Functional approach to turnkey system procurement

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The advent of the low cost minicomputer has extended the computer into many new application areas. Minicomputer systems are used in manufacturing control, laboratory automation, and industrial data acquisition and control applications where the high cost of computers have traditionally prohibited their use. In many of these growing application areas, users want to purchase a fully developed hardware and software package which requires no further development and which provides guaranteed performance. This is the concept of the turnkey system.

Turnkey computer systems are being offered today by a tremendous number of companies. Not only are they offered by computer systems houses and by the manufacturers of minicomputer systems, but also by instrumentation and control systems companies which have traditionally served the markets where these computer systems are now being applied. Most companies in the turnkey systems business have approached a particular application area by developing a standard base of computer hardware and application software which can be adapted to the specific requirements of a particular application. For a given application area, various companies may offer turnkey systems which are very similar from a functional and performance standpoint, but which differ markedly in terms of hardware and software approaches.

A successful procurement procedure for a turnkey system must allow and encourage competitive bidding in which the bidders can take legitimate advantage of their applicable technology in both hardware and software. The procedure must include methods for specifying the system requirements, for selecting the system which best meets those requirements, and for contracting for the implementation of the selected system.

The procurement procedure described here was developed by the City of Dallas, Department of Data Services, for use in the procurement of a minicomputer based real-time data acquisition and control system for the City’s water distribution system. The technique is not specific to this application, however, and can be used for any turnkey system procurement.

SYSTEM SPECIFICATION

Specification of the system requirements is the key to any procurement procedure. Many users make the mistake of using a physical specification of the type normally used to specify construction work. The physical specification identifies the minimum physical requirements of the hardware and software in detail and is usually used in conjunction with a low bid system selection. Proposed systems which fail to meet a specified minimum requirement are rejected for non-compliance.

This approach, while it works well for buying concrete, has inherent deficiencies when applied to the procurement of a turnkey computer system. The physical specification fails to consider the system as a single integrated entity, but rather considers each element of the system separately. Total system capabilities, as expressed by such measures as throughput or response time, are more significant than the capabilities of individual component specifications, such as memory cycle time or number of registers.

Physical specifications are often used as a matter of convenience. In fact, most physical specifications are written around one company’s hardware and software. Such a specification obviously gives that company a tremendous competitive edge. The user may find that he has effectively created a single source situation with a commensurately high bid price. Even worse is the case where the physical specifications represent an amalgamation of the features of several systems. Either the user gets no bids or he pays the price for special development required by everyone to meet the specifications.

The specification problem can be solved by the use of a functional system specification which places the emphasis on the functional and performance requirements of the system. The functional specification does not omit physical requirements. There is an obvious need for definition of the required system components. Physical requirements are stated, however, as nominal specifications and are intended to provide a framework within which each bidder can propose the best integrated system to meet the overall functional requirements.

The functional specification is not without its own set of problems; problems, however, which have solutions and which are worth the effort to solve. The first problem is that system selection becomes more difficult. If physical requirements are interpreted to be nominal specifications, proposals can no longer be rejected for non-compliance. Low bid system selection must be replaced with a cost/performance evaluation of the proposals. A detailed method for performing the cost/performance evaluation
will be discussed later. A second problem is that the flexibility which the functional specification provides during the proposal process is not desirable, in fact is intolerable, as part of the contract for system development. The contract requires better definition than provided by a functional specification. The solution to this problem is a two phase contract in which technical specifications are developed prior to the beginning of system development. This form of contract will be discussed in further detail.

The functional system specification can be organized in a number of ways. The following organization includes all of the important elements of a functional specification:

1.00 System Concept Summary
An introduction to the required system and the application for which it will be used. In addition, it is helpful to have a brief statement of work which describes the contractor's responsibilities. Special project requirements, such as user participation in the system development, should be described in this section.

2.00 Physical Requirements
A description of the required computer and peripheral equipment. Hardware specifications should be stated as nominal values. It is important to state any preferences the user may have and also to state any alternatives which the user sees as being acceptable. For example the specifications for on-line storage might state that either a fixed-head disc or a moving-head disc or a combination of the two types of storage would be acceptable, as long as they provide the required performance and functional capabilities. This section should specify component packaging requirements and describe where the equipment will be located.

