiring to do business with government.[2]

The principles of competitive bidding generally require the following actions: public advertisement to bidders inviting submission of proposals; preparation of plan specifications for the work; formal submission of proposals to the contracting agency; submission of financial security by the low bidder guaranteeing his acceptance of the award; consideration of proposals under uniform criteria; and award to successful bidders.

In one audit report, it was observed that few situations are found where competitive bidding is unnecessary, and that the competitive bidding (lowest bidder) concept is generally desirable. Such desirability has been well demonstrated by such problems as the recent New York City scandals involving contracts which were not competitively bid.

Need for Change

With the current emphasis on controls over public officials, on seeing that the public money is spent prudently, why should we think that such a system should be examined and possibly changed? The answer should be obvious. Do we build 1989 model cars so they resemble the horse and buggy of the 1890s? Do we build airplanes in the 1980s that resemble the hot-air balloons of the 1850s? Hasn't government reached the point that in most instances, it is run by professionals who have the same basic desires and goals that you find in the private sector corporate world? The lowest bidder concept has served the public well over the years, but it is not necessarily the best way for governments to obtain the best product for the dollar spent.

Innovation has been a key to the success of the American economy. The person that can do something more efficiently, cheaply, or more timely generally gets ahead, but another important factor in this success story is the ability of the product to hold up under the stresses placed on it. Today, car manufacturers are providing longer and longer warranties to demonstrate the reliability of their product. How far would IBM and others, who have used innovative practices to become giants in American industry and commerce, have gotten if they had been saddled with contracting with the lowest responsible bidder as would best promote the corporate interest? Price is important, but it has become an increasing burden on considering the other necessary product requirements such as timeliness, durability, and quality.

Consider, for example, what would happen if selection of consultants utilized the competitive bidding process. (Fortunately, the Brooks Law does not permit this.) Engineering firms would reduce to a small cadre of true professionals and a large number of piece workers or hourly employees who came and went as the demands of the corporation varied. There would be little incentive to have retention or retirement plans, and employees would be constantly striving to hire another person at a cheaper rate than the present employee in order to cut expenses, to the detriment of the quality of the professional services that the consultants had been retained to provide.

There is a need to select on merit, to select on ability, and to select on product, quality and durability in some areas of public works endeavors. We must be innovative in the most costly of our public works undertakings, the construction contracts.

Collusive Bidding

There have been numerous incidents in which the competitive bidding process has not worked as smoothly as it might have in theory. Major problems have arisen in connection with competitive bidding, most notably with collusive bidding. Unfortunately, despite controls that government officials have recently come to recognize as important, such as the BAMS process, it still requires years to detect collusive bidding. In many instances, the punishment dealt out to the wrongdoer, such as finding a firm not to be a "responsible bidder," has the effect of diminishing competition and costing the public even more than the collusion. There has to be a better way of determining who is awarded public works contracts. New York State has grappled with these problems during the 1960s and again during the past few years.

In 1963, for example, the New York State Legislature responded to a bid-rigging scandal by enacting an additional requirement for the bidding process, State Finance Law, Sec. 139-d, which requires all bidders to certify in statutorily prescribed language that their bids have been arrived at independently without collusion.[3]

This did not cure the problems, and another bidding scandal occurred just a few years later. This led the state comptroller to issue audit reports on June 4, 1969, and January 15, 1971, detailing the lack of genuine competition for State contracts. On the basis of statistics for 1966 and 1967, the comptroller found that prices were within 2 percent of the published estimates for projects on which few bids were received, whereas prices were on average more than 14 percent less than the estimates for projects on which a large number of bids were received. On this basis, the comptroller strongly recommended changes in the bidding statutes and procedures.

The Prebid Estimate

The legislature responded by enacting extensive amendments to Highway Law, Sec. 38, the "lowest responsible bidder" statute mentioned earlier.[4] Although the "lowest responsible bidder" language was not changed, the earlier approach of publishing an estimate before submission of bids and prohibiting award at a price in excess of the estimate was abandoned, as inviting bids rigged to be at or near the estimate. In its place, the current approach of keeping both the estimate and the itemized bids confidential until award of the contract was established. The former prohibition against award in excess of the published estimate was, in effect, superseded by FHWA's federal-aid requirement that, when the low bid exceeded the estimate by more than 10 percent, no contract be awarded without express concurrence from FHWA.

Even these changes did not prevent further bid-rigging during the late 1970s and early 1980s. In a series of recent cases from 1984 to the present, some major contractors and material suppliers have been convicted of or pled guilty to federal racketeering and antitrust charges in New York. One of these cases involved a highway project where the low bid was almost exactly double the confidential engineer's estimate. In other cases, contractors have been charged but acquitted. Today, at lease one federal indictment against several major contractors remains pending, and is scheduled to go to trial this fall.

The administrative actions which we have taken to deal with the responsibility issues raised by these prosecutions have generated a number of challenges through civil litigation. It would go beyond the scope of our session today to delve into the details. Suffice it to say that the

New York courts have issued numerous judicial interpretations of the meaning of "lowest responsible bidder" during the past several years. The courts have ruled that, while this language does not authorize debarment, it clearly authorizes rejection of bids by indicted or convicted firms.

POSSIBILITIES FOR REFORM

Malcom B. Coate, staff economist of the Federal Trade Commission has analyzed current issues in an excellent article entitled, "Techniques for Protection Against Collusion in Sealed Bid Markets."[5]

Coate stated that collusion occurs when firms coordinate their pricing policies in an attempt to increase their profits. The likelihood of collusion depends on the ease of reaching a consensus and the ability to detect cheating on the consensus. In sealed bids, the need to consider the second factor disappears because of ex-post announcements of the winning bids. Thus, the firms need only to reach an explicit agreement on price.

To deter collusion, Coate argues, one should create an open, well-defined market to identify the costs of the project by collecting information on particular projects and bidders. All bidders should be required to disclose preexisting subcontracts and miscellaneous business relations with other potential competitors. A computer analysis of sealed bid data may identify markets where collusion is likely to occur. Every effort should be made to broaden competition. Alternative measures should be taken concerning the delayed publication of the winning bid. Bidders should be required to list price, discounts, and payment terms separately. This complicates cartel agreements by requiring collusion on more terms.

Coate also suggests the aggregations of small contracts into large lumpy contracts to increase the benefits of winning the auction. Very large contracts, so his theory goes, would induce bidders to cheat on the cartel price and win the auction with a more competitive bid. By permitting separate bids on the items, small firms may win the bids on particular projects and avoid the affects of aggregation.

However, such theories do not always work out in practice. New York tried the large contract concept during the past few years without apparent success. As an example, five highway projects on Long Island were combined into one large project, referred to as the "Super Job," with the hope of fostering genuine competition by drawing bidders from outside the immediate area. In fact, a number of potential bidders to consider were solicited to compete for the project.

However, when the bids were opened only one firm from outside Long Island had bid, and that one was from New York City. Concerns about the difficulty of obtaining materials at competitive prices and establishing workable relationships with local unions apparently convinced other potential bidders that the barriers to entry in this market were unacceptably high. Despite the obvious opportunities for economies of scale, the low bid that was received for the "Super Job" was well in excess of the total low bids for its components that had previously been rejected as unacceptably high.

Announcement of Winning Bid

Contractors opposed requirements that discount and payment terms be itemized, as this complicates the bidding system. In addition, a system that did not announce the winning bid was considered unfair because the losing firms cannot check their bid against the winner. The bidders' concerns would be minimized if the system allowed the bids to be published eventually and guaranteed the honesty of the procedure by audits.

The post-bid announcement of winning unit bids in sealed-bid markets represents an open invitation to collusive behavior. The system can be structured to minimize the incentive for collusion and the auction process can be adjusted to restore some incentives for independent behavior. A sealed-bid auction should be structured so that it is open to as many bidders as possible. Competitive cost of the project to be bid should be estimated and internal information should be gathered from each auction participant. If this fails, a randomization scheme should be introduced into occasional auctions to make it more difficult for a cartel to detect independent pricing behavior. Competition in a sealed-bid market is probable if the government undertakes a well-thought-out strategy to deter collusion.

In developing reform proposals, economic gains must be balanced against the prevention of moral hazards. When a government agency calls for bids from the interested firms and selects the lowest bidder, it cannot review the bidders' expected costs and, therefore, does not know which is the most efficient firm. Absent collusion, the bidder too must determine his bid in ignorance of the expected costs of his rivals. Such a situation led to the Pentagon scandals in which companies bought information concerning rival bids.

Moral Hazard

McAfel and McMillan[6] suggest that fixed-price contracts should be used rather than cost plus contracts because on cost plus, the contractor has no incentive to limit his costs. Potential contractors (agents) submit sealed bids on the basis of which the government (principal) selects one to

perform a task. The bidding process induces the potential agents to reveal their relative expected costs. The optimal contract trades off giving the chosen agent an incentive to limit costs against stimulating bidding competition and sharing risks. The optimal contract trades off, as in the usual principal-agent analyses, moral hazard against risk sharing. The bidding competition effect serves to reinforce the risk-sharing effect. Payment should depend on true valuation as well as bids. The gains from making payment dependent on valuation must be weighed against losses from moral hazard.

