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Project Controls and Management Systems Interface Management

*Global Project Controls and Management Systems Research Team
Construction Industry Institute*

*Implementation Resource 244-3
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* Electronic versions of Appendices A, B.1, and B.2 are included as part of this product.

Overview

The Construction Industry Institute (CII) chartered Research Team (RT) 244, Global Project Controls and Management Systems (PCMS), to review and update project controls practices in the industry and make recommendations for improvement. Two significant findings of the research are that the number of PCMS interfaces has grown and that management of these interfaces is essential to effective project execution. These interfaces exist both within and between firms, and within and across PCMS functions. The extent and scope of interfaces on projects suggest that significant attention must be paid to them on several fronts. These areas of focus include the following: improved information technology; standards and contractual clauses that include PCMS data; and increased awareness of the scope and importance of interfaces among project team members.

A survey of CII member companies indicated significant perceived shortcomings in project controls interface management between project phases. In this context, the research team observed that one significant shortcoming in project execution is the industry's lack of effective planning for interface management. In the rush to deliver facilities, interfaces can often be an after-thought. Interfaces should be planned early on in a project, both in terms of management interfaces for each function in each project phase—an increasingly important need, since PCMS functions draw information from several firms—and in terms of planning for specific information flows. In response to this industry need, RT 244 developed two tools to support interface planning: the PCMS Participants Involved Tool and the PCMS Information Flow Tool. These tools are computerized to allow users to adapt them to their own needs and purposes.

While the tools can be used as stand-alone applications on a per-project basis, they can also be part of a broader review of a firm's PCMS execution.

For this application, the tools should be used in conjunction with the other implementation resources produced by RT 244:

- Implementation Resource 244-2, *Adapting Your PCMS Program for Success*
- Implementation Resource 244-4, *Best Practice Forecasting*
- Implementation Resource 244-5, *Project Controls Team Learning and Development Program*.

This document, Implementation Resource 244-3, *PCMS Interface Management*, is part of the set developed by the team to enable an overall assessment of PCMS; it also can be incorporated into a company's education efforts.

PCMS Tools for Interface Management

This section describes both the PCMS Participants Involved Tool and the PCMS Information Flow Tool. These tools were developed by a RT 244 sub-team and were validated through review by the larger team, as well as through a trial application within a CII member company without any representatives on the research team. Both tools are straightforward, either for planning or as aids to education and evaluation. Recommendations for deployment are made below, along with an application case study demonstrating the potential value of the tool.

PCMS Participants Involved Tool

The PCMS Participants Involved Tool is a matrix of the seven PCMS functions and five project phases, identifying the organizations that typically would participate in each function-phase. (See the text and format of the tool matrix in Appendix A.) The tool further indicates which organization typically has leadership responsibility within each function/phase. Using the tool—really, a simple template—is a first step toward effective interface management. It is most useful if used by the owner organization’s business managers as a planning and alignment tool before front end planning (FEP). To tailor this tool to a specific project, the owner should identify the lead participant and the active participants in each function and phase. This allows the project team to see the various interfaces throughout the project. The tool can serve as a guide for developing contracts and management plans that reflect the roles and duties of these participants and responsible parties.

Although simple in design, the tool contains a considerable amount of information about interfaces that was somewhat surprising even to the RT 244 team members. Specifically, the team members had not fully considered the consequences of the shifts of leadership across PCMS functions. Given all the changes in responsible parties, team members ultimately concluded that the large number of interface problems is understandable and that early planning and leadership are needed to overcome these common challenges. One significant advantage of using the tool would be to help identify parties responsible for creating planning document distribution lists.

PCMS Information Flow Tool

The PCMS Information Flow Tool is designed for project controls personnel as an aid to setting up specific information requirements and interfaces within and across project controls functions. The tool lists 132 types of controls information, the functions that use them as an input or output, and the phases during which that information is used. The tool is presented in two forms: 1) by information item, to allow users to focus on specific types of information and trace their uses across functions (Appendix B.1) and 2) by function/phase, to allow users to focus on specific functions (Appendix B.2). The tool supports planning meetings among the extended PCMS team to ensure alignment of responsibilities and provide details of information flow. It can further be used to develop, refine, and validate the division of responsibilities, and document distribution lists. The tool also supports education efforts to help all project participants better understand the information flows supporting PCMS.

