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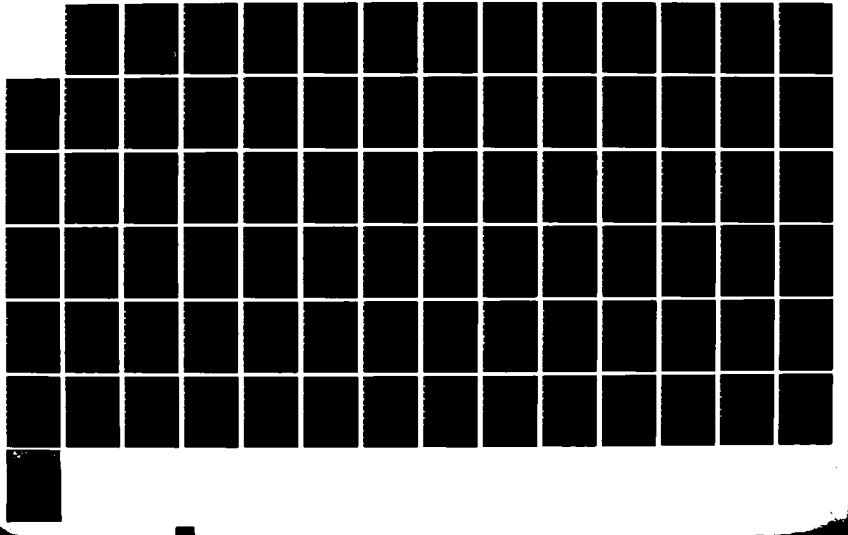

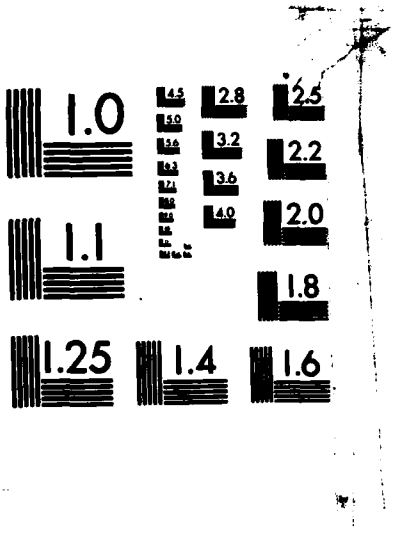

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REPORT ON THE FEASIBILITY OF DESIGNING EXPERT SYSTEMS FOR CONTRACT PRICE ANALYSIS

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This report identifies the knowledge base and support requirements for automated contract price analysis as an application area for expert systems technology. A theoretical, textbook based model of cost/price analysis is presented. A prototype design using the INFO system is presented and some problems with that design are identified. A brief survey of the educational environment and current computer support for price analysis in the Air Force is presented.

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Price Analysis

ABSTRACT

This technical report describes the work accomplished during Phases I and II of Contract F33615-82-C-5114 from 1 October 1982 to 30 April 1983. The report contains conclusions about the feasibility of expert systems for price analysis, provides an analysis of contract pricing, discusses the preliminary design of an intelligent manual, and briefly surveys the educational environment within the Air Force.

We identify problems associated with price analysis during procurement in the Air Force and discuss the feasibility of designing an "expert system" using techniques from the field of artificial intelligence. The applicable areas of procurement are identified, and an analysis of contract pricing is presented. An "intelligent manual" type of expert system can impact base-level procurement activity significantly.

We then present the design of a prototype of an intelligent manual in an information base called XINFO[1], discuss some of the problems with this design, and present a proposed redesign using another information base called ZOG[2]. We address issues related to the education and training of price analysts and identify how an expert system could improve performance among both untrained and trained personnel. We show how the system could integrate price analysis in the Air Force.

Appendix 1 contains a summary of the interviews that were performed along with conclusions from these interviews. Appendix 2 shows a buyer guided by the XINFO version in making a competitive procurement decision.

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[1]This is not an abbreviation. The name is intended to suggest that it is an extended information base.

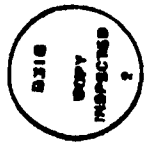
[2]ZOG is not an abbreviation either. The name was selected for its ease of pronunciation and novelty, and is intended to suggest that ZOG is a novel system for human-computer interaction.

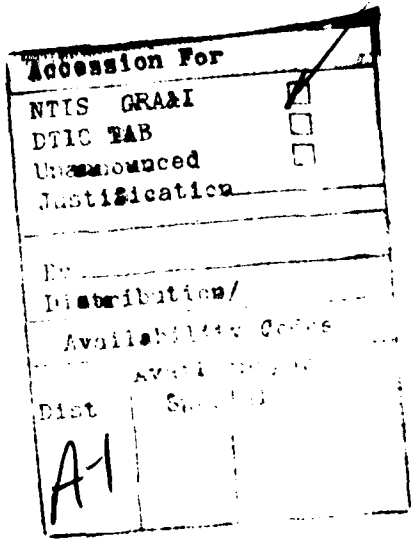
Appendix 3 describes the ZOG system and shows an example of pricing in ZOG that corresponds to the XINFO example.

PREFACE

This report is based on interviews with instructors at the Air Force Institute of Technology and with price analysts in the Air Force Logistics Command and at the Air Force Contract Management Division. We would like to thank them for their generous help. The final opinions expressed here are our own.

The XINFO system was developed at the Massachusetts Institute of Technology. The ZOG system was developed in Carnegie-Mellon University (Dr. Ramesh Ramakrishna was one of the researchers involved in the design of ZOG) — the ZOG p r o j e c t was supported by the Office of Naval Research. The versions of XINFO and ZOG used here are in the public domain and may be obtained freely.





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1. INTRODUCTION

This report concludes the first two phases of our feasibility study on designing an expert system for the contract pricing task. We conclude that it would be possible to define such a system. Given current Air Force price analysis methods, an "intelligent manual" approach will pay off the most in the short term. The development of an intelligent manual will focus long-term efforts for integrating different levels and systems for price analysis.

We developed one prototype version of an intelligent manual and are developing a second one. By the end of the contract period, we should have an intelligent manual that covers a small but significant part of the price analysis task at the base-level.

Our conclusions may be summarized as follows:

1. The three levels at which price analysis is performed have different immediate needs — in base procurement, the support needed is expert guidance; in central procurement, the support needed is in computation, information pertaining to the contractor and to the solicitation, and in focusing attention to the relevant factors; in systems procurement, the support needed is good human interfaces between users and existing databases and computational tools.

2. Price Analysis is a multi-level, hierarchical task — not all price analysts function at all these levels. The price analysis system of the future should support all levels of this task and should allow the use of advanced techniques even by relative novices.

3. An intelligent manual is an appropriate support mechanism for base procurement. We have examples of what such a manual should look like.

4. An intelligent manual will act as a focus for long-term development of support mechanisms for price analysis.

5. An intelligent manual is an appropriate training tool both for initial education and continued on-the-job training of price analysts.

2. EXPERT SYSTEMS FOR PRICE ANALYSIS: A FEASIBILITY STUDY

2.1 Introduction

The following chapter summarizes the pricing environment within the Air Force and contains recommendations for feasibility. Price Analysis is performed at many different levels within Department of Defense procurement activities. At the highest levels, price analysis is fairly sophisticated, carried out by highly trained personnel; however, at lower levels this is not the case. This study surveys the price analysis function at three different levels (Systems Command-Central Management Division, Logistics Command-Central and Base procurement) within the Air Force in order to ascertain the feasibility of designing "expert systems" by evaluating the following questions.

1. What kinds of expert systems can be designed with current technology for buyers and price analysts at the different levels?
2. What kind of assistance can be or should be provided?
3. What kinds of information, knowledge, and environment would have to be maintained by the Air Force to exploit expert systems?

We recommend that the Air Force embark on a long-range program of providing support at all levels of the procurement function. Base-level buyers who function without specialist assistance need the most support in the short-term (1 to 2 years) and we have designed an instructional expert system for this purpose (described in Chapter 4). We also recommend a three to five year program intended to support central procurement activities, and a five year (and longer) program for extending the support to all levels of procurement in the Air Force.

2.2 The Price Analysis Task

An intelligent computer system designed to aid in price analysis must have the capabilities to function within the Air Force procurement domain. There are three major functional groups involved: the customer, the contractor and the contracting office. The customer provides a technical evaluation of the proposals submitted and an estimate of the proposed procurement costs. The contractor submits a proposed price for providing the desired procurement. The contracting officer is responsible for soliciting proposals, evaluating the proposals, establishing a negotiation position, carrying out the negotiations, and consummating a contract. Throughout this process the contracting officer may call specialists to assist in the process. The most general type of intelligent system would carry out all these functions of the contracting officer. A less ambitious undertaking would concentrate on one or more of the several components of the task. If the latter course is chosen, one must determine which components of the procurement process are amenable to automation in the form of an intelligent computer systems.

Price analysis is the specialty function chosen for study. This function is defined as the determination of a fair and reasonable price for the buy. The task may be as simple as comparing two numbers and choosing the smaller or as difficult as constructing a price based on costs generated from engineering specifications. As with the contracting officer, the price analysis function has access to other specialty functions. For example, field personnel can provide information as to the level of compliance with Cost Accounting Standards Board (CASB) disclosure requirements and technical specialists can provide evaluations of proposed work processes and material and labor specifications. The system design problem is choosing which of these to include as part of the price analysis function and which to treat as specialty areas to be called by the price analysis system when needed.

The functions carried out by a price analyst have to do both with an analysis of the price proposed as well as an analysis of the costs of the

item or service being offered. Ideally, a cost analysis is undertaken to determine the validity of the cost estimates of the individual components of a proposal. A determination of the fairness and reasonableness of the price should use these results as a major input. Thus, the price analyst needs both capabilities.

Price analysis is characterized by five basic types of comparisons used in evaluating proposals (ref: AFLC Base Level Pricing Guide, Regulation 70-6):

1. Competitive price quotations
2. Catalog, Market or Regulated prices
3. Prior quotes and prices for similar items
4. Cost estimating relationships
5. Government estimates

If cost analysis is to be undertaken the contractor must provide adequate data. This data is usually found on DD Form 633. It should be noted that contractors are required to file DD Form 633 for buys of $500,000 or more; thus, detailed contractor cost data is generally not available for buys of less than this amount. The evaluation requires a detailed analysis of the direct and allocated costs associated with the proposal. An analysis of these costs and the process used by the contractor to put together the proposal are used to derive a government negotiating position.

Another relevant issue is the differentiation in the price analysis function among different commands or types of procurement. For example, what are the similarities and differences between Air Force Systems Command and Air Force Logistics Command price analysis? Does base level pricing have any commonalities with central procurement pricing? Are different systems needed for the buying facilities? The following sections address these issues as they relate to the feasibility of constructing an expert

price analysis system.

2.3 Characterizing Price Analysis in the Air Force

We identified and evaluated three levels of buying activity (AF Systems Command central procurement, AF Logistics Command central procurement, and AF Logistics Command base procurement). This evaluation is summarized in Table 1 and is in terms of the following:

- type of analysis generally undertaken;
- type of procurement;
- type of accounting systems encountered;
- availability of data;
- areas of possible assistance.

	Base-Level	AFLC	AFSC
Analysis	Price Analysis	Cost & Price Analysis	Cost Analysis
Procurement Type	varied	diverse, mostly Spares	Large Systems
Accounting Systems	Non-standard, Poorly developed	Unique, DCAS support	Sophisticated, but diverse
Data Availability	very little	occasionally	lots of data

Table 1: Summary characterization of Price Analysis

At the AF Logistics Command base level pricing function[3] price analysis is undertaken because of the inability to obtain extensive data from the contractor. The types of procurement at the base level are varied and

[3]Referred to as base level pricing. AFLC is evaluated because of the availability of the command to the research team. It is recognized that the pricing problems and the environment are somewhat different between AFLC and other commands, but there are many similarities.

include construction and engineering services, basic services, and commodities procurement. The types of accounting systems used by the contractors are poorly developed, non-standard, and provide little price analysis support. Thus very little data is provided to the buyer.

Both price analysis and cost analysis are undertaken by AFLC central procurement. There appears to be a large diversity in the size of contracts handled. The major type of activity is procurement of spares. Analysts are confronted with many diverse contractors having somewhat unique accounting systems. The data available tends to be contractor specific and is generally provided at the discretion of the contractor. This data is unlikely to be standardized. There is some field support from Defense Contract Administration Services (DCAS). Contract administration offices at the contractor's plant also provide support, especially for the larger contractors.

