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Engineering project organization: defining a line of inquiry and a path forward

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The formalization of a line of inquiry requires three elements: a foundational definition, an operational context and a path forward to guide researchers within the domain. In this initial Pathfinding paper, these elements are addressed for the engineering project organization line of inquiry. The field of engineering project organization research is put forth as a distinct pursuit within the overall field of organization research. In this distinct domain, engineering, social science, business and public policy are integrated as foundational pillars within the context of infrastructure development and the requirement to meet multiple levels of stakeholder requirements. The paper puts forth the argument that traditional perspectives of project-based organizations and project management are no longer sufficient to address the challenges of an evolving global economy, focus on environmental concerns and multi-cultural projects. Rather, it is necessary to forge a new path that embraces interdisciplinary perspectives as a basis for studying engineering organizations at all levels. From this basis, a path forward and a specific set of milestones are specified that should be measured and achieved by the Engineering Project Organization community as it solidifies engineering project organization research as the next generation of interdisciplinary research within a project-based context. Finally, a charge is given to the community to collaborate while developing novel insights and challenging entrenched beliefs and modes of inquiry in both industry and academia.

Keywords: Engineering organizations, interdisciplinary research, project organizations.

Introduction

In 1911, Taylor wrote that, 'The best management is a true science, resting upon clearly defined laws, rules, and principles, as a foundation' (Taylor, 1911). From this initial foray, it can be argued that project scholars have spent a century searching for the definitive scientific definition to explain and define the role of management in executing projects. The authors, including Henri Fayol, Chester Barnard and Peter Drucker, provided building blocks upon which the academic discourse in management science expanded and organizational science inquiry embarked. However, these building blocks ultimately launched divergent paths including management, engineering and social science-based philosophies. These divergent philosophies are evident in a continuous timeline of debates from New-Deal politics to free-market economics and global free-trade resolutions (Harvard, 1997). The result of these competing lines of inquiry is an academic environment that is fractured with academic degrees in multiple disciplines from management to engineering and the social sciences.

The sub-field of project organizations mirrors the debate surrounding the lines of inquiry within organization science. George Steiner, Chris Argyris and John Fondahl intoned the concept that organizations are formed with the objective of successfully completing projects. The literature base emerging from these early contributions is the one comprising engineering, management and social science journals espousing competing and complementary theories. The authors debate whether organizations develop projects with associated organizational structures or whether projects require supporting organizations. Associations sponsor conflicting certifications for domestic and global management professionals. Rather than progressing towards a unified theory of management guiding the

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development and execution of complex projects, the landscape is cluttered with a discordant affiliation of theories, academic degrees and directions from which the next generation of project-focused management inquiry must emerge.

The goal of the Pathfinding paper series is to address this discordance by blazing a path towards achieving clarity in the area of engineering project organizations. In this first Pathfinding paper, the author strives to establish this clarity through two efforts: (1) defining the line of inquiry in this domain and (2) establishing the contextual boundaries in which this research is currently being, and will continue to be pursued. The author proposes that a line of inquiry into engineering project organizations must be formalized which recognizes the intersection of engineering, management and social science as a unique entity requiring new applications of research methods, interdisciplinary academic collaborations and the removal of long-held academic and professional silos.

Although significant work is currently being executed by researchers from multiple domains in the area of project-based organizations, a formalization of the engineering project organization field that recognizes this work as a single field of inquiry is currently absent. This paper addresses the requirement to fill this void while setting a path for current and future researchers in this domain to follow. The paper incrementally constructs an argument for this line of inquiry through four elements: (1) establishing the uniqueness of project-based organizations within the overall management context, (2) defining engineering project organization research, (3) establishing the context in which this field of inquiry resides and (4) putting forth the path to follow and the milestones for the field of engineering project organization inquiry to achieve.