Note that the two formats of the PCMS Information Flow Tool present the same information; in each case, this information is presented in different ways for different audiences or purposes. The item or list format presents the information by category and in alphabetical order. (See Appendix B.1.) This format allows a user to find a specific piece of information and to understand the timing and flow of that information across project phases. The research team found this format to be especially helpful for education of new members of project controls teams. It is also helpful for explaining functions to personnel outside of project controls. It may also serve as a reference if a question arises about which functions need reports for specific PCMS information.

The second format, information grouped by phase and function, is seen by the team to be the primary format for planning. (See Appendix B.2.) The function rows indicate which functions generate and receive information, with columns representing the standard project phases. Every piece of information is generated by a function inside or outside of PCMS and is the input to at least one function inside or outside of PCMS. For example, the information Historical Data on Start-up and Commissioning time frames is the output of Outside PCMS and is the input to Estimating and Scheduling. The tool is helpful for the planning and review of standard PCMS reporting procedures, such as the development of distribution lists. By bringing together lists of PCMS information

in one place, PCMS teams should have an easier time of comprehensively reviewing PCMS information needs and planned distribution.

It is important to note that while the PCMS Information Flow Tool is comprehensive in nature, it should be adapted for each project. Firms may have unique reporting requirements that will modify the details of the tool. Editable copies of both tools are available so that firms can customize them to their needs.

Recommendations for Deployment

The PCMS Participants Involved Tool is designed for use principally by owner-company business and program managers before FEP, or in its very early stages. This simple tool is designed to encourage owners to think about the scope of PCMS across all project phases—front end planning, design, procurement, construction, and start-up. It is also meant to extend this focus on PCMS across the seven PCMS functions—estimating, scheduling, planning, cost control, change management, progressing, and forecasting.

The tool provides a template for the user to designate which parties should be involved in each phase, as well as which party should take the lead in each phase. The leadership role will most likely shift among participants as the project progresses. A sample matrix of the major participants involved in each phase/function is provided as a reference in Appendix A. Owners should use this tool early in a project to identify which participants need to be involved in planning for PCMS execution. Such identification may also aid contracting strategies, helping define which firms need to be involved in the early planning for interface management/transition of responsibility.

The tool's template allows for the creation of a simple and useful reference for all project team members; once adapted to a project and filled out with the names and contact information of responsible PCMS personnel, the template generates a simple contact sheet for posting. It can also help identify personnel who should be involved in planning sessions in which the PCMS Information Flow Tool can be used.

The PCMS Information Flow Tool should be used as early as possible once the principal firms on the project have been identified. Ideally deployed

during FEP, the tool should serve as a basis for an alignment meeting among project controls personnel. Typically, project controls information needs are buried in numerous sources such as operating procedures, distribution lists, and contractual requirements. The PCMS Information Flow Tool is designed to assemble standard information in one location and quickly identify who generates that information and where it goes. Thus, the tool—perhaps enlarged, printed, and placed on a wall—can be used at the meeting to facilitate alignment on what information is to be generated by whom and which parties need what information. While meant to be comprehensive, the PCMS Information Flow Tool is generalized and should be adapted for project and organizational needs. Its use should not be an end check point, but rather the beginning of the PCMS conversation and review. Also, the tool is not meant to replace distribution lists. Rather, the results of the review with the tool should inform standard project documents such as distribution lists.

Beyond its project applications, the tool also supports education efforts to help all project participants better understand the roles and duties of each participant involved in PCMS. Moreover, it helps all participants get a comprehensive view of the information flows supporting the system. In IR244-2, the research team identified “graying of PCMS” as a trend; as experienced personnel retire from the industry, firms risk losing their capacity to effectively review and renew project controls systems. By pulling information together in one location, the tools presented in this document have a significant educational value that should not be overlooked.

