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THE CONSTRUCTION USERS ROUNDTABLE

"THE OWNERS VOICE TO THE CONSTRUCTION INDUSTRY"

Optimizing the Construction Process: An Implementation Strategy

WP 1003
July 2006

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Notice:

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The Mission of (CURT) is to promote cost effectiveness for owners doing business in the United States by providing aggressive leadership on issues that will significantly improve project engineering, maintenance, and construction processes, thereby creating value for the owners.

1. Executive Summary

This paper envisions a substantially changed project environment, where projects are undertaken by deeply collaborative, multidisciplinary teams that contribute to project fruition, and where better, faster, more capable projects—*optimized projects*—are the norm rather than the exception.

This vision will be achieved through consistent endorsement and application of the principles of owner leadership, integrated project structure, open information sharing, and dedicated use and development of building information models. These principles are more fully explored in CURT White Paper, WP 1202, Collaboration, Integrated Information and the Project Life Cycle in Building Design, Construction and Operation. WP 1202 presents the initial vision of fully integrated and collaborative projects that improve quality, time, and cost, on which this paper builds.

Why Optimize?

Benefits of optimized project techniques to owners include better value through improved delivery times; higher-quality relationships, processes, communications, documents, and construction; safer workplaces; more efficient use of resources; less waste of time and money; and much more effective use of dollars invested in projects.

Change Is Required

For the construction industry to step forward into an optimized future and realize these significant benefits, owners must:

- ▲ Change the organization of projects and teams.
- ▲ Change ineffective behaviors.
- ▲ Demand that project teams use technology to its fullest.

This paper examines these areas of change and offers examples of how they might lead to maximum capitalization on unique opportunities.

Before examining these elements of transformation, this paper describes clear hypotheses for what “optimized projects” using “optimized processes” should look like. At their core, such projects are implemented by fully collaborative, fully integrated, and thus highly productive project teams guided by principles of true collaboration, open information sharing, owner leadership, team success tied to project success, shared risk and reward, value-based decision making, and use of full technological capabilities and support. On the basis of these principles, the final section proposes a plan to develop a pilot program/research effort that would test these methods and concretely demonstrate the benefits of using an optimized process, and finalize a recommendation that CURT members endorse such a pilot.

2. An Implementation Strategy

Characteristics of Optimized Projects and Teams

Fully Collaborative, Highly Productive

CURT WP 1202 refers extensively to the terms “fully collaborative” and “highly productive.” Projects that have these essential characteristics do the following:

- ▲ Assemble integrated project teams (including all life-cycle project stakeholders) early in the process, yielding high-functioning teams.
- ▲ Establish and ensure the understanding of clear and concise goals, values, and objectives for the project and for all team members **BEFORE** design begins; this will require project preplanning.
- ▲ Use contracts that promote, not impede, high degrees of collaboration, defining new business terms.
- ▲ Match resources with the needs of the project and its ebb and flow as needed. Additional knowledge and expertise are “woven in” as required, providing insight at the optimum moment.
- ▲ Share information in an open, honest way as a norm, and create no disincentives to share; no information is considered proprietary within the team. This creates an open information environment.
- ▲ Optimize objectives of the project as a whole and do not sub-optimize results of the separate participating firms; this approach creates a common vision of success.
- ▲ Make decisions based on overall value and not simply lowest first cost (defining measurable outcomes).

- ▲ Assess risk continuously to evaluate each decision and manage its corresponding risk, allocating risk to the party best able to manage it.
- ▲ Tie participant success directly to project success.
- ▲ Share risk and reward equitably.
- ▲ Use comprehensive technologies that support, not inhibit, collaboration.
- ▲ Drive the project process on the basis of the owner's needs.
- ▲ Foster owner leadership with new processes that reflect these practices.

Teams and projects following this prescription will realize the integration necessary to achieve the successful projects defined in the CURT WP 1202 vision.

Full Collaboration AND Integration

Is wholesale industry change necessary to achieve these ends, or can these characteristics be consistently achieved within traditional project arrangements? Consider that

- ▲ Traditional contracts and roles often impede collaboration.
- ▲ Incentive of the parties (both financial and risk-related) is often to do as little as possible.
- ▲ Team-member focus is often on self-efficiency rather than project efficiency.