The central level procurement facility of the Systems Command is primarily concerned with large dollar value buys from a relatively small number of contractors. Cost analysis is the primary form of analysis. The major areas of procurement responsibility are research, development and production of new equipment. Systems Command contracts primarily with 25 defense contractors. There are government teams on site at each major facility (AFPROs). The estimation systems are sophisticated — they include programs for aggregating cost information, determining cost-estimating relationships, evaluating learning curves, etc. The systems must also reflect the internal accounting/estimation system of the contractor and so tend to be very diverse. Air Force buyers can obtain extensive data on a contractor's pricing procedures from on-site contract administration offices. Because it operates in a complex, data-rich environment and the dollar values are large, systems command procurement activities have developed sophisticated procedures for analysis.

2.4 Characterizing Support Requirements

An ideal cost/price analysis system would have the following capabilities:

(a) Specify and support specific company cost models;

(b) User-friendly interfaces for computer-based systems;

(c) Standardization within companies across contracts and across companies for the same contract;

(d) Identification of cost-estimating relationships and cataloging, and the ability to retrieve forward pricing agreements;

(e) Access to field data available.

Such a system is not feasible at this time for the following reasons:

(a) Historical data and other information necessary for constructing such models is not available. No specific models exist -- the general models that do exist are not useful for pricing specific items. It is not clear that current data-gathering procedures can be used to construct such models.

(b) None of the computer systems that we have evaluated are user-friendly. The design history of many of these systems does not facilitate joint use and makes the user interface very cumbersome. The current design of many of these systems also makes the addition of an user-friendly interface difficult.

(c) There are no legal requirements for standardization. Cost Accounting standards do not provide the necessary procedures at an appropriate level of detail.

(d) Identifying cost-estimating relationships or other relations between an item and parameters of the manufacturing company requires centralized access to standardized production data. Such information is typically not available for small purchases (and occasionally may not be kept by the company either).

(e) Field data is collected in many instances, but not available to the analyst. To make it uniformly available requires a centralized information system. Some components of this system are already in place, but it needs to be extended before it is of significant use.

Our recommendation is to provide subsystems that will eventually be joined

to provide a total system. These need to be evaluated at the different functional levels described earlier as well.

2.4.1 System Alternatives

Another system design issue has to do with the level and sophistication of the "intelligence" which can be implemented in the system. We investigated three alternatives. They are:

1. Intelligent Manual
2. Deductive System
3. Data rich System

These are elaborated in succeeding sections.

2.4.1.1 Intelligent manual

An intelligent manual is an interactive expert computer system that does not have problem-solving capabilities, but is intended to guide a user to performing at an expert level. Such a system can be constructed at several levels of complexity. The simplest computer manual is an online reference manual that would point the user to information that might be needed. The online manual itself would not necessarily contain that information. At the next level of complexity, one can provide a spread sheet that would help aggregate and manipulate data as well as offer simulation capabilities. This is similar to the current COPPER IMPACT system. A system that provides a series of question-and-answer procedures to aid the user in using stored information would be at the next level of complexity. This is, in essence, an elaborate indexing scheme connected with the underlying manual. Next, a structured trace of the user responses to the system's questions can be used to construct a descriptive model of the contractor's bid. A more sophisticated system would be capable of constructing normative models of the contractor's bid based on the descriptive models. A different, but not unrelated, objective of such a system would be to provide a computer-aided tutorial.

The particular characteristics that make a domain appropriate for an intelligent manual are:

- Theoretical knowledge in the domain does not necessarily lead to expertise in performing the tasks.
- There is considerable knowledge peculiar to specific local situations.
- The pure problem-solving aspects of the task are overshadowed by other aspects of the task, ranging from mundane information gathering to communication with other humans.
- The problem-solving aspects of the task are so closely interleaved with other task components that a system oriented towards problem-solving support would not be appropriate.
- Any computer-based support, whether using AI technology or not, would enhance productivity and quality of the overall task performance. Basically, computer-support for the non-problem solving aspects of the task should aid rather than hinder task performance.

The procurement task satisfies these constraints.

2.4.1.2 Simple Deductions

A system capable of making simple deductions on its own requires some reasoning capabilities. One way of designing such a system is to construct a subsystem containing a control structure, one having a capability for making historical deductions given specified relationships, and specialists that can be called when specific expertise is needed. In the case of price analysis, these might include an accounting specialist, management specialist, auditing specialist, and overhead allocations specialists. The accounting specialist would provide information mainly concerned with cost accounting standards, financial accounting standards and interpretations, and alternative accounting systems. The management specialist would provide information about to organization structure and management strategy that might affect to contract evaluation. The audit specialist would provide information obtained by on-site personnel (such as DCASPRs) including company pricing policies, consistency of application of accounting procedures, prior performance history, and certification of cost

allocation policies. The overhead allocation specialist would provide knowledge related to allowable cost allocations, procedures for allocations and cost pool definitions.

The user would be required to provide the system with input data and also respond to requirements which could not be handled by the system. These circumstances would most likely be encountered where the price analyst either interfaces with other specialists, needs information not contained in the system's data base, or where very sophisticated, unstructured reasoning is required.

2.4.1.3 Data Rich Systems

A data rich system would be the ultimate in intelligent systems for contract price analysis. It would have the capability to read the contractor's proposal and based on the historical and analytic data in the system, analyze the contract and formulate a government position. This requires that the system *have access* to the technical specifications of the buyer, a history of the activity in purchasing related items, a history of the contractor's performance on other contracts, a history of similar contractors and similar buys as well as the logical reasoning capabilities required to analyze the the current contract in light of these considerations.

A data-rich system is appropriate for a domain in which most of the problem-solving and task performance can be put online. The price analysis task (or its parent procurement task) does not currently meet these conditions. However, one may expect these conditions to hold sometime in the future.

2.5 Support Alternatives

We consider here the types of computer-based assistance feasible for the three levels of price analysis. One must take a realistic view of viable system characteristics. In the short term, an intelligent manual is a

realistic alternative. It can be implemented fairly quickly, will not require a great deal of personnel retraining to implement, and does not require an extensive historical data base.

The types of assistance that could be provided within the intelligent manual alternative at the the base level are:

1. Provide an intelligent manual for price analysts that would guide the analysis with sequences of questions and by elaborating and explaining issues relating to these questions.
2. Provide general indices (e.g., Consumer Price Index, Wholesale Price Index) and specific indices (e.g., machine tools index) online.
3. Provide data bases of historical contract data for the base, the region, and the Air Force as a whole.
4. Provide very general models of contractor types.[4]

Potential areas of assistance at the AFLC central procurement level are:

1. Provide general and specific indices online.
2. Make available data bases of historical contract data.
3. Specify general parameters for analysis.
4. Provide crude cost modeling of the contractor's estimation systems.

Possible assistance at the Systems Command central procurement level include:

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[4]These models are functional relationships that describe cost structures for contractors who share a set of common characteristics. For example, given that a contractor has a known accounting system and management strategy, the cost estimation system could be expected to have certain properties in common with other contractors using the same accounting system and management strategy.

Price Analysis

1. Provide online historical data bases.
2. Provide guidance in establishing parametric and predetermined rates.
3. Provide access to previously established parametric and predetermined rates.
4. Provide contractor specific cost models.

An intelligent manual will be of the most benefit at the base level. Two major objectives could be achieved. First, the buyer would be provided with assistance that is not currently available. For example, the user will receive informed access to useful tools such as analytical programs and spread sheets, and information on prior buys, catalog listings and pertinent DOD regulations. The intelligent manual will also provide guidance and structure for actually carrying out the evaluation task. This assistance will reduce the buyer's dependence on a price analyst.

Second, contract evaluation can be expedited by increased data availability and automated document preparation. For example, the Price Negotiation Memorandum (PNM) could be automatically generated by the system from the buyer's responses to the system during evaluation. A trace of the buyer's actions while analyzing a proposal is recorded and provides an audit trail useful for evaluation as well as documentation. The uniform availability of the intelligent manual would facilitate on-the-job training. Buyers could increase their skill level without expensive formal training programs. Buyers at the base level currently do not have access to similar capabilities efficiently. The intelligent manual will be applicable to all procurement actions undertaken at the base level.

An intelligent manual will not be as advantageous to the AFLC central procurement level because they currently have access to some computerized tools for analysis. However, central procurement would be improved by access to on-line data access as well as access to spread sheet capabilities and analytic models. Also, an intelligent manual would enhance the educational capabilities for teaching novice buyers more

sophisticated price analysis procedures and requirements. As before, an audit trail would be provided along with assistance in completing the PNM.

Pricing functions performed at the Systems Command level are more complex and are supported by more sophisticated tools. The initial prototype system developed here (or even the first full-scale expert system for contract pricing) would not necessarily be an improvement. These preliminary systems implemented for base and central procurement can grow into the kinds of systems that would be useful at the systems level. This growth will depend on the acceptance of the system and participation in its development by the AF pricing community.

The current level of computer support available at the systems level is desirable at the base and central levels. The proposed system can facilitate the transfer of this support. For example, parametric estimators and cost estimation ratios would be useful at all levels, especially at the base-level where little pricing assistance exists currently. Implementation of the intelligent manual system would allow data to be gathered and technology to be disseminated that could be used to construct such a system in the future. The relationships established from evaluating the first system will be the basis for constructing a simple deductive system. This, in turn, will be the basis for constructing a data rich system for price analysis. Each level is the building block for the next, improved, expert computer system.

3. ANALYSIS OF THE CONTRACT PRICE TASK

3.1 Introduction

The following analysis is based heavily on the Armed Services Procurement Regulation Manual (ASPM-1) on Contract Pricing. ASPM-1 is a well-organized description of the task of price and cost analysis, though it is apparently more praised than used in practice. ASPM-1 makes clear the organization of the cost/price analysis task and the relation between the internalized knowledge of the price analyst and the task. This analysis is a necessary prelude to the design and organization of the intelligent manual for cost/price analysis.

3.2 A multi-level model of cost analysis

Cost analysis is performed at four distinct functional levels. These are: the Contract Negotiation Level, the Contract Accounting Level, the Work Breakdown Structure Level, and the Line-Item Level. The relation between these levels is approximately top-down -- the Contract Negotiation (or the Negotiation Level) is the highest, while the Line-Item Level is the lowest; the Contract Accounting Level (or the Accounting Level) and the Contract Work Level (or the Work Level) are at roughly the same intermediate level.

The general features of the model are:

1. A set of levels corresponding to a breakdown of the contract into sub-entities,
2. A set of questions peculiar to each level that the analyst must ask and answer,
3. Operations peculiar to each level (primarily aggregation and quantity determination), and,
4. Information bearing entities whose structure is unique to the level.

We define the levels of our cost analysis model and discuss each in detail in the following paragraphs.

3.2.1 Contract Negotiation Level

This highest level views the task in terms of the contract as a whole. Certain global variables and parameters of the contract have to be determined. These include, among others:

1. The contract amount (and its range),
2. The contract structure,
3. The contract type,
4. Data availability, and,
5. The Statement of Work, or the Work Breakdown Structure (WBS).

Also, at this level, certain global decisions have to be made -- for example, is the situation competitive, or should each offer be evaluated with respect to independent standards, or should the offers be analyzed in greater detail.

3.2.2 Contract Accounting Level

This level consists of the accounting categories into which an offer can be partitioned. In operational terms, this level consists of aggregation nodes organized as a hierarchy. A cost estimate at each node is the weighted sum of the cost estimates of lower nodes in the hierarchy. The Accounting level identifies elements of the contractor's cost accounting system with items in the statement of work. It may also connect the WBS with cost-specifiable items in the contract. Most contracts display two primary Accounting level nodes: Direct costs and Indirect costs. Within Direct costs, there are Materials, Factory Labor, Engineering Labor, Tooling costs, and any other Direct costs. Within Indirect Costs there are a number of categories (see page 5A-44 of ASPM-1). Each node suggests a set of questions to the price analyst -- these questions constitute the

expert knowledge associated with that node and can be obtained from the technical literature (for example, ASPM-1 page 4-B-27 provides a list of summary questions about direct factory labor costs).

