

# **CAPITAL FACILITY DELIVERY WITH ENTERPRISE RESOURCE PLANNING SYSTEMS**

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## EXECUTIVE SUMMARY

The need for business system integration has lead many large manufacturing companies in America to invest heavily in ERP systems. With these large investments have come high expectations regarding system performance and associated benefits to the corporation. Many executives in these companies expect ERP systems to integrate nearly all facets of their business, including the acquisition of new or expanded capital facilities. This has raised many concerns within both owner engineering/project management organizations and contractor/ supplier organizations. Accordingly, it is worthwhile to assess the impact (or anticipated impact) that these systems will have on the facility engineering and construction delivery processes.

The basic purpose of this study is to investigate the impacts of ERP systems on capital facility project delivery processes. In order to accomplish this, the following objectives were pursued:

- Gain insight into ERP systems;
- Gain further insight into SAP R/3;
- Assess and document the impacts of R/3 on capital venture delivery processes and projects.

Evaluation or comparison of ERP systems was not in the study scope. SAP's R/3 system was chosen as the ERP system of focus because of its high frequency of use among those large industrial owners with substantial capital facility programs. This report is not intended as an advertisement nor as a criticism of any one system. It is intended to increase awareness of the issues involved in applying ERP systems in the execution of capital facility projects.

To this end, this report summarizes the findings derived from the following:

- functional gap analysis of R/3 relative to common project execution functions;
- satisfaction survey of a small number of "power users";
- presentations given during an industry forum; and
- discussions and breakout sessions during the industry forum.

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# CHAPTER 1: INTRODUCTION

## 1.1 Purpose and Objectives of Research

Enterprise resource planning (ERP) systems are becoming more and more prevalent throughout the American and international business world. These information systems are designed to integrate and partially automate many of a company's business processes. Companies such as SAP AG, Oracle, Baan, Peoplesoft, and J. D. Edwards offer popular ERP systems and have collectively sold billions of dollars worth of ERP systems in each of the last few years.

The largest of the ERP vendors, SAP, and its product, R/3 are extremely popular among large industrial manufacturers with large capital building programs. SAP has targeted the engineering and construction (E&C) sectors as growth markets for their products and have developed unique supplements or extensions of its R/3 software to handle some of the unique needs of these sectors. SAP reports that these E&C supplements can perform many of the functions required in capital facility delivery such as supply chain management and workforce planning [SAP 1998].

The basic purpose of this study is to investigate the impacts of ERP systems on capital facility project delivery processes. In order to accomplish this, the following objectives were pursued:

- Gain insight into ERP systems;
- Gain further insight into SAP R/3;
- Assess and document the impacts of R/3 on capital venture delivery processes and projects.

This document does not include an evaluation or comparison of ERP systems. R/3 was chosen as the ERP system of focus because of its high frequency

of use among large industrial owners with sizable capital facility programs. This report is not intended as an advertisement nor as a criticism of any one system. It is intended to increase awareness of the issues involved in using ERP systems in executing capital facility projects.

## **1.2 Motives for Research**

The need for business system integration has lead many large manufacturing companies in America to invest heavily in ERP systems. With these large investments come high expectations regarding system performance and associated benefits to the corporation. Many executives in these companies expect ERP systems to integrate nearly all facets of their business, including the acquisition of new or expanded capital facilities. This has raised many concerns within both owner engineering/project management organizations and contractor/ supplier organizations. Accordingly, it is valuable to assess the impact (or anticipated impact) that these systems will have on the facility engineering and construction delivery processes.

Other industrial owners have a very skeptical view of ERP's use in their business. They feel that ERP systems would either:

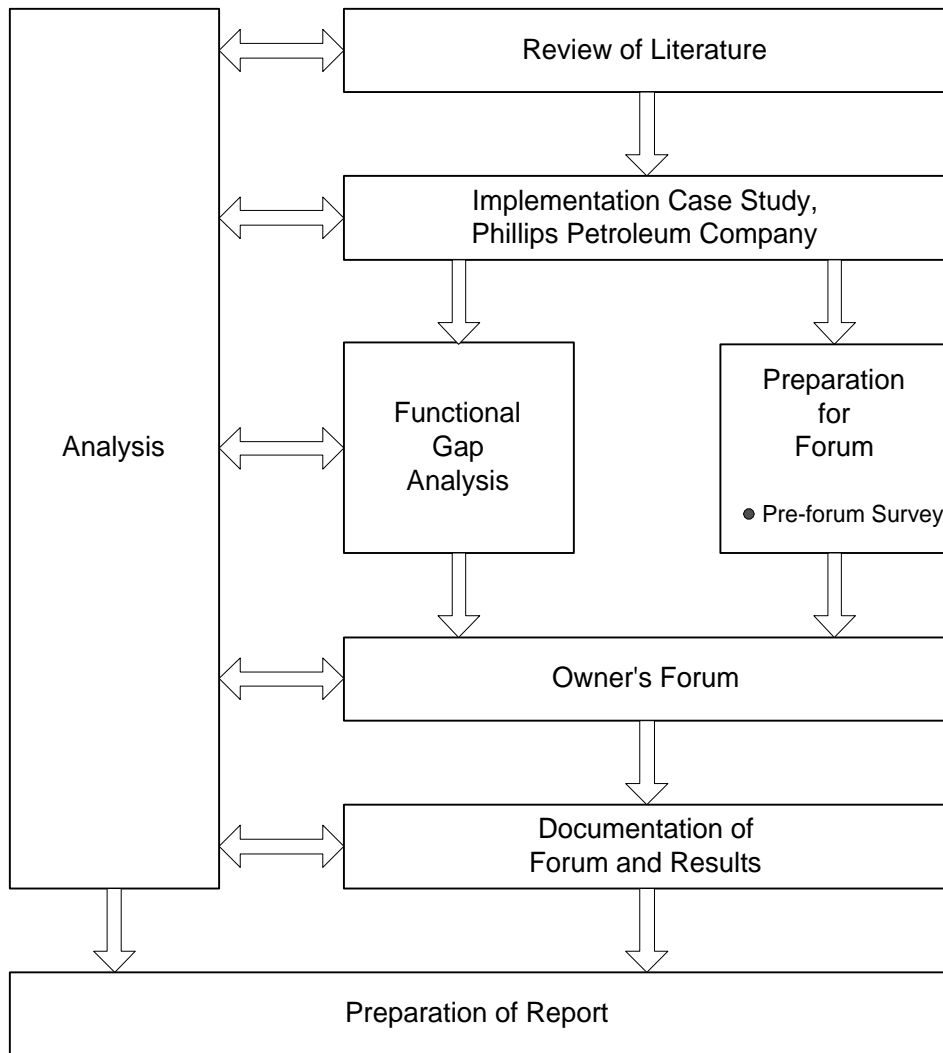
- lack some of the functionality needed by their business, and/or
- require them to radically change the way they do business.