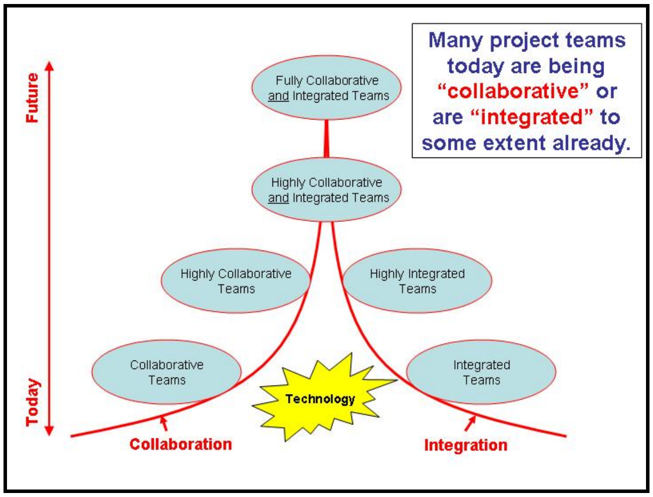
Thus the answer to the second question is clearly "no," and industry's need for a whole new project structure and approach becomes clear.

Anecdotal evidence suggests that new approaches are being attempted; for example:

- ▲ Private industries that use creative project delivery and contracting options to bring in contractors early and increase collaboration among their team members.
- ▲ Project teams that include building and manufacturing process trade contractors early in the process to share their expertise and through this collaboration add value during the planning and design stage.
- ▲ The steel industry's growing list of projects where the engineer, the detailer, the fabricator, and the installer use technology to integrate their efforts and improve their productivity.

Clearly, attempts at collaboration have progressed further than those at integration, but this is rapidly changing. Technology is the catalyst that is accelerating this change. As digital models are created with more intelligence and interoperability, the integration of disciplines, expertise, and processes will be easier and easier.

The following diagram suggests an evolution of the industry, acknowledging that many organizations are already implementing various levels of collaboration strategies. The diagram also acknowledges that there are members of the industry who are beginning, primarily through technology, to integrate their processes with other members of the project team.



Although many firms probably rate high on the collaborative scale, fewer are as high on the integration scale. The fully collaborative, fully integrated, highly productive team capable of delivering an optimized project consists of firms that are fully collaborative and integrated.

The Team Entity

In the optimized project, integrated project teams composed of all life-cycle project stakeholders are assembled early in the process and behave in accordance with characteristics listed at the start of this section.

This optimized team entity can be structured in a myriad of ways, ranging from loose, virtual, and informal, to tighter, legal structures. At one end of this continuum is where the team becomes a legal entity, a single-purpose entity (SPE); other options will undoubtedly emerge as collaborative techniques and supporting contractual language evolve.

The expectation is that an owner organization evaluates its project and its in-house ability to provide the required services, and then determines what outside resources the entity requires. On the basis of the organization's assessment of both its in-house capabilities and the ongoing risk, resources are brought into the entity as they are needed, for as long as they are needed.

The entity functions as the project “brains” and is the home of as much knowledge as can be brought into it. This includes traditional expertise such as the knowledge necessary to design, engineer, and plan, and to estimate, procure, manage, and build the project; it could also include the expertise to finance, maintain, and operate the facility. Skill and knowledge traditionally available only at the trade and supplier levels are identified and brought into the entity wherever possible, as well.

Risk Sharing

Projects have inherent risk, which impacts team members differently at different times. The ability to understand and manage risk varies accordingly through the design-to-build process. The concept of group-based “gain share/pain share” is recommended as a proper focus of the SPE in managing risk. Projects using this model will manage risk better, leading to less cumulative risk, fewer claims, and ultimately lower premium costs and fewer instances of litigation.

The risks are not different in an optimized project, but they are likely to be mitigated differently. For example, an SPE could serve as a risk “consolidator” and could work more efficiently by managing the risk of the entire project, versus each member organization trying to deal with its small part.

By combining the entire project team into one entity, whether through legal means or not, the owner can consolidate the risks of the project as well. All members of the entity share the incentive to manage and mitigate the risks and reduce the costs of doing so. The entity and its members reap the reward if risks are managed well.

Another possibility for risk management is the concept of a product handling the overall project risk, possibly called “Project Guard” (similar to Sub Guard used by trades).

