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Project History – Closing the Loop

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This paper outlines a comprehensive process for collecting, analyzing, and applying project historical information. With all the recent discussion about internal benchmarking, re-engineering, strategic planning, parametric estimating, risk evaluation, organizational learning, management information systems, and continuous improvement, surprisingly little is ever said about the historical information process that provides the underpinnings for all these subjects. I believe there is a false assumption that project professionals universally understand the importance of project history and that they know how to integrate it into all aspects of their project work. Rather than assume this knowledge, this paper will highlight the importance of project history, illustrate how it fits into the project cycle, and outline a way to put history into action in the project process.

BACKGROUND

In project planning, we accept that collecting, analyzing, and applying project history is an important part of the process. AACE International puts it this way; "the most fundamental and useful planning tool available is ... experience." It goes on to state that "the experience gained is fed back to the company to increase its knowledge for the next planning action. This cycle represents the learning curve in action—each repetition makes planning for and achieving the next opportunity much easier"[1]. In a more poetic fashion, John Nevison sums it up this way: "Planning is learning from the past. You apply the lessons of the past to a forecast of the future in a way that will allow you to learn from the unfolding present"[9]. In his text on cost and schedule control, James Bent adds, "The continuous evaluation of current experience and practices is essential for a dynamic cost operation"[2]. In the context of strategic planning, Cleland and King state that "The need for a continuously operating and continuously updated information system to support planning is...acute"[3].

History is also an essential part of Total Cost Management (TCM) which has a goal "to identify opportunities for, and monitor progress toward, continuous cost improvement"[5]. History is the stake in the ground that provides the internal benchmarks against which we measure our improvement. One contractor expresses it's importance to improvement this way "... measurements and resulting internal benchmarks are the backbone of our continuous improvement process ... No measurement—no improvement"[6]. For this reason performance metrics have become a major initiative of the Construction Industry Institute. We also accept that risk evaluation, organizational learning, parametric estimating, and many other aspects of our work depend upon the evaluation or consideration of our project experiences to some extent.

While we can go on with more quotations, the point is that we all agree that historical information is an important part of the project process. Many would say that historical analysis is as important as estimating, scheduling, and control. Given these perceptions, it is a paradox that most of us still fail to collect and use our project experiences in a comprehensive and continuous manner. We say history is important, but we rarely build it into consistent practice or integrate it into our regular work flow. In addition, our literature provides few examples of how to deal with historical information in the project process. A review of numerous texts on project management and controls failed to find any significant treatment of the subject. Also, the literature on generic management information systems (MIS) is too broad to easily interpret in the specific context of project historical data.

To help combat this problem, the paper will provide cost engineers with a better understanding of how historical project information fits into the overall project process cycle and the performance of their everyday work. The paper will also discuss the many valuable information products and tools that can be created from historical data. Finally, it will talk about steps and considerations for implementing the historical process in a continuous, comprehensive, and consistent manner using examples from Eastman Kodak Company's methodology.

HISTORY'S PLACE IN THE PROJECT PROCESS

Description of the Project Process Cycle

The project process is generally described as a cycle where the steps of planning activities, executing them, measuring and analyzing results, and taking corrective actions are continually repeated throughout the life of the project[1]. It is very much like the continuous improvement process with which we are all familiar. If we fail in any of these steps, there is a greater risk of the project getting out of control. This is the cycle we know and live by as we attempt to "do the projects right." The cycle begins and ends with the project and can be thought of as a race between learning and catastrophe.

What we often fail to recognize however, is that the cycle also represents the steps of overall management of the project process by an organization. In other words, each of an organization's projects can be viewed as a single activity in the project process. In this broader view, "projects" must be measured and analyzed so that corrective actions can be taken to improve the organization's project process and to improve our evaluation and planning of future projects. This helps assure that we do both "the right projects" and "the projects right." In this view, the race between learning and catastrophe is seen as never ending, continuing from one project to the next under the stewardship of the organization. If we fail, the consequences are ineffectual project organizations due to the resulting low quality of the project process, punctuated by the repeated disasters of doing the wrong projects! Figure 1 illustrates this cycle from both the project and organization views.