3.2.3 Contract Work Level

This level, like the Accounting Level, is also an aggregation level. However, unlike the Accounting level, this level identifies items peculiar to the particular contract or statement of work. The structure of the Work level is often obtainable from the Statement of Work specified in the solicitation (or in a related WBS). The Work level is orthogonal to the Accounting Level in that the same (or similar) cost items may be distributed differently over different entities in the two levels. Usually there is a simple relationship. For example, an Accounting level entity such as Factory Labor can be broken down at the Work level into particular items by task, say, Factory Labor for each of ten different widgets. The Labor amount for each widget will be classified into different kinds of labor at different rates. At this level, the analyst decides if some component or entity is necessary for the contract, whether the composition of a charged item is correct, and whether the calculation proposed is being done correctly (for example, is a cost pool defined correctly to include only relevant work). This level also identifies the questions raised about specific items. The general form of these questions is established by the Accounting level node that includes the item, but the analyst must modify the question to apply it to the specific item (e.g., the summary questions mentioned above from ASPM-1, page 4B-27, for Direct factory Labor costs must be converted to questions about a particular item and answered with reference to that item).

3.2.4 Line-item Level

At this level an estimate is directly generated for an item. For example, the contractor may estimate 2 hours of assembly labor for widget #5 at $7.95 per hour. This estimate may correspond to some specific line item in the contract (but need not). At this level, the analyst is

required to decide whether the rate $7.95/hour is correct, and the changes that may be necessary.

3.2.5 Characteristics of the levels

The Accounting Level and the Work level are not strictly subordinate to each other. There is some evidence (both from the nature of the task and from the organization of COPPER IMPACT programs) that they should be considered "equal" or coordinate levels.

Every level is almost independent of other levels, except for connections made via common global state-variables defined for the Negotiation level. The Contract Accounting, the Contract Work, and the Line-item levels are frame-based levels -- the structure of the entities at these levels can be described a priori with frame-like structures. As indicated above, price analysis may occur at the Line-item level; this analysis determines if a particular price on a particular contract is appropriate.

The Negotiation level is not a frame-based level -- it depends on the results returned from the lower levels to make decisions about the contract as a whole. Decisions at the Negotiation Level may result in re-evaluation at all other levels. The rest of this chapter describes these levels in further detail.

3.3 The Contract Negotiation Level

The contract negotiation level reflects the economic and political environment faced by the contracting parties and determines the global parameters within which the negotiations must take place. At this level, the analyst considers the following issues:

1. Contract situation: The context of the proposal is important -- competitive situations are preferred as they are believed to lead to a fair market price for the product. However, the analyst must determine that a competitive situation exists. If

competition is absent, some other basis for determining a fair price must be found. The situation determines the procedures and regulations that govern the analyst's approach to the price analysis problem.

2. Contract contingencies: Offers usually have contingencies and the analyst must allow for these.[5] These include: labor or material price escalation; changes in manufacturing process; changes in tax rates, and so on. These contingencies affect the offerer's ability to perform the contract. Recognizing them is central to negotiating a fair agreement.

3. Cost proposals and contract components: (specified in DD 633 forms) The offerer may be required to submit a proposal specifying the cost and its breakdown into more specific components. Under certain circumstances, the offerer may be required to submit different kinds of DD-633 forms that break the proposed cost down in other ways. The proposal and the DD-633 forms constitute the offerer's justification for the offered price. The analyst must determine if proposed costs are to be allowed or not; if special circumstances claimed by the offerer apply or not, and so on.

4. Contract pricing arrangements: Different pricing arrangements are a response to the differential distribution of risk or obligations between the contractor and the government. All contract situations involve uncertainty -- this includes uncertainty in performance (especially for R&D contracts), uncertainty in the price of primary factors, and uncertainty in the quality of product. The basic distinction is between fixed-price contracts (in which the risk is largely borne by the contractor) and cost-plus contracts (in which the risk is largely borne by the government); however modifications to these basic forms can result in a wide variety of pricing arrangements.

5. Cost accounting systems and principles: The government has rules that specify how and why specific kinds of costs are allowed (or disallowed). The cost accounting system of the contractor is crucial to the identification of such costs. There are a variety of cost accounting systems in use. Such systems usually develop in response to the contractor's need for information on its own operations, and so there can be considerable variation in the accounting systems used by different contractors.

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[5]Though getting a low price is an objective for the price analyst, it is not the primary objective -- the price analyst must determine a "fair and reasonable price", not a price that would ruin a contractor, nor should he arbitrarily reduce the contractor's profit margin.

6. Cost estimating systems: Most contractors use cost estimating methods and procedures in determining their offers. The function of such estimation systems is to help company management, and under certain circumstances, this information is available to government analysts. Estimation methods are tied to cost accounting methods -- like accounting methods, they also vary widely from company to company and often between divisions of the same company.

In Chapter 4, we present an intelligent manual that helps the buyer determine the actions to take. For example, whether price analysis or cost analysis is undertaken depends to a large extent on the availability of the necessary information. This decision is made at the contract negotiation level. The procedures to be followed at later stages are dictated by this decision.

In particular, at the negotiation level, the analyst decides whether to evaluate information at the accounting or work levels. One consequence of deciding to perform price analysis (as opposed to cost analysis) is that the analyst decides not to use accounting or work level information or procedures. The analyst may still use line-item level methodology for price analysis (this is the degenerate case of a single item). Decisions at the negotiation level also determine the forms and regulations that the analyst will attempt to apply to a proposal. For example, the analyst decides whether to use the "weighted profits guideline" form for assessing a reasonable profit in a particular case at the negotiation level.

3.4 The Contract Accounting Level

As mentioned earlier, this level is an aggregation level. There are three major categories into which cost items can be aggregated:

1. Direct Costs
2. Indirect Costs
3. Profit

Direct Costs
- Materials
- Factory Labor
- Engineering Labor
- Tooling
- Other

Indirect Costs
- Material overhead
- Engineering overhead
- Manufacturing overhead
- General and Administrative Expenses

Figure 1: Accounting Level: Direct and Indirect Costs breakdown

Each of these categories are broken down further -- Figure 1 shows the first-level of such a breakdown for Direct and Indirect Costs. Associated with each category there are a "typical" set of questions to be asked or problems to be solved.

Since the accounting level is an aggregation level, many of the operations performed by the analyst appear routine and mechanical. This has resulted in attempts to automate this level. For example, the PPS program (for Proposal Pricing System) in the COPPER IMPACT system provides support in laying out the structure of a contract in accounting level terms and for performing simple calculations on this structure. However, there is more to the accounting level than addition -- certain deep questions about the offer are raised and answered at this level. These deep questions are less easily mechanized and will cause difficulties in regular use of any PPS-like system. For example, the analyst must ask the following questions of every Direct Cost item:

1. What is it?
2. Where is it?
3. What does it represent?
4. How was it used?

A PPS-like system cannot answer these questions. These questions must be answered at this level in the appropriate way. Similar and more detailed questions can be raised at every node of the accounting level hierarchy.

3.5 The Contract Work Level

The contract work level corresponds roughly to the WBS of the task (specified by the Statement of Work (SOW) specified in the RFP or other solicitation). The entities at this level are specified by the domain of the contract. For example, the task of constructing a power-plant consists of two subtasks: (1) constructing the turbine, and, (2) constructing the housing facility. The turbine task, in turn, consists of (1) the electrical system, and, (2) the mechanical system.[6] This hierarchy is additive — i.e. the cost for the power-plant is the sum of the costs for the turbine and the housing facility sub-tasks.

The work level is an aggregational level (like the accounting level). However, there is more to it than addition. The work level provides the justification for the particular design decisions and cost choices made by the contractor — e.g., if the contractor specifies (at a lower level) that ten transistors are needed for the electrical system of the turbine, he must explain why (or the analyst must ask why) ten transistors are needed. Again, if the contractor proposes twenty hours of skilled labor, the analyst must determine if this is an appropriate amount of time for the task. Such decisions are made at the work level.

It should be noted that there are commonalities between questions raised at the work level and at the accounting level. The answers, however, are phrased differently. For example, the work level answer is in response to the question "Why is this needed"? At the accounting level, the answer is to determine "Why in this category"? The same low-level entity may be

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[6]This example is taken from the PPS manual of COPPER IMPACT.

queried in both cases. There are clearly close links between the accounting and work levels in practice.

3.6 The Line-Item Level

The line-item level is the one at which price analysis properly occurs. For every line-item, the analyst must ask: "Is the price specified for this item correct"? The necessity for the item has already been established at the work level; the accounting category (or categories) in which the item is to be included has been determined at the accounting level; the only thing left to determine is the fairness of the unit price.

At this level, items look like frames[7] with at least one unfilled slot (the price slot). Depending on the techniques to be used, there may be other slots that must be filled also (such as, the justification for a selected price, or the source of an estimate, etc.). That is to say, the line-item level is a frame level — all entities at this level are frames with associated procedures and models for providing values for slots. Slots in a frame can also provide mechanisms for determining the value of other slots in the same frame (or in related frames). For example, the techniques to be used for establishing an item's fair price depend on a number of factors, such as: a market price if any, the production cost plus profits, a competitive price, inflation rates since the last purchase (at a fair price), technology-dependent factors, learning curves based on production experience, etc.. These techniques constitute the options in a Price-Establishment-technique slot in a line-item. Some of these techniques apply to certain kinds of line-items and not others.

Being a frame level, a number of intelligent data-base operations can be performed on line-items. For example, line-items may be related in a type

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[7] Frames and slots are technical terms in the expert system area. Roughly speaking, a frame is analogous to a form and a slot in a frame is analogous to an entry on a form

hierarchy (a "jeweled bearing" is a type of "bearing", and so is a "metal bearing"). Items of related type may have common slots, common procedures for filling slots, or other commonalities that may be relevant for pricing the item (or performing other functions on them).

3.7 Validating the theory

The above task analysis is based on the description of the task in textbooks and manuals. It needs to be validated by studies of cost and price analysis as performed in practice. We propose to design cases in price and cost analysis to perform these studies.

We will evaluate these studies by "protocol analysis". Protocol analysis has been widely discussed in the cognitive psychological literature [4]. The procedure consists of analyzing an intensive verbal record of a problem-solver (in this case, a buyer or a price analyst) solving a problem (in this case, analyzing a price proposal).

Protocol analysis is necessary partly because the usual record of a finished negotiation (the Price Negotiation Memorandum, or the PNM) is virtually useless from an analytic viewpoint. The PNM is a post-decision record of the results and gives very little information on the processes used by the price analyst in coming to her conclusion.

The PNMs of about 30 different cases provided by the Air Force have been examined. These PNMs were accompanied by varying amounts of documentation on the cases. Unfortunately, there appeared to be little consistency from document to document. From this basic set, the research group has begun constructing realistic case studies that consist of:

1. The solicitation and amendments.
2. The statement of work and amendments.
3. The price proposal of the contractor(s) (this is often simply a filled-in version of the solicitation and the SOW).

4. DD-633 forms (if submitted by the contractor(s)).

5. Other documentation submitted by the contractor(s) (such as, a cover letter, supporting evidence for claimed prices, etc.).

6. The Audit report and other associated technical reports (if these have been requested).

7. The transmittal letter from the buyer to the price analyst (if the analysis is to be performed by a price analyst and not the buyer).

8. The PNM (this is not shown to the price analyst studying the case).

Protocol analysis will enable us to validate our model of the task as described in this chapter and to estimate how significant different parts of it are in actual practice. It will also enable us to identify any additional heuristic rules and schemas used by buyers (or price analysts) in making their decision.

	Base Buyer	Base P.A.	Central P.A.
Competitive	3	3	1
Catalog	3	3	1
Market	3	3	1
Prior Quote	3	3	1

Table 2: Cases being developed for protocol analysis

Table 2 shows the number of cases in each of four price analysis categories and two procurement levels that are being developed. At least one case from each of the following areas of procurement has been included:

1. Construction

2. Supplies

3. Services

4. Spare parts

We will concentrate on base-level procurement and price analysis, but will pay some attention to central procurement. This basic decision was explained in the preceding chapter and accounts for the larger number of base-level cases in the above set. Also, our cases should be designed so that a price analyst or buyer will be able to solve a case in less than 2 hours. In particular, it is expected that a typical base-level case should only take about 20 minutes and the longest base-level case should take less than an hour.

4. A SYSTEM FOR PRICE ANALYSIS

Price analysis is performed almost entirely at the contract negotiation level with occasional forays into the line-item level. A model for this task is presented in the following section (4.1). Based on this analysis, an intelligent manual is implemented in a locally available information system called XINFO.[8] This system is described in section 4.2. In the course of implementation in XINFO, of using the system, and of displaying the system to price analysts, problems with the analysis were identified. Also, other limitations of the XINFO system made the design less than ideal. Work has begun on a different analysis (presented in section 4.3), that will be implemented on a different system, called ZOG.[9] The new implementation is described in section 4.4. Both XINFO and ZOG are also described in a little greater detail in Appendices II and III.