In either case, a better understanding of the use of ERP systems in executing capital facility projects is needed.

## **1.3 Study Methodology**

### ***1.3.1 Introduction***

The approach for this study is shown in Figure 1.1.



**Figure 1.1: ERPS Study Methodology**

### ***1.3.2 Review and Analysis of Literature***

A review of published literature was the first activity undertaken. Sources of information included published articles on various ERP systems and the web pages of ERP vendors and alliance (partner) software vendors. Two University of Texas courses in management information systems (MIS) were audited to gain more background on ERP systems (MIS 382 Cross-Functional Integrated Systems

and MIS 380 N.3 Business and Systems Change). Both classes focus on SAP R/3 as well as other ERP systems.

Findings from the literature review were organized and analyzed. A list of questions was developed to help further guide the research. Findings were organized accordingly. Also during the review of literature, possible future corporate participants were identified. Upon completion, much was known about ERP systems, but little focused on their uses in capital facility delivery processes. Additional activities were pursued in order to acquire such insights.

The findings of the literature review are not included in this brief report, but may be found in the source document of this research [Dodd 1999].

### ***1.3.3 Phillips Petroleum Implementation Case Study***

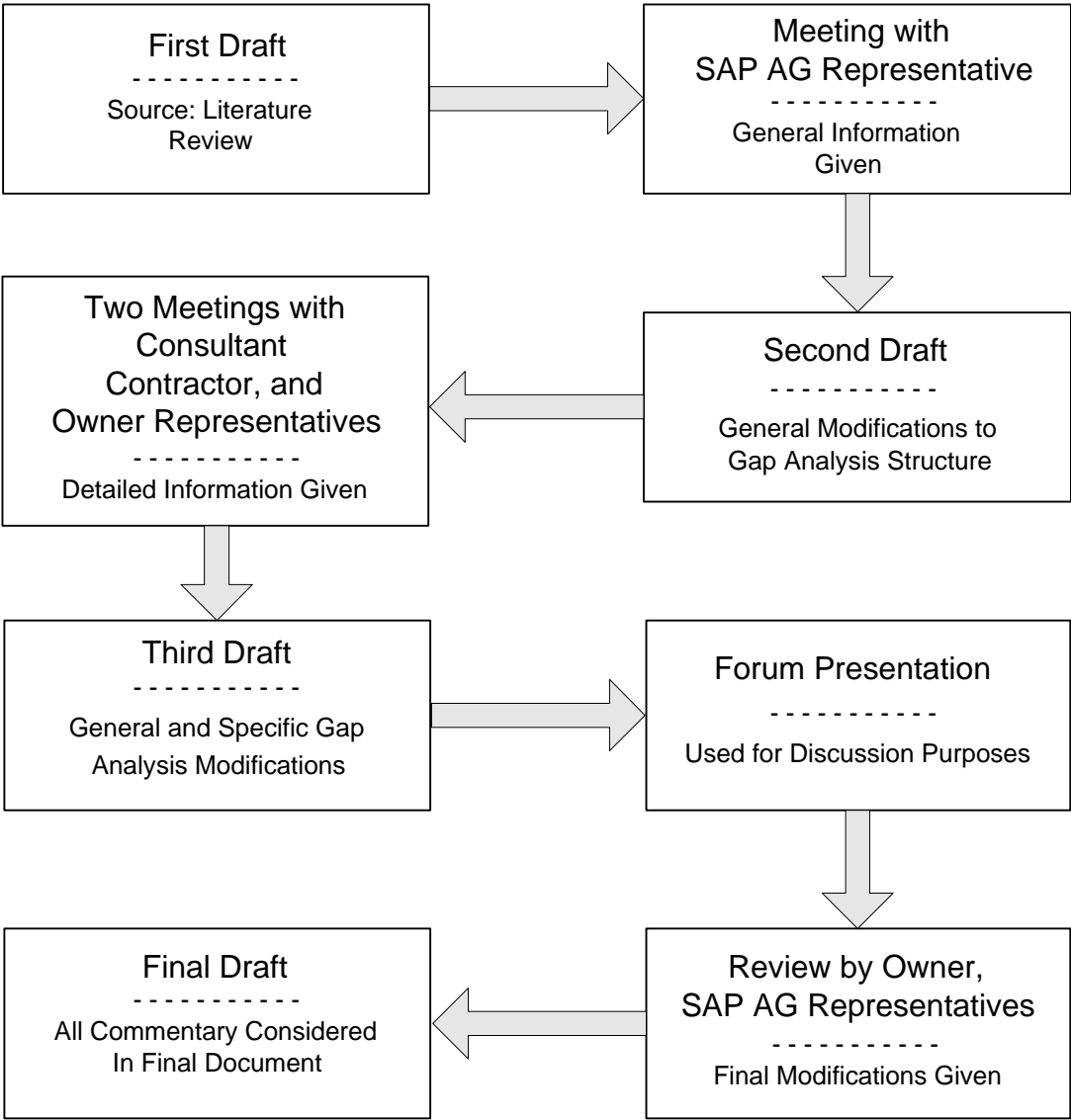
To gain further knowledge of SAP R/3 and other ERP systems, a case study of Phillips Petroleum Company's SAP implementation was documented. Phillip's implementation gave additional information about R/3 and helped to clarify details regarding system selection, implementation, and usage.

The implementation case study, like the findings from the literature review, are presented in Dodd's M.S. thesis [Dodd 1999], but for the sake of brevity are not included here. It is not the purpose of this report to address general ERP observations, but rather only those pertaining to ERP use within capital facility delivery processes.

### ***1.3.4 Preliminary Functional Gap Analysis***

To gain more focus and depth on SAP's use on capital projects, a functional gap analysis of R/3 releases 3.0 and 3.1 was developed. This analysis assesses R/3 functionality and adequacy pertaining to a large number of capital project execution functions. The gap analysis was conducted with input from a small number of knowledgeable individuals. The detailed methodology involved in developing the

functional gap analysis is shown in Figure 1.2. However, the analysis is still regarded as *preliminary* since it has not been possible to confirm or validate the specific assessments in any detailed manner.