The Information Flow Diagram

The discussion above shows how history fits in the broad context of the project process, but there is a better way to show how it fits into

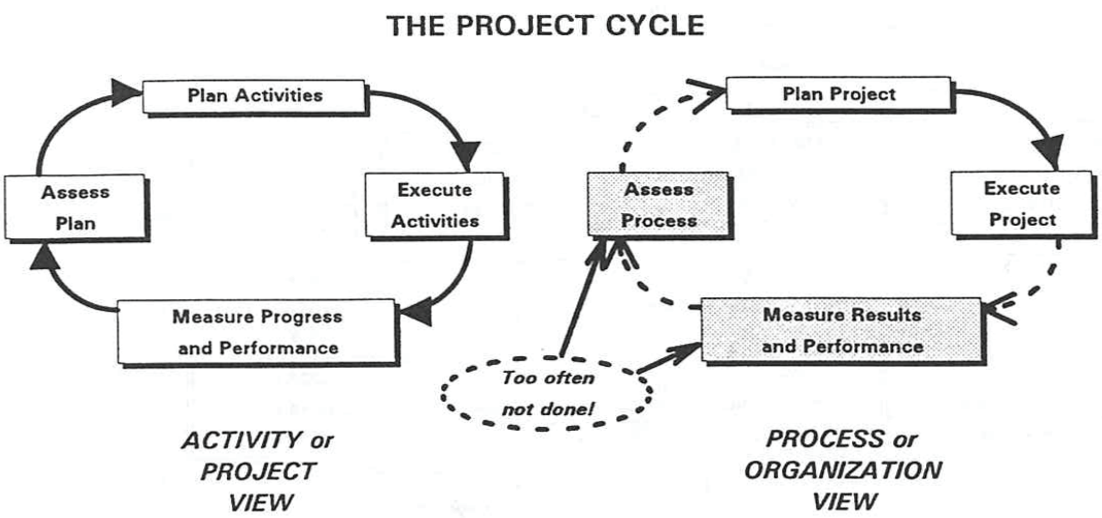

Figure 1—Project versus Organization Views of the Project Process Cycle

our everyday work. Figure 2 is a diagram of the flow of information in the project control process (it is similar to a block flow diagram for a production process.) Each of the blocks on the diagram illustrates a data manipulation step such as cost estimating or scheduling. The interconnecting lines show the flow of data and information products among these steps. Clearly, the one step that supports and is intimately connected to all the others is project historical data collection and analysis.

If you remove the historical block from the diagram you will see that there is no closure in the information flow and the communication cycle is truncated. Without data collection and analysis, the project planning, cost estimating, budgeting, engineering, and construction processes must all draw information from a vacuum. It is left to the memories and private files of individuals to fill the information void. A project historical database is the heart of any integrated project MIS.

Information Products and Uses

In the flow diagram, the material streams leading to and from the historical block are unprocessed cost, time, resource and technical data flowing in and processed information products coming back out. These products are calculated benchmarks, ratios, factors, algorithms and other information needed to measure and evaluate performance and quality, and to provide information tools to help improve functions such as strategic cost estimating and scheduling, project risk evaluation, planning, and organizational work forecasting. The information products fall into these general categories of items:

- **Tools for Strategic and Conceptual Cost Estimating and Scheduling** — ratios, factors, benchmarks, parameters, cycle times, algorithms, and other data essential to estimating, budgeting and project front end planning.
- **Measures of Estimating Database Quality** — feedback on actual cost to help improve the detailed estimating database by establishing productivity factors, item usage's, labor/material ratios, etc.
- **Measures of Project, Function, and Organization Quality and Performance** — objective factors related to issues such as rework, unit productivity's, process variance, and cost of quality compared to other projects as well as to outside firms. Subjective factors can be captured as well. For instance, one firm has gone so far as to establish a post-project appraisal (PPA) unit to capture and publish project lessons for the education of strategic project management and teams[5].
- **Tools for Organizational Forecasting** — objective factors and algorithms that when applied to gross budget forecasts can yield organizational workload and resource forecasting based on technical and performance characteristics of the project backlog.
- **Tools for Planning (models, templates, lessons learned)** — work breakdown structures, schedule logic, account coding, lessons learned from successful and failed approaches, and other "go by" information can be used to speed up and improve the quality of project front end planning.
- **Tools for Risk Assessment** — identify risk factors and algorithms for evaluating project risk considering types of technology, execution strategies, etc.

More information on the development and use of these products are provided in the following sections.

IMPLEMENTING A HISTORICAL INFORMATION PROCESS

Ideally, the project historical information system should exist within the overall MIS environment of the firm. If you have a robust, integrated MIS, the discussions to follow should be interpreted in that context. In any case, to implement a historical information process, activities, tools, and procedures must be determined. A plan for a historical data collection and analysis process should at a minimum address these key elements:

- management and responsibilities;
- data structure/code and level of detail;
- data and information collection procedures and systems;
- data and information storage and maintenance procedures and systems;
- information retrieval procedures, systems, and uses; and
- information analysis procedures (creating information products).