Wicks Law Contracting

Another approach to competitive bidding was relatively unsuccessful. A New York statute, known as Wicks Law, requires public building projects to be broken into four separate categories: general contractors, plumbing, heating and ventilating, and electrical. Specialty contractors bid on those items. Another requirement is that the general construction contractor cannot supervise the other three specialties, and that there is no privity of contract between the general contractor and the three specialty contractors. When bids are opened, if one segment of the four-part contract fails, generally the other three fail even if they are good bids.

On occasion, the letting agency also receives no bids on one of the specialty categories, making it difficult or impossible to award construction with a major component like electric, heating and ventilating, or plumbing left out of the overall project. There are always other problems such as specifying a large exhaust fan and forgetting to tell the general contractor to put a hole for the fan or telling the electrical contractor that he is to provide wiring for the heating and plumbing contractor to hook up his fan. For these reasons, the potential competitive benefits of the Wicks Law have often been offset by the difficulties it creates.

Other Factors

For multimillion dollar projects, it is becoming more and more obvious that there are few companies that can competitively bid that much work, so there really is a monopoly, a one-bidder concept. Also, strong anticollusion statutes prevent effective joint venturing of several smaller companies. Further, the trade unions actively campaign against nonunion contractors and exert enormous amounts of pressure on the public agencies to find those nonunion contractors to be nonresponsible in connection with submission of bids.

Every day, lists of disqualified or suspended contractors are issued. The rigors of pre- or postqualification are potentially discouraging to new firms that want to start up, but have little chance in competitive low-bid contracting. At the same time, government should not be the training school for contractors in which they attempt to provide adequate performance, but fail.

THE NEED FOR INNOVATION

Despite all these problems, just about everybody accepts the competitive bidding (lowest-bid) concept as gospel. To attempt to revise it even with the benefit of experience has been portrayed as almost un-American.

The competitive (low-bid) concept will be difficult to overcome. It has created the Ma Bells of the construction world, and they do not easily fall. It has created the labor market controls and the supply controls that work to the advantage of a few powerful firms and organizations, that will not yield easily.

The age and durability of statutes requiring competitive award of contracts to "the lowest responsible bidder" also command respect. They have served the public well over the years, under varying circumstances not always clearly foreseen by the legislators and others who developed them. We should avoid making change for change's sake. At the same time, the current system has not prevented bid-rigging, and it does not provide enough flexibility for close cooperation between design engineers and construction contractors. This is particularly true on major rehabilitation projects in densely developed urban areas, where it is extremely difficult to identify all conditions and problems at the design stage.

A way must be found that demonstrates that government officials can be good administrators, can be innovative in getting the best quality and performance for the dollar spent and that the good of the general public can be substituted for the profit motive to obtain the results that the public really desires. Incentive and disincentive clauses, timely performance, quality performance, turn key, design-build, and many other concepts, such as encouraging use of project managers who bring all of these resources together as is done in the private sector, must be considered. The term "brokerage" has become a dirty word. If we permit the obtaining of public works projects and then broker it (administer it) we are going to have to be very careful how we provide for this.

It will be our task to analyze suggestions in this country or abroad, to sort out the good from the bad, to come up with a complete system that considers all of these factors, to test it, and then to demonstrate that our proposal will work. The parochial interests of many groups

or organizations will be a major factor that we will have to deal with. Certainly, any modification that we think of has been tested somewhere, so that we can produce a good analysis of strengths and weaknesses for each of the individual aspects. We can then consolidate these concepts into an innovative approach to public bidding processes. No matter how good the resulting system appears, the abilities, honesty, and integrity of public officials, and the desire to make the system work by those that administer it will be key factors in whether the approach succeeds.

ENDNOTES

1. See *New York State Laws of 1847*, Chapter 278; Laws of 1898, Chapter 115.

2. 103 Florida 976, 138 So. 721 (1931).

3. For background, see Memorandum of the State Attorney General on Chapter 965 of the Laws of 1963, *New York State Legislative Annual*, 1963, at p. 238.

4. Laws of 1971, Chapters 938 and 1110.

5. *Antitrust Bulletin*, Winter 1985.

6. R. Preston McAfel and John McMillan. Bidding for Contract: A Principal-Agent Analysis. *Rand Journal of Economics*, Vol. 17, No. 3, Autumn 1986.

TRENDS IN CONTRACTING PRACTICE FOR CIVIL WORKS

Ernesto E. Henriod and Jean-Marie Lantran[1]

As contracting practice evolves, there is growing awareness of the need to refine the basic documents on which it rests--the bidding documents and the contract itself--to ensure that the facility owner gets the work on time, to specification, and within budget; and the contractor realizes his expectation of profit, which is the primary reason for his being in business. Contractors are also experimenting with new ways of acquiring business and enhancing profit. Two areas in particular have been subject to close scrutiny in recent years: the definition of risk, and the optimizing of incentives.[2]

Both these factors, risk and incentive, come hand-in-hand in the construction industry. Contractors who succeed have learned to manage risk and maximize profit-taking, often in conditions of almost suicidal competition. But for every contractor who succeeds, many are victims of poor planning, poor budgeting, and poor resource management. The failed contractors are a measure of the industry's inefficiency, and their failures necessarily affect the facility owner and his expectation of results from the economic asset that was under construction.

Worldwide, the industry has a poor reputation for coping with risk. On the contractor's side, many excellent craftsmen and engineers attempt to become entrepreneurs, usually with little or no knowledge of good management practice; contractors' ranks are also graced by adventurers, lured by the aura of the "fast buck" which construction conjures for many. On the owner's side, minimizing cost is often the absolute goal, regardless of market realities; impossibly low prices are accepted in bids, and contracts of adhesion are foisted on contractors, often with clauses that give the owner all the rights and the contractor all the obligations. A fairer meeting of the minds will lead to a more harmonious contractual relationship and the achievement of the contract goals.

As the construction industry gains recognition as one of the pillars of economic development and sustained economic strength, more and more work is being done by business and academic circles in trying to define risk, and in improving the overall business environment and internal management of the industry. These are means to improve the reliability of contracting and the value that the owner receives for the money he invests in construction. In the United States, for instance, the Business Roundtable carried out in 1982-1983 a construction industry cost effectiveness project[3] that investigated the market and managerial shortcomings of the industry. The summary report of the project presented a dark picture. It began with the statement, "By common consensus and every available measure, the United States no longer gets its money's worth in construction," and went on to give some chilling figures on the drop of productivity that the industry had experienced over the preceding decade. Part of this drop was blamed on labor and regulatory constraints, poor management practices, and, in no small measure, on the "constant state of confrontation," internally and with its clients and regulators, in which the industry carries out its business. Regarding this last point, the report included, as part of the action plan it proposed, a recommendation for owners to "accept that contraction is complex; recognize that astute contract preparation . . . can yield improved project cost effectiveness; develop appropriate expertise; and develop a formal contracting plan in depth as a means of arriving at a logical method of risk management based on the project objectives."

The concerns expressed in the 1983 Business Roundtable report are still in effect, judging by the frequency and character of the papers on contracting, risk management, and business failures that appear in the ASCE Journal of Construction Engineering and Management.

Those concerns are, to a large degree, universal, and do not apply exclusively to the United States.

In the United Kingdom, the University of Manchester Institute of Science and Technology (UMIST) has been studying ways of handling construction work in which risk is poorly defined, for instance, through the use of target contracts; and more recently, looking at risk management in broader terms. Among the principal conclusions of a recent paper prepared by UMIST researchers[4], they state that "all too often, risks are either ignored, or dealt with in a completely arbitrary way . . . The need for judgment should not be used as an excuse for failing to give adequate consideration to project or contract risk," and that "Clients should ensure that the allocation of risk is clearly stated in the tender documents, and contractors clearly specify the provision made in their bids." The paper discussed techniques of risk assessment, and the ways to handle risk in the formulation and management of the contracts. After defining risk, the contract should deal with the way in which it will be paid for. Not "if" risk should be catered for, but "how": contracts must be clear and specific in this respect.

The World Bank has also been looking at the construction industry and its business environment, seeking to improve bidding and contract conditions, *inter alia*.[5] It is following developments in the field of contract formulation with great interest, realizing that the momentum needed to develop the construction industry inlatte borrowing countries will have to be propped on a correct understanding of risks and rewards and their fair apportionment among the parties to the contract. World Bank borrowers and the construction industries in their countries cover a wide range in the spectrum of development: from active internal markets, which have permitted contractors to develop and learn to manage risk, including the high level of risk involved in the export business, to countries in which the degree of development and the demand for construction have not allowed a domestic construction industry to arise. In the former case, the problems are similar to those of contracting in developed countries; in the latter case, contractors have to be weaned into basic management procedures, and the owners must initially shoulder most of the risk. Also, in civil engineering construction work simple contract forms are used, and the tasks are initially simple, later increasing in complexity and risk.