**Figure 1.2: Functional Gap Analysis Methodology**

### **1.3.5 Owner's Forum**

In addition to the functional gap analysis, an Owner's Forum was held in order to learn more about the uses of R/3 on capital facility projects. The forum occurred in Los Angeles, California in September of 1998, and was planned so as to minimize travel for participants who attended the SAP Sapphire '98 Americas conference. The forum involved 38 invitees who had a variety of technical backgrounds. Forum participants represented SAP AG, manufacturing owner companies [from either information technology (IT) or project management (PM) groups], design/construction contractors, alliance system vendors, and IT system consultants. The specific makeup of participants is shown in Table 1.1.

**Table 1.1: Owner's Forum Participation**

<b>Participant Type</b>	<b>Number in Attendance</b>
SAP	6
Owners	14
Contractors	7
System Consultants	5
Other System Suppliers	3
UT - Austin	3
	38

A brief pre-forum survey was also conducted. Its purpose was to acquire further insight into aspects of satisfaction and dissatisfaction among system users. Both the functional gap analysis (previously described) and the results from the pre-forum survey served as catalysts for Forum discussions. The forum focused

primarily on the successes to date and continuing needs for improvement with SAP's R/3 system in the context of capital facility delivery.

The Owner's Forum was tightly scheduled in order to share as much information as possible. All participants were challenged to share information based on first-hand personal experiences. The Forum agenda activities are listed in Table 1.2.

**Table 1.2: Forum Agenda**

<u>Session</u>	<u>Topic</u>
1.	Introduction
2.	Individual reports of successes and concerns
3.	<u>Pre-forum survey results</u>
4.	<u>SAP presentations</u>
4.1	-Introduction
4.2	-E&C Summary
4.3	-Current status/planned developments
4.4	-Product data management (PDM) overview
5.	Selected owner's perspectives on SAP & project execution
6.	Contractor's perspectives on SAP & project execution
7.	Alliance vendors' comments
8.	Breakout exercise
8.1	-Group A - Owner expectations of contractors and suppliers
8.2	-Group B - Concerns and successes of R/3 functionality
8.3	-Group C - Owner expectations of contractors and suppliers
9.	General observations / questions & answers

Brief question and answer sessions followed each agenda item. The information gained from the Owner's Forum was accumulated, organized, and integrated into this document.

### ***1.3.6 Preparation of Report***

This final report integrates the key findings from the functional gap analysis, the pre-Forum survey, and the Owner's Forum. It has been formatted into five chapters.

Chapter 2 provides the results of a pre-forum survey and key observations presented during the Forum by industry speakers.

Chapter 3 overviews the results of the functional gap analysis of R/3 and itemizes recent and planned improvements to R/3 in releases 4.0 and 4.5.

Chapter 4 presents the results of the Forum discussions and break-out sessions.

Chapter 5 presents conclusions and recommendations associated with this study.

## **CHAPTER 2: PRE-FORUM SURVEY AND HIGHLIGHTS OF FORUM PRESENTATIONS**

This chapter presents the results of the pre-forum survey and abbreviated overviews of owner, contractor, and supplier forum presentations.

### **2.1 Pre-Forum Survey Results**

In order to gather information on opinions of performance of R/3 with respect to capital facility delivery, a survey was sent and collected from forum attendees prior to the event. The results were used to stimulate discussion during the Forum. The results also provide insight into the functional gaps of R/3 in capital facility project execution.

The survey was distributed to all forum attendees, but only a small number were returned and only those respondents considered to possess the highest level of R/3 knowledge were analyzed. This amounted to six respondents, four of whom considered themselves to have high knowledge of the system and two of whom considered themselves to have very high knowledge of the system. As far as specific project management knowledge, four of the six respondents had applied R/3 on multiple capital projects. One had applied R/3 on only one project, and one had just begun applying R/3 on a project.

The overall response to the survey was slightly “upbeat.” Four of the six respondents felt their companies had already achieved moderate business improvement, while one felt high improvement was achieved, and one felt low improvement was achieved. Five of the six respondents expected high overall improvement out of their R/3 system in the future, and one respondent expected very high overall improvement. Written comments on the surveys indicated that such improvements are expected from R/3 as more facility-related functionality is

added to the system and as organizations become more effective in applying their systems.

Each respondent was satisfied with different general (vs. project) aspects of the R/3 system, but the one aspect of R/3 that was consistently associated with such satisfaction was *systems integration*. All felt there was strong integration between R/3 modules.

Other general aspects associated with some level of satisfaction included the following:

- Schedule integration with cost and finance data
- Purchasing and materials management
- General Ledger and control functions

There were also a variety of R/3 general (vs. project) aspects that respondents were *not* satisfied with. However, again, no one issue was consistently regarded as such. Varying levels of dissatisfaction were associated with the following:

- Plant maintenance functionalities
- Difficulty in keeping pace with new R/3 releases
- Integration of R/3 with non-SAP applications
- Quality control procedures and configuration documentation
- R/3 system “bugs”
- Higher-than-expected implementation investment

With respect to satisfaction with those aspects that deal directly with capital projects, general *integration* was a common satisfaction point, whether it was within materials management, procurement, fixed assets, resource planning, budgeting/availability control, project management, and asset accounting. Beyond general integration, however, there were few other R/3 functions associated with

high satisfaction levels. Overall, the tone of the responses was more negative towards R/3's ability to handle project management functions than for general business functions. Yet the negative responses were not consistent. One respondent was very satisfied with the scheduling function, while another was very dissatisfied with this function.

Specific areas of *dissatisfaction* with R/3 project execution functional areas included the following:

- Too many accounting settlement rules in cost control
- Cost control's inability to forecast additional costs
- Lack of engineering work request functionality
- Cash-flow planning deficiencies
- Awkward confirmation processes
- Determination of % complete based on physical progress

Finally, the respondents were asked to assess the satisfaction level and need for improvement for seventeen specific project execution functions associated with capital venture projects. The response modes (most common responses) of the six respondents are listed below in Table 2.1. Particularly noteworthy are the responses associated with schedule management and construction planning/analysis, indicating particular need for improvement.

## **2.2 Overview of Forum Presentations**

During the morning and early afternoon sessions of the Forum, owner, contractor, and supplier representatives gave presentations regarding implementation of SAP. This section summarizes the presentations made by these industry representatives. Readers should refer to Figure 3.1 (page 29) for abbreviations pertaining to SAP module names.