As the length of this paper will not permit a detailed discussion of these elements, the rest of the paper will be limited to highlighting a few of the more important considerations for each topic above, using Kodak's approach as an example. While the discussions are tailored for engineer/procure/construct (EPC) process plant projects, they can be applied to other kinds of projects as well.

MANAGEMENT AND RESPONSIBILITIES

At Kodak Park, which is Kodak's primary manufacturing site, the responsibility for collecting and maintaining nontechnical project historical data rests with the Project Management Division (PMD) which is part of the Capital and Maintenance Organization (C&MO). An integrated project MIS environment does not exist within C&MO at this time, so PMD project controls engineers (PCEs), under the direction of the project managers, collect the data and information.

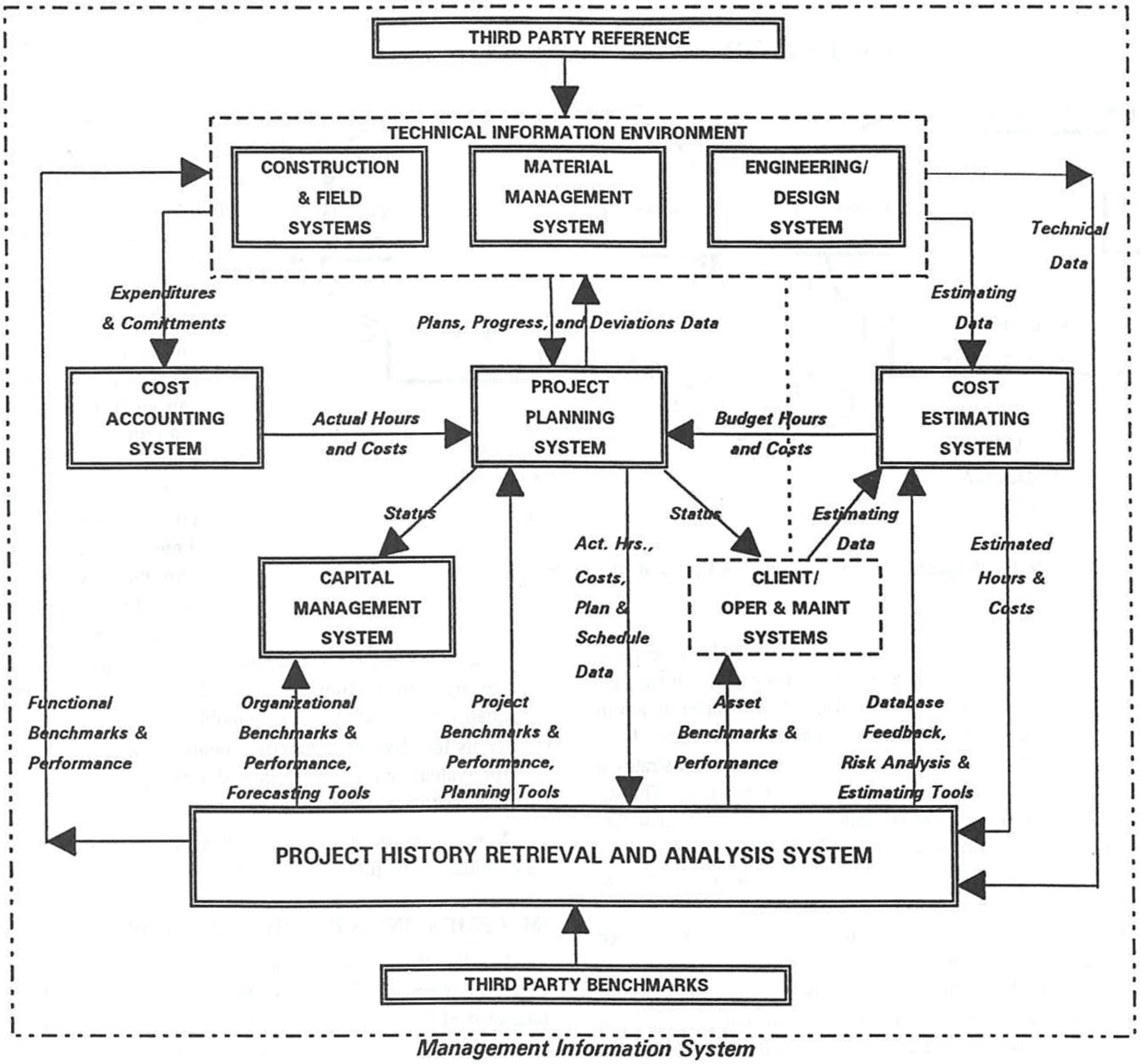

Figure 2—Project Information Flow Diagram

The PMD Capital Estimating Department holds the close-out files, enters the data into the electronic database and maintains the historical data system, because; 1) this group has experience with maintaining a large estimating cost database; 2) it is a principal user of the data for evaluating productivities and material costs, etc.; 3) it has programming expertise available for development of database applications; and 4) the group was the only one with significant prior experience with the use of historical project data.[4]. The department also conceived and designed the system and procedures. The estimating group also performs much of the data analysis because it has experience with statistical cost analysis related to estimating.

Other C&MO groups such as engineering are responsible for providing PMD with technical data such as capacities and drawing counts, but otherwise, these groups maintain their own more detailed technical data files. These other groups also are responsible for identifying the information needed for their functional efforts. In determining responsibilities, consider where the above resource elements exist within your organization and their degree of integration.

A Note About Consultants

Most of what has been discussed here concerns "internal" measures or benchmarks. Consultants can expand the value of the process by providing you with access to a large database of projects from outside your company. Periodic outside benchmarking of your project process and results is essential to remaining competitive. Kodak and other companies such as Chevron[5,6] have used consultants to benchmark their project process. Also, if you do not perform many projects, your internal database may be too small from which to draw statistically significant conclusions. Finally, if you have never done much historical data collection and analysis, a consultant can help you leant the process and set up a program. However, as will be discussed later, opportunities for organizational learning will be lost by becoming overly dependent on consultants.

DATA STRUCTURE / CODE REQUIREMENTS

Prior to collecting data in a meaningful way, a standard data coding structure must be established that will allow you to retrieve, sort, and analyze all the information in an electronic database. The code(s) will allow segregation of processes, activities, and resources (labor, material, equipment, etc.) At Kodak, this structure takes the form of the following separate codes devised to work within the constraints of our cost accounting system:

- a cost code of accounts (as used during project execution);
- a process code of accounts (applied post-completion to project areas in the database); and
- an equipment code of accounts (applied post-completion to equipment in the database).

Cost Code of Accounts

Before you can collect and analyze cost data you must have a standard cost code of accounts. Fortunately, the elements that make for a good cost control code also facilitate historical analysis functions. A code that differentiates process types, broad activity types (such as engineering and construction), and resource types (such as labor and material, discipline and trades, directs and indirects) will permit useful ratios, factors, and benchmarks to be developed. This paper will not discuss the various code of accounts which are well covered elsewhere.

Kodak uses a code with prime accounts that put an emphasis on process equipment, piping, electrical, and instrumentation disciplines as key accounts with little emphasis on architectural items. This type of process oriented code is conducive to equipment factoring and other conceptual process estimating approaches that are well documented elsewhere[7].

Level of Detail

At Kodak, our electronic database retains project data down to a “discipline” or prime account level of detail. This means we can easily analyze piping data separate from electrical, but not raceway from conductors. Our cost coding structure does extend to the item-type level of detail, but our execution cost charging process is not disciplined enough to justify using the data at this level for historical analysis. It also should be kept in mind that each level of detail represents an order-of-magnitude increase in the amount of raw data to be collected, stored, and handled. Most literature reports effective use of data at the discipline or prime account level of detail for benchmarking, but some, particularly in disciplined EPC firm environments, have reported success at collecting and using historical data at an item-type level of detail[6,8].

Process Code of Accounts

It does little good to analyze all project historical data as a single group or population. Statistical cost/time/resource relationships are not consistent between different project and process types. For instance, the amount of engineering required on a complex pilot chemical process will be much greater than for a simple building structure with similar field costs. The process of sorting projects into like groups for statistical analysis is greatly facilitated by having a code of accounts that differentiates these process or project types.

A useful code must differentiate between project types that have different cost and schedule traits. These traits include such things as the mix of trades and disciplines involved, different levels of effort and cycle times required, different execution strategies and contractor mixes, different emphasis on resources (such as labor, material, process equipment), different technologies, different feed stock and product forms (i.e., liquid/solid/gas or raw/refined), and so on.