In gravel road construction, for instance, a workable progression proceeds from haulage of gravel and spoil; to excavation and haulage; to excavate, haul, spread, and compact; to full construction, with a corresponding increase in the complexity of the contract form and the degree of risk taken by the contractor. Initially, the risk is limited to that of supplying a truck and drive, and performing an operation on a cost-plus basis.

There are also important initiatives in World Bank member countries to develop management skills among contractors: for instance, the courses for project and construction managers given in the Eastern and Southern Africa Management Institute (ESAMI), in Arusha, Tanzania, and the National Institute of Construction Management and Research (NICMAR), in Bombay, India, to quote only two of many notable endeavors. The World Bank follows the work of such institutions, encourages their use by borrowers in other developing countries, and supports them where possible.

THE FORM OF CONTRACT

One important aspect in contracting is that of achieving that the parties fully understand their rights and obligations as arise from the contract. Language has often been a problem: contracts have tended to be written in tortuous legalese that has in itself been the cause of misinterpretations and disputes. Efforts are being made to simplify the language in which contracts are written, so that both parties can understand more clearly the intent of their clauses. FIDIC, in the new edition of their conditions of contract for civil works[6] have made a brave attempt at simplifying contract language. The previous edition, launched in 1977 and used worldwide over the last decade, was reputed to be written in a way that "86% of its sentences could be understood by only 4% of the population," in terms of IQ.[7] It is not difficult to visualize the extent to which this kind of language can generate problems of contract administration.

The new FIDIC Conditions also go a step further in defining risk, for example, in the area that traditionally had been dubbed "force majeure" and left to arbitrators or judges to decide on how to resolve disputes over compensation. Whereas the previous edition of the FIDIC Red Book termed these risks special risks, the new Conditions defines them clearly as employer's risks, lists them (including engineering design not supplied by the contractor), and provides for remedies. Although we are still discussing among ourselves the extent to which the new Conditions cover this subject adequately and fairly, in terms of the World Bank disseminating its use among its borrowers (the previous--third--edition of the FIDIC Red Book is included with the Bank's "Sample Bidding Documents for Procurement of Works"), the intent of improving the definition of risk and responsibility is welcome.

Another approach is that taken in the general conditions of contract[8] for projects funded by the European Community in developing countries. In that standard document, the contractor has the right to claim for compensation or termination of the contract in case of unforeseen events that were not caused by the owner (and, of course, are not traceable to the contractor), provided those events result in damages which are "large, unforeseeable, and unavoidable."

The Institution of Civil Engineers (ICE) of the United Kingdom has launched an initiative to design a new style contract for engineering projects, seeking objectives such as flexibility, to adapt to new contractual situations and relationships, particularly the varying degrees to which contractors take part in design; stimulating good management; and clarity and simplicity, to define rights and obligations and the apportionment of risk among the parties in clear language, free of legalese jargon.[9] The initiative is in its early stages of implementation, but the ICE is to be commended for this healthy new approach at designing a contract form that departs from a tradition of obscurantism that plagued earlier standard documents. One such standard document goes as far as stating that the contractor may not be capable of understanding its terms, and encourages him to consult his lawyer before signing the Contract.

Risk in Bidding

Some attempts have been made to reduce the exposure of contractors to ruinously tight pricing, and to elicit bids that would be closer to realistic prices, allowing adequate financial resources for construction, as well as a fair return for the Contractor's efforts. One example arises from the Peruvian regulations for bidding and contracting for public works,[10] which aimed to achieve this through the averaging of the bids received. Article 4.3.13 of these regulations states (in a slightly abridged translation):

"An award will be made in accordance with the following procedure:

1. When three or more bids have been received:
   a. The average of all bids and the base budget[11] will be calculated.
   b. All bids that lie 10 percent above and below this average will be eliminated.
   c. The average of the remaining bids and the base budget will then be calculated.
   d. The contract will be awarded to the bidder whose bid is immediately below the second average or, should none of the bids lie below the second average, the award will be made to the bid which more closely approximates the average.
2. If less than three bids are received, the bidding agency may cancel the process, and award the contract to the lowest bidder or to the only bidder if this were the case."

The intent of this procedure was clearly to achieve fair pricing, and draw away from cutthroat competition. However, the system has important drawbacks: in the first place, bidding is transformed into a lottery of sorts, where the contractor's skill in pricing and work management is no longer a deciding factor; and second, concerted pricing by groups of contractors may control awards to a certain extent, by drawing the averages toward a prearranged level.

Another similar practice is that of bracketing, i.e., considering only those bids that lie within a certain range above and below the engineer's estimate. In this system, the lowest responsive bid within the range gets the award. Once again, ingenuity in pricing is discouraged through the arbitrary setting of brackets.

Is it practicable or wise to disregard very low bids? Some contractors complain about the excesses of price competition, and suggest that abnormally low bids should be disregarded. They argue that contractors running into financial difficulties induced by excessively low pricing will be unable to perform, or will strive to reestablish a normal cash flow through claims. In many contracts that have been let at very low prices, both contractors and owners have suffered. On the other hand, it is difficult for the owner to assess accurately what should be a minimum reasonable threshold; and the more diverse the competition, the harder it will be to establish such a threshold.

The French Public Works Regulations[12] state that abnormally low bids should not be accepted: "Any bid whose price appears to be abnormally low, and consequently may cause implementation problems, should be disregarded without any hesitation..." However, the rule is later qualified by an elaboration of the concept of what is a "normal" price:

"Clearly, the normal cost (to the owner) of the works, to which the bid must be compared, is not the cost which would result from the collusion of contractors in pricing previous works, nor that which would be obtained by updating previous prices by applying general indices or escalation formulae, since one must take into account, *inter alia*, improvements in productivity; in this regard, a careful analysis of the breakdown of unit prices may assist in estimating if the bid prices are reasonable" (in a slightly abridged translation)."

We do not know of any sure method of identifying and excluding an irresponsibly low bid, other than carrying out a careful analysis of the lowest bid, including the work methods proposed and the resources available to the bidder (personnel, equipment, and financial). This procedure requires a thorough preparation of bidding documents that set out well-defined, quantifiable criteria for evaluation of those nonprice factors. Unless they can be quantified objectively, the determination of responsiveness will have to rely on expert judgment, with the attendant differences of opinion and potential for conflict.

CONTRACTOR-PROPOSED DESIGN AND CONTRACT ALTERNATIVES

For works of a certain magnitude, of a size where prequalification would normally be advisable, contractor's skill and imagination may be tapped, seeking to reduce project costs and construction time. The bidding documents may open up the field of competition to embrace the engineering design and technical specifications, construction methods, time schedule, and even contractual clauses. Care should be taken to establish appropriate rules for bid evaluation, which should be clearly spelled out in the bidding documents. Also, the prequalification of bidders should be carefully carried out, to select only those firms that would be capable of putting forward responsive and responsible bids, particularly if involving design alterna-

tives. Another reason to prequalify bidders is to reduce the impact of the considerable cost that may be involved in the production of alternative engineering design or devising construction methods that improve cost and time performance. Needless to say, narrowing the field to those firms that are eminently qualified for the job will also enhance their interest to produce their best possible effort: their fears of excessively numerous bidders and irresponsibly low bids are allayed.

The French regulations include several bidding procedures that allow for the presentation of alternative proposals for the engineering design and specifications:

1. Bids with restricted alternatives, under which contractors must bid on the basic engineering design but may also propose alternatives for specified parts of the project;
2. Bids with major alternatives, under which the bidders may propose their own alternative engineering design for the whole works, subject to compliance with performance specifications; and
3. Bids without basic engineering designs, where the bidders must propose their own, on the basis of performance specifications.

Bidding documents must of course detail carefully the performance specifications under that the alternatives will be judged, as well as the method which will be followed for evaluation. Those concerned with the preparation of bidding documents and bid evaluation must have a high degree of technical sophistication. The same applies in cases where contractors may offer alternative time and cost-saving construction methods.

The use of completion time as a factor in bid evaluation has also been proposed, for instance, by discounting a stream of costs and benefits (or benefits foregone, in case of late completion) at a given discount rate, and comparing the present values as a means of arriving at the lowest evaluated bid. The authors are reticent to fully endorse bid comparison on the basis of promised time benefits. To be effective and forestall abuse at the time of bidding, contracts would have to include "cast iron" clauses tying the completion date to weather conditions, engineer's instructions, change orders, etc. These are, on the whole, difficult to write and implement in "ad measurement" type contracts. They may apply more readily to "lump sum" contracts, where significant variations are unlikely to occur. For "ad measurement" contracts, the authors prefer alternatives based on tangible proposals such as design or constructional methods.