**Table 2.1: Pre-Forum Survey: Satisfaction Level and Needs for Improvement**

<u>Function</u>	<u>Level of Satisfaction</u>	<u>Level of Need for Improvement</u>
1. Scope Information	Moderate	Moderate
2. Configuration Models	Moderate-High	Moderate
3. Cost Management	High	Low
4. Project Design/Analysis	Moderate	Moderate
5. Schedule Management	Low-Moderate	High
6. Procurement Management	High	Moderate
7. Quality Documentation	Moderate	Moderate-High
8. Safety Management	Moderate	Moderate
9. Human Resources	Moderate-High	Moderate
10. Subcontractor Management	Moderate	High
11. Project Documentation	Moderate	Moderate
12. Project Communications	Moderate	Moderate
13. Material Management	High	Moderate
14. Equipment Management	Moderate	Moderate
15. Constr. Planning/Analysis	Low-Moderate	Moderate-High
16. Facility Operations	Moderate	Moderate
17. Maintenance Management	Moderate	Moderate

**2.2.1 Owner Presentation: Exxon**

Exxon currently uses R/3 to handle many capital project functions, including cost management, schedule management, procurement management, and materials/warehouse management. It is looking for greater functionality out of its system and would like to see new SAP project management functions as identified in the functional gap analysis (discussed later) [Sedlak 1998].

There are opportunities for shared and/or integrated project management control systems among EPC contractors and clients. Such shared systems could lead to the following:

- Strengths – partnering, standardized reporting, common understanding of terms/functions, single data sources, wider integration opportunities
- Weaknesses – tied to SAP development path, limited use of “bolt-ons”, increased access requests, technology change
- Opportunities – reduce redundant effort, simplify contracting, subcontractor/vendor interfaces, sharing contractor systems, map work processes
- Threats – impacts on EPC contractors, stifle local innovation, captive to SAP, micro-management of EPC by owners, security/control

SAP “industry solution maps” (Oil & Gas, and Engineering/Construction/Maintenance) are “blueprints” which should offer higher levels of integration. The SAP Oil & Gas solution map identifies engineering, construction, and maintenance as business support processes. However, the SAP Engineering/Construction/Maintenance solution map and functional gap analysis (discussed in Chapter 3) should be reconciled to one another.

### ***2.2.2 Owner Presentation: Chevron***

Chevron originally wanted to use all R/3 project management functionality to manage projects and support the project management process. Users felt the Project Systems (PS) module was difficult to use and lacked some reporting capabilities. PS use has diminished and is now used primarily for cost and financial reporting [Redden 1998].

The vision to make R/3 the underlying tool for project management has only partially been realized:

- R/3 vision realized: integrated financial solution
- R/3 visions *partly* realized: financial process cost reductions, information supports planning and decision making, information is timely and consistent, operational and financial data are linked
- R/3 visions *not* realized: easy to use, data input only once, low system support costs, flexibility for change and to meet local needs

With future versions, there is an opportunity to “close the gap” between available SAP project management functionality and that needed by targeted users..

There should be a differentiation between large and small (less than \$5 million) projects within R/3. Small projects only need part-time R/3 users and R/3 should be integrated with tools like *MS Project* and *Questimate*. Large projects need full-time R/3 users from both EPC contractor and owner and R/3 should be integrated with more sophisticated tools like *Primavera*.

Successful use of the PS module depends upon the following factors: SAP “learns” project management, common needs for integration identified, SAP makes improvements as needed, and industry aligns with SAP.

### **2.2.3 Owner Presentation: CITGO**

CITGO uses the functionality of SAP R/3 vers. 3.1H. Pertinent information regarding CITGO’s SAP implementation is as follows:

- Modules used are FI, CO, AM, MM, PM, IM, and PS
- PS is used for investment and maintenance project management, particularly for cost control/monitoring and resource procurement
- PS objects used include standard WBS, networks, milestones, and user statuses
- IM is used for capital budgeting and control
- Projects are assigned to IM positions for budget monitoring

- Scheduling is via networks
- Both SAP reports and developed reports are used
- SAP Workflow is used for requisition approval

CITGO's "likes" with the PS module include integration with other modules, excellent reporting capabilities, and its feature-rich design. CITGO's "gripes" with the PS module include inconsistencies between similar operations, the extensive testing required, and the needs for cash management capabilities, particularly those that link with planning/scheduling. CITGO is looking forward to future "appropriation request" functionalities from R/3 [Parks 1998].

#### ***2.2.4 Contractor Presentation: Brown and Root***

Brown and Root is globally implementing R/3 in association with Halliburton. It is expected that there will ultimately be approximately 15,000 users. All modules are being implemented in 4-5 phases in about 400 different physical locations. Halliburton is committed to SAP and significant changes are generally both understood and expected [Jackson 1998].

SAP will be used for smaller projects with defined scope. Brown & Root's other project management software system, IPMS, will be used for larger, complex projects, but R/3 will still handle the financials (interfaces are being developed).

IPMS is better for large projects because:

- It is better at dealing with scope and budget changes
- It is based on quantity- or unit rate-based planning
- It can track progress from both engineering and supplier documents

Expected benefits of R/3 are:

- Responsibility distribution to appropriate managers or users
- Better management above the project level

- Redundant data input is eliminated
- Removal of organizational “silos”

Larger, more complex projects require enhanced functionality. System design concerns with R/3 include the following:

- Support for cost-reimbursable projects
- Work packaging versus technical discipline focus
- *Primavera* interface for complex scheduling
- Management of evolving project scope; management of scope changes
- Lack of quantity and man-hour unit rates
- Client costs versus Halliburton costs
- Plant purchases versus project costing
- Billing integration
- Material logistics and expediting
- Asset utilization across plants
- Cost center/work center/ chargability integration
- Government certification

### ***2.2.5 Supplier Presentation: The Foxboro Company***

Foxboro’s Integrated Control and Information Management System (ICIMS) is a data management system that links business, technical, and plant information systems, including distributed control systems (DCS) and SAP’s R/3 system. Foxboro has certified integration with SAP in PP, MM, and PM modules [Hodgson 1998].