Project-based organizations

Project-based organizations revolve around the concept that a group of individuals or firms join together with the explicit purpose of producing a tangible set of outputs that can be physical (e.g. a building), logical (e.g. software code) or social (e.g. a marketing or public relations campaign). The concept, formalized at the peak of the aerospace and military build-ups during the 1950s, emphasized the optimization of project resources to produce the given scope of outputs within given budget and schedule constraints (Middleton, 1967). In contrast to the long-term, market-centred focus espoused by strategy advocates, project management advocates emphasized the role that projects play in achieving longer-term strategic objectives and the need to re-evaluate organization structure (Morgan *et al.*, 2008)). In this perspective, the optimization of short-term objectives to complete projects can establish priority over long-term strategic positioning. The reasoning for this optimization being that the failure to successfully complete a project severely inhibits the opportunity to achieve longer-term goals.

Figure 1 informs this discussion by dividing organizations along a spectrum from continuous-process to project-focused. As illustrated, continuous-process organizations are the ones that are based on providing consistent services over an extended period of time with minimal changes to the product or service. Hospitality and consumer products share this end of the spectrum as each emphasizes market share growth through experiential or marketing-based efforts. At the opposite end of the spectrum, we see organizations that centre on unique, large project delivery. Engineering and construction companies anchor this end of the spectrum with an emphasis on individual projects where the identity of organization members may be tied more to a specific project than to the overall organization.

At the project-focused end of the spectrum, the continued pursuit of innovative processes to support the optimization of project resources dominates the thinking behind the preponderance of engineering literature, the stated objectives of professional engineering enterprises and the specialization within engineering academic curricula. The continuous reinforcement of these objectives by academic and professional entities is arguably driving a broader wedge between the industries residing at the opposing ends of the spectrum.

However, the thought that the engineering industry stands alone with this perspective is a false assumption. Project management continues to be a central element within the tools wielded by the defence and aerospace industries in completing multi-year, multi-billion dollar contracts. Programmes such as the Airbus A380 and the International Space Station require large-scale coordination of resources over multiple organizations and countries to successfully deploy complex entities. Similarly, organizations traditionally perceived as utilizing projects as a means to achieving strategic market

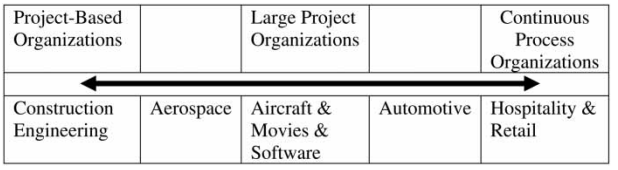

Figure 1 The spectrum of organization types extends from organizations focused on supporting continuous processes to ones focused on projects as primary elements

goals are adopting project-based management as the liability of individual efforts threatens to bankrupt an organization (Cooke-Davies *et al.*, 2009). Examples of this movement include the film industry, the pharmaceutical industry and even healthcare (DeFillippi and Arthur, 1998; Pinto, 2002). The commonality in these movements is the realization that individual projects place the overall organization in danger as the level of resource commitment grows in relation to overall resource reserves.

Engineering project organization discipline defined

Given that there is a century of project-based organizations and a field of inquiry rooted in scientific management, why are we still searching for a definition that properly informs us of the boundaries of this academic and professional discipline within the engineering domain? The answer lies less in the need to alter the position of engineering organizations as a reflection of economic changes, a greater emphasis on global impact and the move to environmental stewardship. Specifically, engineering organizations can no longer exclusively focus on controlling internal resources. Beyond the need to improve tools such as Gantt charts or critical-path techniques, today's project-based organizations must focus on inter- and intra-organizational concerns including adaptation, collaboration, absorption and cultural integration take precedence in strategic thinking. Additionally, the divisions between public, private and governmental concerns are giving way to collaborative concerns such as governance, financing and global investment. It is now appropriate to reverse the trend towards specificity and espouse a horizontal and vertical definitional expansion. The following sections invoke this expansionist philosophy and provide a definition for engineering project organization research.