While each industry understands its common process types, there is no accepted standard “code”. In any case, it may be best to devise one that fits your company’s lines of business. A multicharacter, hierarchical code is recommended that will allow application and analysis at selected levels of detail. The first character should segregate broad divisions of project types such as chemical processes versus commercial building, etc. The last character should differentiate unit processes within each broad division such as you will find on a process block flow diagram (i.e., hydrotreating versus distillation, etc.). In between the broad divisions and unit processes, you may desire more levels of detail as fits your situation. A few example codes from Kodak’s standards are:

- **232x** where 2 = general processes, 3 = chemicals, 2 = distillation, and x = indication that project contained more than one detailed unit process for which costs were not segregated; and
- **3324** where 3 = web/converting, 3 = roll coating/Estar, 2 = machine conveyance, and 4 = drying.

Treating Each Process Unit as a Project

Historical data analysis and system design is complicated by the fact that each process or project “area” must be retrievable as if it were a stand alone project. The complication results from the fact that most projects have prorate costs that were not accounted directly to the various process areas. A historical data analysis system must be able to allocate these prorates back to the process areas.

Equipment Code of Accounts

At Kodak, the equipment list is entered into the electronic database. For heavy industrial, hydrocarbon, chemical, and other process projects, it is useful to analyze relationships between the project cost and schedule and the cost and design parameters of the process equipment (this may also apply for nonprocess projects such as for computer software/hardware relationships for “white-collar” projects, etc.) It also allows strategic, gross equipment cost charts to be developed for estimating. A coding structure for equipment types will facilitate database searches and groupings for these purposes.

As with process codes, little has been published on standard codes. The guidelines for establishing a code are similar to those for process types as previously discussed. Some example codes from Kodak’s standards are:

- **123** where 1 = containments, 2 = tanks, and 3 = spherical; and
- **442** where 4 = prime movers, 4 = pumps, 2 = specialty pumps such as metering, etc.

DATA COLLECTION PROCESS AND SYSTEMS

Data collection at Kodak is a primarily a manual process, but for others much of the data could be collected electronically depending upon the nature and quality of their existing project management information systems and environment. Data are collected in formats suitable for either hard copy file retention or entry into an electronic database as will be discussed further on.

At Kodak, the PCE’s are encouraged to collect the data while the project is in progress because there is usually little time available at project close-out. This means that some of the data which goes into the database are based on forecast information at 90 to 95% completion. PCE’s are also encouraged to modify recorded data if they feel that the accounting record contains “noise” (i.e., creative accounting, omissions, etc.) which will detract from data usage and understanding in the future. The above factors all advise against automatic downloading of data.

At Kodak Park, we collect data on all projects down to $50,000 in value. Most projects are capitalized maintenance jobs with an average value of only about $200,000, but a few are greater than $l0M. For firms with more dispersed plants and organizations, $50,000 projects would probably be too small to consider, However, because small projects tend to have greater cost and schedule variability, we have an opportunity to demonstrate to our clients that they should consolidate their work into larger controlled programs. Also, ongoing consideration of historical information on all projects avoids the bit and run mentality of evaluating only selected (i.e., cherry-picked) large projects which will not be a statistically representative sample.

Hard Copy Database Items

Some historically important project information can't be readily stored in a computer database. This includes graphical and text records that contain definitive project information which can improve the speed and quality of front-end planning of future projects. At Kodak, these documents include a project assessment narrative (statement of lessons learned), project basis documents, summary cost and schedule reports, and summary technical deliverables. These records are kept in three-ring binders that are labeled for easy retrieval. The binder may also include diskettes with scheduling system backup files and the like, which may be useful on future projects. Voluminous project records such as deviation notices and periodic progress reports are discarded at project closeout. Figure 3 shows the index of Kodak's hardcopy closeout file reports. Potentially, in an integrated MIS environment with standard electronic forms and files, all of this information could be kept in a central database.

Electronic Database Items

Numerical data to be used in analytical calculations should be stored in the computer database for rapid retrieval and analysis. At Kodak, the data collection form for this type of data has 5 pages (copies can be obtained by contacting the author.) In summary, each data item requested on the forms is needed for one or more of the end uses as was listed in the Information Products section. Each end use will require one or more factors or other relationships to be calculated from the project data. The relationships are usually ratios that compare units of cost, time, labor, and deliverables to each other.