ICIMS functionalities are as follows:

- Business Information Management System -  
- Finance

- Supply Chain
- Capital Assets
- Human Resources (HR)
- Technical Information Management System –
  - CAE
  - CADD
  - Electronic document management system (EDMS)
  - Plant maintenance management
- Plant Information Management System –
  - Advanced process control
  - HVAC facility management system
  - Real-time process information system
  - Laboratory information system
- DCS –
  - Process control system
  - Safety shutdown system

Beneficial aspects of ICIMS include the following:

- Cost reduction
- Improved productivities and associated manpower reductions
- Immediate and accurate production/process information
- Reductions in raw material stocks
- Reduction in production lead times
- Reductions in off-spec batches

### ***2.2.6 Supplier Presentation: Intergraph***

Intergraph has created software that works with SAP to achieve improvement in capital facility delivery. ERP systems currently cannot manage the

complexities of the life cycle of engineering data. A complementary system is needed to “fill the gap.”

The Intergraph Engineering Business Object Model and Engineering Information Management Data Warehouse can link to the SAP system. While SAP handles the business framework, Intergraph handles technical engineering data and associated data relationships and dependencies. This integrated solution can coordinate all the major players involved in projects: budget holder, maintenance manager, contractor, and subcontractor [Wallace 1998].

## **CHAPTER 3: PRELIMINARY FUNCTIONAL GAP ANALYSIS**

### **3.1 Functional Gap Analysis**

A preliminary functional gap analysis has been conducted which compares needed project management functions with those provided by SAP R/3. The analysis is summarized in Table 3.1 and a legend that explains abbreviations used in the analysis follows in Figure 3.1. The gap analysis is regarded as preliminary since it has not undergone rigorous validation or verification, which is considered necessary but beyond the scope of this study. One of the recommendations of this study is that this analysis be validated by either the America's SAP User Group (ASUG) or a committee from the Construction Industry Institute (CII).

SAP has created many versions of the R/3 system including multiple versions of R/3 3.0 and R/3 3.1. Different versions contain variable degrees of need fulfillment. The analysis presented in Table 3.1 is based on these versions. Future versions will have greater functionality, and this is specifically addressed toward the end of this chapter.

The functional gap analysis presented is based on the owner's perspective on capital project delivery. An entirely separate gap analysis could be assessed for consultants, contractors, and suppliers. The needs of these organization types certainly have some similarities to those of an owner, but they can also be very different.

Some explanation is required to better understand the scope and structure of the gap analysis. "Owner engineering and construction need" for the individual functions refers to need during the engineering and construction (E&C) phases of the capital facility lifecycle. The focus of the analysis is purposefully on the E&C phases rather than the operations and maintenance phases, which would focus more on manufacturing itself rather than facilities delivery.

The E&C functional need is split into general owner need (column 2) for the function and the need of R/3, the integrated information system (column 3), to handle the function. The numbers that indicate “E&C” owner needs are based on an assumption that there are three types of owners in capital facility project management:

1. Owner controlled—owner is primary driver
2. Owner involved—owner is “hands on”
3. Owner uninvolved—owner is “hands off”

These different approaches are all considered in arriving at an average value for general owner need. For example, a “hands off” owner does not need subcontractor management functionality during E&C, but a “hands on” owner may need such functionality. In all cases, a value of “1” means low need and a value of “5” means high need.

R/3 need fulfillment is split into two categories: “Generated by R/3” and “Linked & Accessed by R/3”. “Generated by R/3” (column 4) refers to functions that are directly generated, stored, and processed by R/3. “Linked & Accessed by R/3” (column 5) refers to functional data that are not created by R/3 but can be beneficially processed by R/3. For example, R/3 cannot perform CAD drawing functions but it can link to an alliance system that can. Within R/3, the CAD drawing can be accessed and viewed. A value of “Yes” in either column means R/3 usually handles the function without excessive supplementation. A value of “No” in either column means R/3 cannot handle the function without excessive supplementation. A value of “Yes-D” indicates that R/3 can handle the function, but with some deficiency, and therefore needing supplementation.

The “Done By” column (column 6) and three “Secondary” columns designate what R/3 modules or systems within R/3 handle the itemized function. The “Done By” column refers to the module or system that normally handles all or most of the given function. The “Secondary” columns are split into modules or

systems that “Send Data” (column 7) to the “Primary” for processing, “Pull Data” (column 8) from the “Primary” for processing, or that can be used as “Alternatives” (column 9) to the “Primary” module or system. Because of the integrated R/3 structure, in many instances several systems can be placed under each of those “Secondary” categories.

The final column (column 10) in the gap analysis is a listing of “Alliance Vendor Support” that can be used in association with or to supplement R/3. Because these are “alliance” vendors, R/3 offers some degree of connectivity to these systems.

Although many project management functions can be handled by R/3 to some degree, for some functions, there are other well-established specialized systems that arguably perform better (these are often referred to as “best-in-class” or “best of breed” systems). The advantages associated with having an integrated system such as R/3 should be compared with the possible loss of functionality that may result from replacing a “best-of-breed” system.

Another point worth noting is that while R/3 may not handle a specific function well or even at all, only individual users can judge the relative significance or loss of value of such a function to the specific organization. In some of these cases, users will simply continue to use multiple systems that are not integrated to any significant degree.

The graduate thesis that serves as the source document for this research contains detailed explanations of how R/3 accommodates each of the project execution functions assessed in Table 3.1 [Dodd 1999].















**Owner need is split into four areas:**

1. Need during the Engineering and Construction (E&C) project phase
2. Need of R/3 during the Engineering and Construction (E&C) project phase
3. Need during the Operations project phase
4. Need of R/3 during the Operations project phase

**R/3 capability to handle a function is split into two areas:**

1. Generated by the R/3 system
2. Accessed and stored by the R/3 system

**Modules / features of R/3 that are associated with a function are listed in four areas:**

1. The primary module/feature, which performs the function
2. A secondary module/feature, which sends data to the primary module
3. A secondary module/feature, which pulls data to the primary module
4. An alternative module/feature that could also be used to perform the function

**Alliance software vendors that can perform the function are listed by name**

**Function need is measured on a 5-point scale:**

- |   |                                    |
|---|------------------------------------|
| 1 | Need for the function is very low  |
| 3 | Need for the function is moderate  |
| 5 | Need for the function is very high |

**Handling of function is characterized as follows:**

- |       |  |
|-------|--|
| No    | Function is not handled, nor will it ever be without customization   |
| Yes   | Function is commonly handled under a normal R/3 setup  |
| Yes-D | Function might be handled, but there may be system deficiencies, satisfaction problems, or needed system customization |