Key Elements for Transformation

To realize the benefits of optimized construction projects, owners need to behave differently. An optimized process focus extends far beyond the procurement process; it also addresses proper alignment of the terms of the contract: goals, relationships, expectations, and the definition of project success. Which behaviors need to change and how do they need to change?

This section addresses some of the essential elements that must be transformed in order to achieve an optimized construction project. For each issue, examples, along with suggested guidance on how to make the transformation, are also provided.

Key elements for transformation necessary to achieving the optimized process include the following:

- ▲ Cost Focus
- ▲ Compensation
- ▲ Incentives
- ▲ Preplanning
- ▲ Contract/Legal or Regulatory Constraints
- ▲ Contingency/Cost Management
- ▲ Technology/Building Information Modeling
- ▲ Information Sharing

Cost Focus

A critical concept of the optimized project process is a focus beyond lowest first cost. This applies to all parties in the team or project entity. The solution is in driving for optimum value, not necessarily the lowest cost. It is not that cost is not a driver; rather, cost in an optimized project is simply one of a range of factors important to the success of the project, all of which must all be balanced. Efficiencies measured solely in cost lead to poor decisions, actual inefficiencies, and ultimately greater cost.

Owner behavior regarding cost versus value is critical. Education of other participants in the construction process, including procurement professionals and senior management who may not be familiar with construction, is equally important.. Strong owner leadership and a true understanding of cost, particularly the choice of value over cost, is essential.

The recommended process is not about choosing exclusively between schedule, quality, safety, or cost, but about achieving the optimum balance of all four while allowing owners to define value differently. Having a process that focuses on identifying and delivering that value becomes paramount to achieving a successful project.

Compensation

Optimized projects should be managed through measured outcomes that are established at the project outset. These outcomes should include the traditional objectives of time, risk, and cost, but may also include specific quality and performance criteria. In one possible compensation scenario, participants could be compensated in accordance with the value of their contribution to the established outcomes in a gain-share/pain-share philosophy.

Outcome-based compensation may not be tied to the particular cost structure of a given project participant, but to the value of work transmitted. For example, the generation of digital assets by a consolidated project team has a value to the design, procurement, and operation of an owner’s project, and compensation should be provided accordingly. In another scenario, compensation to the project team may be tied to the owner’s performance measures and business goals.

In general, compensation mechanisms proposed should respect the value of competition in the marketplace as well as applicable procurement regulations, and should be correlated to project structure, characteristics of deliverables, and approach. Compensation should be correlated to both the value (in terms of both time invested and measurable outcome) and risk ascribed to each member of the team.

Incentives

Incentives can take a variety of forms, but typically are used to reward performance that is consistent with the owner's desired goals for the project. Creative uses of cost incentives to reward the desired performance can be extremely helpful in focusing a team on an optimized path.

Tying the team entity's definition of success to the definition of project success is critical to the optimized project. Incentives may then be awarded not on the basis of individual team member performance, but according to the overall performance of the team entity and the members' level of contribution to that success. Incentives should be available to the key team members who can affect the desired outcomes.

Some owners use incentives that are tied to performance. The US General Services Administration (GSA) has successfully used incentive award fees   Incentives tied to achieving specific milestones that help realize the project goals are another option.

Use of cost-savings splits with caps is an option for consideration when the owner wants to drive down construction costs. Projects driven by objectives, other than cost reduction, should consider using performance-based incentives tied to the desired outcomes, such as decreased delivery times , increased program, or quality.

Preplanning

Establishing project criteria early, before starting design, is critical to the success of the optimized project. The team entity must develop a clear, mutually held understanding of all project and team entity goals, values, and objectives. A concise description of project scope and program, along with a preliminary budget that is aligned with the scope, is vital to setting a project up for success. This process takes time, and owners must do two things: demand that the team entity follow the process, and provide the time needed to do so. Attention should be given to the source of information used as the basis for the preplanning effort. In the optimized project, whenever possible, members of the eventual project team are asked to contribute to the preplanning effort.

The decision to fund a project and approve it to move forward into the development phase is often based on information produced during preplanning. In many situations, there is a delay between the execution of the preplanning and the actual receipt of both the necessary approvals and the funding to move forward. Therefore, a necessary but often ignored step is taking time to update the results of the preplanning effort before moving forward with project design and construction.

For example, planned cost escalation must be validated against actual and anticipated escalations. If costs have risen beyond amounts allowed for in original preplanning estimates, a major decision must be made. How an owner behaves at this critical point will determine a project's ultimate success.