Certain contractual clauses may also have an impact on cost: payment schedules, working conditions on site, use of the employer's facilities, etc. Whether they may be the subject of alternative bidding or not depends on each particular case; bidding documents should indicate the permissible departures from a conforming bid, and the method by which they would be evaluated.

The contract itself should include appropriate clauses to cover for whatever alternative is solicited or permitted by the bidding document. Alternatives in fact enhance contractor's risk, in that they place on the contractor the onus for doing something differently, for which added benefits are expected. The contract should therefore assign such added risk to the contractor, and allow for such bonuses or penalties as may be necessary to acknowledge the contractor's production of the promised results.

TARGET-PRICE CONTRACTS

The use of target-price contracts has been promoted since the early 1960s for situations in which risk is not well defined, and contractors cannot quote a price with any degree of certainty. For example, for very long tunnels where the depth of cover or other circumstances make it impractical to carry out extensive exploratory drilling; or for projects that must be started before full engineering design has been completed. The Contractor must make a best guesstimate on the cost of the project (which becomes a target cost), and quote a fee for completion within a certain range above and below the target. If the final cost, paid on a reimbursable basis exceeds the range, the fee is reduced following a sliding scale; conversely, it increases on a sliding scale if the final cost is below target.

Target-price contracts could therefore provide an answer in situations of rapidly changing site conditions or unquantifiable risk. However, they do require excellent project management on both sides, owner and contractor, with the former providing a sophisticated, well-informed supervisor, capable of managing changing circumstances flexibly and fairly. The key issue is the definition of the target cost at the time of bidding, and its later adjustment as circumstances vary. It has been found in practice that contractors will seek to increase the target level if their calculations of productivity, etc., were on the low side, and address their most strenuous efforts towards that end. In fact, the target itself is the most contentious element of this system.

In a World Bank-financed highway maintenance project in a developing country, a target system was used to create incentives for the contractor providing management support to a force account unit. The target was partly defined in terms of the volume of compacted gravel to be place in the roads to be resurfaced, but the actual thickness of gravel to be place was left to be specified by the supervisor on site, as work progressed. The contractor

quickly achieved and exceeded his contract targets by placing excessive thicknesses of gravel near the borrow areas and, although the planned volume of regraveling was achieved, a large part of the road network remained untouched. This is an example of how poor supervision can in fact invalidate the target system.

Another use has been proposed for target incentives, providing the same sliding scale for completion before or after a target date, in the determination of a bonus or penalty to be received by the contractor or deducted from his final account.[13] This is a practical way to apply the concept of targets to create incentives for performance, and to a certain extent assist in managing some risks attached to timing.

THE CONTRACTOR IN A WIDER ROLE

In latter decades, contractors have diversified, and have often made inroads into the field of commercial development. This practice, which is extended within some industrialized countries, is not frequently observed in the international arena. However, as the international market for construction work receded, the larger and more sophisticated contractors in developed countries have been searching for ways to use idle resources (particularly trained personnel) and to generate work for themselves by stepping into areas of risk that hitherto were the domain of governments or utility concessionaires. Increased activity of contractors has occurred in a whole range of pursuits, usually including some form of responsibility over design.

At the lower end of risk and responsibility, and also of potential profit-taking, is the managing contractor, who acts as an agent of the owner in coordinating design, bidding, contracting, and supervision activities, for a fee. The contractor, cast in this role, provides his experience in all aspects of practical and detail engineering, procurement, expediting, site management, cost control, etc. The incentive for quality of performance is almost exclusively that of maintaining good will and reputation.[14] For the owner, this approach means having access to the skills and know-how of a reputable contractor, and potential savings in time and money through skillful project management. A measure of financial incentive can be introduced, for example, by linking the fee to a target cost (but note the risk to the owner, if the target is not properly defined and managed).

Further up the scale of risk and responsibility are the well-known and tried concepts of design-build and turnkey, where the Contractor accepts responsibility for the quality of design, and often takes on a financial risk, for example, where a turnkey job is let on a fixed-price basis. However, the contractor's responsibility ceases more or less at the same time as it would in a normal construction contract, i.e., on completion of the maintenance period (statutes of limitations excepted).

Of late, however, contractors are often seen as promoters of BOT, BOTT, and BOOT[15] ventures, for projects as diverse as power stations, railways, bridges, and tunnels. Here the contractor's risk is enhanced to the maximum, as he not only takes on the physical and financial risk of constructing the works; he also, and most significantly, embarks on risk related to the marketing of the end product, be it power, transportation, or water. The approach is novel, in that the promoter is no longer an entity whose main activity is that of holding utility or service concessions, but it now involves the contractor himself in the venture.

In developing countries, the introduction of BOT projects has followed a financial motive, spurred by governments wishing to develop a utility without increasing the national debt. The principal constraint is usually the perception of the risk involved in developing the new facility, including any risks perceived regarding the long-term prospects of amortization of the loan principal and transfer of interest and profit. These risks have not deterred entrepreneurs from setting up a number of BOT ventures, mainly in Asia, largely for power generation.

In developed countries, the primary motivators have been political, to induce privatization of utility functions, and financial, to reduce governments' financial strains. Perhaps the most daring BOT ventures today in developed countries is that of the Channel Tunnel, between England and France. This was launched initially through a 50 million pounds sterling equity issue, taken up by 10 contractors and 3 banks. At a later stage, the concessionaire venture Eurotunnel was formed, still including the initial equity partners; this concessionaire venture has raised further equity and loans for a total of about 5 billion pounds sterling. When the "Chunnel" is completed, revenues will come from road tolls and from contracts with British and French Railways. It is interesting to note the types of contracts let by Eurotunnel. The principal ones are:

1. Lump-sum contracts for laying railway track and building the intermodal transfer facilities, which can be defined and quantified before the start of work.
2. Cost-plus-fee contracts, tied to target incentives, for construction of the tunnel, perhaps the best approach for tunneling work under considerable risk. The contractors will be working almost at the limit of tunneling technology. But it will also include certain checks and controls not usually available, because the contractors are themselves partners in the concessionaire venture, and are thus interested in minimizing the capital cost of the tunnel.

3. Management contracts for the procurement of rolling stock and other equipment, an excellent approach, given the amount of negotiation involved with many potential suppliers, and the need for close collaboration in designing equipment that is specifically tailored to the Chunnel's operational characteristics, between the management contractor and the suppliers.

The above three types of contract imply a varying degree of risk for the contractor: from the almost total risk of the lump-sum contract, through the intermediate stage of cost plus fee and incentive, in which risk centers on the amount of the fee, to the management contract, in which risk is minimal. However, underlying the contracts is the risk of success of the whole venture, in itself a potent motivator for efficiency and economies.

In all these types of ventures, over the whole range of contractor responsibility, the form of contract is the critical element: whether defining the risks that the employer acknowledges as his own, or the target in an incentive-assisted management contract, or the government guarantees that will support the floating of a BOT venture, a clear understanding of the risks involved and the responsibility for dealing with them is essential. They must be spelled out in clear terms, fairly stating the rights and obligations of both parties.

CONCLUSIONS

The quality of bidding and contract documents is critical to the successful implementation of the project. Risks must be properly defined, and the remedies associated with those risks spelled out, in a way that enables the contractor to put his best bid forward. The owner must also be protected against irresponsibly low bids that later result in an excess of claims and controversy. Apart from insisting on clarity of the contract terms, the owner should also carry out a close scrutiny of the bidder's credentials and the responsiveness of his bid. These are the best safeguards for a timely completion of the work, within budget; and they should be used, linked to awarding to the lowest responsive, responsible bidder, in preference to other means to avoid ruinous competition, such as averaging, bracketing, or targets.

There is a considerable resource of unused capacity and skill among contractors, which is available to assist owners in the management of contracts. When charting the course of a new development, new approaches, ranging from management contracts to BOOT, should be considered by owners as valid options, together with the more traditional methods of bidding on the basis of existing designs and specifications.

ENDNOTES

1. Procurement Advisor (Works), Central Operations Department; and Senior Construction Industry Specialist, Technical Department, Africa Region, respectively, at the World Bank, Washington, D.C.

2. The views and interpretations herein are those of the authors and should not be attributed to the World Bank, its affiliated organizations, or any individual acting on their behalf.

3. *More Construction for the Money, Summary Report of the Construction Industry Cost Effectiveness Project.* The Business Roundtable, New York, Jan. 1983.

4. *Risk Management in Engineering Construction*, by R. W. Hayes, J. G. Parry, P.A. Thompson, and G. Willmer, UMIST, Dec. 1986.

5. See, for instance, *The Construction Industry -Issues and Strategies in Developing Countries*, "The World Bank, Feb. 1984 (Second printing, June 1986); and *Sample Bidding Documents - Procurement of Works*, Inter-American Development Bank and World Bank, Sept. 1985.

6. Federal Internationale des Ingenieurs-Conseils (FIDIC): Conditions of Contract for Works of Civil Engineering Construction. Fourth Edition. Lausanne, Switzerland, 1987. (Widely known as the "FIDIC Red Book.")