**Module name abbreviations are as follows:**

FI-AA	Asset Accounting	MM	Materials Management
Class	Classification System	PS	Project Systems
CO	Controlling	PM	Plant Maintenance
DMS	Data Management System	PP	Production Planning
EH&S	Environment, Health, & Safety Management	QM	Quality Management
Email	Electronic Mail	SD	Sales & Distribution
FI	Financial Accounting	SM	Service Management
IM	Investment Management	TR	Treasury
HR	Human Resources	Wkflw	Workflow

**Figure 3.1: Functional Gap Analysis Table Legend**

### 3.2 Summary of Functional Gap Analysis

Of the 54 project execution functions listed above, eight have been judged as fundamentally necessary to an integrated system but *not* provided by R/3:

- Existing facility configurations
- Schematic facility configurations
- Detailed design configurations
- As-built configurations
- Technical specifications
- Physical interference detection
- Facility walk-through simulation
- Equipment selection & scheduling assistance

Perhaps of greatest concern here are the missing functions that pertain to facility configuration, since these functions provide much data “feedstock” to many subsequent execution functions. However other software systems can be used to supplement R/3 in these areas but with varying degrees of data integration. Alliance vendors such as Documentum, Bentley, Autodesk, Primavera, and Microsoft offer systems that can serve many of the functional “gaps” itemized above. The primary concern pertains to the extent to which data generated by these systems can be accessed and manipulated.

An additional 15 functions have been judged as provided by R/3, but deficient in some way and/or to some extent. These include the following:

- Unit price tracking
- Job cost reports
- Labor cost reports & workhour forecasting
- Change order cost tracking
- Work breakdown structure model

- Project conceptual/milestone schedule
- Detailed activity precedence network
- Project schedule reports
- Short interval planning
- Purchase order development & issuance
- Monitoring of change orders, rework, and back-charges
- Management of contractor retainage
- Tracking & documenting percentage of physical completion
- Field warehouse inventory management
- Warehouse inventory reorder processing

The remaining 31 of the 54 functions (57%) are adequately or even fully served by R/3, which is very good, considering the difficulty organizations encounter otherwise in integrating so many necessary functions.

### **3.3 Improvements to SAP R/3 for Capital Facility Projects**

The observations presented thus far pertain to the capital facility delivery functionality and associated user opinions of SAP R/3 versions 3.1 and earlier. SAP has or soon will address many of these concerns with its newer versions of R/3. Today, version R/3 4.0 is available with increased functionality over the earlier R/3 versions. R/3 4.5 will be released in the near future with even more functionality. These new versions contain many improvements for R/3's capital facility project functionality. However, it is important to note that at the time of this writing there was no user data available to support or verify SAP's announced improvements.

### **3.3.1 SAP R/3 Improvements within Release 4.0**

SAP first released R/3 version 4.0 in spring of 1998. This version has many improvements to help with overall business processes. Some of R/3 4.0 general system improvements claimed by SAP (but not verified by the authors) are listed below [SAP 1998; Grach 1998; Heimann 1998]:

- Stronger value chain handling
- Integrated process development
- Accelerated SAP (ASAP)
- Object-oriented APAB
- New BAPIs and ALEs
- More TR functionality
- New self-auditing functionality
- Improved functionality within Joint Venture Accounting
- Improved HR benefits administration
- New options within compensation management
- New HR payroll functionality
- Enhanced time management functionality

Some additional improvements within R/3 4.0 that can directly help a company execute capital facility projects are listed below [SAP 1998; Grach 1998; Heimann 1998]:

- Transfer pricing enables materials movement to be evaluated as a whole, or for individual divisions, units, or profit centers
- Activity-based costing system allows resources to be allocated to individual business processes in accordance with cost origin to show profitability and cost structure
- Capital investment programs process capital project requirements in IM

for simplified planning, decisions, and approvals

- Available-to-promise (STP) server provides information on products and resources for accurate deliveries
- Automated confirmation functionality for fast responses in production and maintenance orders
- Improved subcontractor integration functionality, which integrates subcontractor production work and associated purchasing tasks
- New ALE functionality within PDM for material master records, bills of materials, document management, engineering change management, and object dependencies
- Improved procurement functionality through web-based catalogs and vendor consignment
- Improved resource planning and goods process monitoring through enhanced warehouse management functionality
- Distribution Resource Planning (DRB) system accounts for material needs and timing
- Letter of Credit functionality within SD
- Credit payment processing functionality in financial accounting
- Material release functionality based on contract variables
- Improved freight charge processing functionality
- Simplified interfaces, improved functionality, and stronger PM integration within QM
- New refurbishment and serial number functionality within PM
- Increased outsourcing interface functionality
- Enhanced cash and cost control management
- New lead time simulation functionality
- Simplified PDM document handling

- Stronger interface between PDM and PS
- New Cross-Application Time Sheet (CATS) work recorder
- New Business Engineer model designed specifically for E&C functionality needs
- New project data change flexibility

### **3.3.2 *SAP R/3 Improvements within Release 4.5***

SAP is working on additional improvements for R/3 version 4.5, which will be available in 1999. The expected general business improvements are listed below. These primarily deal with HR and Financials [SAP 1998; Grach 1998; Heimann 1998]:

- Appraisal system within Personnel Development
- Improved job pricing functionality within compensation management
- Improved viewing of organizational structures and employee information within the HR Manager's Desktop
- Off-cycle payroll activities within Payroll Accounting
- Improved Business Planning, Consolidation, and Profit Center Accounting (PCA) functionality within EC
- Improved individual value adjustment, purchase order process, and appropriate request functionality within FI
- Trip functionality within Travel Planning
- TR will manage credit and loans, link to the Executive Information System (EIS) for planning, and link with Workflow
- Enhanced integration of activity-based costing and activity quantity calculations with profitability analyses in CO
- New compatibilities with common platforms and databases
- High Volume Order Management will allow mass production

functionality to manufacturing systems

Future improvements within 4.5 that will enhance capital project execution functionality include the following [SAP 1998; Grach 1998; Heimann 1998]:

- SM will define serviceable materials or equipment and repairs processing through Installed Base Management
- The Engineering Workbench will handle product structures that exceed the BOM framework
- Milestone trend analysis capabilities within PS
- Project cost forecast functionality within PS
- Occupational Health functionality within EH&S
- PDM will have an enterprise-wide view of product data with linkages to Engineering Change Management (ECM) and Workflow graphical processing
- Project BOM availability
- Improved asset structure to see functional locations
- Continuous processing of quotations will be available
- Workforce planning enhancements
- Improved date monitoring and expediting for external procurement functionality

As reported by SAP, the 4.0 improvements in R/3 have already made it a much stronger product in handling the business needs of companies that work on capital facility projects. The improvements expected in release 4.5 are expected to make the system even stronger.