Vertical inclusion

The concept of project management as a function to support production activities is one that received attention in the latter part of the twentieth century and remains a central tenet of project management. Although production is a valid focal point, the concept of projects as exclusively production activities is limiting in the context of changing engineering organization dynamics. Rather, the appropriate perspective is inverted and considers the multiple granularities of project influence. The concept of project, when expanded to include the multiple stages of project implementation, requires a broader consideration of stabilizing and destabilizing influences. In this context, the broadest vertical consideration must be given to the overall impact that projects have on society and social institutions. When fully integrated, the successful project may result in landmark status that is tied to the identity of the society as much as it is identified for a technical achievement. For example, landmarks including the Eiffel Tower, the Brooklyn Bridge and the Great Wall of China are as much a symbol of national identity as they are technical achievements. Although every project is not intended to, nor will it, achieve such status, every project ultimately must succeed in the context of a societal setting and thus society resides at the top of the vertical axis.

Similarly, governments at national and regional levels invest significant resources with the intent of promoting projects that positively impact the population. This impact includes multiplying effects that affect local, national and even transnational social, political and industrial entities. For example, the social benefit of a school extends well beyond the specific monetary compensation provided to project participants. These multiplicative social benefits are arguably of greater concern to governments than the individual impacts of a project delay or cost overrun.

A progression to the level of project implementation does not alleviate the need for perspective enhancement. The scope of projects undertaken by many public entities exceeds the capacity of an individual organization to accept the engagement. The imperative to join resources into partnerships or joint ventures is becoming a rule rather than an exception in infrastructure delivery due to concerns including liability, professional capacity or financial resources. The capacity to analyse and foster network relationships within these dynamic environments of often conflicting objectives is directly reflected in the project outcome. Similar to this inter-organizational coordination, programme management exceeds the capacity of traditional work-face perspectives. Issues including inter-project learning, knowledge transfer and resource allocation exponentially enhance or detract from the overall programme success. Finally, individual projects are not immune to changes in the contextual environment, as witnessed by the numerous studies on workforce demographics, project financing, globalization and technology introduction.

The effect of this multi-granular perspective is that traditional project research initiatives emphasizing a limited context of project schedule and budget need significant extension and enhancement. Engineering project organization concerns extend within a multi-granular and multi-temporal stage. The project-, institutional-, governmental- and global-level concerns in

these areas necessitate the vertical expansion of project perspective. Moreover, since different parties may bear the costs and benefits associated with different phases of the project life cycle, transaction costs in long-lived projects such as infrastructure delivery are far more complex than those envisaged by transaction cost economists such as Oliver Williamson and require sophisticated relational contracting to be successful (Henisz and Levitt, 2010).

Horizontal context

Gaddis (1959) provided an expansionist perspective of a project when he stated that, 'a project manager uses [specialist knowledge] in all the phases of the creation of his product, from concept through the initial test operation and manufacturing stages'. As the first formal construction management programmes were instituted, a similar expansionist perspective was advocated as the concepts of life-cycle costing and project phases were incorporated into textbooks (Peurifoy and Ledbetter, 1956; Halpin and Woodhead, 1980). In each of these perspectives, the importance of the project life cycle in its totality is emphasized as the responsibility of the project manager. The commonality between these informing statements is the reality that a cradle-to-grave existence of a project requires analysis beyond the contextual boundaries of the implementation stage. Concurrently, the reality that each project stage represents an incremental investment of resources, and implementation may not always be the prime recipient of funds, establishes a motivation to recognize the horizontally extended boundaries of engineering project organization research.

In a discussion of project governance as part of the future research directions of the construction domain, Levitt (2007) argued that the project perspective must broaden to fully understand the financial, cultural and political aspects of project development in a broad governance structure. Additional project scholars expand upon this need for inclusion to address expansion of the domain to incorporate a broader set of knowledge beyond the technical to include the social, managerial and governmental influence on projects (Taylor and Chinowsky, 2010). In the present context, these recommendations are extended to the broader context of engineering project organizations to address the concerns of project governance at all stages and at all levels of engineering projects.

