

## **A Tool for Improving Construction Organizations' Innovation Capabilities**

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### **ABSTRACT**

Nearly 200 interviews and surveys collected by a Construction Industry Institute research indicate that innovation is valued within large engineering-procurement-construction (EPC) organizations but is hindered by organizational factors such as lack of resources allocated to innovation efforts; low risk tolerance; and a failure to establish innovation-enhancing processes. To enable EPC organizations to evaluate and improve their innovation capabilities, the team created an Innovation Maturity Model (IMM) that evaluates an organization in each of 61 innovation-related attributes. The IMM, which is based on the data collected and a review of relevant innovation literature, includes a macro-enabled spreadsheet that aggregates the individual survey data, identifies the ten attributes offering the greatest opportunity for improvement, and provides the recommendations for improving these ten attributes. The IMM was pilot tested using six large EPC organizations and will be available through the Web.

### **INTRODUCTION**

Although the ability to innovate is considered to be a fundamental requirement for long-term business success in nearly all industries, the need for innovation has been undervalued within the industry that provides engineering and architectural design, construction procurement and construction services in the industrial, infrastructure and building construction markets (hereafter referred to as the "EPC industry"). In response to the need to enhance innovation, the Construction Industry Institute (CII) established a research team to "Explore and document the current levels of innovation in the E&C industry, identify opportunities for enhanced levels of innovation; and best practices for E&C companies individually (and the industry collectively) to become more innovative." The research was co-sponsored and guided by the

Charles Pankow Foundation (CPF). The joint CII/CPF research team actively performed research between November 2006 and August 2009. This paper summarizes the research team's methodology, findings and the tool it developed to enhance innovation within EPC organizations.

It is important that the reader keep in mind that every aspect of the research reflected the unique context underlying the research team. One key aspect of the research was the composition of the research team: four academics and eight industry professionals with between two and twenty years of industry experience, including two senior managers who were appointed as Co-Chairs. In other words, the research was a joint academic-industry effort, as is the expectation for all CII-funded research projects. Another key aspect was the objectives of the research: rather than contributing to the theoretical understanding of innovation held by academics, the research was directed to providing practitioners with knowledge and tools that offered immediate and practical value.

## **LITERATURE REVIEW**

The team elected to begin the research process by reviewing the relevant literature on innovation and establishing seven specific research questions. The following paragraphs present the seven research questions and a very brief summary of the literature related to each question.

**1. Is innovation perceived to lead to higher profit margins?** Although researchers and practitioners have found that innovation is required for organizations to prosper or survive in competitive markets (Damanpour and Schneider 2006; Howell and Higgins 1990), one of the key findings of the literature search was that there has been no published research analyzing the relationship between EPC firms' investment in innovation and their financial performance. Findings establish an indirect link between investment in innovation and enhanced business performance. For example, LePatner (2007) found that construction's low investment in innovation has contributed to the EPC's very low growth in productivity since 1964 (25% compared to 250% for other industries).

**2. How is innovation measured?** Metrics for assessing the success and impact of an innovation have been identified and discussed in literature but practical application of these metrics is limited. Egbu (2001) and Tucker (2004) suggest tracking innovation success by measuring lagging indicators such as the percentage of profit/sale derived from the innovation. Dikmen et al. (2005) built upon these studies by identifying trailing indicators of innovation such as technological advancements, improvements in schedule, budget, and quality, and increased effectiveness of the firm.

**3. What are the key perceived drivers of innovation?** Toole (1998) suggests that the adoption of innovative products and processes can directly improve the achievement of product and firm goals because they can decrease project cost and duration and increase the performance of the final structure or system. Dikmen et al. (2005) also points out that that innovation should be evaluated in terms of the overall

value that results, which transcends products and service metrics. For example, innovation can lead to competitive advantage through improved firm reputation, easier work processes and improved ability to attract new employees (Slaughter 1998).