4.1 A Model for Price Analysis

Price analysis the task of determining which comparison technique is appropriate for a given contract, performing the selected technique, and making the award as a result of this comparison. There are four comparison techniques as shown in Figure 2, each differing from the rest in the complexity of the comparison. The first comparison technique is Competitive. In this technique, the price analyst (or PA) compares the contract to other current offers submitted in the spirit of competition. If competition is not possible, the PA uses the second technique -- comparing the contract to published prices. If that is not appropriate, the PA uses the third technique of Secondary Comparisons, i.e., comparing the proposal to a price determined by some other means, such as old

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[8] XINFO is a version of INFO, a system designed at MIT.

[9] ZOG is a system designed at Carnegie-Mellon University. Dr. Kamesh Ramakrishna, one of the principal investigators on this project, was one of the designers of ZOG.

contracts, cost estimation models, and other government estimates. Finally, when all else fails, the PA is forced to look at the purchased item and make an "educated guess" as to what price is fair and reasonable. We call such methods Delphic methods.

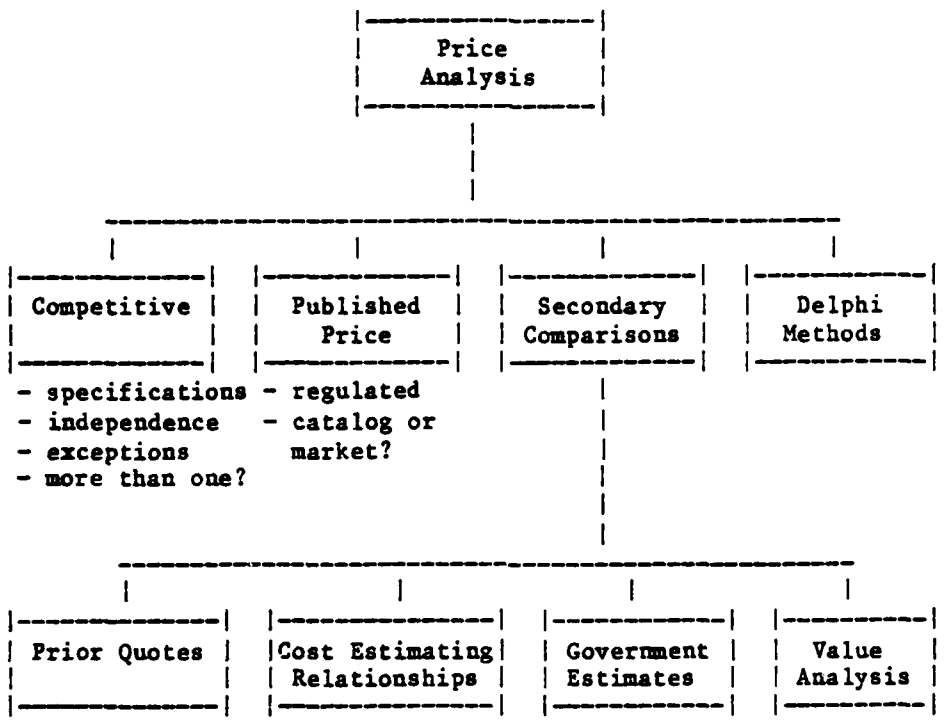

Figure 2: Model of the Price Analysis Task

4.1.1 Competitive: Comparison to Current Offers

Competitive pricing is applicable when competition exists. If it does, the process is relatively simple. Determining whether or not a competitive situation exists is also simple (most of the time). Guidelines exist for determining if competition exists. A short sequence of simple (YES/NO) decisions suffices. If competition exists, the PA selects the low bidder, unless the situation is exceptional for some reason. This can be determined with a sequence of simple yes/no questions too. In the case of

an exception, competitive comparison cannot be applied. However, this does not mean that the low contract is unacceptable, merely that another comparison technique must be used to justify the price of the low contract.

There are four criteria for competitive pricing (as specified by DAR 3-807.7):

1. Each offer must meet the technical specifications of the contract,
2. Each offer must meet the pricing specifications of the contract, and
3. Each offer must have been submitted independently,
4. There must be at least two offers.

After taking the appropriate action,[10] the PA determines if an exception exists by checking the following three criteria (DAR 3-807.7):

1. The solicitation's requirements must not be such so as to eliminate some potential offerers from competing,
2. The lowest bidder must not have a "lock-on" the competition (i.e., some advantage that allows this contractor to be lower than the other contractors such as no need for start-up costs), and,
3. The lowest bidder must not be too high (based on the government estimate supplied by the user or determined by the funds allocated for the procurement by the funding agency).

4.1.2 Comparison to Published Price

Comparison to published prices is the primary method for dealing with "sole-source" contracts. In addition, the method is applicable if the price for the item is regulated by the government or there exists a catalog

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[10]The "appropriate action" can either be the removal of unqualified offers from consideration or a request for re-submission of such an offer.

or market price for the item. Given this, the following three criteria must be confirmed (DAR 3-807.7 (b)):

1. The item must be a commercial item,
2. The item must be one that is sold in substantial quantities, and,
3. The item must be sold to the general public.

If these criteria are confirmed the PA determines whether or not the price is fair and reasonable by comparing the price for the item on the contract to the published price.

4.1.3 Secondary Comparisons

Secondary comparisons requires that the PA independently develop a price. This may require some significantly more complex decisions be made. A number of different methods for developing a price exist. They include, comparison to prior contracts or quotes, use of cost estimating relationships, comparisons to government estimates, and value analysis. Comparing to prior quotes requires knowledge of past contracts and the ability to quickly recognize those past contracts that are the same as or similar to the current one. It also requires the ability to determine the differences -- in technologies, environmental factors (different tax laws, etc.), specifications (differences in the technical aspects of the product) and historical differences (effects of inflation, etc.) -- in the two contracts. Finally, the PA must be able to use this information to determine if the present contract is indeed fair and reasonable. This structure of the method is shown in Figure 3. Similar structures can be constructed for the other methods.

Figure 3 is a modular decomposition of the prior quote comparison method. The basic components are:

1. The Contract Record (CR) Module gives the Prior Quotes (PQ) Expert a number of prior contracts which are similar to the present one.

2. PQ gives the Technology Difference (TD) Module these similar contracts and TD returns to PQ only those contracts that do not have significant differences in technologies.

3. PQ gives the Environmental Difference (ED) Module these contracts and ED returns to PQ only those contracts that do not have significant differences in accounting standards.

4. PQ gives to the Specification/Historical (S/H) Module the contracts that have passed both the above criteria and S/H identifies the differences in technical specifications and historical differences between the proposal and the contracts.

5. PQ uses these comparative lists to determine a fair and reasonable price for the contract.

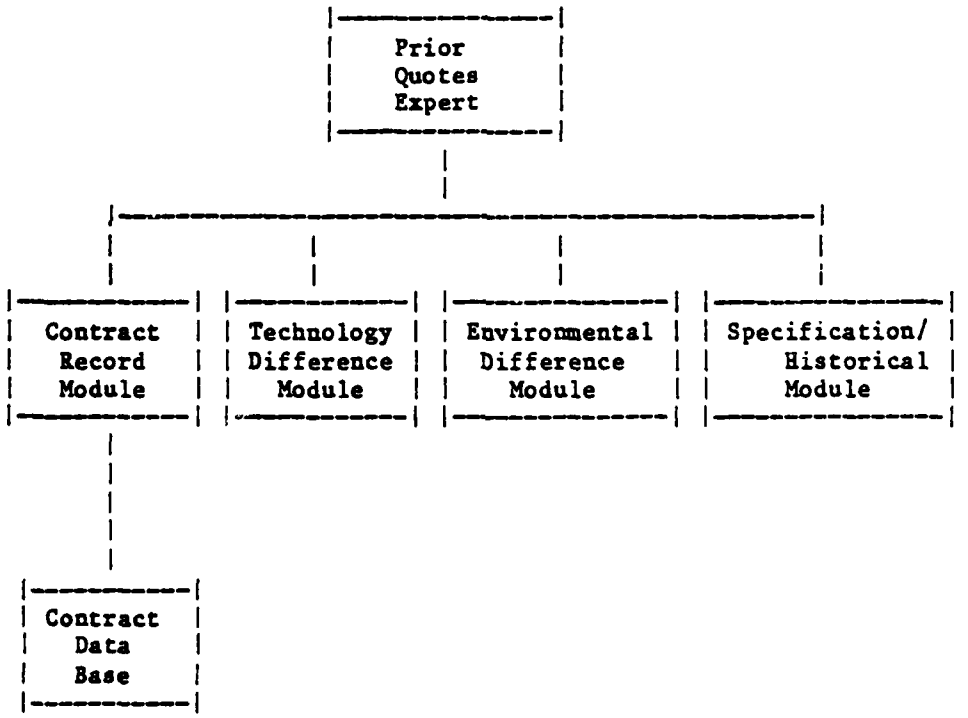

Figure 3: Prior Quotes Expert

4.1.4 Delphi Methods

As a last recort, the PA must determine reasonableness based on very little information. Visual Analysis is an example of a Delphic method — it is based on a visual inspection of an item, or the drawing of an item, or sometimes, any other description, in order to come up with an approximate estimate of the probable value. Such a process requires the most complex form of comparison; thus specifying adequate guidelines is very difficult. Because of its lack of objectivity, this technique is used as a last resort.

4.2 The Price Analysis Tutorial and Intelligent Manual

We used the above structure for price analysis to design and implement a tutorial-cum-intelligent manual for price analysis. This was implemented in an information system called XINFO (see Appendix II for further information on XINFO). The initial implementation was restricted to Competitive and Catalog pricing situations. The tutorial assumes that a base-level buyer is analyzing offers made by one or more contractors. The system then guides the buyer through the decisions to be made, provides explanation on actions to be taken, and gives the buyer access to definitions and examples of these. The structure of this system is described below. Appendix II contains an example of a buyer making a decision in a competitive situation.

XINFO is a computer information system that organizes information as a set of nodes arranged in a tree-like network called an INFO-net. This INFO-net contains any number of subnets. The Price Analysis Tutorial requires two subnets: a Problem Solving net and a Learning net. The user of this tutorial is guided through the Problem Solving net via a series of nodes where the user is given the opportunity to take actions and make decisions or learn more about the contract pricing domain.

Price Analysis

4.2.1 Problem Solving and Learning Nets

There are two separate nets - the Problem Solving net (PS-net) and the Learning net (L-net). The PS-net contains DECISION/ACTION nodes (see Figure 4) that direct the price analyst in analyzing a contract. The L-net, on the other hand, gives general knowledge about a given subject. For example, for Competitive pricing, the PS-net would identify the decisions necessary for determining that a situation is competitive, whereas the L-net would explain (in economical terms) the meaning of and degrees of competition. In the PS-net, the user (price analyst) is guided through the net via DECISION/ACTION nodes. Each major decision may be answered subject to review or may be elaborated into a number of smaller decisions. Figure 4 shows the conventions that have been followed in the XINFO implementation.

4.2.2 DECISION/ACTION nodes

Decisions must be made and actions must be taken during price analysis. The XINFO net contains three different types of nodes. DECISION nodes aid the price analyst in making important decisions. The decision to be made is explained, as are its relevance and importance, and the analyst is given a list of possible answers that will direct the analyst to further decisions and actions. ACTION nodes aid the price analyst in performing appropriate actions. Typically, the DECISION nodes are at the top of the XINFO net, while the ACTION nodes are toward the bottom of the tree. However, actions can also occur during intermediary stages in the processing. Since decisions and actions often go together, we designed joint DECISION/ACTION node that direct the user to perform a given action and then make another decision. See Figure 4 for the format of these nodes.

```
DECISION/ACTION Nodes:

   Node (Subnode) Format:  ACTION (if any)
                           DECISION (if any) - question
                           OPTIONS (if any)  - answers

   Options:  YES/NO       - direct you to next decision or review
             NOT SURE     - elaboration of question (PS-net)
             DON'T KNOW   - elaboration of subject area (L-net)


DECISION Nodes:

   Node Names:  Check <major decision>
                -asks the general (major) questions

   Subnode Names:  C<major decision abbr.>#
                   -asks specific questions

   Subnode types:    - no present action, no previous action
                  A - present action
                  B - no present action, previous action


REVIEW Nodes:

   Node Names:     Review <major decision>
                   -reviews the major decision


ACTION Nodes:

   Node Names:     <major action> Action
```

Figure 4: XINFO Conventions

4.2.3 Current Implementation

The current implementation of the PAT (for Price Analysis Tutorial) network in XINFO consists of competitive pricing and published price (Appendix II shows the complete network). Because of XINFO limitations, adding the prior quote method (that we have investigated to some extent) was not feasible. We have therefore decided to move our implementation

over from XINFO to ZOG. This redesign is discussed later.