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Case Study

This case study gives a practical example of how one firm could have used the PCMS Participants Involved Tool and the PCMS Information Flow Tool in the cost control function during the construction phase of a project to prevent cost and schedule overrun. The cost control function became very important to the owner because of a high rate of changes in organizational structure, as well as in scope of work.

Ideally, the interface tools should be used at the beginning of a project but in this particular example, involvement of a second EPC contractor was not anticipated during front end planning. Had this addition of another entity been expected, the necessary adjustment would have required significant changes in overall planning. This sample project uses the recommendations after the second EPC contractor was involved in construction operations.

Project

The case study focused on a multi-year program to upgrade refinery flare and relief systems. The individual projects of this program were relatively small (<\$5 million) and had short durations, with cash flow averaging \$50 million per year. As many as 20 projects were active at any time, with significant engineering or construction occurring on about half of them. For the purposes of this example, this program will be referred to as the Flare Upgrade Program.

This program was well underway when the interface management tools became available. This case study is review of how the Flare Upgrade Program could have benefitted from the interface management tools, had they been used from the outset. It is interesting to note that once the firm recognized that interfaces were not being managed well, management developed a memorandum of understanding (MOU) to clarify the scope of responsibilities. Although RT 244 tools and recommendations were not used to develop the MOU—an agreement developed several years into the program—many of the same principles formalized in the tool were used.

Program Organization Structure and History

At the start of the program, a national EPC contractor, referred to here as National Engineering, was performing the engineering while construction was being performed by refinery forces. Eventually the program exceeded the capacity of the refinery's staff and a second national EPC contractor was engaged. This second contractor, referred to here as United Construction, was responsible for construction and for program oversight. In this oversight role, United Construction was responsible to the owner for management of the program. National Engineering retained responsibility for engineering and for the technical aspects of each project. In most cases, this project manager role was filled by a project engineer or another individual from National Engineering who was more a technical person than a manager.

Due to the nature of the projects, several owner representatives were involved, depending on the refinery unit or system. Over time, these representatives changed. A high-level manager within the client's organization had nominal program responsibility, but in practice was not involved day to day. The owner assigned one project control individual to monitor program cost and schedule. This individual was contracted from a third party. Mostly because of the owner's lack of a clear hierarchical organization, this individual had to serve many masters and became nearly ineffective.

National Engineering had two cost engineers and two schedulers whose responsibilities were split geographically. The layout of the plant made it straightforward to divide the reporting into East Plant and West Plant. A Project Control Manager was responsible for plant-wide cost and schedule.

The United Construction organization was composed of several cost engineers and several schedulers. One or two of the cost engineers and schedulers were dedicated to the program, but several others were only assigned briefly on the basis of labor availability and on whether the job was a turnaround-type project. Since no one was assigned as the project control manager for construction, no one was onsite to provide overall project control responsibility. In addition, United Construction was providing certain services from their home office organization. A cost engineer was responsible for compiling home office and procurement costs across the program. After the

program was underway for several years, a project control manager from United Construction was assigned to have program oversight responsibility.

In summary, the organizational structure specified the following parties and responsibilities:

- Owner had ultimate project oversight.
- United Construction provided oversight management.
- National Engineering was responsible for engineering and procurement of equipment and materials.
- United Construction was responsible for construction and procurement of bulk material shorts.

Implementation

The Flare Upgrade Program illustrates how using the RT 244 Interface Management tools would have been beneficial, especially if implemented at the beginning.

PCMS Participants Involved Tool

There are two steps to using the PCMS Participants Involved Tool:

1. Identify the participating organizations.
2. Determine who has leadership.

For each phase and function, all of the various entities need to be identified, and one of these entities should be designated as the lead for each of the phases and functions. In the example, entity identification is complicated by the involvement of two competing national EPC companies. Strong intra-company forces create an additional layer of project entities. In practice, the intra-company interfaces tended to receive a disproportionate share of attention from project controls, diluting their project effectiveness.

