

Building Options at Capital Project Front-End Strategizing: The Power of Design for Evolvability

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ABSTRACT

KEY WORDS

Capital projects
Uncertainty and Risk Management
Evolvability strategies
Requirements management
Stakeholder management

This research provides insights on strategies to cope with changes in requirements over the course of a capital project delivery time and later during the asset's operational lifetime. At the heart of the research is the dilemma faced by capital project teams during front-end strategizing: How to design and develop new capital assets that can adapt and evolve economically to cope with future changes in design requirements.

Data were collected between September 2009 and December 2012 via case studies on Network Rail, a private company with a public guarantee that owns Britain's railway infrastructure and lab-based experiments.

THE PROBLEM

Capital projects are long-term investments that require vast and diverse resources to forge ahead, and thus involve many independent parties.

Capital projects are long-term investments that require vast and diverse resources, e.g., financial, capital, land, knowledge, political support—all of which are required for the schemes to forge ahead. The control and ownership of these resources is, however, likely to be distributed across various legally independent parties, and thus all these stakeholders are likely to make claims on the final project design. Infrastructure projects such as transport and utility networks and waterworks, e.g., dams, sewerages, are the most common examples of capital projects in the private-public sphere. Capital projects are widespread in the corporate world as well, as firms allocate large sums of resources to build upon or maintain capital assets, such as factories or resource extraction facilities.

Evolvability strategy (future-proofing): a strategy that specifies the qualities of the design that ensure it can cope economically with changes in requirements.

The number of stakeholders involved in project front-end negotiations can be vast and includes sponsors (the ultimate funder like a government or a corporation), the project client (typically an agent appointed by the sponsor and often termed the "client" from a project suppliers' perspective), future operators and suppliers, and others such as local communities, local authorities, and other public agencies. Excluding these stakeholders from the project front-end strategizing process is a risky strategy that can back fire later on. These stakeholders control critical resources for the project to forge ahead, and thus have legitimate rights to make claims on the final design.

Central to multi-party front-end strategizing is the problem of balancing decisions to make extra investments in design flexibility (to mitigate the risk of high adaptation costs if things change later on) with decisions to invest in cheaper but rigid designs (at risk adaptation costs will spiral if things do change later on). This complicated problem of designing for evolvability, aka future-proofing, is compounded by the need to collectively negotiate these front-end decisions, and thus the inter-organizational structure that frames the design decision-making.

■ THE PROBLEM *(continued)*

The focus of this research is how to help multi-stakeholder capital project teams bridge their divergences and coalesce their different views of the world into an upfront design for *evolvability strategy* (i.e., a strategy that specifies the qualities of a final design that is both affordable and robust to cope economically with changes in requirements). Investments in design flexibility can be equated with buying options: If the future resolves favorably, the options can be exercised to adapt the design economically; otherwise, a limited investment has been lost. A design for evolvability strategy is about devising ways to cope with changes in requirements during project delivery and operational lifetime. This issue is particularly important in capital projects unfolding under scenarios with high uncertainty, tight budgets, and multiple claimants on the final design.

The difficulties of designing for evolvability become amplified whenever multiple stakeholders are involved at front-end strategizing.

Teams that worked with a design for evolvability champion were systematically more efficient.

This research recommends practitioners adopt formal options reasoning to support design decision-making at front-end strategizing.

The Key Preliminary Findings

A set of in-depth case studies on railway schemes undertaken by multi-party development teams led by Network Rail produced two key insights:

- 1) Project teams invariably use options thinking intuitively. Options thinking is therefore not a notion alien to the way project teams approach early design decisions. However, our findings also suggest that the analytical models behind real options theory are inadequate to support mundane decisions to design options or not at the project front-end.
- 2) Decision-making on design for evolvability happens in an inter-organization, flat structure. Our findings show that the capital project structure, notably the fact many legally independent parties share legitimate rights to directly influence the final design, complicates decision-making around upfront investments in design for evolvability.

These findings suggest that a more structured procedure to design for evolvability may help inter-organizational teams strike a better balance between short-term affordability and long-term adaptability. To test this proposition, the research develops an original proof-of-principle of a formal framework to support early design decision-making when front-end strategizing capital projects, and a simulation experiment.

A controlled experiment was then conducted—grounded on fine-grained empirical data from a real-world railway station redevelopment project—to compare the performance of the experimental and control groups in terms of effectiveness, efficiency, and satisfaction. The experimental teams were instructed to adopt the formal design for evolvability framework, and received aid of a champion who facilitated the process. The control group teams were unaided and did not use the framework.