7. Nail Bunni, quoted by Martin Barnes in "International Construction," Dec. 1987.

8. Cahier General des Charges des Marches Publics de Travaux it de Fourniture Finances par le fonds Europeen de Developpement, *Journal Official des Communautes Europeenes*, Feb. 1972.

9. Institution of Civil Engineers, Great George Street, Westminster SWIP 3AA, United Kingdom (unpublished).

10. Reglamento Unico de Licitaciones y Contratos de Obras Publicas, Decreto Supreme 034-80-VC, Nov. 24, 1980.

11. Equivalent to the engineer's estimate.

12. Marches Publics de Travaux. Guide a l'Intention des Maitres d'Ouvrage et des Maitres d'Oeuvre. Commission Centrale des Marches. Journal Officiel de la Republique Francaise No. 2009, Paris, France (Current Edition).

13. See, for example, *Contract Time Determination*, compiled by P. E. Irick, T. L. Copas, and H. A. Pennock, TRB, National Research Council, Washington, D.C. Oct. 1981.

14. See, for instance, *The World of the Management Contract*. The Export Group of the Constructional Industries, London, England, 1988. This booklet explores various possibilities of this concept.

15. Build, Operate, and Transfer; Build, Operate, Train, and Transfer; Build, Operate, Own, and Transfer. We refer to these ventures as "BOT" in the text.

AN OVERVIEW OF INCENTIVES AND DISINCENTIVES

Orrin Riley

There have been two damaging and well-publicized slurs on the construction industry recently that some may not realize are closely related. About 4 years ago, the Business Roundtable--a collection of Brahmins from the Fortune 500--castigated our industry for high cost, slogging torpor, and terminal malignant ennui. About 2 years ago, the American Society of Civil Engineers--the Brahmins from the ENR 500 reacting to a string of spectacular, grotesque, and unforgivable failures, started to write a "how-to" manual.

They were slurs because--in both cases--the concerned practitioners (buyers in one case, designers in another) stepped outside of and around the construction establishment to find a solution. The Roundtable ignored the Associated General Contractors and founded instead the Construction Industry Institute. The ASCE ignored its own Construction Division and founded a task committee on Quality in the Constructed Project.

These were core entities grown leery. They were related because both found out that both the problem and its solution were rooted in poor management--poor management of costs from business and poor management of risk engineers.

It has been known for 50 years that the essence of effective management is motivation. The driving force of motivation is *incentive*--the pat on the back, and its mirror image, *disincentive*--fire the rascal.

Incentives can be *soft* (intangible) or *hard* (tangible). And the hard incentives can be *unspecified*, such as profit (never mentioned except for extras, and then only to restrict it), or *specified*, such as bonus clauses.

Soft Incentives	Soft Disincentives
Participation	Idleness
Creativity	Boredom
Recognition	Opprobrium

Richard Tucker and Charles McGinnis, the director and associate director, respectively, of the Construction Industry Institute, spoke about these things in their paper entitled "The Design Construct Management Challenge":

> An additional area of incongruence between design and construction organizations can be found in their respective motivational structures. Designers tend to derive significant satisfaction from professional activity and recognition. The commitment to quality, which in turn yields a high probability of client repeat business, is a major objective. Designers are sensitive to status, and often will respond more positively to some form of management recognition than to reasonable pay increases. They are given to conservatism for the most part in their professional activity. They are not risk takers, in fact, risk avoidance is a strong article of faith. The designer is interested in money, but the concern seems to be with achieving a reasonable threshold level of salary compensation which will permit maintenance of a standard of living on a par with professional peers at work and in the neighborhood. The design salary structure tends to be significantly lower than for construction executives with comparable qualifications and experience in their field of activity.
>
> The builder's principal driving force seems to be financial. By the very nature of his business he is a risk taker, with significant exposure to loss and with a high anticipation of reward if successful. Bonus payments for profitable projects are routine. He tends to be somewhat more mobile in moving between employers, following the work and driven by salary and bonus considerations. He obtains great satisfaction from surmounting the physical challenge of solving a difficult construction problem. He is sensitive to his status amongst peers, and he fights hard to obtain and retain improved status. He builds a reputation which is known widely in the industry, and which enhances his mobility between employers.

(It seems plain from the context of this paper that the word "bonus" as used here is internally generated, that is, from the employer, and not externally generated, that is from the project owner, which is the usual definition of a bonus incentive.)

The check list for hard incentives might appear as follows:

Hard Incentives (unspecified)	Hard Disincentives (unspecified)
Profit	Loss
Growth	Atrophy
Rewards	Bankruptcy

SOME WAR STORIES

When I was a young man and just starting out in the construction game, I recall having heard--over and over again--three startling things about contractors' bidding strategies:

- That some bid low, and expect to make their money on claims;
- That some bid low, and expect to make their money on change orders;
- That some bid low, and expect to make their money on their subs.

After decades of working with both owners and contractors, I have been able to verify only one and a half of those three postulates.

Some Contractors Do Abuse Their Subs

I did indeed work with a building contractor (I saw his bid with my own eyes) who totally brokered a job; he broke out every aspect of the work into about thirty different trades--masonry, glazing, carpets, etc.; obtained a bid price from each trade; totaled up the subs bids, and that became his bid, and he was low. Nothing for his own carrying costs, nothing for general conditions, nothing for overhead, management, or profit. Then he would get on the telephone and work the buy-down. "OK, I got the job," he would say, "now what's your *real* price?" Then he would haggle. His incentives were real. The job was for $2 million over 18 months. He needed a superintendent on the job with an office and a phone, he needed security guards, he needed sanitary facilities, safety features, and bid bonds. He needed to buy down $200,000 before he could break even. It must have been a gut-wrenching week on the phone. If I were the owner, I would worry about the time management on that job. In fact it did go sour, and it was the bonding company that called me in to see what I could put together at a reasonable cost to get the thing settled.

Change Orders Are "Creative Opportunities"

On the matter of change orders, I never experienced a contractor who relied on change orders for his sole profit source, but I did run into an electrical contractor who relied upon a change order to supply what was intended. The specification for 50 elaborate changeable message signs for a major turnpike called for a complex control panel mounted in a sealed box "similar to" that manufactured by a local reputable supplier, who had made all of the boxes for the other electrical signs on that road. When the shop drawings came in from that supplier, via a new electrical contractor, the drawings showed a piece of junk. It seems that the new contractor had rummaged around and found a bottom-of-the-line sample that the manufacturer had once supplied to a hamburger joint and convinced the skeptical supplier to base his price on that. It cost many thousands of dollars per box to correct that specifying error.

On the Matter of Contract Claims

I have never known of a contractor that depended on claims to earn a profit.

A caveat here about my own attitude on claims. There is a notion, and a very widespread one, that there is an explosion in contract claims. In two opportunities to look into the root of construction contract claims, I have never been able to prove this hypothesis. For one thing, there is no common definition of claims; for another thing, often claims are settled by an agency outside of the contracting agency such as an attorney general's office, and sometimes claims are paid out of a fund after a settlement conference, the results of which are unknown to the contract administrators. For these and a host of other reasons, it has been extremely difficult to get a handle on any specific hard data to show the trend in contract claims. In agencies such as turnpike authorities and the like, where comparative records are available, the total settlement for all claims should not come to more than 2 or 3 percent of the total construction budget. This can hardly be called an explosion.

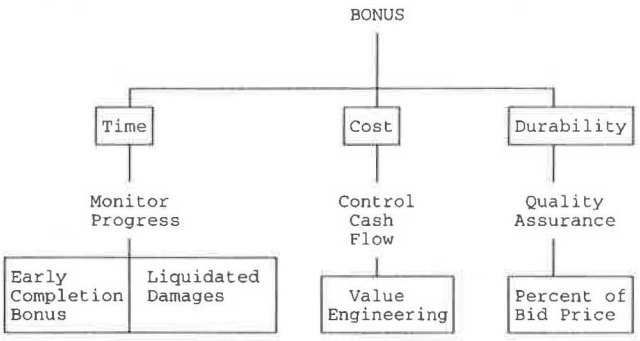
- The proliferation of claims is a perception without proof.
- A checklist of hard (specified) incentives as taken from a typical department of transportation specification might appear as follows:

Hard Incentives (specified)	Hard Disincentives (specified)
Bonus	Penalty
	Retainage
	Liquidated damages
	Bond forfeiture

It is clear that specified incentives have a strong bias on disincentives.

BONUS SYSTEM

Bonus systems tend to be focused on one or the other of three principal aspects of contract construction; time, cost, and durability. These systems can be chartered as shown in the following diagram.