The EPO definition

As illustrated in Figure 2, the expansionist perspective creates a horizontal context and a vertical perspective for engineering projects founded on a set of domain pillars, the whole of which is guided by a focus on

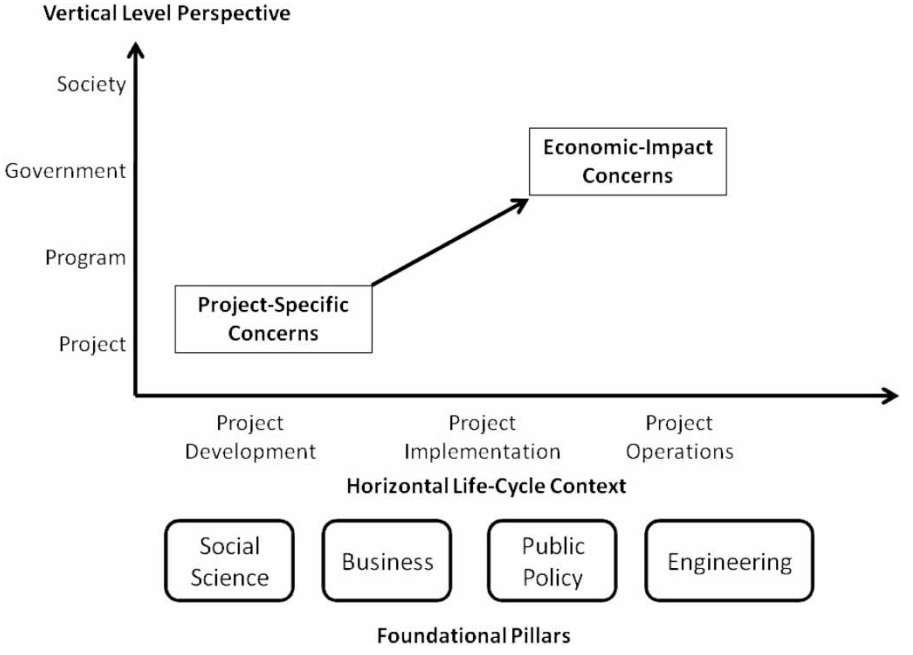

Figure 2 Engineering project organization research requires a basis in multiple pillars of inquiry, while applied to one or more horizontal and vertical contexts, within an overall influence of project governance issues

project governance. Defining these elements specifically, we obtain the following.

- *The pillars*: The four contributing domains combine to support engineering project organization research and implementation. Engineering informs the technical requirements for projects at all stages and provides the boundary for the technical feasibility. Social science informs the human context in which projects are completed including focal points on individuals, networks and institutions. Business informs the requirement that projects evolve in a financial context within economic realities and require management principles for successful implementation. Finally, public policy guides the decision-making process surrounding the project and ultimately determines the legitimacy and appropriateness of a project in a given context.
- *Horizontal life-cycle context*: As stated, projects exist in a continuum of life-cycle phases that define the requirements and boundaries for the inception, development, use and retirement of a project. The horizontal life-cycle context provides the expansionist boundaries under which projects need to be considered, researched and understood by professionals, students and academics.
- *The vertical-level perspective*: The vertical-level perspective informs the domain that project organizations exist at multiple levels, each of which is influenced by the actions undertaken at the preceding and succeeding levels. The vertical-level perspective demands that engineering project organization research references these influences and addresses the greater impact of actions along the vertical perspective.
- *Project governance*: Engineering project organizations operate in a project governance structure that defines the manner in which organizations operate, the economic and financial context of the project focus and the social norms and cultures that influence project acceptance.

The influence of these four factors provides the basis for engineering project organizations in terms of their study and their focus.

A domain definition: Engineering project organizations are networks of individuals and/or firms that undertake the development of tangible outputs within the requirements of a specific infrastructure sector.

A research definition: Engineering project organization research combines the perspectives of multiple pillars (social science, business, public policy and engineering) to study the engineering project organization within one or more vertical perspectives and one or more horizontal contexts.

Areas of inquiry

The definition of engineering project organization research is purposely broad and diverse to encompass the diversity of topics required to understand the influences on modern engineering-based initiatives. However, in such a diverse environment, structure is necessary to reduce the propensity of the field to splinter into increasingly finer divisions until a cohesive whole is no longer viable. In the context of this paper, the definitional effort sets the path on which the *Engineering Project Organization Journal* will operate and reflects the current breadth and structure of the Engineering Project Organization Society. The following areas of inquiry are established as the initial lines within the overall path established for the engineering project organization journal and society. However, these paths reflect current research efforts and should not be considered the final contextual pathways. Rather, the *EPOJ* community encourages exploration that continues the expansionist perspective into new areas that will be incorporated into the current contextual areas described below.