4.3 An Alternate Model for Price Analysis

Price analysis is performed in two phases as shown in Figure 5 (this figure may be compared to Figure 2). The first phase, the Contract Selection phase, is a thinning-out step prior to a Preliminary Negotiation step that we do not show in this figure. In the contract selection phase, the PA determines which offers adequately meet the technical, pricing, legal, and other non-comparative specifications of the solicitation. Those offers that do not adequately meet the specifications are dealt with appropriately as discussed earlier. After thinning out the list of offers, the PA performs the Contract Comparison phase of the task. This phase is the central price analytic process performed by the PA. During this phase the PA decides if a given offer is fair and reasonable. The result of the contract comparison phase is used in a Final Negotiations phase (not shown in this figure) in which the buyer and the contractor negotiate a final, agreed price for the contract. It should be apparent from this description that the buyer's price analysis is performed in the global context of procurement (that is, at the contract negotiation level).

4.3.1 Contract Selection Phase

The contract selection phase is a thinning out process in which the PA checks certain criteria. Each offer must satisfy both the technical and pricing specifications of the solicitation. Also, the offerer must not have been disqualified (or blacklisted) for some reason (say, for a legal offense). Determining whether or not an offer meets the technical requirements of the solicitation requires the aid of a number of technical specialists (Engineering experts), while determining whether or not an offer meets the pricing requirements of the solicitation requires the aid of other technical specialists (Accounting experts). Those offers that do not satisfy the technical requirements and/or are not priced responsive to the solicitation are dealt with appropriately (as described earlier).

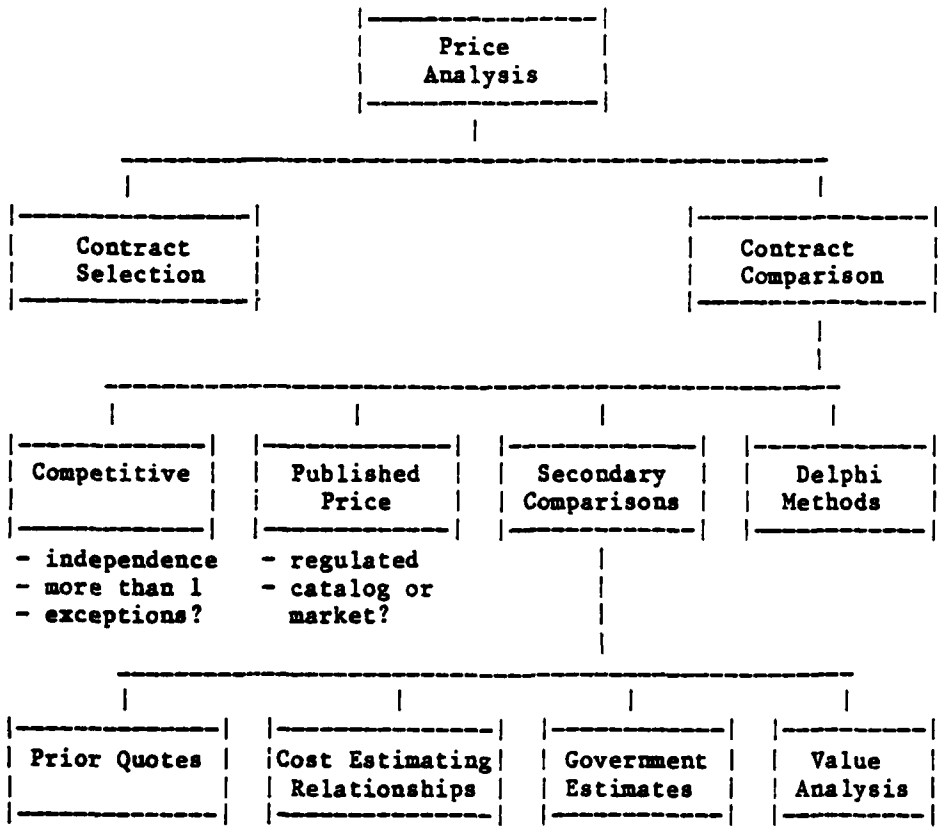

Figure 5: Alternate Model of the Price Analysis Task

4.3.2 Contract Comparison Phase

During the contract comparison phase the PA must determine if the lowest submitted offer that passed the contract selection phase was fair and reasonable. If the price is not fair and reasonable, it must be reported for use during the final negotiations.

The contract comparison phase is similar to the comparison phase discussed in the first model of price analysis. Contracts are compared to determine a fair and reasonable price. The methods to be used differ in their complexity, and is largely determined by the quality and quantity of data available. The primary comparison technique is Competitive Pricing.

Price Analysis

The next comparison technique is comparison to Published Prices. The last two comparison techniques, Secondary Comparisons and Delphi Methods, are more complex techniques. The PA should use the easiest method that is applicable to the contract.

Competitive pricing is the preferred method. The PA must check if the offers were submitted independently. If not, those offers that were not submitted independently must be removed from consideration. If the removal of these offers results in the elimination of all but one offer, then competitive pricing is not applicable and the PA should attempt to compare the offer to published prices. If, on the other hand, there exist at least two offers, then the PA chooses the lowest offer unless an exception exists. These are the same exceptions that were described earlier in section 4.1.1. One of the "sole-source" comparison techniques (Published Price, Secondary Comparisons, and Delphi Methods) must be used whenever competition does not exist. These comparison techniques are the same as described in the earlier model for price analysis presented in section 4.1.

4.4 The Price Analysis Tutorial in ZOG

ZOG is a computer information system that is like XINFO in that it organizes information into nets and subnets (generally called ZOGnets). Its capabilities include a better organization of information for display and the ability to invoke and interact with other programs and other jobs on the computer system through the menu-selection mechanism. This "active" capability makes ZOG more suitable than XINFO as a vehicle for an increasingly "intelligent" system.

PAT (Price Analysis Tutorial) is a computer aid for contract pricing implemented in ZOG (See Appendix III for further discussion of the ZOG system). PAT is intended to guide price analysts (or buyers operating in the capacity of a price analyst) in analyzing contracts. The user (the PA) navigates through a series of frames at which the user must make decisions, take actions, and is given the opportunity to learn more about performing

price analysis. PAT contains four types of frames: DECISION, ACTION, REVIEW, and DOCUMENT frames. These are discussed now.

4.4.1 DECISION and ACTION frames

Most of the frames in PAT consists of DECISION and ACTION frames as shown in Figures 6 and 7. These frames contain five sections: Title, Text, Options, PAT pads,[11] and global pads. The Title is a one or two word description of the contents of the frame. The Global Pads of the DECISION and ACTION frames are universal ZOG commands that can be used for help on ZOG, editing, branching to other locations in the ZOG-net, etc. They are briefly discussed in Appendix III.

```
Pricing Specifications                                    Pat27

Each solicitation has specific requirements about the type of
contract that is acceptable (e.g., firm fixed price, cost-plus,
etc.) and a requirement as to how much pricing data must be
given.  You must determine if each offer is priced and
responsive to these requirements.

 IS EACH OFFER PRICED AND RESPONSIVE TO THE REQUIREMENTS OF THE
                        SOLICITATION?


      1.  Yes

      2.  No


S.  SPECIFY          E.  EXAMPLE          L.  LEARN

edit help back next mark return zog display user goto find info
```

Figure 6: Sample DECISION frame

[11] These are Local Pads as described in Appendix III. However, they have been re-named PAT pads because they are common pads in all of the DECISION frames of the PAT ZOG-net.

```
Offer Elimination                                          Pat28

Those offers that fail to meet the technical specifications
of the solicitation must either be revised and resubmitted or
eliminated from consideration.

     ELIMINATE THOSE OFFERS THAT DO NOT MEET THE TECHNICAL
   SPECIFICATIONS OF THE SOLICITATION AND CANNOT BE REVISED
                    AND RESUBMITTED


       1.  Continue

       2.  Return


S.  SPECIFY              E.  EXAMPLE              L.  LEARN

edit help back next mark return zog display user goto find info
```

Figure 7: Sample ACTION frame

The text of each DECISION frame consists of two components: TEXT and DECISION. The TEXT component contains a few sentences that describe the process that the PA must perform. The DECISION component is a question at the end of the Text section. A number of options restrict the answers the user can give to the question. These options lead to other DECISION or ACTION frames.

The Text of each ACTION frame consists of instructions to the PA describing the action to perform. The Options of the ACTION frame allow the PA to continue on through PAT or to return to the previous DECISION frame.

The PAT pads are three options that exist in every DECISION and ACTION frame. The "S" pad is available to the user who desires an elaboration of the decision or action of the current frame (e.g., an elaboration of the decision -- Does this contract fall into some exception category? -- would lead the user to frames which describe the conditions of each exception).

On the other hand, the "L" pad leads the user to the Learning-net where the user can learn more about the subject of the current frame (e.g., for the same frame as above the user would be lead to a portion of the Learning-net that explained the economic theory for preferring competition). By selecting the "E" pad, the user would be shown an example of performing the decision or the action.

4.4.2 REVIEW and DOCUMENT frames

Two other types of frames exist in PAT: REVIEW and DOCUMENT frames. REVIEW frames are entered whenever the user makes a positive selection on a major decision. A major decision is one that can be further elaborated into a series of sub-decisions (e.g., the decision -- Does the contract fall into some exception category? — can be elaborated into 3 sub-decisions, one for each exception category). A positive selection to a major decision is one that supports the current hypothesis. (Here the hypothesis is that Competitive Pricing should be the method of analysis and the answer -- NO -- is a positive selection). A negative selection, on the other hand, would be one that rejects the current hypothesis. The Text of a REVIEW frame consists of two components. First, the criteria[12] that have been assumed to be met as a result of the positive selection in the previous frame are displayed. Secondly, the user is asked to confirm the previous decision. The user has two Options -- to continue with the same hypothesis or to begin a new hypothesis after documenting the failure of the current one.

This documentation of rejected hypotheses is performed in a DOCUMENT frame.[13] These frames allow the user to submit text that will appear on the

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[12]Deciding between competitive pricing or published price methods is accomplished by checking the set of criteria discussed earlier.

[13]DOCUMENT frames can also be reached from DECISION frames on a negative selection.

official report that explains why the current hypothesis (method) is not applicable and then directs the user to a new frame where a new hypotheses (method) is tested.

4.4.3 Current Implementation

The current implementation of PAT contains the first phase of the price analysis task, the contract selection phase, and the first two comparison techniques, competitive pricing and published price, of the contract comparison phase.[14] Whether or not a contract can be analyzed using competitive pricing is determined by asking a number of questions. This exists in PAT as a network of DECISION and ACTION frames that guide the Price Analyst to the ACTION frame where the competitive pricing action ("take the lowest bid") is applied or to network of DECISION and ACTION frames for published price comparisons.

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[14] It should be noted that although PAT in ZOG contains some components in common with PAT in XINFO, it differs in that it is being designed with the alternate model just discussed.

5. EDUCATIONAL ASPECTS OF CONTRACT PRICING

Price Analysts are developed within the Air Force via a system of both *on-the-job* training and formal education. We looked at educational and other supportive materials provided to prospective buyers and price analysts (and other personnel involved in procurement). Based on the considerations discussed earlier, we concentrated on materials intended for lower levels of procurement — in particular, base-level buyers who must perform price analysis without the aid of a trained price analyst.

5.1 The Current Educational Setup

The basic buyer support mechanisms are:

- Defense Acquisition Regulations and associated manuals for procurement.
- Courses in price analysis at the Air Force Institute of Technology and at Lowry Air Force Base.
- Computer programs in COPPER IMPACT.

5.1.1 Manuals for Price Analysis

The bible of price analysts is the Armed Services Procurement Manual, Number 1 (generally called ASPM-1 [3]). This manual discusses in clear language and at a detailed level, the issues an analyst must consider when analyzing an offer. ASPM-1 is a comprehensive document and discusses both cost and price analysis. As a result, it concentrates largely *on cost* analysis and is oriented to price analysts. This makes it difficult for a buyer to acquire the knowledge in ASPM-1 and understand how to apply that knowledge.