3.00 Performance Requirements
A statement of the important system performance parameters. These may include system availability, throughput, response time, expandability, failure mode integrity, and any others which are important to the application. In the case of the water distribution system, the City included a subsection on performance requirements for the man-machine interface.

4.00 Functional Requirements
A statement of what the system must do. The functional capabilities described should give the bidder a clear idea of what the system must do without being too restrictive in terms of how the functions are accomplished. Again, preferences or examples can be used, but they should be represented as nominal requirements.

5.00 Information Requirements
A definition of the type and volume of data which the system must process.

6.00 Implementation Requirements
A detailed statement of the contractor's responsibilities for system implementation. This section should detail requirements for project management, system development, installation, test, maintenance, training, and documentation. The schedule requirements should also be stated in this section. The requirements contained in this section may be interpreted literally, if desired, by including a statement in the request for proposals to that effect. As a matter of practicality, this approach is advisable. If all bidders are required to provide the same implementation services and to meet the same schedule, then the difference in bid prices should reflect only the difference in system capabilities.

Writing a good functional system specification is not easy. The functional approach provides the desirable flexibility to the system specification at the expense of adding the problem of interpretation. There is an increased requirement for responsibility on the part of both the user and the bidder. The user must make sure that the specification honestly represents the requirements of the system he is trying to buy. The bidder has a responsibility to propose a system which meets fully the intent of the system specification.

PROPOSAL SOLICITATION AND EVALUATION

Once the system specification has been completed, it is combined with a request for proposals (RFP) and general specifications to form the bid document. The general specifications will not be discussed in detail here. Suffice it to say that this section of the bid document deals with the general requirements and conditions of the contract and is not specific to a particular system or a particular contract.

The RFP is an important section of the bid document. The RFP must give the bidder a clear idea of the functional nature of the specification and how it will be used in the evaluation of the proposals. It must also specify what information is required in the proposal, where and when proposals will be received, and the conditions of submitting a proposal. Let us turn for the moment to the problem of proposal evaluation.

Many schemes have been proposed for performing a cost/performance evaluation of computer systems. The problem is to come up with a way of relating the capabilities of a proposed system to the bid price of the system so that a single measure of cost/performance is available for comparison purposes.

The most sensible approach to a cost/performance evaluation is one in which the capabilities of proposed systems can be compared in terms of dollars, which can then be directly related to the bid prices. Evaluation techniques which develop some figure of merit for each system
in terms of a point total have one glaring deficiency: how is the point total to be related to the bid price? Proposed systems can be evaluated through the application of evaluation criteria which represent, in quantitative terms, the importance which the user places on specified attributes of the computer system. It is also important to evaluate the vendor and the vendor's capabilities. This can be accomplished through the use of the same technique.

The evaluation criteria identify items to be evaluated and an assigned dollar value for each item. The dollar value represents the maximum penalty which may be assigned for each item. Penalty assignment should consider the projected system life. Penalties may be assigned on a one-time or recurring basis, depending on the nature of the evaluation item, up to the maximum penalty specified for each evaluation item.

The assignment of penalties is based on the existence of some deficiency which will require additional development, purchase, or support; or a deficiency which will limit the useful benefits of the system. Penalty assignments are based on a zero value for the proposal which best meets the specified requirements for each evaluation item, as stated in the system specification. A summation of the assigned penalties for each proposal is used in conjunction with the bid prices to determine the successful bidder.

The specific evaluation items chosen will be different for every procurement but should relate closely to the organization of the system specification. Vendor qualifications can be judged on the basis of the following evaluation items:

A. Experience and Customer Ratings
   1. Installed systems of similar size and nature
   2. Standard computer hardware and software base
   3. Length of experience
   4. Specific application experience

B. Company Resources
   1. Personnel
   2. Facilities
   3. Depth of resources
   4. Financial

C. Support Capabilities
   1. Maintenance organization
   2. Location of maintenance support
   3. Software support

In evaluating vendor qualifications, it is mainly a matter of looking at the risk which may be incurred in doing business with each vendor. Even though the user has a great deal of contractual protection when buying a turnkey system, there are certain irrecoverable costs to the user, due to project delays, if the contractor does not perform. In many cases support capabilities may be the overriding consideration. Support of a system can sometimes be crucial to its success. The user has to evaluate the risk associated with the vendor's continued support of the system over its projected life. Although no maximum penalties were shown for the evaluation items above, they must be determined and specified along with the evaluation criteria in the RFP. The maximum penalty selected should be consistent with the actual worth of the item and the importance of the item to the user.