**4. What are the key perceived barriers to innovation?** Unfortunately, many organizations focus on optimizing the current value system rather than pursuing more radical, systemic improvements (Hamel 2006). Sawhney and Wolcott (2004) suggest the lack of innovation in EPC is not due to employees lacking innovative ideas but to a lack of mechanisms for implementing these ideas. According to LePatner (2007) EPC organizations' lack of economies of scale, lack of financial cushion and the process interdependency of many separate firms each trying to maximize individual profits hinder innovation.

**5. What are the management characteristics that promote innovation?** A recent study of innovation within homebuilding organizations identified management strategies that differentiate successful firms including: (1) motivated leaders, (2) a technology advocate within the firm, (3) stressing the importance of being creative and the first to use new products, and (4) using technology transfer programs (Koebel et al. 2004). One of the most impactful factors on innovation within organizations is the specific characteristics of project managers and supervisors themselves. Researchers have found that senior managers' tenure in position (Hambrick and Mason 1984; Huber et al. 1993), industry experience (Damanpour and Schneider 2006), age (Damanpour and Schneider 2006; Huber et al. 1993), gender (Sonfield et al. 2001; Stelter 2002), education (Hausman 2005; Lee et al. 2005), willingness and ability to manage conflicts (Hausman 2005) willingness to share control (Scott and Bruce 1994; Timmons and Spinelli 2004) highly influence the innovative capacity of an organization.

**6. What are the project related characteristics that promote innovation?** Success in the construction industry requires effective inter-organizational management. That is, construction projects often require collaboration among and management of diverse firms in order to achieve a common goal. Gambatese and Hallowell (In Press) identified specific project-related factors that promote co-innovation including Owner vision; funding from the Owner; contractor input during the design phase; overlap of the different project development phases; an innovation "champion" and entrepreneur; and co-location of the project team.

**7. What are the elements of a successful innovation process?** In the 1990's there were significant efforts to create process models for successful achievement of innovation within organizations (e.g., Abd El Halim and Haas 2004; Kangari and Miyatake 1997; Bernstein et al. 1998; Rogers 1995; Subramanian and Nilakanta 1996; Schroeder et al. 2000). Bernstein et al. (1998) identify four key steps: (1) generalization or conceptualization of an idea; (2) development and production of the new technology; (3) transfer of knowledge; and (4) subsequent application to solving problems. These steps are similar to those identified by Kangari and Miyatake (1997)

who found that the innovation process incorporates three major activities in the progression from new idea to implementation: envisioning new work strategies, designing the process, and implementing change.

## **METHODOLOGY**

Another aspect of the research that reflected the unique context of the research team was the research methodology, which was organic and pragmatic. This preceding sentence does not mean that the methodology was crude or sloppy. Where an important research method issue was involved—such as the wording of interview and survey questions—appropriate care was taken. The team planned, coordinated and analyzed much of its work through a dozen face to face meetings, approximately 50 conference calls, and hundreds of email conversations.

Based on the findings from the literature review the team drafted an interview script and performed approximately twenty-five semi-structured interviews of EPC professionals using a convenience sample. This script was modified based on the feedback obtained through the interviews and converted to a survey. The written survey was initially completed by 46 members of the CII Board of Advisors at their Spring 2007 meeting..

The survey was subsequently converted into an online version and made available on [www.surveymonkey.com](http://www.surveymonkey.com). The approximately 110 EPC practitioners who completed the anonymous survey represented a convenience survey of CII members, CPF members, and a few alumni from the academic research team members' universities. Univariate and multivariate analysis was performed using SPSS and Excel. Analysis of the demographic data on the survey indicated the sample was fairly well stratified by market sector (commercial, process or infrastructure), geographic location across the U.S., and number of years in the EPC industry.

The results of the survey provided clear evidence that innovation was valued in most EPC organizations but attributes needed to effectively innovate was frequently missing. The research team found the attributes can be appropriate grouped into eight areas:

1. Culture
2. Resources
3. Risk perspective
4. Customer focus
5. Learning
6. Collaboration
7. Leadership
8. Processes

It was clear from the interviews, surveys and team members' analysis of their own organizations that with regards to innovation, EPC managers don't know what they don't know—that is, they do not realize that weakness in two to three of the above areas can outweigh strengths in other areas. As such, the team decided to create a

tool that could be used to evaluate an organization’s innovation capabilities, identify weak areas, and suggest ways to strengthen weak areas. This tool was named the Innovation Maturity Model (IMM).