Recently, the Air Force has produced a "Guide for Base-level Pricing" that provides more specific guidance for base level buyers. This document provides a buyer with explicit decision making procedures. It focuses on procedural matters and does not explain some complex concepts in price

analysis well. For example, the guide does not explain what is to be done if collusion between two offerers is discovered. The buyer can solve a few pricing problems by blindly following the guide, but more complex problems would cause difficulties.

Other manuals include AFCMD regulation 70-8 that discusses the functions of price analysts in Systems Command. This is not a base-level function, so we do not discuss this manual further.

Principles of Contract Pricing is a text used for the price analysis course at AFIT and provides a fairly complete and readable presentation of the skills needed by someone doing price analysis. As with ASPM-1, it concentrates on cost analysis, but does not neglect price analysis.

5.1.2 Courses for Buyers and Price Analysts

We were provided with the syllabi for two courses taught at the Air Force Institute of Technology School of Systems and Logistics that cover base level contract pricing. These courses were "Principles of Contract Pricing" and "Quantitative Techniques for Cost and Price Analysis." The first course is an introduction that teaches the rudiments of price analysis and cost analysis. The course follows the text, Principles of Contract Pricing. It is an adequate course, given the current level of technical sophistication available to the analyst. The course is attended by buyers with a year or two of on-the-job experience, and is intended to give them some theoretical background for activities they currently perform under supervision.

The second course is an advanced course that acquaints the student with the quantitative tools and programs available within COPPER IMPACT. The course covers the major quantitative methods that would be useful in the field. Our initial observations are that these tools are seldom utilized by base level buyers. Nor is there a tradition among base level buyers of using these tools. The course is usually taken by contracting officers and price analysts from AFLC and AFSC, rather than base level buyers. It

appears that rough and ready methods of approximation (sometimes resulting in inadequately documented prices for contracts that are not "fair and reasonable") are easier to apply. The tools also require specialized training, are not well documented, and are not user-engineered; using them and learning to use them can be time-consuming and tedious. This might imply that continuing assistance and education (over and beyond the course) are needed in the field.

We were also provided with study guides and workbooks for technical training for Central/Systems level contracting. The same comments are appropriate here as were those presented for the AFIT courses.

5.1.3 COPPER IMPACT

Our initial observation is that COPPER IMPACT is not utilized to its full potential. The biggest problem appears to be the lack of appropriate documentation of available programs and indifferent dissemination of information about system capabilities. There is no effective central control for the programs available (there is a central office for managing the COPPER IMPACT program as a whole, but its influence is apparently negligible). Programs, data standards, and styles of interaction are idiosyncratic; little standardization results in little interactive use. Duplication of effort results. Other problems appear to be: little programming assistance in the field, the high up-front cost of learning to use the system, inadequate input data for the statistical models, and the inapplicability of standard quantitative models to base level situations. Base-level buyers often have difficulty analyzing complex buys because of their inability to obtain or manage the necessary high-level information and to apply sophisticated analytical techniques. COPPER IMPACT could aid in this area if understanding and accessibility were improved. The current system does not guide the buyer in analyzing a contract. It has no deductive capabilities. It, therefore, does not help the buyer in analyzing and evaluating more complex buys.

For COPPER IMPACT to succeed, its capabilities should be studied right from the first introductory course for procurement and price analysis. The students should become acquainted with computer-aided procurement and price analysis early in the training process. This interaction should be reinforced when they return to the field to perform their responsibilities. These requirements hold true for any computer-aided system for price analysis.

5.2 A Proposal for Improving the Educational System

A buyer goes to a price analysis course and returns to the base; then, the buyer faces the problem of integrating this new knowledge into a daily schedule of activities. How much time this takes and how well this integration is done depends on how many times the buyer has done the task before and after training. We propose here the development of an intelligent manual for contract pricing that will support the buyer in analyzing offers. Such a system has a number of roles in the continuing education of buyers and price analysts.

1. Training related usage

   a. Before Training: A buyer without formal training in price analysis can be guided through a variety of simple decisions that do not rely on a deep knowledge of regulations. The system can also help the untrained buyer identify situations in which the buyer should ask for assistance from trained personnel.

   b. After Training: A buyer who has received formal training will find the guidance provided by the intelligent manual useful as a refresher. This is especially useful in the initial period after training (when the buyer may still be unsure of the acquired knowledge) and for the occasional unusual case that the buyer runs across. Also, the system provides a centralized mechanism to update all buyers concerning new regulations that affect old ways of doing the task.

   c. During Training: An intelligent manual can act as a computer-assisted training/educational tool. During a course the buyer can be trained to use this tool in more

sophisticated ways, as well as to use the tool for the basic task.

2. Interaction with other systems

   a. With COPPER IMPACT programs: An intelligent manual can act as a transparent, knowledge-based, supportive interface to COPPER IMPACT programs (ZOG is an example of such an interface). For example, the intelligent manual could be used to obtain data for some COPPER IMPACT program in an appropriate way from the user and use it to run that program and other programs to get the necessary result. Over a period of time, such a system could be "optimized" to perform routine tasks automatically.

   b. With other systems (for example, centralized data bases): Just as the intelligent manual can interact transparently with COPPER IMPACT programs, it can interact with other systems and present the information to the buyer/analyst in the appropriate fashion.

3. For System Integration: In the long run, all the programs and systems that a buyer/analyst might use should be available as an integrated set of systems. An intelligent manual is a viable progressive step in that direction. The style of interaction provided by the intelligent manual and the ways in which it will interface with other systems will encourage the development and enhancement of the capabilities of the manual by users of the system themselves. If this enhancement is managed appropriately, it will encourage system integration.

The intelligent manual approach is of use at the higher levels (Central and Systems Command) of performance of price/cost analysis as well. In particular, as the systems developed for the lower levels of analysis become more integrated, they will be of increasing use for the higher levels as well. Also, some of the current human interface problems faced by cost/price analysts in dealing with the data and information they are given may be better handled using the intelligent manual approach. Changes in regulations affect the performance at these levels of cost analysis more significantly than at the base-level -- an intelligent manual would bring such changes to the attention of the price analyst under relevant conditions.

6. SUMMARY AND FUTURE ACTIVITIES

We briefly summarize the future actions required to bring the study to a successful conclusion.

Our continued survey of the pricing environment will be based on the following information:

1. Sample contracts and other contract documents that provide examples of the actual documentation received and processed by a price analyst,
2. Educational materials used by the Air Force in training price analysts and others doing comparable tasks.
3. Documentation and access to computer programs and systems used by price analysts (e.g., COPPER IMPACT).

The primary task during this phase of the study has been to organize, codify and analyze the above information and to evaluate the current system for contract pricing. Based on the educational documents and interviews with educational and operational personnel, we have constructed a preliminary model for contract pricing. We have recommended the use of computer-based intelligent manuals to enhance the current educational process.

As discussed throughout this technical report, a model of price analysis has been formulated and the resulting prototype intelligent manual is under construction. What is needed is to compare the model with actual behavior. Also, we are studying the problem of integrating COPPER IMPACT programs with the prototype implementation in ZOG.

Portions of the prototype system are currently in place. We plan to continue to develop and refine this system. We have currently passed through one iteration of the system and are in our second iteration using a different underlying system (ZOG) with better capabilities for interacting with other systems like COPPER IMPACT.

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Price Analysis

I. INTERVIEWS CARRIED OUT DURING PHASE I AND PHASE II

Four separate interview trips were undertaken during Phase I and Phase II in accordance with the contract requirements. The purpose of these interviews was to gain insight in the methodological approach used by Air Force price analysts in performing cost/price analysis of contract proposals. In-depth interviews were undertaken in most instances. These sessions provided insight into the rules and experience used by Air Force price analysts. Each of the four trips are summarized in this appendix.

AFIT PRICING GROUP, WPAFB, DAYTON, OHIO. 11/23/82

Meetings were held with AFIT price analysis instructors: Mr. Jeff Daneman, Maj. Matthew Shields and others. We were introduced to the learning objectives of several price analysis courses, the instructors' perception of the contracting environment, and to the COPPER IMPACT system. The morning session was devoted to fact finding. The contract evaluation process was explained to the research group — the discussion was interactive, with members of the research group asking questions of the AFIT personnel. The following areas were discussed:

1. Base level procurement.
2. Command-level procurement.
3. Major categories of procurement — construction, material items, service, and R&D.
4. Parametric estimators.

The afternoon session was devoted to COPPER IMPACT. Two potentially useful items were identified: the PPS program and the set of learning curve programs. The PPS program can be used for building WBS trees and for viewing a contract's cost structure at different levels of details. The learning curve programs are basically curve-fitting and slope-estimating programs.

AIR FORCE LOGISTICS COMMAND, WPAFB, DAYTON, OHIO, 20 JAN 1983

We met with Mr. Bob Hill, an expert price analyst assigned to the ALC support staff and Mr. Steve Stitzel, his assistant. The objective of the meeting was to gather data concerning the price analysis function at both the central and base level, to determine the behavior of an expert price analyst in certain pricing situations and to make arrangements for gathering case material. An interview format was used where the members of the research team asked questions of the pricing experts. The following issues were covered:

1. Major problems faced by price analysts.
2. Characteristics of given sets of dollar level buys.
3. Current data available to the buyer, and the buyers' propensity, and capability, for accessing the data. This includes procedural guidelines as well as operational information.
4. Sources of data used by the analyst.
5. The decisions that are required to be made by the buyer or price analyst during a contract analysis.
6. The degree, if any, of contractor type specialization by analyst.
7. The use of price indices.
8. The capabilities and utilization on COPPER IMPACT.
9. Comparisons of central and base-level activities along the above dimensions.

CMD AFPRO SUPPORT GROUP, KIRTLAND AFB, ALBUQUERQUE, NEW MEXICO
24 AND 25 JANUARY 1983

Two days of intensive interview sessions and briefings were undertaken with the following members of the CMD AFPRO support group: Mr. William Chamberlain, Mr. Jeff Gardner, Mr. Wayne Gaede, Mr. Bob Gibson. The visit was to acquaint the research group with the buying activities and capabilities of Systems Command. An interactive interview format was used.

Price Analysis

The following objectives were addressed:

1. Level of sophistication in analyzing contracts and the capabilities available.
2. Degree of access to access to contractor specific information and how this information is used.
3. Available computer systems (e.g., COPPER IMPACT and others) and their utilization by analysts.
4. Determine the interrelationship, if any, between AFSC, AFLC, and base level procurement; determine the applicability of procedures and evaluate the possibilities for the transfer of technology across these areas.
5. Gain a better understanding of overhead rates, their impact on a contract analysis, the appropriateness, and procedures, for negotiated rates and methods for estimating them.
6. AFSC support requirements that might be addressed by an intelligent system.
7. Investigate and understand specific costing procedures: grass-roots, parametric estimators, formula pricing, standard setting, and historical costing.
8. Identify AF programs designed to improve productivity and that would have an impact on contract pricing.
9. Task based estimation and contractor cost model based estimation.
10. Questions asked by the AFSC price analyst in analyzing a contract.
11. The analyst's function in the price negotiation process.
12. Development of cost estimation relationships and an understanding of how they are, or could be, used.
13. An understanding of the computerized cost model system in use at AFCMD and the knowledge required to implement it.
14. An introduction to the generalized data base model for factors and rates currently under development.

AIR FORCE LOGISTICS COMMAND, WPAFB, APRIL, 1983

We met with Mr. Rollie McReynolds at OSU. The objectives of the meeting were:

1. A detailed discussion of pricing cases.
2. Assistance as to the items needed in the case packets.
3. An expert's reactions and evaluations to a portion of the prototype computer system.

Two interview protocols were used. First, Mr. McReynolds was asked to review and analyze approximately ten case-packets. These sessions were taped. He was requested to "think aloud" during this process. The researcher took an active part in the session by asking questions about the procedures used by a buyer, the representativeness on the case, and the additional documentation needed. The cases were cost analysis cases and PNMs from pricing cases. The cases were evaluated as inadequate for collecting detailed protocol of buyers' behavior. Mr. McReynolds was able to provide valuable information by generating scenarios based on his experience. He identified the supporting data that would probably have been used, or would have been needed, and the processes used by the buyer in analyzing the contract.

During the second session, Mr. McReynolds evaluated the prototype system that has been implemented (in XINFO) up to that point. The system was explained and Mr. McReynolds went through the system to criticise and evaluate the usability of the system by an expert price analyst.

