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Project Management: Why have computers made things harder? And what to do about it

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ABSTRACT: In spite of the construction industry's wide adoption of computerized systems, project management tasks have not become significantly easier and, in fact, computerized systems have added to the challenges faced by project managers. This paper argues that the combination of the dynamics of project structures, increased business pressures and inappropriate software systems have led to this state of affairs. This paper also provides guidance for how to correct the situation.

1 Overview

Widespread adoption of computerized systems has already taken place in most construction projects. However, project management remains a discipline poorly supported by automated systems, in spite of the widespread availability of such systems. This is surprising, especially given the efficiency gains due to computers in other areas.

Effective project management requires both setting up a structured framework and making good use of human talent to collaborate on the project's goals. This paper argues that a project culture that promotes collaboration is key to effective project management. This paper also addresses the structured part of the project management, that which provides the framework necessary to define and coordinate the multitude of tasks, personnel, deadlines, costs, etc. that comprise the project.

In construction projects, collaboration requires that all team members know and agree to the project's goal and that they are willing to work together and share the information and resources necessary to reach it. Collaboration is important and really makes a difference in construction projects. There are short-term costs, but there is also an overall benefit to the project.

Unfortunately collaboration isn't working all that well on construction projects. Although there is often good teamwork within individual groups, collaboration across company boundaries is generally limited to ad-hoc, individual efforts.

Many of the barriers to collaboration arise from a single source: *the clash of objectives between the companies taking part in the project and the project itself*. Eliminating the barriers to collaboration requires resolving this issue.

Construction collaboration technology, consisting of a web-based project management support platform, can enable the production and sharing of project information, based on the project structures and processes that are well known to the construction industry.

Company management must take the responsibility to eliminate the organizational barriers that prevent project collaboration and to build a corporate culture that promotes collaboration across company boundaries. Project managers typically do not have the organizational and financial authorities (competences) required to instigate and execute the measures required to establish a collaborative culture.

In order to implement a construction collaboration technology platform, project needs must dictate the implementation of software systems. Thus, IT must be a service/system supplier, not a standards definer. The authors strongly recommend gradual development and deployment of an infrastructure of smaller separate tools (components) based on open standards and open data formats.

2 Enablers to Effective Project Management: Collaboration and Structure

Effective project management requires both a structured element and a social element. The structured element provides the framework necessary to define and coordinate the multitude of tasks, personnel, deadlines, costs, etc. that comprise the project. The social element is required to create a project environment that fosters teamwork and promotes collaboration between the team members. Taken together, the structured framework ensures that the all project work is defined and can be managed, and collaboration ensures that it actually gets done.

Both collaboration and structure are required. If collaboration (e.g. the sharing of knowledge, learning and building of consensus and commitment) is lacking then there will be low motivation and poor teamwork, which will cause delays and cost overruns. If the project is unstructured (e.g. with no proper definition and management of goals, work scope, work assignments, etc.) then, in spite of the team's best intentions, there will be a confusion of goals, coordination problems and difficulties reacting to project changes. Delays and cost overruns also result.

Effective project management requires both setting up a structured framework and making good use of human talent to collaborate on the project's goals. Good use of human talent means having the leadership skills required for engaging qualified people and building an appropriate project culture (this can be a considerable challenge, given the trend to globalized projects with team members located all over the globe). A project culture that promotes collaboration is key to effective project management and will be further addressed throughout this paper.

This paper also addresses the *structured* part of the project management, that of providing the framework required for managing all the planning, technical and financial project information. Recognizing that most construction project tasks produce *information* as a part of their outputs, typically in the form of documents or datasets (e.g. drawings, reports, schedules, contracts, instructions, etc.), the project management structure should be capable of assisting their initial production and updates. Since all task outputs are inter-related, the structure should also facilitate coordination and checking.

Using software terminology, construction project processes (design, scheduling, cost control, etc.) can be thought of as algorithms that accept input datasets and produce output datasets. The management challenge then becomes that of defining the datasets, determining their inter-dependencies and knowing which are fundamental inputs to be updated in the event of a change (Hodgkinson and Kaelin 2012). Note the actual project processes are all well known to construction professionals. The core project management processes for engineering consultants are listed below:

1. Scope management
2. Organizational chart
3. Procurement management
4. Work plan
5. Cost control

To effectively carry out the project work and achieve the project deliverables, additional project management support processes are required. These typically include design management, document management, risk management and interface management. Project management processes are discussed in a previous paper by the authors (Hodgkinson & Kaelin 2012).

Modern computer systems would appear to ideal for implementing project management processes. Indeed this has occurred, but unfortunately they are usually implemented as isolated solutions that do not take into account the dependencies to other processes and datasets. This is a major source of difficulties and is discussed in section 5.2.