I. Table of Contents
II. Project Summary
- *a. PHRAS Form 1 - Basic Project Fact Sheet*
- *b. PHRAS Forms(s) 2 - Area Fact Sheets*
- c. Project Narrative Appraisal - 1 to 3 page write-up
- *d. PHRAS "Snapshot" and Project/Area Reports*
- e. CBS "Snapshot" Report

III. Scope Documents
- a. Requirements Document
- b. Conceptual Design Proposal
- c. Basis of Design Document
- d. Project Organization Chart
- e. Approved Preliminary and Final Funding Documents
- f. Final Acceptance Notice including Success Matrix

IV. Schedule
- a. Final Statused Master Summary Schedule
- b. Special/Unique Control Level or Detail Schedules
- c. Engineering and Design Progress Report

V. Project Estimate and PBS
- a. Project Estimate
- b. PBS
- c. Shop Order Basis of Estimates (if not in Project Est.)

VI. Cost and Performance
- *a. PHRAS Forms 3a & b - Cost Reports by Area*
- b. Final Cost Control Report
- c. PCA log
- d. Cost or Cash Flow Curve(s) / Expenditure Plan
- *e. PHRAS Form 4 - Engineering Fact Sheet*
- f. Performance Curves (hrs/progress/perf) (if any)

VII. Contracts
- a. Contract Bid Summaries
- b. Subcontract Plan
- c. Unit Price and Other Detail Cost Submittals

VIII. Technical
- a. Plot or Site Plan, and Block Flow Diagram (reduced size)
- *b. PHRAS Form 5 - Priced Equip. List & Procurement*
- c. Drawing List (may be part of Eng. Design Progress Rpt)

Figure 3—Kodak's Hardcopy Project Closeout File Index

Table 1 on the next page illustrates suggested end products/uses, typical types of relationships, and typical data calculations that are common for process type projects. The data to collect are typified by the units used in the calculation expressions. Please note that this list is just a sampling of typical measures—it could be extended to many pages depending upon the detail desired.

Note that in addition to cost and time information, selected technical information is also captured. This is so benchmarks such as capacity factors and hours per drawing can be calculated. At Kodak, we also capture both actual and estimated cost information. This is done so that prefunding estimate review evaluations and post-project evaluations of estimating data quality can be made.

DATA STORAGE AND MAINTENANCE

Hard Copy Close-Out Files

At Kodak, hard copy files are kept in a central location by the Estimating Department. Users can locate files by using the computer system described below as an on-line catalog. The system permits the user to search for files selectively using a criteria filter that can be applied to most fields in the database. Each file is given a review date upon which the file will be pulled and reviewed for relevancy to current conditions.

Electronic Data

As can be seen from Table 1 there can be a lot of data to collect and manipulate. Companies that are serious about long term data collection and on-going analysis will have no choice but to establish a computer database to hold and retrieve all this information, Kodak's database is currently available on a local area network (LAN) that is accessible by most of the project management community at our Kodak Park site in Rochester, New York. The system is called PHRAS which is short for Project History Retrieval and Analysis System. It is a DOS application that uses a mouse with pull-down menus. PHRAS was programmed using Clipper, which is a dBase compatible application development language.