II. THE XINFO SYSTEM

II.1 The XINFO System: A Brief Introduction

XINFO is database of information organized as a network of nodes. The user of the XINFO system views the contents of this database by moving through the network from one node to another. The information contained in these nodes can be arbitrarily long. However, by convention the information contained in each node is small enough so that it can be displayed on a single screen. Each node contains a node-name (that is unique) which is used to reference the node, a menu containing other node-names, and a set of a designated nodes that may be easily referenced.

Movement through the XINFO-network can be performed by either selecting one of the nodes listed in the menu or by referring to one of the designated nodes. When selecting a node from the menu list you may either type in the node-name listed or type a number that represents this nodes place in the menu (i.e., the third node in the list may be reached by typing 3). Designated nodes are shown at the top of each node (e.g., the Previous node, Up node, Down Node, Next node, etc.) and can be reached by simply typing the first letter of its type (i.e., if the Next node is "Document Exception," then "Document Exception" can be reached by typing N).

Earlier it was mentioned that there was no restriction on the amount of information that could be contained in a node, but that by convention the information contained in a node was small enough so as to allow the entire node to be displayed on one screen. However, if it becomes essential to use more than one full screen to display the node then two other XINFO commands are necessary. When this is the case, the user is given as much information as would fit on one full screen and a message indicating that there is "MORE" is displayed at the bottom of the screen. The user may see the next full screen by hitting the <space> bar; the user return to the portion previously viewed by typing the letter "B".

XINFO imposes no set format for the information that is contained in the node. Some rules are that the menu items must follow the keyword: "* Menu:" and be on separate lines. Each item is preceded by a "*" and followed by a "::". the nodes in PAT follow some conventions the format of which was discussed in Chapter 3 of this report.

II.2 The XINFO-Pricing Guide: Example and Discussion

The following documented example gives a sample of the use of PAT. The user has been given 3 proposals for a solicitation and asked to analyze them and select one that is the most "fair and reasonable."

The user initially enters PAT by typing the appropriate command to the monitor (on our system that command is "XINFO"). The root node of the XINFO system is displayed (we do not show this node as it is not relevant to PAT). The user then types "G" (the "go to" command) and specifies the PAT subsystem by typing "(<PRICING>DIR)PAT". The top node of PAT is then displayed (see Figure 8). Note that XINFO has left the last line typed by the user near the bottom of the screen. Also note (in subsequent displays) that the selections are echoed on the bottom line of every node.

In this example, the buyer determines that the lowest offer out of three offers that have been made is not competitive as the buyer had a "lock" on competition. Since there is a market for the item, the buyer documents in the PNM that the situation was not competitive and that the comparison to published price technique would be used to evaluate this low offer. Our example stops at this point.

```
DIR Node: PAT,  Up: , Previous:

This is a Price Analysis Tutorial.  You will be lead through a series of
DECISION/ACTION nodes in which you will (possibly) be given a set of actions
to perform and then (possibly) be given a question to answer.  The basic idea
of this tutorial is to help teach you the task of analyzing a contract and
determining if it is fair and reasonable.

IS THE PRICE OF THE CONTRACT FAIR AND REASONABLE?

* Menu:

* Review Fair & Reasonable::   (1)  YES

* Document Fair & Reasonable:: (2)  NO

* Method::                     (3)  NOT SURE


INFO documentation reader  Node (DSK:<PRICING>DIR) PAT
Go to Node (<pricing>dir)pat
3
```

The XINFO-user has three offers for the solicitation. Obviously, she is unable to answer whether or not the the contract is fair and reasonable without further investigation and therefore she selects 3 - NOT SURE.

Figure 8: PAT node

```
DIR Node: Method,  Up: , Previous:

The first stage of analyzing a contract involves the determination of the
appropriate method to use.  The Air Force has set down a series of guidelines
to follow that determine which of these is appropriate.

                        WHICH METHOD IS APPROPRIATE?

* Menu:

* Check Competitive::      (1)  COMPETITIVE or NOT SURE

* Check Published Price:: (2)  PUBLISHED PRICE

* Secondary Comparisons:: (3)  PRIOR QUOTES, CER MODELS, GOVERNMENT ESTIMATES
                               and VALUE ANALYSIS

* Wild Guess::            (4)  NONE APPLY


INFO documentation reader  Node (DSK:<PRICING>DIR) Method

31
```

The user knows that the contractors each gave published prices, but knows that Published Price is only used on "sole-source" contracts. Being unsure what to do, she selects 1 - NOT SURE.

Figure 9: Method node

DIR Node: Check Competitive, Up: , Previous:

At this point, we must decide upon which method to use to analyze the contract. If we have a competitive situation, then we simply accept the bid unless the particular solicitation falls into some EXCEPTION category.

DO WE HAVE A COMPETITIVE SITUATION?

* Menu:

* Review Competitive:: (1) YES

* Document Competitive:: (2) NO

* CC1:: (3) NOT SURE

INFO documentation reader Node (DSK:<PRICING>DIR) Check Competitive

313

She desires an elaboration on the criteria involved in determining whether or not the situation is competitive. She selects 3.

Figure 10: Check COmpetitive node

DIR Node: CC1, Up: , Previous:

At this point, we must decide whether the offers meet the technical specifications. Among the issues to be considered are what differences exist between the required specifications and the proposed specifications, and whether the differences are critical. The using agency is the appropriate judge of this.

DOES EACH OFFER SATISFY THE REQUIREMENTS OF THE SOLICITATION?

* Menu:

* CC2:: (1) YES

* CC2A:: (2) NO

* L-mat:: (3) NOT SURE

INFO documentation reader Node (DSK:<PRICING>DIR) CC1

3132

After close evaluation of the second offer, the user determines that the offerer actually submitted a proposal that does not conform to the technical specifications of the solicitation. She selects 2 - NO.

Figure 11: CC1 node

```
DIR Node: CC2A,  Up: , Previous:

You must eliminate those offers that do not satisfy the requirements of the
solicitation.

Each solicitation has specific requirements about the type of contract that
is acceptable (e.g., firm fixed price, cost-plus, etc.) and a requirement as
to how much pricing data must be given.  You must determine if each offer is
is priced and responsive to these requirements.

   ARE EACH OF THE REMAINING OFFERS PRICED AND RESPONSIVE TO THE REQUIREMENTS
      OF THE SOLICITATION?

* Menu:

* CC3B::        (1)  YES

* CC3A::        (2)  NO

* L-mat::       (3)  NOT SURE


INFO documentation reader  Node (DSK:<PRICING>DIR) CC2A

31321
```

The user is given an action to be performed (eliminate the second offer). The user selects 1 - YES.

Figure 12: CC2A node

```
DIR Node: CC3B,  Up: , Previous:

One major problem that arises is that the bids are really not made
independently.  You should make every attempt to guarantee that this indeed
is not the case.  For instance, often the only offers are actually made from
different divisions of the same company.

   DID THE REMAINING RIVAL OFFERERS INDEPENDENTLY CONTEND FOR THE CONTRACT?

* Menu:

* CC4B::        (1)  YES

* CC4A::        (2)  NO

* L-mat::       (3)  NOT SURE


INFO documentation reader  Node (DSK:<PRICING>DIR) CC3B

313211
```

The user selects 1 - YES.

Figure 13: CC3B node

DIR Node: CC4B, Up: , Previous:

Now we come to the most important question necessary for the determination of whether or not the situation is competitive or not.

ARE THERE AT LEAST 2 REMAINING RESPONSIBLE OFFERERS?

* Menu:

* Exception:: (1) YES

* Check Published Price:: (2) NO

* L-net:: (3) NOT SURE

INFO documentation reader Node (DSK:<PRICING>DIR) CC4B

3132111

She selects 1 - YES.

Figure 14: CC4B node

DIR Node: Exception, Up: , Previous:

There appears to be a competitive situation. You should accept the lowest offer unless this offer falls into some EXCEPTION category.

DOES THIS SOLICITATION FALL INTO SOME EXCEPTION CATEGORY?

* Menu:

* Document Exception:: (1) YES

* Review Exception:: (2) NO

* RCl:: (3) NOT SURE

INFO documentation reader Node (DSK:<PRICING>DIR) Exception

31321:12

She selects 2 - NO because she knows what the exceptions are and does not require further elaboration. This directs her to a REVIEW node.

Figure 15: Exception node

DIR Node: Review Exception, Up: , Previous:

By claiming that no exception exists, you are saying that the lowest bid does not fall into one of the following EXCEPTION categories:
(1) The solicitation was made under conditions that unreasonably deny one or more known and qualified offerors an opportunity to compete.
(2) The low competitor has such an advantage over the other competitors the she is practically immune to the stimulus of competition.
(3) The lowest final price is not reasonable, and this finding can be by facts. Such a finding must be approved at a level above the contracting officer.

IS THERE A REAL COMPETITIVE SITUATION?

* Menu:

* Competitive Action:: (1) YES

* Document Exception:: (2) NO

INFO documentation reader Node (DSK:<PRICING>DIR) Review Exception

3132111122

The user realizes that she has made a mistake - an exception does exist. The lowest bid has a "lock-on" the competition. She selects 2 - NO.

Figure 16: Review Exception node

DIR Node: Document Exception, Up: , Previous:

<Document what exception exists.>

Because an exception exists, competitive pricing is not applicable. However, this does not mean that the low bid is not reasonable. It simply means that you must select a different method to analyze the contract.

WHAT METHOD WOULD YOU LIKE TO TRY NEXT?

* Menu:

* Check Published Price:: (1) PUBLISHED PRICE or NOT SURE

* Secondary Comparisons:: (2) PRIOR QUOTES, CER MODELS, GOVERNMENT ESTIMATES, or VALUE ANALYSIS

* Wild Guess:: (3) NONE APPLY

INFO documentation reader Node (DSK:<PRICING>DIR) Document Exception

3132111221

The user now documents on the PRN the reason for not using Competitive Pricing (an exception exists) and continues on to Published Price by selecting 1 - PUBLISHED PRICE.

Figure 17: Document Exception node

DIR Node: Check Published Price, Up: , Previous:

At this point, we must determine if the contract price is a CATALOG, MARKET, or REGULATED (SET BY LAW) price. In all of these cases, price are set by forces beyond the direct control of an individual firm.

DOES THE CONTRACTOR JUSTIFY THE CONTRACT PRICE AS A MARKET, CATALOG, OR A REGULATED PRICE?

* Menu:

* Check Market & Catalog:: (1) YES (MARKET OR CATALOG PRICE)

* Regulated Action:: (2) YES (REGULATED PRICE)

* Secondary Comparisons:: (3) NO

* CPP1:: (4) NOT SURE

INFO documentation reader Node (DSK:<PRICING>DIR) Check Publish

31321112211

The user knows that a catalog price exists for this offer and therefore selects 1 - YES (MARKET).

Figure 18: Check Published Price node

DIR Node: Check Market & Catalog, Up: , Previous:

By claiming that the price for the item is catalog or market, you are saying that the following three criteria are satisfied:
(1) The item is a "commercial item"
(2) that is sold to the "general public"
(3) in "substantial quantities"

Now, you must determine which of these two prices exist. An established catalog price is one included in a catalog, price list, or other format that is regularly maintained by a manufacturer or vendor. The price material is either published or otherwise available for inspection by customers. Price listed are the prices at which sales are currently or were last made to a significant number of buyers, including the general public. A market price is a price currently established in the usual and ordinary course of trade between buyers and sellers free to bargain. The price must be established from sources independent of the manufacturer or vendor.

(Hit the space bar for your next question.)

INFO documentation reader Node (DSK:<PRICING>DIR) Check Market —MORE—

31321112211

The user desires to see the bottom half of the node, so she hits the <space bar>.

Figure 19: Check Market and Catalog Price node -- top half

WHAT IS THE ESTABLISHED PRICE?

* Name:

* Catalog Action:: (1) CATALOG

* Market Action:: (2) MARKET

(Hit '?' to read the definition of these terms)

INFO documentation reader Node (DSK:<PRICING>DIR) Check Market

31321112211

Note that this node is longer than the rest. In fact, it is too long to fit on one screen and therefore the user must hit the <space bar> in order to see the bottom half of the screen and hit the <3 key> to see the top half again. At this point, our user selects 1 - CATALOG ACTION and is directed to a terminal node in the net where she is instructed on her final action of the task.