The IMM evaluation survey consisted of 61 Likert scale items, each associated with an important organizational attribute that facilitates innovation. The IMM also contained a brief set of recommendations on how to improve the attribute associated with one of the 61 statements. These recommendations reflected a synthesis of the literature the research team had reviewed as well as the survey and interview data. The IMM evaluation survey and a macro-enabled spreadsheet that allows managers to aggregate their surveys and identify recommendations to improve their organizational attributes most hindering innovation can be downloaded from [www.facstaff.bucknell.edu/ttoole/innovation](http://www.facstaff.bucknell.edu/ttoole/innovation).

Table 1: Example of an IMM Evaluation statement and the associated recommendation

Our organization expects individuals to share ideas through formal forums.	Continuous learning is essential for highly innovative organizations. One of the best ways to really learn about a subject is to prepare to explain or teach it. Companies can stimulate the participation of their employees in learning activities by engaging as many employees as possible in defining and optimizing processes and sub-processes. Tracking the new techniques and processes learned by employees during the annual performance review and encouraging employees to prepare and deliver presentations on new ideas and approaches in non-threatening environments can be highly effective. Firms may also want to establish a “process improvement suggestion” program and track the number of suggestions generated by various employee groups.
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The IMM was presented at the 2008 CII annual conference with a call for volunteer organizations to help validate and refine of the tool by pilot testing it. Five of the approximately twenty firms who volunteered were requested to participate as case study firms. In addition, one CPF member company identified by the CPF Board was requested to participate. The identities of the six organizations that participated in the case study process are being kept confidential due to the sensitive nature of the data recorded for each firm. Each case study firm was asked to perform the following actions:

1. have a small set of employees review the format and overall content of the IMM evaluation questions and the specific wording of each question and provide the team with constructive criticism;
2. have a larger set of employees (25-100) complete the IMM evaluation tool, adding demographic questions as appropriate to allow the organization to identify statistically significant differences in data from different groups within the organization (such as supervisory versus non-supervisory personnel, geographic locations, etc.);
3. allow the research team to analyze the results and provide the organization with recommendations for improving the organizational characteristics that offered the most potential for improving the organization’s innovation potential;

4. implement the recommendations within at least one portion of the organization and share the outcomes with the research team; and
5. provide any feedback regarding the effectiveness of the IMM.

The number of completed evaluation surveys in each organization ranged from 20 to 90 responses. The selection of the respondents was left up to the organization. In each case, the organizations selected a segment of the organization to focus upon, although this focus was different in each organization. Once the surveys were completed, the following four-step process was utilized for each organization:

1. Analyzed the results to determine the top ten attributes with the highest potential for innovation improvement within the organization.
2. Reported the findings to the case study liaisons along with the specific recommendations for improvement.
3. After agreeing on the specific recommendations to adopt, the implementation process was placed under the direction of the individual companies. The RT 243 team provided advice when requested but ensured the implementation remained independent.
4. Revisited the companies to determine what progress had been made on the suggested implementations. In one case, the same group of respondents as well as a new group of employees were asked to complete the IMM survey several months later to measure innovation-related changes in the organization since the implementation.

## **FINDINGS**

While space limitations do not allow the statistical analysis of the survey data to be presented here, the survey data combined with interview notes provided strong empirical support for the overall finding alluded to in the previous section: EPC organizations value innovation but lack key organizational attributes necessary for sustained, organization-wide innovation. The key attributes are summarized below.

Mindset: While EPC firms have a culture that generally affirms the importance of innovation, managers apparently enable innovation only on a project basis. They do not adopt a long-term, risk-tolerant perspective that enables innovation on an organization-wide basis. Specifically, EPC managers must allow the costs and risks of an innovation to be spread across multiple projects, such that the risks of using an innovation is not unacceptably high for one project or one set of project leaders.