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## **CHAPTER 4: RESULTS OF FORUM DISCUSSION AND BREAKOUT SESSIONS**

Sessions 2 and 8 of the Owner's Forum offered opportunities for attendees to share experiences with R/3 usage on capital facility projects. Salient comments made during these sessions are presented in this chapter.

### **4.1 General System Concerns Identified at Forum Kickoff**

Following the introduction of the Forum in Session 1, Session 2 involved individual reports of successes and concerns. Participants were asked to individually comment on each of five issues:

1. Personal introduction
2. Status of R/3 implementation
3. Status of implementation on capital projects
4. Successes to date
5. Concerns

The R/3 implementation status varied greatly among the participants. Some had used the system for several years, some had used the system for briefer periods, and a few participants were only then considering use of R/3 for the future. Degree of system usage success also varied widely. Some attendees were relatively satisfied with the system while others were very dissatisfied. Participants emphasized the concerns they had with executing capital facility projects with R/3. Concerns among owners were as follows:

- Converting from R/2 to R/3
- User friendliness
- Networking

- Integration with PM
- Report production
- Data handling / document management throughout project lifecycle
- Cash flow capabilities
- Support for investment decisions
- Engineering work request processes
- Change management
- Confirmation processes
- Capability for internal tracking of contractor work
- Link between materials management and engineering
- Forecasting capability

Contractor concerns were as follows:

- Support in permitting contractors to stay “flexible”
- System intuitiveness and training for engineers
- Getting the work process “right” prior to implementation
- Common data dictionaries
- Document management
- Data exchanges and interfaces with non-SAP software
- Using PM versus PS for contracts
- Scheduling
- Cost and completion projections
- Earned value capabilities / calculations
- Materials Management (MM)
- Integration for cost, schedule, and quantities progress measurement
- Working with maintenance and capital simultaneously

## **4.2 Results from Breakout Discussions**

The mid part of the afternoon of the Forum was devoted to breakout sessions in which the entire group was broken up into three separate groups. The breakout groups were apportioned equally with regard to size (about 12 participants per group) and representation. The groups were allowed to identify their own topic of focus. Two groups chose to discuss the common yet specific data needs of facility owners that integrated information systems (such as ERP systems) should be able to accommodate. The third group chose to discuss further the needs for improvements within R/3. Highlights of the comments and findings of these group discussions are presented below.

### ***4.2.1 Owner Needs for Data and Integration***

Owner needs for project data *during* the detailed design, procurement, and construction phases were identified as follows:

- Cost: original planned, current forecast, current actual (including commitments)
- Integrated EPC schedule
- Manpower loading curve: planned, actual
- % Physical complete: planned, actual
- Physical plant configuration data: AFD, AFC
- Logical plant configuration data: AFD, AFC
- DCS details
- Status of operator training
- Construction safety data: incidence rates
- Project administration communications (correspondence, submittals, change orders, etc.)

Owner needs for *final project data at the transition from construction to operations* were identified as follows:

- Asset costs and depreciation data
- Asset warranty data
- Manufacturing operating instructions and documentation
- Maintenance plan (including spare parts plan)
- Operations production data: performance targets, performance actuals
- Final physical plant configuration data (as-built)
- Final logical plant configuration data (as-built)
- Operational safety, health, and environmental performance data (including MSDS)
- Other regulatory data (permit data, etc.)

ERP systems like SAP should give particular attention to meeting these needs for data among owners.

#### ***4.2.2 Continuing System User Concerns with SAP R/3***

General system user issues of concern with R/3 that need further improvement are as follows:

- User interface inconsistencies
- Data input rigidity
- User-friendliness for occasional user
- Learning curve
- Logical and intuitive approach
- “PS-lite” system for occasional users
- Ability to cut-and-paste

- Intuitive Excel-like function availability (like  $\Sigma$  column; Note: to be addressed in R4.5)
- Use of typical project management reporting terminology (vs. accounting terminology - e.g., for commitments)
- On-line help capability
- Release strategy improvement (release codes are bracketed)

R/3 system functionality issues of concern that need improvement are as follows:

- Scheduling
- Programming of different calendars in PS
- Leveling of resources on specific projects (SAP levels across multiple projects)
- Establishment of links to estimating programs
- Creation of settlement rules
- Ability to perform an audit of a system
- “Best of breed” module quality
- Reports
- Financial Accounting for projects (FI)
- Whole budget re-calculation (for changed hourly rates)
- Inability to “kill” an ongoing operation
- Lack of mass updates (addressed in Release 4.5)
- Workflow routing of questions (engineers should not answer accounting questions)

To add balance to the discussion documented above, without developing a complete listing, the group identified a number of specific positive features of R/3.

These were cited as follows:

- System is scalable, except for some performance issues with really large projects
- Release codes are bracketed
- Aggregation of multiple PM work orders to WBS elements
- Statistical reporting
- Integration of structures, planning, budgeting, execution
- Wildcard capability
- Good multiple reporting views

## **CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS**

### **5.1 Conclusions**

#### ***5.1.1 ERP Systems and R/3***

Enterprise resource planning (ERP) systems can integrate many work processes for streamlined operations. SAP R/3 is the ERP system of primary interest in this study. Other notable ERP system suppliers include Oracle, Baan, Peoplesoft, and J. D. Edwards.

An implementation of R/3 is a huge investment in time, money, and resources, and the decision must be considered carefully. When implemented to solve the right problems, R/3 can be a powerful tool for business improvement. Also, the benefits of systems are increasing as newer releases gain more functionality. A detailed discussion of the costs and benefits of system implementation is beyond the scope of this report but may be found in the source document for this research [Dodd 1999].

#### ***5.1.2 Capital Facility Project Execution Functionality***

The primary focus of this study is on executing capital facility delivery with an ERP system. Most of the capital project execution functions pertain to the logistics modules of R/3, which include the PS, MM, and PM modules:

- PS handles many functional needs involving cost management, schedule management, subcontractor management, project documentation, and construction planning. PS is the primary module associated with capital facility delivery. It pulls information from modules such as MM and HR in order for it to perform its activities.
- MM handles many functional needs involving field equipment

management, field materials warehouse management, subcontractor management, and procurement management. MM is primarily a supplier of material resource information to PS.