Figure 20: Check Market and Catalog Price node -- bottom half

III. THE ZOG SYSTEM

III.1 The ZOG System: A Brief Introduction

ZOG is a large database (potentially very large) of information organized as a network of frames. A ZOG-user moves from frame to frame using the computer terminal to view the contents of one frame at a time. Frames are designed to be displayed on a single screen; by convention, every frame has a one-line Title at the top of the screen, a few lines of Text below the title, a set of numbered (or lettered) menu items of text called Selections, and a line of ZOG commands called global pads at the bottom of the screen. Selections are divided into Options and Local Pads — options are usually numbered ("1. ...", "2. ...", etc.), while local pads are usually lettered ("A. ...", "X. ...", etc.). Functionally, options lead to other frames, while local pads provide the user with locally defined commands (though this is only a convention, not a rule enforced by ZOG).

Frames are interconnected by the selections. When the user selects an item (by typing its number or letter, or in more advanced systems by touching the screen location of the item), ZOG "moves" the user to the frame "pointed to" by the selection. This new frame is now displayed on the screen, replacing the frame from which the selection was made. The new frame will have the same general format; it will usually contain new information and further selections that lead to more detailed information. Occasionally there may be "dead-ends" — frames that have no selections. Basically, the frame network is a hierarchical information structure with extensive cross-referencing as well as mechanisms for moving directly from frames deep down in the hierarchy to frames much higher up. The network of frames is often termed a ZOGnet.

Figure 21 shows an example ZOG frame. This frame called Estimate1 (see the upper right hand corner of the frame for the Frame-Id), is the initial frame for a ZOGnet that was used for estimating the cost of a new building

for the Mining Department. There are lettered selections P and I that identify the project by Project and Identifying number, a set of numbered selections that point to frames giving further information (and provide a brief summary as well); there are more lettered selections D, N, S, R, H that provide further information appropriate to the global level of cost estimation implied by the contents of this frame. The global pads at the bottom fall into three groups -- the set edit, help, back, display help the user move around the ZOG system (e.g., back will always move to the previous frame seen by the user); the set root, next, prev, last, new, old help the user move in special ways around this particular ZOGnet (e.g., old will take the user to a previous, saved estimate for this building); the set print, specs, fill, chk allow the user apply certain functions to this frame (e.g., fill will prompt the user to fill up blank spaces in selections of this frame). These global pads are invoked by typing the first character of the name of the global pad (e.g., f for the fill global pad).

```
Estimating System: Level 0 Building                    Estimate1

  P. Project Name: Mining Department (Filled in by Estimator)

  I. Project ID: DM-501

  1. Location: ____(address)____

  2. Building Type: ____

  3. Direct Estimated Value: $xxxxx   Range: $xxxxx to $xxxxx

  4. Aggregated Estimate: $xxxxx      Range: $xxxxx to $xxxxx

    D. Documentation     S. Specifications      H. History
    N. Supporting Notes  R. Risk Assessment

edit help back display  root next prev last new old  print fill chk
```

Figure 21: An Example ZOG Frame Estimate1

III.2 The ZOG-Pricing Guide: Example and Discussion

The ZOG-based pricing guide is intended to guide the user (a buyer or price analyst) through a series of questions that must be raised in a procurement situation. If the user cannot answer a particular question, the system will simplify the question into simpler questions; at the lowest level (at the level of primitive concepts) the user may obtain background knowledge of the subject domain by directing oneself to the tutorial section of the ZOG-net (the Learning-net) that teaches the necessary concepts or to another section that provides the user with examples.

```
Pricing Specifications                                    Pat27

Each solicitation has specific requirements about the type of
contract that is acceptable (e.g., firm fixed price, cost-plus,
etc.) and a requirement as to how much pricing data must be
given.  You must determine if each offer is priced and responsive
to these requirements.

 IS EACH OFFER PRICED AND RESPONSIVE TO THE REQUIREMENTS OF THE
                      SOLICITATION?


1.  Yes

2.  No


S.  SPECIFY              E.  EXAMPLE              L.  LEARN

edit help back next mark return zog display user goto find info
```

Figure 22: PAT27 — A decision frame

The are four types of frames in the ZOG-based pricing guide: DECISION (see Figures 22, 23, and 25), ACTION (see Figure 24), REVIEW (see Figure 26), and DOCUMENT frames (see Figure 27). The user begins in a DECISION frame. At this frame the user has the option of answering the question shown (for example, in Figure 23 the question is "What is the appropriate method?") by selecting one of the options on the menu (in Figure 23, the options are "1. Competitive Pricing" to "4. None Apply") or typing S

```
Contract Comparison                                          Pat29

The second phase of the price analysis task is the Contract
Comparison Phase.  You must make the determination of the
appropriate method of analysis to use on the contract(s)
that you have from the Contract Selection

            WHICH METHOD IS APPROPRIATE?


1.  Competitive Pricing

2.  Published Price

3.  Secondary Comparisons (Prior Quotes, CER Models,
                           Government Estimates,
                           and Value Analysis)

4.  None apply


S.  SPECIFY              E.  EXAMPLE              L.  LEARN

edit help back next mark return zog display user goto find info
```

Figure 23: PAT29 — A Decision Frame

(i.e, "please specify or elaborate on the question being asked"). In the frame of Figure 23, typing S would send the user to the frame that checks if competitive pricing is appropriate, while selecting one of the options would lead to a frame that checks if the selected method is appropriate.[15] All of the possible selections from this frame lead to other DECISION frames. However, this is not always the case. From the frame shown in Figure 22, the user will reach another DECISION frame by selecting option 1 or the ACTION frame shown in Figure 24 by selecting option 2.

The ZOG-net has been created by connecting a series of major DECISION frames together with minor DECISION frames and ACTION frames between them

[15] Notice that typing 1 and S leads the user to the same frame.

```
Offer Elimination                                          Pat30

Those offers that fail to meet the pricing specifications of
the solicitation must either be revised and re-submitted or
eliminated from consideration.

     ELIMINATE THOSE OFFERS THAT DO NOT MEET THE TECHNICAL
   SPECIFICATIONS OF THE SOLICITATION AND CANNOT BE REVISED
                  AND RE-SUBMITTED

1.  Continue

2.  Return

A.  ACTION

S.  SPECIFY          E.  EXAMPLE          L.  LEARN

edit help back next mark return zog display user goto find info
```

Figure 24: PAT30 — An Action Frame

```
Competitive Pricing                                        Pat32

At this point, we must decide upon which method to use to
analyze the contract.  If we have a competitive situation,
then we simply accept the proposal unless the particular
solicitation falls into some EXCEPTION category.

          DO WE HAVE A COMPETITIVE SITUATION?

  1.  Yes

  2.  No

S.  SPECIFY          E.  EXAMPLE          L.  LEARN

edit help back next mark return zog display user goto find info
```

Figure 25: PAT32 — A Decision Frame

for elaborating the major questions and necessary actions, respectively.

```
Review Competitive                                          PAT33

By claiming that a competitive situation exists, you are
claiming that:

(1) At least 2 responsible offerers responded to the solicitation and
      passed the Contract Selection Phase.
(2) The offerers independently contended for the contract.


  1.  Continue

  2.  Document (not a competitive situation)


S.  SPECIFY              E.  EXAMPLE              L.  LEARN

edit help back next mark return zog display user goto find info
```

Figure 26: PAT33 — A Review Frame

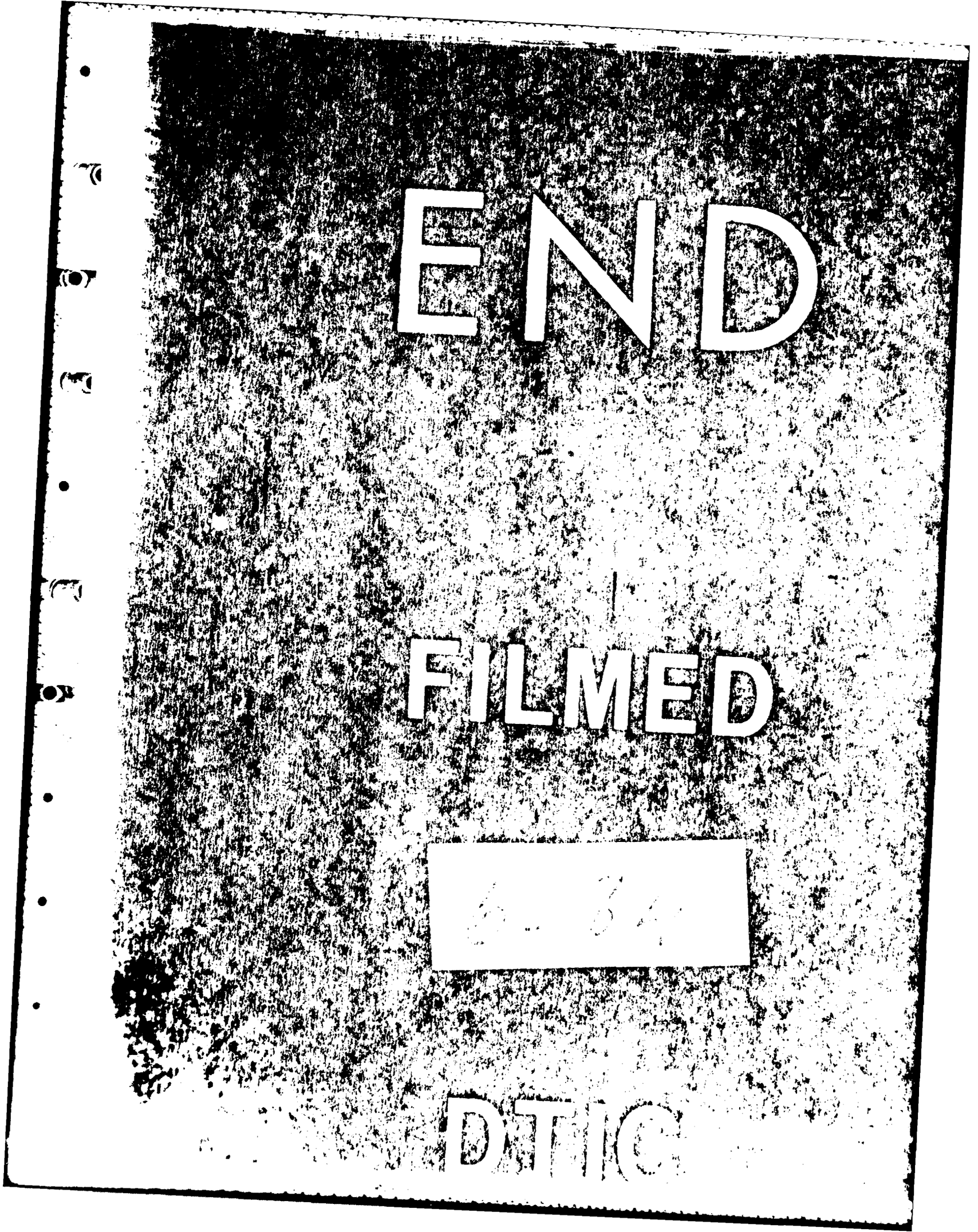
```
Document Competitive                                        Pat34

Enter text documenting your reasoning for not being able to
use Competitive Pricing on this solicitation.
<You can do this by typing the "D Pad">


  1.  Continue

  2.  Review (is a competitive situation)


  D.  DOCUMENT


S.  SPECIFY              E.  EXAMPLE              L.  LEARN

edit help back next mark return zog display user goto find info
```

Figure 27: PAT34 -- A Document Frame

The other two types of frames, viz. REVIEW and DOCUMENT frames, also exist between major DECISION frames. REVIEW frames are entered whenever a major decision is answered positively with respect to the current hypothesis. A

positive response to the hypothesis supports its appropriateness. For example, in the frame shown in Figure 25 the answer "yes, it is a competitive situation" is a positive response to the hypotheses "competitive pricing analysis methods may be used". By selecting option 1 the user is directed to the REVIEW frame shown in Figure 26. DOCUMENT frames, on the other hand, are reached whenever the user gives a negative response. Such a frame allows the user to document the rejection of a current hypothesis and directs the user to a DECISION frame where a new hypothesis can be tested. For example, from the frame shown in Figure 25, the user will be lead to the frame shown in Figure 27 by selecting 2.

Eventually, the user of the ZOG-Pricing Guide will be directed to a terminal ACTION node from which there are no selections or paths to other frames in the Pricing subnet of ZOG. When this point is reached, the user will have analyzed the offers for the solicitation, determined which one will receive the proposal (if more than one existed), and completed the PNM (Price Negotiation Memorandum) for the contract. Now the award can be made! Such a terminal frame also provides facilities for documenting the action taken.


END
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