Resources: The vast majority of respondents indicated their companies lack the resources necessary to identify, nurture, track and apply innovations. These resources include expense budgets as well as managing staff to ensure they have sufficient time and incentive to nurture innovations. Especially as a result of the global economic downturn over the past few years, EPC organizations are now “lean, mean design and construction machines,” with little slack resources. Austere staffing promotes short-term earnings but not long-term success through innovation.

Processes and Structure: The innovation literature makes it clear that innovation will rarely happen when there is not an organizational structure and formalized processes for methodically identifying and evaluating potential innovations, and effectively implementing them on appropriate projects.

Changed Project Environments: Successful innovation requires real and sustained commitment by all project entities. Project delivery and contract methods that inhibit collaboration between entities during design and construction, and prevent risk taking, are not conducive to the creative integration needed to innovate.

The results of the six case studies provided two valuable sets of empirical information. First, the pilot tests of the IMM provided confirmation that the content and wording of the IMM questions and recommendations were appropriate and useful. The organization who had employees retake the IMM several months after IMM recommendations were implemented experienced statistically significant improvement in the scores for the attributes that were targeted for improvement. Second, the pilot tests supported the overall findings from the survey, namely that the organizational culture and leadership may support innovation, but resources, processes and risk perspective do not. Figure 1, below, provides average scores for the first four organizations that completed the IMM evaluation tool. A score of 3 represents a mostly weak area in that in responding to a statement affirming the organization possesses an innovation-related attribute, the average response was “I am neutral.”

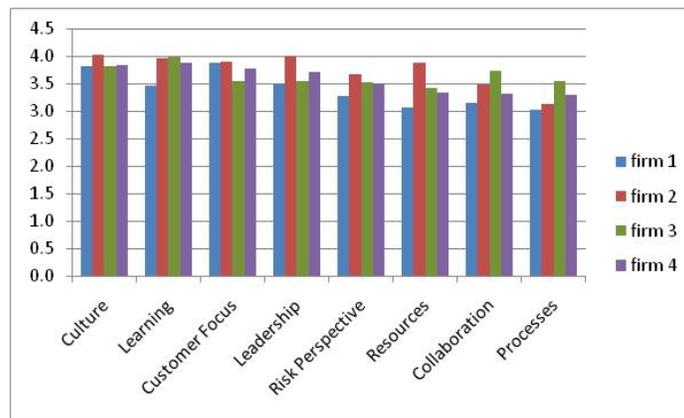


Figure 1: Average scores for each organizational area for each of four case study organizations

## CONCLUSIONS

EPC organizations focus on bringing capital projects in on time, under budget and without injury. They believe the best way of achieving these goals are by implementing best practices, that is, by adopting what has worked on past projects and eliminating all unnecessary sources of risk to achieving project goals. EPC organizations are rightfully proud of their strategic abilities to manage successful

capital projects and of their lean organizations that facilitates positive financial performance even during market downturns.

The trouble is that EPC organization's project management strengths are exactly what keep them from being innovative, despite the value attached to innovation by managers. EPC organizations like the idea of being innovative but most are poor at identifying, trying, nurturing, and managing knowledge regarding innovations within their organizations. New methods, processes, products and systems may sound exciting, but the reality is that they are treated as too costly and too risky to pursue even on the smallest projects. Project and corporate budgets are too lean to allow personnel from pursuing innovation-related activities.

This paper has summarized the research that led to the development of a tool to allow EPC managers to identify the attributes of their organization that are hampering their ability to innovate. The research process reflected not a tightly planned and executed methodology but a pragmatic and evolving process that best suited the strong industry composition of the research team. This paper therefore does not represent paper with ambitious theoretical goals supported through a tight methodology but exploratory research that reflects the research team context. Nonetheless, the positive feedback received from the six organizations who pilot tested the IMM indicates the tool has promise for helping EPC organizations identify and implement the changes needed to enhance innovation within their organization.

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