3 Collaboration in Construction

Collaboration is defined as *working together.* Collaboration includes the collective commitment to achieve an agreed goal and the sharing of resources in order to do so. In construction projects,

collaboration requires that all team members know and agree to the project's goal and that they are willing to work together and share the information and resources necessary to reach it.

Collaboration in construction has been defined as *the agreement among specialists to focus their abilities in a particular process to achieve the longer objectives of the project as a whole, as defined by a client* (Hobbs 1996). Collaboration is needed to share visions among different stakeholders and to maximize team efforts on a particular job. *Collaboration involves people working together by sharing (interacting, communicating, exchanging, coordinating, and approving) information and processes* (Illich 2006).

Construction collaboration technology refers to software applications used to enable effective sharing of project-related information between geographically dispersed members of a construction project team, often through use of a web-based software as a service platform (Wikipedia). Such software can assist collaboration, but is generally not sufficient without support from management.

Professor Woodie Flowers of the Massachusetts Institute of Technology coined the term *Gracious Professionalism* that describes the mindset necessary for effective collaboration: *Competition for the sake not of destroying one another, but for the sake of bettering and improving both competitors as a result of the competition* (FIRST). Gracious Professionalism can be paraphrased for the construction industry as:

> *Working together with competitors to achieve a project goal*.

Collaboration cannot be achieved by mandate. A necessary condition is that project teams have clear and agreed objectives. The combination of all teams actually knowing and 'buying into' their goals provides a focal point for effort and motivates them to succeed.

The authors have first-hand experience on projects with both good and bad collaboration. In projects with good collaboration, difficult problems can be overcome by collective effort. The focusing of mental and physical resources occurs spontaneously before problems become too big to handle. Each project member trusts that everyone on the project team 'has their back' and in return, is willing to help others.

In contrast, in projects with poor collaboration, team members work in isolation without regard to the bigger picture. They are unwilling to make the effort to share information or assist in solving problems that do not directly affect them. Problems tend to be pushed away rather than solved, further exacerbating them. The result is a vicious circle of increasing isolation and less willingness to collaborate. In extreme cases, the participating companies can actively subvert collaboration (described in section 4). This occurs in spite of the best intentions of the individual team members. Symptoms of poor collaboration include organizational barriers, lack of coordination and interface difficulties.

Collaboration is important and really makes a difference in construction projects, but is not without cost. There are short-term costs, but there is also an overall benefit to the project.

4 Barriers to Collaboration

Unfortunately collaboration isn't working all that well on construction projects. Although there is often good teamwork within individual groups, collaboration across company boundaries is generally limited to ad-hoc, individual efforts. This is not surprising as collaboration is easier with nearby people who are known and trusted, than with far away strangers.

Globalization has raised the stakes for collaboration. Collaboration is more difficult, but at the same time, more important. The increase in distance, both physical and cultural, between companies makes collaboration harder and also makes the penalties for failing to collaborate more severe. Distance makes it harder to catch, and more importantly, to communicate and take action on problems before they become serious issues. Thus, globalization makes it more likely that minor problems will become serious problems.

The authors believe that there are three primary barriers to effective collaboration on construction projects:

1. Poor definition and agreement of goals for teams and team members, caused by poor use of established project structures and processes (discussed section 2, Hodgkinson and Kaelin 2012 and Hodgkinson & Kaelin 2012a).

2. Insufficient recognition of the benefits of collaboration (discussed in section 3, Hodgkinson and Kaelin 2008 and Hodgkinson et al. 2008).
3. A consequent unwillingness to bear the initial effort and cost required to promote a collaborative project culture (since the benefit is not recognized).

The poor use of established project structures and processes may however be symptomatic of an underlying case of unwillingness to bear the initial effort and costs required enable a collaborative project culture. This topic will be further explored in section 5.

There are additional contributing factors that further hinder collaboration:

a) Unwillingness by companies to share information outside the immediate corporate environment. This might be due to commercial considerations or simply the unwillingness to bear the cost to overcome the technical difficulties of sharing.

b) Project organizations that follow a command-type hierarchy (effectively the opposite of a collaborative organization) or that fail to establish clear responsibilities (e.g. where organization charts have more coordinators than lead engineers).

c) The Balkanization of projects, due to conflicts between the participating companies, largely arising from cost pressures. Companies frequently bid low to get jobs and depend on outsourcing of work and claims and variations to make their profit, which leads to an adversarial project culture.

d) An ongoing trend of staffing projects with less experienced personnel, leading to an overall decrease in experience levels. A parallel trend is the use of senior staff trained in general management rather than engineering. Project are consequently unable to benefit from the practical engineering experience of previous generations.

e) A tendency by participating companies to deploy in-house project management support systems intended for internal corporate use, at the expense of their appropriateness for projects where information must be shared with outsiders. A further hindrance is that the development of the software systems emphasizes ‘checking the boxes’ of corporate requirements and not it’s usability by project managers and engineers.

f) The difficulty of defining and implementing project management support systems that take into account the unique features of the dynamics of construction project management. Essentially, construction professionals do not understand computer technology well enough to build appropriate systems, and software vendors do not understand the specialist need needs of the construction industry, believing that they can simply adapt systems designed for other industries.