If the result of such an analysis suggests that the project is not feasible, then the preplanning effort must be updated to reflect either a higher budget or a reduced program. At minimum, a contingency plan should be developed for worst- and best-case scenarios.

Contracts/Legal or Regulatory Constraints

Essential to an optimized project are contracts that define business terms and facilitate collaboration. Fundamentally, the premise is that the parties should determine the basis of their relationship: out of relationships contracts are born, not vice versa. Contract terms should be a tool to align the team member's goals with those of the project. By their uniform nature, standard contracts tend not to accommodate the unique requirements of specific projects.

Project relationships should be recorded in contract documents that describe desired outcomes and expectations in clear and measurable ways. The team entity should use documents as a method of recording responsibilities, rewards, and consequences in clear, positive, proactive language.

Contract language should reinforce the sharing of information throughout the life cycle of the building project. Ownership and rights-of-usage definitions that allow all parties of the team entity to access, use, and share information that is developed are key. Joint and shared liability arrangements must be created to eliminate barriers that discourage information sharing. For example, in an optimized project, information, drawings, and building information models (BIMs) created during the life-cycle process are available to all appropriate parties so that they can carry out their individual business processes efficiently, effectively, and without redundancy. Contracts must address the risk associated with the data developed in BIM design as it relates to the different parties participating in its development; re-use of the data developed in BIM design also needs to be clearly articulated.

Contract documents must allow owners to use different project delivery methodologies consistent with their risk tolerance, experience, and corporate culture, while not dictating a limited palette of solutions. Design professionals will likewise find opportunities to be of service in nontraditional roles throughout the life cycle of a building project.

While these new contractual models evolve, owners should continue to look for contracts that address the difficult task of describing collaboration. These include contracts that have language addressing the use of digital information such as BIM, describing the contractual responsibilities related to the creation and use of the model. This also includes the use of open-book, not-to-exceed or guaranteed maximum price (GMP) contracts.

Contingency/Cost Management

Project participants generally come to the table with some contingency funding in place to cover the unknowns of what they perceive to be their responsibilities. Projects themselves, in design development and construction estimating, carry contingency. As a result, there are on each project a range of uncoordinated contingency funds that can result in redundant coverage. Although necessary in current practice, under the “gain-share/pain-share” philosophy of the optimized world, project contingency becomes a single shared entity to be leveraged in its use. Ultimately for owners, contingency management may result in project savings or increased quality.

Contingency management then becomes the process of effectively managing this fund. At completion, unspent contingency funds become the fruit of successful contingency management. With the support of proper compensation, incentive, and business relationship models, effective contingency management can occur. In the end, it can be one significant key to managing project risk. Owners should give the team entity an appropriate level of authority to manage project contingencies.

Technology/Building Information Modeling

Desire for re-use of project information beyond the building design created by architects and engineers will drive market adoption of building information models. Standards will be established for how building information models are developed with regard to content and modeling methods to produce information supporting downstream BIM automation services that are aligned with the owner's business objectives. Ultimately, for BIM to succeed, owners must acknowledge that all risk comes from them and ultimately returns to them.

Owners must set the tone for the project by requiring their design and construction teams to use the latest technologies. Including these requirements in requests for proposals is one simple step that owners can start using. Further, the owner should use the technology as well.

Owners should support industry initiatives to create standards where they are needed. Owners should also increase their awareness of the technology tools their consultants and contractors are using on their projects. Owners must recognize that the choice of technology solutions will affect their projects, not just during the development phase, but also after the project is completed and operating.

Information Sharing

An essential element woven throughout the vision of transformation to an optimized model is the ability for all parties to communicate freely. Current practices of silence for fear of liability must be eliminated and a new process where decisions are made at the highest and most appropriate level of competency must be established to leverage team knowledge. This may result in "nontraditional" project roles/job descriptions and may vary from project to project on the basis of the participants' skill sets. This issue most certainly is the greatest obstacle to transformation and the realization of the optimized project. Owners must demand this openness and transparency from the team entity of which they are a part.

3. Research Scenario Description

Objective

Although many involved in collaborative and integrated efforts can relate anecdotal evidence of anticipated benefits, and all involved certainly believe in the optimized vision, when promoting change to the larger community it becomes necessary to clearly define *why* anyone should consider change. This requires measures, metrics—or, because instances of new techniques may be less developed than established methods, "nuggets of truth" about the results of current industry collaborative efforts..