The assignment of penalties during the proposal evaluation process is based primarily on information provided in the proposal. The RFP must describe what kind of proposal is required. It is a good idea to specify both the content and the format requirements for proposals. This will make the evaluation task much easier. The following outline is suggested for the RFP:

1.00 Invitation for Proposals
2.00 Definition of Terms
3.00 Proposal Requirements, Information, and Conditions
   .01 General Information
   .02 General Form of Contract
   .03 Inquiries
   .04 Pre-bid Conference
   .05 Examination of Site of Work
   .06 Preparation of Proposals
   .07 Receipt and Opening of Proposals
   .08 Proposal Guaranty
   .09 Proposal Modification
   .10 Withdrawing Proposals
   .11 Irregular Proposals
   .12 Rejection of Proposals
   .13 Disqualification of Bidders
   .14 Statement of Qualifications
   .15 Technical Proposal Content and Format
4.00 Consideration of Proposals
   .01 Proposal Tabulation and Evaluation
   .02 Proposal Presentations
   .03 Method of Proposal Evaluation
   .04 Evaluation Criteria
5.00 Documentation Controls
   .01 Revision of the RFP and Specifications
   .02 Revision Notice
6.00 Proposal Forms
7.00 Contract Award and Execution
   .01 Award of Contract
   .02 Retention of Proposals
   .03 Return of Proposal Guaranties
   .04 Surety Bonds and Insurance
   .05 Sureties
   .06 Execution of Contract
   .07 Failure to Execute Contract
8.00 Contract and Bond Forms

There are many aspects of the RFP which have not been
discussed, but hopefully the outline provided above will indicate some of the necessary elements of an RFP which are not detailed here.

**FORM OF CONTRACT**

The final important element of the functional approach to turnkey system procurement is the two phase contract. As previously discussed, one of the problems presented in the use of a functional specification is that it does not provide sufficient definition for a contract to develop the system. The selected proposal may lend further definition, but may also contain sections which seem to conflict with the system specification or at the very least lead to ambiguities. There is a need for a single document which specifies in detail the system and the work to be performed by the contractor.

The first contractual phase is designed to provide the necessary definition in the form of technical specifications. Phase I of the contract is the final design phase during which technical specifications are developed by the contractor in cooperation with the user. These technical specifications should satisfy the requirements of the system specification and should be specific to the hardware, software, and services offered in the contractor’s proposal.

It should be possible to complete the technical specifications in a fairly short period of time. The City allowed three months to develop the technical specifications for the water distribution system project. User approval of the technical specifications should be contractually required before further work commences on the project. The technical specifications developed during the final design phase, upon approval by the user, become the contractual basis for Phase II, the system development phase of the contract.

The technical specifications are intended to be an amplification or extension of the requirements stated in the system specification and the offerings made in the contractor’s proposal. Some requirements may be sufficiently detailed as presented in either the system specification or the proposal and may be repeated verbatim in the technical specifications. Other requirements should be developed during Phase I so that the technical specifications completely describe the hardware, software, and services to be provided by the contractor during the second phase of the contract. The following items should be included in the technical specifications:

- Detailed specifications for all major equipment
- Specifications of all necessary minor equipment
- Final design and drawings for any special consoles or other hardware
- Detailed system flowcharts
- Complete functional descriptions of all computer programs including I/O requirements
- Database design
- Display and report formats
- Installation drawings
- Detailed test procedures
- Detailed documentation standards

A notice to proceed with Phase II, system development, is issued only after approval of the technical specifications by the user. If for some reason agreement cannot be reached between the user and the contractor on the technical specifications, the contract should contain a provision to pay the contractor for the work done with no further obligation to the user. The payment should be specified as a fixed fee in the contract and should not be excessively high. The contractor should be encouraged to make his profit during Phase II, not Phase I.

**CONCLUSION**

The functional approach to turnkey system procurement is designed to give the user a method to buy the best system for his application at the lowest price. It is certainly not the easy way out and demands a high level of interaction between the user and the vendor. In many ways, the procurement approach described here is simply a formalization of the interaction that must occur in any successful computer system procurement.