The authors believe that many construction projects suffer from at least one of these contributing factors, undermining collaboration.

5 The Corporate-Project Clash

Many of the barriers to collaboration discussed in the previous section arise from a single source: *the clash of objectives between the companies taking part in the project and the project itself*. Eliminating the barriers to collaboration requires resolving this issue.

The Corporate-Project Clash occurs because construction projects are quite different from traditional commercial enterprises:

1. Projects are composed of inter-disciplinary teams from multiple companies. The team members report both to project management and their own corporate hierarchy
2. Projects are temporary business entities that are long and complex enough that they require a sophisticated and dedicated support framework, yet short enough that there can be big difficulties justifying the cost and setting it up

These points must be addressed in order to provide an environment in which promotes collaboration.

The first issue is to address conflicting loyalties of the project management and team members. This is can only be resolved at the executive management level of the participating companies, as discussed in section 5.1.

The second issue is to address the project support framework, which has two components:

1. Willingness to allocate budget for systems that promote collaboration, with the expectation of longer-term savings (discussed in section 5.1).
2. Implementing the technical infrastructure, primarily composed of IT systems, to support collaboration (discussed in section 5.2).

5.1 Management Issues

Over the past couple of decades there has been a radical change in the structure of engineering companies, which has had a consequent affect on construction project management.

Traditionally, engineering consultants were mostly smaller, specialized firms, managed by engineers who had moved up through the engineering and project management ranks. Given their hands-on experience, they had the ability and motivation to set up and enforce good engineering and project management processes. In the authors' experience, the project culture fostered by management with engineering experience produced collaboration that crossed company boundaries. The focus was on successfully completing projects, which emphasized maintaining good client relations and working as a team, rather than competing against project partners.

The last couple of decades have seen a consolidation of many smaller engineering consultants into larger corporations that now take on a broader range of engineering work. General managers, with MBAs but little hands-on engineering experience, are frequently in charge. Their priorities focus on the financial, legal and risk controls, typical of the corporate cultures found in other industries.

Engineering and project management processes have been relegated to be responsibilities of the engineering staff assigned to projects. Company management focuses more on their own corporate interests. Unfortunately, management now tends to view partner companies in projects as competition, and neglects to promote active collaboration and information sharing, due to the perceived threat to competitive advantage.

The result is that the interests of the project and the companies taking part are no longer aligned. Given that project managers and team members are ultimately beholden to the company that employs them, there is a widespread reluctance to respond to project needs if they conflict with company goals. The corporate mentally has trumped the project, to the detriment of collaboration on construction projects, and the projects themselves.

5.2 Information Technology Issues

In parallel with the 'corporatization' of construction projects, there has been a corporatization of IT (Information Technology) in engineering firms, which has led to a secondary corporate-project clash. This occurred because IT departments report, typically via a CTO (Chief Technology Officer), directly to top-level management. IT departments mandate systems based on corporate needs, with little regard to what actual projects require. Generally, only the most basic services are provided:

1. Computer hardware and network infrastructure
2. Internet access
3. Email, shared calendars, MS-office
4. Shared file storage (network drives)

Additional systems are often provided to fulfill corporate requirements, such as general account management, sales tracking, timesheets, expenses, etc. However, none of these systems provide any assistance for promoting collaboration on construction projects.

The problem is that personnel in IT departments typically do not have training or interest in construction management, nor do they have a mandate to produce systems that actively share information outside the immediate corporate environment. Since no ideal systems appropriate for managing multi-company construction projects are currently available, the IT departments are often beholden to software vendors selling systems adapted for other industries.

The fundamental issue is that non-project management issues dominate the selection and deployment of computer systems for managing construction projects. The result is a patchwork of inappropriate

and incompatible systems, which make project management based on the core processes and structures, recommended in section 2, extremely difficult.

Since there are no ideal systems appropriate for managing multi-company construction projects, it will be the responsibility of the construction industry to define the software systems it needs. This issue is addressed in section 6.3.

6 What Has to be Done?

The authors believe that effective project management requires good collaboration by the project team, using a structured framework to manage the planning and all the project's technical and financial information.