The goal of the proposed study is to examine a range of recent and current construction and process projects, carefully evaluate them against a defined range of criteria, and record the findings. The intent is to analyze the findings, to sift them, sort them, and uncover underlying commonalities, differences, or patterns—to distill "nuggets of truth" that could be used in comparative conversations to illustrate the benefits of industry change and optimizing the construction process.

Scope and Process

The research will begin with a facilitated workshop with the CURT Productivity Committee and the research team from the Center for Integrated Facility Engineering (CIFE) at Stanford University. The purpose of this first session will be to engage the committee and allow the research team to develop a deeper understanding of CURT's goals and values, ideas about metrics and measures and evaluation criteria, thoughts about project scope and building types and phases, and all as regards the search for "nuggets of truth."

The research team will synthesize material gleaned from this session with knowledge of other ongoing or recent industry research and resources, consider all in terms of time and budget, and craft a research proposal. The CURT Productivity Committee will review this suggested plan..

The work plan will include, but not be limited to:

1. **Scope**—*Elements of work for the research team.*

   1.1. **Integration of Adjacent Research**—*Is there adjacent research that should inform this project? If so, how?*

   1.1.1. **CIFE study of CAD use http://www.stanford.edu/~gaoju/3D4DFramework/index.htm**

   1.2. **Evaluation Criteria**—*Refine the metrics outline from CURT WP 1003 and the facilitated workshop.*

   1.3. **Measurement Methods**

   The research team will create a measurement "instrument" that asks about the specific perceived and measured quantitative value and cost of using virtual design and construction (VDC) methods.

   1.4. **Measurement Methods**

   For the segment of the organization that the respondent knows well, the team will ask:

   - ▲ Background
     - Types of traditional and modeling software applications used in the company for each project responsibility, including 3D computer-aided design (CAD), project management, 4D models, organization models, cost models, energy models, and high-quality architectural visualizations
     - Types of projects

- Dollar fee the respondent's employer received for the work (last 12 months)
- The respondent's current organization goals in implementing VDC methods (assign percentage to the list of factors, summing to 100 percent)
- The respondent's assessment of the extent which each articulated goal has been met

▲ Costs

- Direct cost for new hardware and software
- Indirect costs: Numbers of people who have been through training programs, total number of training days given to those people, and opportunity costs to train those people
- Numbers of current users of VDC methods
- Average hours per week those users spend using VDC method

▲ Proxies for value

- Numbers of design review participants, their roles, their self-assessed understanding of design proposals, and their self-assessed ability to participate in design evaluation
- Value of decisions made that were supported by VDC methods as a fraction of total project value
- Assessed final project cost, schedule, and quality conformance to the approved architectural program, with and without modeling
- Measured periodic cost, schedule, and quality conformance to 1-to-3-week look-ahead schedules
- Perceived and measured response latency (time from asking a question to receiving an answer

that is good enough to proceed), by project stakeholder, by week

  - Value of new projects won
  - Change in numbers of requests for information (RFIs), change orders, and unbudgeted change requests with respect to baseline, by identified type of work
  - Change in cost, schedule, and quality conformance with respect to overall project, major milestones, and weekly look-ahead plans
  - Change in latency (time to respond to inquiry)
  - Respondent's perceived value of the use of VDC methods in the group referenced in the first question

- ▲ Issues
  - Factors that help the respondent derive value from the use of VDC methods (assign percentage to list of factors, summing to 100 percent)
  - Factors that impede deriving value from the use of VDC methods (assign percentage to the list of factors, summing to 100 percent)

1.5. **Evaluation** –*Techniques for analysis and synthesis.*

Initially, the research team will collect and present the data. When data sample sizes are adequate, the team will sort by project type, phase, and size, and participant type and type of involvement. On the basis of the initial results, the team will design additional questions and survey methods.

1.6. **Documentation** –*Approach to documenting the project and outline of the resulting deliverable product.*

4. Glossary of Major Terms

The many uses of the common terms used in construction vary. Given the significant transition the industry is moving through, which probably will continue for some time, this condition is likely to worsen before it improves. Therefore, definitions of the following terms are offered to clarify their usage in this white paper. To provide consistency and context throughout the text, the authors attempted to keep the uses of these terms consistent with the following definitions:

Building Information Modeling (BIM) – Building information modeling is an evolving term generally referring to the broad use of 3D digital building models with linked parametric information to achieve the goal of integrated project data, enhanced visualization, and data sharing and re-use by various members of the building team.