In general, agencies tend to award a bonus, if any, for one of these aspects, but never for two or more. Early completion bonuses seem to be most in favor for commercial work such as office buildings, apartment buildings, factories, and the like. However, according to *NCHRP Synthesis 79, Contract Time Determination*, such incentives are finding their way into the transportation sector. The synthesis states the following:

INCENTIVE PAYMENTS

Agencies set bonus payments in an attempt to reward the contractor with an amount that is equal to the benefit of early completion or the cost of delayed completion. Bonus payments are used only for projects where there is compelling public need. Incentive or bonus payments are not required in order to include a provision for liquidated damages in the contract. (Contracts with incentive payment clauses always include provisions for liquidated damages.)

In the survey of state transportation agencies conducted for this synthesis, only 10 of 43 respondents indicated that they provide for incentive payments on construction contracts. Some of these agencies indicated that incentive payments have been used on selected or special projects (see Table 1). For example, a recent contract in Maine to repair a vital bascule bridge contained a provision for a $10,000 per day bonus for early completion.

The special provisions for incentive payments and liquidated damages used by the Illinois Department of Transportation in contracts for rehabilitation projects are shown in Figure 7. The provisions provide for a maximum payment period of 50 days at $5,000 per day. During a 1-month period no incentive was to be paid of damages charged; thereafter, there would be a damage charge of $10,000 per day (Figure 8). The contractor completed the work during the 1-month period.

Transportation officials are reluctant to use an incentive or bonus payment. If a contractor concentrates forces and equipment to complete a project early and collects a substantial bonus, the individuals setting the time limits and the agency are subject to criticism by the press, federal officials, and others, even though (a) later completion of the project most likely would have increased construction costs, (b) the bonus payment probably resulted in earlier use of the facility, and (c) other contractors had the same opportunity to place bids and collect bonus payments.

Arguments that have been presented against bonus payments include:

- Difficulty in budgeting an amount for bonus payments.
- Need for additional data to decide on an amount to rate.
- Value received may not be proportional to the additional cost.
- Increase in claims contractors.
- Provision in contract for liquidated damages is sufficient incentive.

The transit sector, too, has found it useful to rely on time incentives on some projects. Writing in *Transportation Research Record 1054* in a paper entitled "Using Accelerated Contracts With Incentive Provisions For Transitway Construction In Houston," Upton D. Officer had this to say about the Houston experience:

As an incentive for better performance Metro offered a bonus of $5,000 per day for each day the AVL portion was completed early for a maximum of $450,000, which could be earned if completion occurred 90 days early (on the 270th day based on 360-day bid).

In spite of the tight schedule and support problems the contractor finished this portion of the contract in 269 days and earned the full bonus of $450,000. The

contract performance period for this part was reduced from 975 to 269 working days, which was a reduction of 706 days or more than 23 months.

How much of the $450,000 bonus was profit? According to the contractor only about $100,000 was realized as profit to the company; the remainder was absorbed in increased costs for accelerating the construction schedule.

Because the old adage "Time is money," is widely believed and widely perceived by owning agencies, it seems likely that some combination of low bid and completion enhancement will be the most likely candidate to supplant the low-bid syndrome.

COST CONTROL PROGRAMS

Rewarding cost-saving schemes has been a part of the construction tradition in military and other federal contracts for some time under the rubric of "value engineering."

The idea of encouraging and rewarding innovation has apparently developed into a high art form in Europe. In a personal communication with the author, Boyd Paulson of Stanford University had this to say about European bidding practices:

More interesting than the averaging system (which I think is sometimes used in Italy) is the normal Central European practice of soliciting substantial design alternatives from contractors at the bid stage. For example, in Germany I have seen highway bridge summaries involving 2 or 3 bids from 15 to 20 separate contractors for over 40 separate bids for the owner to choose from. The variations can be quite major, such as different pier spacings, structural systems, etc. Since the contractors know that their competitors are likely to improve on the owner's original design, and that innovation is frequently rewarded with a contract for a design different from the owner's, there is substantial incentive for innovation in design and construction methods. Clearly this also puts a heavy proposal burden on the contractors, but they must innovate if they want to compete. The owner's engineers obviously need to have the authority, integrity and the technical competence to objectively evaluate and select the best bid, even though it might not have the lowest first cost. Finally, it is helpful not to have so many lawyers to bring suit on every turn of the bidding procedures. It is no wonder that technology in some parts of Europe moves so much more quickly than ours, since *our* public agencies normally reject a contractor's bid if a contractor qualifies it with innovative alternatives. We thus tend to penalize innovation rather than reward it.

American culture does not seem to be able to put so much trust in its public officials and their contractors."

In a study published by the Business Round Table entitled *Contractual Arrangements*, the role of incentives in commercial work is discussed in this manner:

THE ROLE OF INCENTIVES

Incentives are used by some owners in construction contracting in an effort to reduce the total contract cost, control the project schedule and support such performance goals as productivity, quality, safety, technological progress and innovation. Incentives, where used, should be designed to promote efficient contract management, achieve high performance standards, reward efficient contractors, and achieve some or all of the owner's specific project objectives. In general, some portion of the owner's risk is assigned to the contractor with a reward for accomplishing the objectives efficiently. Incentives, along with commensurate penalties, are only means to an end. They are only effective if the objectives are clearly understood by both parties and have a mutual benefit.

Incentives are primarily applicable to cost-plus contracts where they can be used to encourage the contractor to share the owner's risks on cost, schedule, quality or other desired project objectives. Appendix C provides a review of incentives that can be considered for construction contracts. The major disadvantages of incentives are the difficulty of arriving at fair and equitable targets, a reduction in the owner's control over the contractor's activities, and the costs of additional administration. Specific areas of difficulty normally encountered include:

- Negotiating problems to arrive at fair and equitable targets.
- Project engineering must be approximately 60% complete to establish the cost and schedule; otherwise, there are too many unknowns for the contract to be defined.
- If incentive provisions are exercised after the project is under way, the contract's general and special provisions must be reviewed and

renegotiated to give the contractor necessary control of the work. Similarly, a change in the owner's contract administration would be necessary.

Devising effective incentives is a very complex undertaking. Owners considering their use may want to focus on one contractor goal, job profit, and one or two owner goals such as controlling cost and schedule, thus making the incentive mechanism easier to manage and to understand for both parties. Owners should either develop in-house expertise or hire consultants versed in the subject to assure fair and equitable provisions in contracts.

The same publication also analyses incentives for various aspects of contractor performance in the following manner:

CONTRACTOR PERFORMANCE INCENTIVES

In this type of cost-plus-incentive contracting, the contractor earns a bonus or a penalty that adds to or subtracts from his earned fee, based on his performance in the field. The items of performance normally considered are very difficult to measure in an objective way, so a performance norm and method of evaluation must be established in the contract against which the subjective performance factors are compared. A performance norm varies from contractor to contractor and sometimes requires considerable time to establish between an owner and a contractor. Four quarters of operation are usually used to establish a performance norm. The use of performance incentive contracting is more appropriate where owners and contractors have worked together before, thus establishing a more equitable basis for setting performance goals.

Performance is measured against items that have the most significant impact on the construction cost and schedule. Some of them are:

- Craft-labor productivity: A measure of how well the contractor manages his craft labor through planning, scheduling, furnishing of skilled workers, training, crew mixes, and other criteria.
- Indirect costs: A measure of the results against an established budget.
- Schedule: A measure of how well the contractor meets the milestone dates set for the project.
- Safety: A measurement of safety on the project is based not only on injury statistics but on the contractor's training inspections, knowledge of, and attitude toward safety.
- Quality of construction work: To encourage the contractor to meet quality goals which may be higher than normally found in the construction industry.
- Responsiveness: Contractor reaction to changes in the site conditions, objectives of the project, and scope of work.

BONUSES FOR QUALITY

TRB has supported the effort of the FHWA to encourage the paying of bonuses for quality work. The Committee On Quality Assurance and Quality Control has recommended several papers for publication and conducted several sessions on the topic. In a forthcoming synthesis, the author describes some of the experiences in the various states.

The success of the QA system in West Virginia has been reported on by Steele and Higgins. They decided early on that only through the concepts of probability could they hope to develop a satisfactory program. They targeted four construction items--portland cement concrete, bituminous concrete, aggregate base course, and embankment construction. They divided their QA system into two distinct functions:

1. Process control by the contractor, and
2. Acceptance inspection in testing by the department.

Another important aspect of the West Virginia experience was a cooperative program for the certification of technicians. A continuing annual training and certification process keeps the program up-to-date. The program has been well received and the use of a qualified technician by industry is now a specification requirement on all department projects. Some of the significant advantages noted with the West Virginia program are as follows:

1. Conflicts between the department and the contractor-producer are greatly reduced because there is no longer a question of test value validity and test results are available to the contract-producer sooner;
2. The contractor-producer can control the number and quality of testing personnel necessary for control of the product and does not have to wait for the department technician to start production;
3. The contractor-producer is able to make better use of good but borderline materials by having control of the process; and

4. Faster test results and knowledge of trends allow more positive response by the contractor-producer, this results in less loss of production and a significant reduction in production or use of nonspecification material.