Construction collaboration technology, consisting of a web-based project management support platform, can enable the production and sharing of project information, based on the project structures and processes, which are well-known to the construction industry (see section 2 above). Such a system allows goals for project teams to be defined and tracked, and also manages the project's inputs and outputs. Unfortunately, the ideal construction collaboration technology does not yet exist. Guidelines for its creation are presented in section 6.3.

Company management must recognize the benefits of collaboration and be willing to bear the cost required to provide an appropriate platform.

More importantly, company management must establish a corporate culture that actively promotes project collaboration.

6.1 Identify and Eliminate Barriers to Collaboration

Company management must take the responsibility to eliminate the organizational barriers that prevent project collaboration and to build a corporate culture that promotes collaboration across company boundaries. Only executive management can make the decision to align corporate and project goals. This is because project managers typically do not have the organizational and financial authorities (competences) required to instigate and execute the measures required to establish a collaborative culture.

A task force of company executives and project managers needs to identify and eliminate the organizational barriers to collaboration (see section 4). The concept of *gracious professionalism*, the willingness to collaborate with competitors on a project (see section 3), provides a vision for doing so.

The task force also needs to work together to define the core project management processes, and requirements to set up and enforce good engineering and project management processes, including the supporting data structures.

Ultimately, company executives will be responsible for the success or failure of the measures introduced. Appropriate metrics need to be introduced (currently, IT metrics do not typically address project productivity, and HR metrics do not typically address project collaboration).

6.2 Define Process and Data Structures

Project management processes and structures are essential to guide the project to a successful completion. This section summarizes the material presented in Hodgkinson and Kaelin 2012.

The *project management structures* are well-known, key components of the practice of construction project management. They refer to the ordering of project management data, which comprise the inputs required for project management processes. Project management structures typically include the following:

1. Scope statement
2. Work breakdown structure
3. Deliverables list
4. Organization chart
5. Responsibilities-authorities matrix
6. Design checking and approvals workflows
7. Project phases

8. Milestone dates
9. Division into contracts
10. Coat account structure
11. Document coding and classification system

Project management processes are the methods used to set up, control and monitor the progress of the project. They include the list of core processes listed in section 2 and the processes that manage the data in the project structures listed above. Construction professionals should already be familiar with them.

Once company executives commit to implementing construction collaboration technology, the data elements and processes associated with each of the project management structures must be defined, preferably by a task force composed of specialists from both the construction and software industries. This only needs to be done to a reasonable depth.

6.3 Take Control of IT

In order to implement a construction collaboration technology platform, project needs must dictate the implementation of software systems. Thus, IT must be a service/system supplier, not a standards definer. In short, IT should answer to projects, not the other way around, as is normally the case.

To implement project management processes, given the typical company hierarchies, it is advisable to create an inter-disciplinary task force, composed of experienced project managers and IT-specialists that reports separately from the normal IT chain of command. The task force should be tasked with defining requirements for systems that implement the defined project management processes (including the data structures that support them) and encourage good engineering practices.

IT should be responsible for the actual implementation, bearing in mind that IT should be a tool provider, not a standards setter, with respect to construction collaboration technology platform. The final implementation is likely to be a combination of the purchase of suitable software tools, together with the implementation of new tools, and interfaces between tools, by IT programmers.

Before starting the actual implementation, fundamental decisions must be made:

1. Development infrastructure following open standards (e.g. web applications) versus proprietary standards
2. Use of open data formats versus closed proprietary data formats
3. Use of a single (large) monolithic system that does everything versus an infrastructure of smaller, simpler separate software tools that interact
4. Buy or build decision
5. Rapid prototyping and deployment versus deployment only after the full system is complete

The authors strongly recommend gradual development and deployment of an infrastructure of smaller separate tools (components) based on open standards and open data formats. This has many advantages:

1. Components are smaller, simpler and easier to implement and test
2. Reduces risk by providing early corrective feedback
3. Gradual deployment provides instant gratification and motivation
4. Buy/build decisions can be made on component basis
5. Reduces the dependency on software suppliers
6. Components can easily be replaced with improved versions without disruptions

See Hodgkinson and Kaelin 2008 and Hodgkinson et al. 2011 for additional details and recommendations.

7 Conclusions

1. Effective project management requires both structured and social elements
2. The structured element is addressed by defining and using well-known project structures and processes

3. The social element is addressed by actively promoting cross-company collaboration
4. The *Corporate-Project Clash* must be resolved by company management, as a prerequisite to implementing cross-project collaboration. A starting point is to resolve the barriers to collaboration
5. *Construction Collaboration Technology* should be implemented, using rapid prototyping methodologies, as an infrastructure of components that interact using open communication and data standards
6. IT specialists implementing the construction collaboration technology should be guided by experienced project managers, in order to ensure that the resulting solutions are appropriate

8 References

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