The PCMS Participants Involved Tool template lists the following the entities:

- owner project management
- construction contractor
- supply and erect vendors
- vendors
- subcontractors.

The intent here is to provide some representative entities. The list may need to be reduced or supplemented according to the particular project. In this demonstration, the construction contractor is designated as the leader for this particular phase and function, i.e., cost control during construction.

Had the tool actually been implemented for the cost control function during the construction phase of the project, the entity list would need to have been modified. The owner project management entity would have been deleted and replaced by three entities: business owner, client area coordinator, and unit supervisor. The business owner would function as the manager of projects for the refinery and would have responsibility for the program. The client area coordinator would, in effect, fulfill the role of the owner's project manager. The unit supervisor would have line responsibility for a process unit and would have such duties as authorizing work and issuing permits. This individual is the operator of the unit or system.

The construction contractor entity would have been deleted and replaced with four entities: engineering contractor project controls, engineering contractor project management, construction contractor project controls, and construction contractor management. The engineering contractor project controls entity would have been identified as a separate entity since, in many instances, this entity operated separately from project management. The engineering contractor project management entity would have fulfilled the role of project manager for a project within the program. The construction contractor project controls entity would have operated somewhat independently from the remainder of the project. The construction contractor management entity would have been identified as a separate entity because, in practice, much of the construction project controls staff placed more emphasis on satisfying the requirements of the construction organization than those of the project.

The supply and erect vendors would have been deleted as not applicable to this project. Vendors would also have been deleted, since materials and equipment were the responsibility of the engineering contractor, and interface issues would have been routed through them. Finally, subcontractors would have been deleted, since the construction contractor provided most of the labor and managed the interfaces with specialty subcontractors, e.g., insulation and painting.

From amongst these entities, it is necessary to define a lead. RT 244 found that, for clarity, it is best to designate a single point of contact, responsibility, and accountability for each phase and function. In the example above, although there seemed to be responsible individuals, the lack of a formal organizational structure did not put any of them into a strong position of accountability. In practice, no single entity or individual took a strong leadership position. The various participants were competent and managed to muddle through, with occasional redirection by a manager when things drifted too far off course. Based on this particular example, a strong individual from National Engineering in the project manager role would probably have functioned well.

The net result of not using the PCMS Participants Involved Tool was that, in general, proactive identification of deficiencies was almost non-existent, no corrective action was taken, and projects were over budget and behind schedule. Furthermore, because these were primarily compliance projects, the owner seemed to accept the situation.

PCMS Information Flow Tool

Another of the research team's findings is that it is essential to have a timely flow of proper information between the project functions. In this example, the projects were small, and the same teams were, for the most part, involved in the program. Because of the size of the projects and the different project teams' familiarity with the program, the flow of information between the phases was less important than it usually is.

The Flare Upgrade Program would have benefitted from using the PCMS Information Flow Tool at any time. Ideally, it should be implemented at project initiation, but in this case there was an extended program life, with a constant shifting of personnel that required continual re-evaluation. Again, an illustrative example is the cost control function during the construction phase; more specifically, the cash flow forecasting function would have been greatly strengthened by use of the tool. The owner is interested in accurate monthly cash flow forecasts of expenditures and accruals. Therefore, it is imperative that relevant information is available in a timely manner.

The PCMS Information Flow Tool has particular value in the example, since the engineering and construction contractors are different independent corporations. Neither organization was familiar with the type and content of data the other had or with the report or system from which the data were produced. When there is a single EPC organization, the information flows between engineering, procurement, and construction should be well understood. Of course, these flows will always need to be modified by contractual requirements, vendors, and related project specifics.