Table 1—Typical Historical Data Products, Relationships and Calculations

End Product/Use	Common Relationships	Example Calculations	Units
Rough Order of Magnitude Cost Estimating Relationships (CERs) *Mgmt. Perf./Quality Review* *Client Perf./Quality Review* *Estimating Tools* *Est. Database Calibration* *Capital Mgmt. Forecasting*	Cost-Cost	DFL$ / DFM$ Total$ / Equipment$	%
	Labor-Cost	DFL-hrs / Equipment $ HO-hrs / Total $	hr/$
	Cost-Labor	DFL$ / DFL-hrs HO $ / HO-hrs	$/hr
	Cost-Deliverable or Output	Total Concrete $ / Total CY Total$ / Output Capacity	$/unit
	Labor-Labor	Process Eng-hrs/Total Eng-hrs HO-hrs/DFL-hrs	%
	Labor-Deliverable	DFL-hrs / Piece of Equipment Engr-hrs / Drawing	hrs/unit
Rough Order of Magnitude Schedule Development Relationships (Cycle Time Analysis) *Mgmt. Perf./Quality Review* *Client Perf./Quality Review* *Planning Tools*	Time-Cost	Construction Days / TFC $ Eng/Design Days / HOC $	day/$
	Time-Deliverable or Output	Debug Days / No. Equip. Pieces Eng-Design Days / No. Dwgs.	day/unit
	Time-Labor	Constr. Days / DFL-hrs Eng-Design Days / HO-hrs	day/hrs
	Time-Time	Front End Days / Total Days Eng-Design Days / Constr. Days	%
Detailed Estimating Database Feedback (Productivity and Unit Rates) *Est. Database Calibration*	Actual-to-Budget-to-Estimate Labor-Labor	Actual-hrs / unadjusted Est. hrs	%
	Same as ROM Estimating, but mostly Cost & Labor/Deliverable		$/unit hrs/unit
Performance and Quality Measurement (Indices and Benchmarks) *Mgmt. Perf./Quality Review* *Client Perf./Quality Review* *Estimating Tools* *Capital Mgmt. Forecasting* *Project Planning Tools*	Labor Efficiency Labor-Labor	Actual-hrs / Budget-hrs	%
	Rework Cost-Cost or Time-Time	Rework $ / Total $ Rework days / Total days	%
	Change Management Cost-Cost or Time-Time	Non-Scope Change $ / Total $ Scope Change days / Total days	%
	Capacity Achieved Output-Output	Actual Units / Nameplate Units	%
	Indices Any Ratio - Process Measure	Rework % / New Process Steps Change % / FEL index	%
	Same as ROM Est. & Sched., but mostly Cost, Labor, Time / Deliverable	Eng. hrs / Drawing	x/unit
Workload Forecasting Factors (CERs) *Capital Mgmt. Forecasting*	Labor-Cost	Eng-hrs / Sum of Project $ Constr.-hrs / Sum of Project $	hrs/$
	Labor-Labor	Electrical DFL-hrs / Constr-hrs Design-Drafting hrs / HO-hrs	%
Risk Assessment Factors (Indices and Benchmarks) *Mgmt. Perf./Quality Review* *Client Perf./Quality Review* *Project Planning Tools* *Estimating Tools*	Technical Process Measures Any Ratio - Process Measure	Rework % / New Process Steps	%
	Execution Strategy Measures Any Ratio - Strategy Measure	Change % / %DFL in shutdown	%
	Location Measures Any Ratio - Location Measure	Productivity Factor / Location Change % / Location	%
	Project Process Measures Any Ratio - Process Measure	Change % / FEL index	%
	Organizational/Client Measures Any Ratio - Client Measure	Change % / selected client	%

Note: Table above excludes complex algorithms developed by off-line statistical analysis, modeling, etc.

Electronic Data Maintenance, Escalation and Currency

Cost data soon gets old, but can be useful for years if escalation is accounted for. Most cost calculations and analyses require that the cost data be adjusted to a common time basis. Kodak's PHRAS system has a powerful utility built in to handle the escalation function. It can store an unlimited number of cost index tables and it allows these indices to be selectively applied to various components of the cost data. For instance, equipment cost can be adjusted to current dollars using an equipment cost index, while labor cost can be adjusted using a selected labor cost index. At this time, Kodak's system does not have any international projects, but in the future a currency exchange utility could be added. We have found from past efforts that most data will be useful for 10 to 20 years before escalation errors accumulate and the underlying technology becomes obsolete.