On the question of bonuses and penalties, Steele and Higgins believe that a bonus for good work is psychologically an excellent motivator; they say that a good case can also be made that a cost reduction for deficient work is an equally persuasive motivator.

They draw the following conclusions from their experience in West Virginia:

1. Performance specifications are workable, practical, and economical when properly implemented through systems-engineering techniques;
2. An agency that uses appropriate performance specifications can cause a decrease in the consumer's risk and generally can provide the opportunity for a decrease in producer's risk--in any event, the risk becomes manageable;
3. The contracting industry is fully capable and competent to provide the QC system necessary for production of a finished project that will meet the requirements of the plans and specifications; and
4. An agency that uses performance specifications can, by using an appropriate QA system, shift its activity emphasis to verifying the adequacy of the contractor's control systems as the principal means of ensuring that the specified facility is received.

One testimony to the success of the West Virginia experience came from a concrete supplier. He stated flatly that automated central mix had enabled them to realize some cost reductions for good process control. It was noted that within 1 year from opening a central mix plant, they had reduced the cement content of 3,000-lb, 6-bag, Class B concrete from 6.25 bags of cement to 5.5 bags of cement. They are so enthusiastic with the Department of Highways procedure that they consider that customer as preferred business and "their jobs at or below rates for comparable commercial jobs."

Another testimony on the West Virginia experience came from the FHWA. A spokesman there noted that the West Virginia Highway Department used the same manpower in the 1970s as in the 1960s to meet a workload that was five times higher than that of the 1960s.

Expanding on the notion of incentive features, Hughes believes that they are the primary reason that improved densities have been obtained in Virginia during the six years from 1976 to 1983.

TABLE 1 ANNUAL AVERAGES IN VIRGINIA

Year	Average Density (%)	Standard Deviation (%)	Pay Factor (%)
1976	91.3	1.3	97.3
1978	91.6	1.6	97.3
1979	92.0	1.5	97.9
1980	92.6	1.3	98.9
1981	92.7	1.2	99.7
1982	93.1	1.2	100.4
1983	93.1	1.1	100.4

The improved density achieved is readily apparent. Average densities increased from 91.3 to 93.1 percent over the entire period. This was entirely attributed to a new specification that allowed for adjusted pay factors including an incentives provision. That specification is as follows:

> Payment for the quantity of material calculated as being under the standard normal distribution curve and that calculated as having a density equal to or greater than 94% of theoretical maximum density will be at the contract unit price per ton for the type bituminous concrete specified. Price adjustment factors as shown in Table 1 will be applied to the quantity of material calculated as having a density less than 94% of theoretical maximum density and being outside the standard normal distribution curve in accordance with the following:

Percent of Theoretical Maximum Density	Quantity in Excess of (%)	Price Adjustment Factor (%)
Less than 88	0	85
88 to 90	3	90
90 to 92	32	95
92 to 94	52	105

This specification achieved greater density and also achieved higher payment levels for the contractors. Pay factors increased from 97.3 percent of bid price to 100.4 percent of bid price. The actual distribution of pay factors in 1983 is shown in Figure 1:

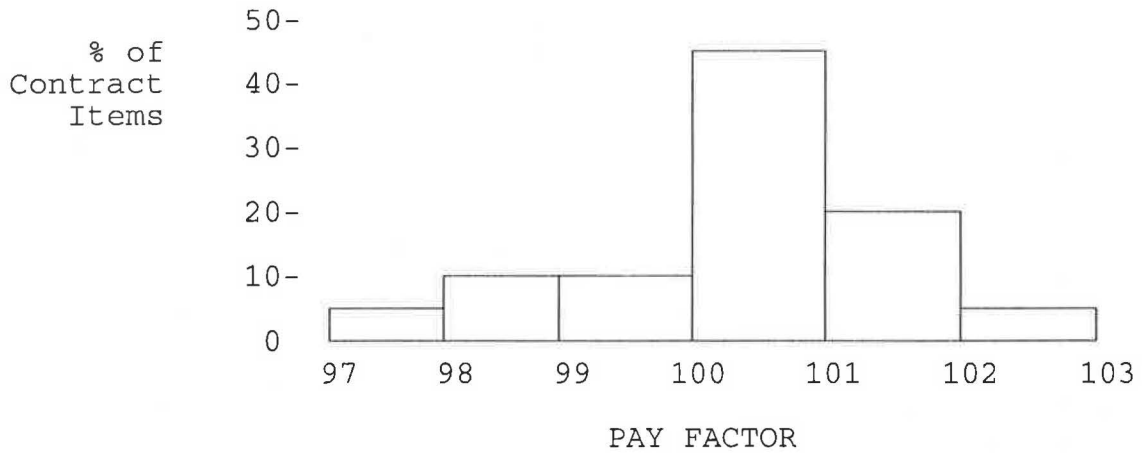


FIGURE 1 Distribution of pay factor for 1983.

AN OVERVIEW

Also in 1984, Kopac surveyed the practices in all of the states with regard to acceptance plans for bituminous concrete compaction. He found 17 agencies that include statistical acceptance plans. He also found several problems with those plans.

Of the 17 agencies, 7 have acceptance plans that give no consideration to the variability in compaction. In these states, only estimate of the mean is needed to determine acceptance. (This means that a submitted lot that has an estimated mean compaction of 98.0 percent and a standard deviation of 0 percent, for example, is treated for acceptance purposes as identical to a lot that has an estimated mean compaction of 98.0 percent and a standard deviation of 5 percent.)

Several of the 17 agencies have acceptance plans that are statistically unsound. One agency, for example, places the same minimum density requirement on individual samples taken from a lot regardless of the total number of samples in that lot. Thus, in that state, the more samples taken from a contractor's lot, the greater the probability that the contractor's work will be deemed unsatisfactory, even if it is actually good. A similar situation exists in another agency's acceptance plan. That agency requires 5 to 10 samples per lot but does not change the acceptance criteria to account for the different sample sizes. It can be demonstrated that, for the acceptance plan in question, the use of five samples would result in full-payment acceptance of material that is estimated to be at least 69 percent within tolerance. If 10 samples are taken, the estimated percentage within tolerance must be at least 75 percent for full-payment acceptance. A decision to use a sample size of 10 instead of 5 could therefore be harmful to a contractor who is producing good material.

Many acceptance plans are not as efficient as they might be. Those agencies that require multiple random samples and then calculate only the sample average are not making full use of available test results. Of the 10 agencies that do use available test results to assess the degree of compaction variability present in the lot, only one does so by computing the standard deviation. It can be shown that the standard deviation method is more accurate, or requires smaller sample sizes to achieve the same accuracy, than the range method. AASHTO is currently considering revision of its standard recommended practice for acceptance sampling plans; one of the changes that has been proposed is the use of the standard deviation method as an alternative to the range method.

Lot sizes, samples sizes, test procedures, and acceptance limits all vary considerably among the states. In regard to sample size (which typically ranges from n = 3 to n = 7), it is surprising that larger sample sizes are not used in conjunction with the nuclear density test. The test is nondestructive and can be quickly performed. By taking 20 samples, for example, a better estimate of quality could be obtained at little or no extra cost.

Kopac concluded with a valuable check list of items that should be included in an acceptance plan:

1. Acceptance plans should provide for a measure of not only the mean but also the variability;
2. The standard deviation is a better measure of variability than the range, and it should be used in all cases;
3. Provisions should be made to adjust acceptance

criteria to reflect changes in sample size;

4. Larger optimum sample sizes should be used where possible;

5. Where possible, price adjustment schedules should be related to expected performance;

6. Pay factors greater than 100 percent should be considered where increased performance can be demonstrated;

7. Continuous price adjustment schedules should replace graduated schedules; and

8. Operating characteristic curves should be used to assist in the development of acceptance plans.

Other improvements will become possible as a better understanding of materials quality characteristics is obtained. More multicharacteristic acceptance plans should come into being, and more rational price adjustment systems should be developed. A greater degree of nationwide uniformity can and should be obtained, even if in the interim it is achieved through an arbitrary but reasonable price adjustment system.

Newman and Hejl, in a paper entitled *Contracting Practices and Payment Procedures*,[1] made these observations:

> There are several different areas in which incentive and disincentive clauses can be applied, but addressed here are only the provisions regarding the completion of a project (a) on or ahead of schedule, and (b) at or better than the minimum acceptable quality standards. Most provisions are disincentives.

BONUSES

Highway agencies are less comfortable with awarding bonuses to contractors as an incentive for early completion of projects. Some states forbid it by law. The few agencies that do pay bonuses do so only on projects of an emergency nature, on projects that disrupt businesses, or on projects that are an extreme inconvenience to the traveling public. Most agencies that have used bonus clauses have applied them only one or two projects.

The FHWA published in the June 13, 1984, edition of the Federal Register (49 FR 24374) a notice of rescission of regulation concerning bonus payments. It had been FHWA policy before that time to not participate, directly or indirectly, in any part of a bonus to the contractor for early completion of a project. However, the results of an FHWA-initiated study under the National Experimental and Evaluation Program showed that the use of bonus (incentive and disincentive) provisions was a valuable construction tool and was cost justified. It is believed that the bonus provisions will be used mainly on 4R and bridge reconstruction projects, where analysis shows such provisions to be in the public interest, with lesser use on other types of projects.