Infrastructure development and governance: This category incorporates research efforts that emphasize the development and governance of civil and social infrastructure projects from initial conception to operations and maintenance. Breadth within this category is represented by governmental concerns at project inception to finance and delivery concerns during implementation and operations. Current research efforts in this domain include public–private partnerships (Garvin, 2010; Mahalingam, 2010), institutional impacts on project development (Scott *et al.*, 2011) and exogenous impacts on project development such as internationalization and climate change (Chinowsky *et al.*, 2011; Ho, 2011). Depth within the category complements the breadth by incorporating top-level entities such as governmental organizations with joint ventures and project organizations as concerns within the context of infrastructure development. The unique aspect of this category within the engineering project organization domain is the intersection of the foundational pillars in addressing the development and governance concerns. Rather than limiting financing explorations to an analysis of payback periods or similar concerns, research in this context bridges the pillars to address economic, environmental and social sustainability perspectives in the pursuit of infrastructure development.

Project- and programme-based enterprises: The historic record informs us that the implementation of projects in an engineering context requires a project or programme-specific organization. Whether it is a military

programme, space launch vehicle, water supply system or rural highway, the common element is the need for a directed team pursuing a common goal of a tangible output. As outlined above, current research along this path is a direct descendent of a line of inquiry extending back over a century. However, this extended lineage does not preclude continued inquiry into this foundational arena. Rather, influencing historic inquiry with inter-disciplinary nuances provides unique perspectives into the development, fostering and performance of these enterprises. As epitomized by work in areas such as knowledge management (Anumba *et al.*, 2005), small and medium enterprises (Kim and Arditi, 2010) and the social role in organizations (Pryke and Smyth, 2006), the intersection of the foundational pillars continues to provide novel insights into the operation of project and programme-based enterprises.

Inter- and intra-firm coordination: The completion of any task requiring more than a single individual introduces interdependencies. The level of interdependency and the number of actors undertaking the task directly influence the degree of coordination required to successfully complete the task (Lawrence and Lorsch, 1967). Project-based tasks are founded on such cooperation and interdependency. Today's environment exacerbates the interdependency factor by introducing cultural, geographic and discipline boundaries into the traditional task-oriented coordination requirements. The expansion and recognition of these elements establishes the foundation for this line of inquiry. As highlighted by research into communication (Dossick and Neff, 2010), social networks (Chinowsky *et al.*, 2011) and cultural relationships (Fong and Lung, 2007; Ramalingam and Mahalingam, 2010; DiMarco and Taylor, 2011), the investigation of inter- and intra-firm networks is providing insights into issues such as strategy, learning, performance and cultural impacts.

Engineering business enterprises: The final area of current inquiry within the engineering project organization domain expands outwards to encompass the enterprises that undertake engineering projects. In contrast to the extensive literature on manufacturing and service enterprises dating back to the early 1900s, a focus on the business component of the engineering-construction sector is significantly less mature. Although authors including Tatum (1987), Moavenzadeh (1991) and Warszawski (1996) provided groundbreaking insights into these enterprises over time, the totality of the inquiry is significantly less compared with the more mature manufacturing-based inquiries. However, the current trend is changing in this respect. Contributions from collaborations between social scientists and management scholars with engineering scholars are increasingly providing insights into issues including business models (Davies *et al.*, 2010) and innovation (Davies *et al.*, 2009).

The path forward

The establishment of a definition and a context in which this definition can be applied is the starting point for organizing a diverse set of current academic initiatives. However, setting upon a path cannot commence prior to addressing the issue of what is expected to be accomplished by those who choose to follow the path. This final section addresses this facet by setting a directive for the strategic pursuit of engineering project organization scholarship. This path is outlined through a series of milestones which serve as measureable achievements for the growth of this domain as well as directional markers for those engaged in this line of inquiry.