As it relates to the optimized construction project, building information modeling is seen as part of the technology that is expected to enable the collaboration and integration that will allow teams to become more productive.

Although BIM is an accepted industry term for 3D modeling and integration in the building industry, it can effectively be applied in the manufacturing process as well.

Collaboration – Collaboration is an act of working together. In an optimized construction process, fully collaborative teams are highlighted by open sharing of ideas in a nonthreatening environment.

Gain-Share/Pain-Share Philosophy – A gain-share/pain-share philosophy's foundation is in the project, and the project's genesis and foundation are in meeting the owner's business needs. Therefore, the nucleus of a gain-share/pain-share philosophy is the owner's business need. The fundamental concept is that all parties in an optimized project bring with them business goals and objectives with the owner objective paramount, as that is the basis for the project. As those business goals are achieved or missed, certain rewards are gained or lost. If the owner's business objectives are missed, the consequences can be far-reaching beyond those of a specific project. Somehow, missed owner goals must be distributed to the team that missed them. On the other side, if the owner experiences a windfall from a highly successful project, that windfall should be shared to some extent with all those involved in achieving it. In this regard, all parties joining a project team understand the intent, urgency, and consequence of the venture they are about to embark upon and share in the gain and pain of their collective actions.

Integration – Integration is the act of combining separate parts or elements into a unified whole. In an optimized construction process, fully integrated teams are highlighted by open communication where individual members are working toward the best interest of the project as a whole. Technology integration is seen as the combining of separate systems supporting individual teams' processes into a system where information is shared.

Optimized Processes – Optimized processes have been streamlined, often using lean principles. Optimized processes are more efficient than more typical processes and have as much waste removed as possible.

Optimized Project – Optimized projects are highlighted by their use of fully collaborative, fully integrated, and thus highly productive teams. They are characterized by their higher level of "success" as defined by the owner and shared by all members of the project team.

Productivity – Productivity is the efficiency with which output is produced by a given set of inputs. Productivity is generally measured by the ratio of output to input. In an optimized construction process, highly productive teams are working collaboratively and are integrated in both their human and technological processes. They are striving for the highest level of efficiency, getting the most from all the effort being put into the project and eliminating as much wasted effort as possible.

Project Success – Project success is realized when projects achieve the project team's goals and deliver to the owner the best balance of cost, schedule, quality, and safety.

Single-Purpose Entity (SPE) – A single-purpose entity, whether virtual or legal, is a fully collaborative, fully integrated, and highly productive team that has been assembled for a specific purpose.

Construction Users Roundtable Publications

The purpose of developing Construction Users Roundtable (CURT) publications is to disseminate recommendations, guidelines, and reports developed by the Construction Users Roundtable. CURT is focused on improving the cost effectiveness of the U.S. construction industry. These publications have been developed from the point of view of owners or users of construction services. Efforts by all segments of the industry, however, are vital if major improvement is to be the result.

This publication is one of a series from committees or study teams addressing a problem area.

Findings and recommendations of The Construction Users Roundtable are included in publication series classified as White Papers (WP), Reports (R), or User Practices (UP). In addition to these classifications, CURT publications are numbered based on the category of the topic:

Category	**Number Code**
Constructability	011 to 099
Contractor Management	101 to 199
Cost	201 to 299
Interface Management	301 to 399
Workforce/Industrial Relations	401 to 499
Material Control	501 to 599
Purchasing	601 to 699
Quality	701 to 799
Safety	801 to 899
Security	901 to 999
Strategy	1001 to 1009
Work Planning and Scheduling	1101 to 1199
Technology/E-Sourcing	1201 to 1299
Special Projects	2001 to 2099

Examples:

WP-1201: A CURT White Paper on Reverse Auction

R-402: A CURT Report on Tripartite Initiatives

UP –801: A CURT User Practice on Construction Safety in Contractor Prequalification

CURT
THE CONSTRUCTION USERS ROUNDTABLE
"THE OWNERS VOICE TO THE CONSTRUCTION INDUSTRY"

4100 Executive Park Drive, Suite 210
Cincinnati, OH 45241-4023
Phone (513) 563-4131
Fax (513) 733-9551
www.CURT.org