In implementing the PCMS Information Flow Tool, the first step is to use it as a guide for listing the information needed by the team. As was demonstrated, with the PCMS Information Flow Tool, the information shown must be tailored to the specific project at hand. Following are specific inputs required from the following project function areas:

From Scheduling

- current forecast—cash flow needs
- detailed logic-driven (CPM) schedules with current actuals, milestone dates, and progress—needed for cash flow
- procurement milestones and sequencing—needed for cash flow
- project critical path—useful but not critical in cash flow
- look-ahead schedules—short-term look-ahead schedules unnecessary for cash flow; full project schedule needed
- schedule impact narrative reports—needed for cash flow to understand project status
- planned/actual (earned value)/forecast curves and histograms (i.e., progress S-curves and histograms)—needed for cash flow

From Change Management

- approved changes—needed for cash flow
- costs of approved changes—not specifically needed for cash flow, assumed included in approved changes
- assessment of any changes in progress and determination of expected impact on cash flow

From Progressing

- complete—useful but not critical in cash flow since; lacking in detail

From Forecasting

- forecast of cost to complete—needed for cash flow
- cost to complete forecast—needed for cash flow.

Following are specific outputs required from the various project function areas:

To Outside PCMS

- cost analysis narrative, including cost trends—for cash flow example, narrative tailored to cash flow
- cost report and curves (i.e., engineering, procurement, and construction cost)—no cost report necessary as such; cash flow report required, presumably in an agreed-upon format

To Estimating

- productivity—not for cash flow
- cash flow information typically not pertinent to estimating

To Scheduling

- productivity—not for cash flow
- typically, any cash flow restrictions preventing timely procurement, or slow labor-hour expenditures; home office or field

To Forecasting

- productivity—not for cash flow
- actual cost of completed activities—not for cash flow
- actual costs and labor hours to date—not for cash flow
- typically no need for information generated by cash flow analysis to forecasting.

In addition to the above information, additional inputs to cash flow would include the following:

- detailed project estimates from estimating
- allocation of original budgets between engineering, procurement by engineering, construction, and procurement by construction; typically, allocation begun with estimate by project control
- field labor costs distributed according to current schedule—as part of resource loading from scheduling personnel
- engineering staffing—a part of resource loading from scheduling
- construction management staffing—a part of resource loading from scheduling
- change orders or forecasting for IFC quantity adjustments as part of data supplied for cash flow analysis.

Once the tool is populated with the information that needs to flow, the next step is to identify the reports or other data sources that contain the needed information. This level of detail is more than included in the tool, but generally, the list of reports is included in the document distribution matrix. It is crucial that this matrix be cross-referenced with the information flow to assure completeness.

After identifying the reports, it is necessary to identify the generators and receivers of the data. Although it would seem that, within project controls, it would be readily apparent who generates what data, in many cases on this project, an individual team member had the information but was unaware of who needed it and when it was wanted. There was neither a consolidated email roster nor a formal document distribution matrix that had undergone necessary review.

The net result was that the information flow between functions and between the organizations for the same function was intermittent at best. At the highest level, there was poor communication between the construction and engineering organizations. Without a single point of contact on the construction side, the engineering project control personnel needed to go through a discovery process to determine their construction counterparts. Information flow was further hindered by the fact that both the engineering and construction staffs focused their efforts on providing information to their own organizations, rather than on keeping each other informed.

Interface Management Corrective Action

After several years of executing the program, the management personnel of both the engineering and construction contractors recognized that the interfaces were being managed poorly or worse than poorly. Through a series of meetings, a memorandum of understanding (MOU) was developed and signed by both parties. Many of the agreements in the MOU are the same as recognized by RT 244, including the following:

- The record-copy-filing of all project documents is the responsibility of the engineering contractor; construction documents are to be transmitted to the engineering contractor for eventual turnover to the client.
- Original budgets should be assigned at project kick-off, based on scope of work (previously, construction was budgeted piecemeal).
- All purchases should be made by the engineering contractor, except for the shorts and field bulks purchased by construction.
- All communication and documents should be transmitted per the project document distribution matrix; although it was not made explicit in the MOU, the distribution matrix was out of date.
- The engineering contractor should be responsible for Total Installed Cost reporting, with requirements and timing for construction reports stated.
- The engineering contractor should be responsible for change management.

At first glance, the above would seem obvious. However, these items were not stated at project initiation, and it became necessary to develop the MOU to clarify them. One of the informal findings of the project team that developed the MOU was the realization that they “should have done this a long time ago!”