Contractors favor the use of bonuses. Those interviewed were successful in collecting awards on projects with bonus clauses. Most believe that if they are to be assessed liquidated damages for late completion, they should be given the opportunity to earn bonuses for early completion.

The contractors and the highway agencies in favor of awarding bonuses believe that the amount assessed for liquidated damages should equal the amount awarded for bonuses.

CONCLUSION

It is envisioned that a more reasonable alternative to the low-bid syndrome would be an amalgam that takes into account all of the factors discussed. Of course, the initial price is important and must be considered. In addition, innovation and value engineering should be encouraged. Let this factor, the adjusted price considering innovative changes, be P. Secondly, it is clear that time is an important consideration in construction, so let there be a factor T. Finally, to ensure a consideration of quality determinants, let us have a factor Q. If T is a decimal number (a contractor who planned to finish the project in 90 of the allotted time would insert 0.9 percent for T, and if a QC rating 10 percent above average would imply 1.1 as Q, etc., then all of these complex factors can be reduced to a simple formula:

$$\text{Bid factor} = (P + T)/Q$$

Such a rational system for contracting for construction services would go a long way toward pulling us out of the low-bid syndrome.

It is plain that if we fail to recognize our own inadequacies, then somebody else will and take over the process of construction from usy. It is for us, the practitioners, to put our own system in order.

ENDNOTE

1. In *Transportation Research Record 986.*

APPENDIX B

TRANSPORTATION RESEARCH BOARD

Innovative Contracting Practices Workshop Program
Stockyards Hotel, Fort Worth, Texas
September 12-14, 1989

Tuesday, September 12, 1989

10:00 a.m.-
1:00 p.m. Registration, Niles City Room

Opening Session — Dwight M. Bower, Presiding

1:00 p.m. Introduction & Welcome, Dwight M. Bower

Keynote Address, John Gray, NAPA

Remarks, William G. Gunderman, TRB

Topic Presentations

2:00 p.m. INNOVATIVE BIDDING PROCEDURES, Darrell Harp, Presiding

TIME IS MONEY, Zohar Herbsman, University of Florida

DESIGN-BUILD CONCEPT, William Deyo, Florida DOT

THE FRONT RANGE TOLL ROAD, W. Ray Wells, R.S. Wells Corp.

USE OF WARRANTEE-GUARANTEE CLAUSES, Darrel Harp, NY DOT

3:15 p.m.Break

3:45 p.m. IDENTIFYING AND OVERCOMING BARRIERS TO INNOVATIVE CONTRACTING PRACTICING RELATED TO HIGHWAY MATERIALS, Garland Steele, Presiding

INSTITUTIONAL FACTORS THAT INFLUENCE INNOVATION, David Gedney, Deleuw Cather & Co.

TESTING EQUIPMENT AND PROCEDURES, Charles Marek, Vulcan Materials Company

CONSTRUCTION PROCEDURES & EQUIPMENT, Doug Bernard, Federal Highway Administration

EVALUATING AND MARKETING NEW MATERIALS AND PRODUCTS, Berry Jenkins, North Carolina DOT

5:30 p.m. Adjourn

7:00 p.m. Dinner at Cattleman's Steak House, 2458 N. Main Street

Wednesday, September 13, 1989

Topic Presentations

8:00 a.m. ENHANCEMENT OF QUALITY IN CONSTRUCTION, Orrin Riley, Presiding

INCENTIVES FOR QUALITY, John Hodgkins, Maine DOT

ENHANCING QUALITY THRU INCENTIVES, Stan LaHue, ACPA

USE OF SENSOR TECHNOLOGIES FOR QUALITY DATA COLLECTION, Randolph Thomas, Penn State University

9:15 a.m. THE INFLUENCE OF INSURANCE/ASSURANCE ON CONSTRUCTION INNOVATIONS, Charles Fleck, Presiding

ASSURANCE/SURETY, Daniel Waldorf, Alexander & Alexander, Inc.

INSURANCE AS IT RELATES TO INNOVATIONS IN CONSTRUCTION PRACTICES, Harvey Brown, March & McLennen, Inc.

10:00 a.m. Break

Breakout Session I

10:30 a.m. Bidding, Niles City Room
Darrell Harp - Presiding, Allen Rockne - Recorder

Materials, North Side Room
Garland Steele - Presiding, Mike Acott - Recorder

Quality, White Elephant Room
Orrin Riley - Presiding, Stan LaHue - Recorder

Insurance/Assurance, Board Room
Charles Fleck - Presiding, Jack Curtin - Recorder

12:00 noon Lunch

Breakout Session II

1:00 p.m. Materials, North Side Room
Quality, White Elephant Room
Insurance/Assurance, Board Room
Bidding, Niles City Room

Breakout Session III

2:30 p.m. Quality, White Elephant Room
Insurance/Assurance, Board Room
Bidding, Niles City Room
Materials, North Side Room

Breakout Session IV

4:00 p.m. Insurance/Assurance, Board Room
Bidding, Niles City Room
Materials, North Side Room
Quality, White Elephant Room

5:30 p.m. Adjourn - Evening Open

Thursday, September 14, 1989

8:30 a.m. WRAP-UP SESSION, Dwight Bower, Presiding

Workshop Topic Reports, Niles City Room

BIDDING, Darrell Harp

MATERIALS, Garland Steele

QUALITY, Orrin Riley

10:00 a.m. Break

10:30 a.m. INSURANCE/ASSURANCE, Charles Fleck

11:00 a.m. Workshop Summary, Dwight Bower

12:00 noon Adjourn

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APPENDIX C

TRANSPORTATION RESEARCH BOARD TASK FORCE A2T51
QUESTIONNAIRE ON
INNOVATIVE CONTRACTING PRACTICES

The above task force is concerned with practices under which highway agencies contract for construction as related to quality and cost. The objective is to find ways to reduce life cycle cost, improve quality, yet give appropriate attention to contractor profitability.

By filling out and returning the following questionnaire, the task force will become aware of your state's current interest and future acceptance of innovative contracting procedures.

(Place "X" in the appropriate box)*

TOPICS					
End-Result Specifications	( )	( )	( )	( )	( )
Quality Control/Quality Assurance	( )	( )	( )	( )	( )
Contractor Administration Third Party	( )	( )	( )	( )	( )
Contractor Surveying	( )	( )	( )	( )	( )
Value Engineering:					
Design Phase	( )	( )	( )	( )	( )
Construction Phase	( )	( )	( )	( )	( )
Design/Build (Turnkey)	( )	( )	( )	( )	( )
Cost-Plus-Time (user cost is considered in low bid determination)	( )	( )	( )	( )	( )
No Claim Clause (excludes change orders)	( )	( )	( )	( )	( )
Bid Averaging/Bid Bracketing	( )	( )	( )	( )	( )
Contractor Qualification Based on Performance Reports	( )	( )	( )	( )	( )
Build/Own/Operate/Transfer	( )	( )	( )	( )	( )
Bid Item Consolidation	( )	( )	( )	( )	( )
Night/Weekend Work	( )	( )	( )	( )	( )

*Assume that problems/barriers could be overcome.

Reimbursement for Engineering Cost (e.g., Overtime)	( )	( )	( )	( )	( )
Pre-bid Conferencing	( )	( )	( )	( )	( )
Elimination of Wage Scales (Davis-Bacon)	( )	( )	( )	( )	( )
Risk Management/Assurances	( )	( )	( )	( )	( )
Incentives/Disincentives:					
Time	( )	( )	( )	( )	( )
Pavement Smoothness	( )	( )	( )	( )	( )
Material Quality	( )	( )	( )	( )	( )
Others (Specify)_____	( )	( )	( )	( )	( )
_____	( )	( )	( )	( )	( )
Alternate Bids:					
Pavements	( )	( )	( )	( )	( )
Structures	( )	( )	( )	( )	( )
Others (Specify)_____	( )	( )	( )	( )	( )
_____	( )	( )	( )	( )	( )
Guarantee/Warrantee Bid Clause in:					
Workmanship	( )	( )	( )	( )	( )
Materials	( )	( )	( )	( )	( )
Time Limits	( )	( )	( )	( )	( )
Others (Specify)_____	( )	( )	( )	( )	( )
Other topics (Please specify)					
_____	( )	( )	( )	( )	( )
_____	( )	( )	( )	( )	( )
_____	( )	( )	( )	( )	( )
_____	( )	( )	( )	( )	( )
_____	( )	( )	( )	( )	( )
_____	( )	( )	( )	( )	( )

Comments:

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_____

Questionnaire completed by:

_____
(Name)

_____
(Telephone)

_____
(Agency)

Please return completed questionnaire by April 15, 1989 to:

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