- PM handles many operational needs such as those associated with facility maintenance management, facility operations, schedule management, and cost management. PM handles many of the same operations as PS, but its operations are primarily used during the operations phase of capital facilities.

Many other project management needs are fulfilled by modules such as Environment, Health, & Safety (EH&S) for safety management functions and QM for quality management functions.

Some important project execution functions are either not handled at all by R/3, or not handled well. The gap analysis indicates that the following functions are not served by R/3:

- Facility configurations (schematic, detailed design, as-built, existing)
- Technical specifications
- Physical interference detection
- Facility walk-through simulation
- Equipment selection & scheduling assistance

The following project functions are served by R/3, but are deficient in some way and/or to some extent:

- Unit price tracking
- Job cost reports
- Labor cost reports & workhour forecasting
- Change order cost tracking

- Work breakdown structure model
- Project conceptual/milestone schedule
- Detailed activity precedence network
- Project schedule reports
- Short interval planning
- Purchase order development & issuance
- Monitoring of change orders, rework, and back-charges
- Management of contractor retainage
- Tracking & documenting percentage of physical completion
- Field warehouse inventory management
- Warehouse inventory reorder processing

R/3 can handle many aspects of capital projects, but there are still needs for improvement within the system. Through personal testimonials many specific concerns have been identified. These areas of need have been split into functional issues, technical issues, and usability issues.

Functional issues of need include:

- Missing functionality for handling earned value, % complete, and cost forecasts in determining project progress
- Missing functionality for handling project work breakdown structures, scheduling, and budgeting
- Project tracking and reporting deficiencies
- Cash-flow and planning deficiencies
- Report production limitations
- Missing resource leveling functionality
- Missing functionality within Plant Maintenance (PM), Materials Management (MM), and Financial Accounting (FI)

Technical issues of need include:

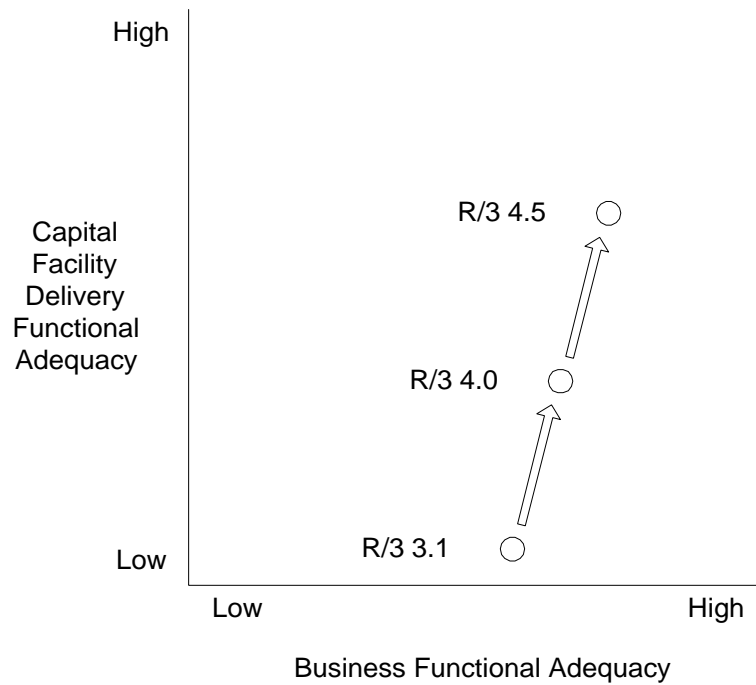
- Coordination difficulties among R/3 releases
- System “bugs”
- Improved integration between the R/3 system and non-SAP systems
- Data interfaces, input, and handling by the system have deficiencies
- Outside document management by the system needs improvement

Usability issues of need include:

- The confirmation processes can be demanding and difficult
- Report terminology can be difficult to understand
- The learning curve for system usability is too high
- System input is not always logical (intuitive)
- The accounting rules can be difficult to understand

R/3 releases 4.0 and 4.5 will have many improvements that will impact the way capital facility projects will be executed. Many will address the concerns itemized above. Highlights of those improvements have been previously described.

Figure 5.1 contains a simplified conceptual view of the functional adequacy of R/3 through its new releases. The figure illustrates that SAP R/3 is widely regarded as acceptable for the general business processes of many companies, and that usability will continue to improve. It also shows that R/3 offers added integration for many capital delivery processes but may not be adequate for a business solely involved in capital facility projects. However, since R/3 is improving its functionality, a business solely involved in capital facility projects should consider future versions of the system for use.



**Figure 5.1: Conceptual Approximation of R/3 Functional Adequacy**

## 5.2 Recommendations

### 5.2.1 Recommendations for SAP

Two recommendations are targeted to SAP:

- Continued system improvement: SAP will make many improvements to capital facility project execution with R/3 releases 4.0 and 4.5. However, more improvement is warranted for future releases. System designers will need to invest more time understanding the detailed work processes of the E&C industry for broad product acceptance to occur.
- Route maps of functionality: SAP needs to develop route maps of functionality. While SAP has already developed a roadmap for its R/3 system that can plan the activities associated with an R/3

implementation, a route map could describe exactly where a given function is contained within the R/3 system. The gap analysis in Chapter 3 may be useful in building a rudimentary form of route map for determining R/3 project execution functionality.

### **5.2.2 *Recommendations for Further Study***

The four following areas are recommended for further study:

- **Functional satisfaction level determination:** The functional gap analysis shows that R/3 handles many functional needs of capital project execution to some degree. At the same time, other data collected indicates there is a high level of dissatisfaction regarding parts of R/3's functionality. This dichotomy of opinion needs further exploration.
- **Owner / E-P-C contractor connectivity:** There is a need to better understand data exchange needs between owners and contractors and to more effectively accommodate these with integrated information systems such as R/3.
- **Contractor use of ERP systems:** This study has focused primarily on owner company use and satisfaction with ERP systems. The use of ERP systems by design and construction contractors needs further investigation. In addition, since a few such contractors are now "early users" of the system, it would be beneficial to develop a case study on this subject.
- **Other ERP system providers:** This study has focused on SAP R/3. A similar study of other ERP systems would provide additional insight and a broader perspective on the functional usability of ERP systems for capital facilities delivery.

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