Milestone 1: building the path: integration of efforts

As stated earlier, multiple paths currently exist in the project management field. However, engineering project organization research is distinct among these efforts and establishes a new path of inquiry. The first milestone in establishing this path is to demonstrate a break from the tradition of single-domain inquiry and embrace the concept of inter-disciplinary collaboration. Specifically, this domain requires interdisciplinary concepts as a foundation for understanding the project-based enterprises and initiatives being studied. This collaboration can include a multitude of combinations from the supporting pillars, but the underlying requirement is to adopt the perspective that an interdisciplinary approach and perspective, from research methods to summary analysis requires a multi-perspective basis. Researchers embarking upon this path of inquiry must incorporate these complementary concepts in a comprehensive analysis. This initial milestone will be measured based on the commitment to this principle and the adoption of it as a guiding marker for both journal and society development.

Milestone 2: intersecting disciplines in a single path

The success of the emphasis on collaborative efforts will be measured by the escalating number of insights into project-based organization behaviours at the intersections of the supporting disciplines. Single-domain inquiry will be replaced by multi-perspective findings in each of the foundational fields of study. For example, project communication summaries will be

complemented by analysis of the underlying motivations for the communication and the small group dynamics that influence the body of conversation. Similarly, project delivery inquiry will be enhanced with an understanding of the socio-political constructs that influence such decisions and ultimately determine the success of such endeavours. In each case, it is the finding at the intersection of the disciplines that this community is striving to highlight and thus build a novel line of inquiry for project-based organizations. The challenge for this milestone is whether researchers are ready to break the traditional mould of research and join with researchers from associated disciplines to generate new perspectives and findings. The evaluation of whether this challenge is being met will occur based on the increasing number of research efforts that establish the intersections as the new mainstream for project-based inquiry.

Milestone 3: moving the path from the wilderness to the mainstream

The third and final milestone for the project-based organization discipline is the need to lessen the perceived uniqueness of this organizational and management field. Using the path analogy, the path needs to be leading towards or through a recognized destination rather than serve as a wandering stroll though the intellectual wilderness without a clear direction. In terms of the academic necessity, the recognized destination is the acceptance of engineering project organizations as a domain of inquiry that is worthy of the efforts of scholars at all stages of their careers. Concurrently, the publishing of scholarly pursuits in such a discipline should be considered the equal of traditional single-domain efforts. The focused pursuit of this line of inquiry by a global and diverse community of established and emerging scholars will serve to meet this requirement by challenging established biases. In this manner, the path is no longer a wandering trail, but rather transforms to a path of discovery towards significant destinations that require equal standing in the eyes of the academic community. This milestone may be difficult to measure in the near-term, but stands as the imperative for motivating long-term pursuit.

Conclusion

This Pathfinding paper set out to accomplish four essential objectives as the initial foray towards setting a course for engineering project organization researchers: (1) set the imperative for the domain, (2) formalize a definition for the field, (3) establish a context in which research currently is being conducted and under which it should continue and (4) clarify the path on which the line of inquiry should pursue. Each of these objectives has been addressed as components of an overall vision for continuing the academic pursuit of engineering project organization knowledge and insights. Concurrently, a set of milestones has been presented to guide the development of this journal and the research community as a whole. This leaves one last task to illuminate the proposed path: motivating the trailblazers to continue the journey along the path.

Proust famously wrote that, 'The real voyage of discovery consists not in seeking new landscapes but in having new eyes'. The essence of this statement is put forth as motivation to those who seek to continue and be leaders in this line of inquiry. Engineering project organization is currently a diverse field of inquiry, but continued growth requires a re-evaluation of how project-based organizations operate, succeed, innovate and exist in a constantly changing global environment. This re-examination requires collaboration, insight and a challenge to entrenched beliefs and modes of inquiry in both industry and academia. While challenging, the reward for such endeavours is the establishment of a new line of inquiry that enriches the existing scholarship of project-based organizations and establishes a field in which scholars can identify and thrive alongside traditionally recognized domains.

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