Table 2—Typical Reports from Kodak's PHRAS System

PHRAS STANDARD REPORT TYPES		
REPORT TYPE	**GENERAL CONTENT**	**PRIMARY END USES**
GENERAL REFERENCE LISTINGS		
FILTER CRITERIA Show Selected Criteria	Field names with selected Operators and Criteria values	Display Query Filter Criteria Selected *for Reference*
DATABASE LISTINGS By Selected Criteria	Project ID, Date, Description, and Total Cost	Database and Close-out File Index *for Searching and Reference*
STANDARDS LISTINGS Cost Code of Accounts Process Code of Accounts Equipment Code of Accounts Customer/Org. Codes Escalation Indices Various Standard Field Descriptor Codes	Applicable Database Contents for Pre-Defined Standards	Display Coding and Descriptor Standards Used *for Reference*
EQUIPMENT LISTING By Selected Criteria	Equipment ID, Type, Descr., Number, Capacity, Value	Display Equipment Database Contents *for Reference*
TABULATIONS, ANALYTICAL, AND BENCHMARKS		
SNAPSHOT REPORT ("3 pager") Single Project	All Project Descriptive Data Summary Cost by Area Summary Benchmarks by Area	Mgmt. Performance/Quality Review Client Performance/Quality Review "Go-by" Comparison for Planning
COST DETAIL Single Project Multiple Project - Sum	All Costs and Labor Hrs Rework $ and Performance Factors	Mgmt. Performance/Quality Review "Go-by" Comparison for Planning
COST RATIO Single Project Multiple Project - Average Only	Proportions per Account Hierarchy Labor/Material Ratios Factored Estimating Relationships	Estimating Tools Estimating Database Calibration
COST BENCHMARK Single Project Two Group - Variance Multiple Project - Comparison Multiple Project - Average Only	Project Statistics Field Relationships Office Relationships Expense Relationships Overall Project Relationships	Mgmt. Performance/Quality Review Client Performance/Quality Review Estimating Tools Estimating Database Calibration Capital Mgmt. Forecasting Tools
SCHEDULE BENCHMARK Single Project Two Group - Variance Multiple Project - Comparison Multiple Project - Average Only	Overall Project Relationships of Cycle Time	Mgmt. Performance/Quality Review Client Performance/Quality Review Project Planning Tools Capital Mgmt. Forecasting Tools
ENGINEERING BENCHMARK Single Project Two Group - Variance Multiple Project - Comparison Multiple Project - Average Only	Overall Eng/Design Relationships Eng. Phase/Cycle Relationships Discipline Relationships Deliverable Relationships	Mgmt. Performance/Quality Review Estimating Tools Capital Mgmt. Forecasting Tools
EQUIPMENT STATISTICS By Equipment Type Criteria	Usage Patterns Cost-Capacity Relationships	Estimating Tools
All Tab, Analytic, & Benchmark Reports available for either ESTIMATE or ACTUAL, and ESCALATED or UNESCALATED		

Note: Excludes off-line statistical algorithm development based on database downloads

INFORMATION RETRIEVAL AND USE

If project teams can't get quick access to project data, the value of the data will be minimal no matter how well it is collected and organized. As was mentioned, at Kodak the electronic data is available to most of the project community on a LAN system. Some of the data are business sensitive, which makes password security a must, but at a minimum, everyone can use the system as an on-line file catalog. Kodak is leaning on the Estimating Department to perform most of the retrieval and analysis, but in the future other groups could be trained to perform more elaborate functions using the system.

As is evident in the information flow diagram in figure 2, many project team members and project organizational units will want access to the data to use in their sub-processes. For instance, design supervisors could use the data to monitor their performance in producing drawings with the many new CAD tools that are available. Engineering and construction wish to measure their progress in reducing rework. The estimating department will use PHRAS as a "virtual" strategic estimating system to support client budget evaluations. Project managers will want to see estimate review reports and project risk assessments. Functional departments can use the data for forecasting their personnel requirements in future years based on long term capital project budgets. Capital management will want to use the data for evaluating the cycle time and cost performance of the overall project community. In short, everyone in the project community will find valuable uses for the data.

INFORMATION ANALYSIS, REPORTS, AND TOOLS CREATION

No matter how easy the information is to get to, if it is not presented in a manner that is easy to use in project and functional tasks, its value will be diminished. At Kodak, we have attempted to anticipate all significant information needs and to produce tailored information products that address those needs. Most of the products are hard coded, standard reports from the PHRAS database system that use predefined analytical calculations. For instance, project estimate reviews require tabulations of project benchmark ratios for comparable projects. Table 2 shows a partial listing of the major reports and their contents.

Other information project needs are too complex to handle in hard-coded reports from PHRAS. These include tools that require regression analysis or other mathematical and statistical manipulation of data. For these products, the database system reports or listings are output in ASCII format for use in programs such as EXCEL or Minitab. These programs are used to perform case by case analyses. The end products include such tools as charts of project or equipment costs versus capacity, or algorithms that can be used to evaluate project risks based on technological and programmatic considerations.

We realize that Kodak's historical data collection and analysis methodology is far from ideal, but it does provide an example of the kind of things that are possible to implement in a given culture and MIS environment. We recognize the importance of project history and realize that we can't wait for re-engineering and new system tools to be implemented.

Because Kodak only began dealing with project history in a comprehensive, TCM fashion in 1994, there are no conclusive results to report from the overall process yet. However, since 1988, we have had much success with targeted historical data collection and analyses and the creation of strategic estimating tools from that selected data[4].

Like Kodak, AACE International has only recently begun taking an active look at issues related to historical information such as benchmarking. It is hoped that more comprehensive discussion and literature about topics such as this one will ensue from these efforts. In addition, an historical database would seem to be an ideal product for AACE to provide. With the advent of on-line association communications, database development through AACE becomes a real opportunity.

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