Specifically, the simulation results show that multi-party teams that worked with a design for evolvability champion were systematically more efficient because they tended to find common ground faster than those in the control group. A formal design for evolvability framework thus makes the different parties in the team more aware of the need to share information about their view of the world in regard to future operating scenarios and funding issues. And as multi-party teams build common ground quicker, they become more efficient and, thus, have more time to discuss which options to build into the design and how exactly to fund them. This, in turn, leads to front-end strategizing outcomes that are more likely to reconcile short-term affordability with long-term adaptability.

In contrast, unaided teams are more likely to run out of time in their future-proofing discussions and hence fail to hammer out a deal to fund design options even if they agree on the need to design in the options.

This research recommends practitioners adopt formal options reasoning to support design decision-making at front-end strategizing. The results suggest this approach can increase the quality of the outcomes and the project teams' accountability for design flexibility decisions. These investments need to be agreed in a multi-stakeholder context and balanced against affordability

■ THE PROBLEM *(continued)*

constraints. The results show the importance of putting in place a formal decision-making process to ensure a proper debate precedes decisions to endorse or rule out design flexibility investments. An informal process increases the chances that the design flexibility debate—whether inadvertent or not—drops off the agenda at front-end strategizing. And this can create unjustifiable risks such that a rigid design moves forward under conditions of high uncertainty. If costly changes then become required, the adaptation costs must spiral and the project can derail. At the limit, failure to properly discuss design flexibility upfront creates an unnecessary risk that a capital project delivers a rigid asset slated to become prematurely obsolete in its operational life.

Importantly, decision-making on design for evolvability happens in a multi-party context. Hence project stakeholders can be expected to exhibit different levels of legitimacy to influence the final design, as well as conflicting priorities, and perceptions of risk. Some stakeholders may advocate final designs that maximize their individual short-term gains, as opposed to maximizing the shared value that the project can create. Others, particularly cash-strapped ones, may be reluctant to commit capital towards investments in flexibility that may take decades to pay off.

The qualitative analysis of the experimental results suggests that the experimental groups were systematically more efficient in the front-end strategizing process and that efficiency, in turn, enabled them to produce more effective outcomes. Table 1 summarizes the key findings and illustrates the discussion that follows.

■ RESEARCH IMPLICATIONS

Established risk management practices also fail to adequately provide multi-stakeholder project teams with mechanisms that can help the stakeholders reconcile their different views.

This research proves that having a skilled and talented design-for-evolvability champion and a technically competent person in charge can be a key factor of success. This study also adds to the theory and the practice of project risk management by proposing a role—the champion of design for evolvability—and a structured way to resolve the project front-end in a multi-stakeholder, flat decision-making environment.

Many procedures exist to guide decision-makers on managing project risks. *The PMBOK® Guide*, for instance, provides project managers with recommendations on how to identify, analyze and respond to project risks. This and other similar processes, however, fail to exploit the power of built-in optionality in design as a means to mitigate foreseeable risks in a multi-party, flat environment. Established risk management practices also fail to adequately provide multi-stakeholder project teams with mechanisms that can help the stakeholders reconcile their different views.

Multi-party, flat teams require new cognitive frameworks, structures, and rules capable of making the future-proofing process more efficient and effective.

In capital project environments, proposed frameworks to formalize options logic need to be simple to be accepted by practitioners. Decision-makers at the project front-end also often struggle with lack of resources and urgency to make decisions, two factors that can make it hard for them to endorse laborious analytical methods for mundane design decision-making. Still, failure to diligently think through early design alternatives under conditions of high uncertainty can have dramatic consequences to project performance and limit prematurely the functional life of the operating asset.

In conclusion, this study argues that multi-party, flat teams—the typical make-up of capital project teams—require new cognitive frameworks, shared rules, and structures that taken together can help them make more efficient and effective early decisions on design for evolvability, aka future-proofing. The results also refute the conjecture that project stakeholders would perceive any new design-for-evolvability procedure as obstructive, time-consuming, and bureaucratic. These are important contributions to practice, and it is up to each multi-party team to figure out how to best implement the notion of capital design for evolvability in their context.

RESEARCH IMPLICATIONS *(continued)*

Usability of the front-end strategizing	Control Group (no framework, not aided)	Experimental Group (using the framework, and aided by a champion)
Efficiency	Low Teams experienced conflict between divergent interests due to poor communication. Teams tended to engage in unstructured and unguided debates.	High Teams more likely to demonstrate creative thinking and ingenuity. Teams generally managed to engage in timely and productive exchanges of information.
Effectiveness	Moderate As the teams ran out of time (as a consequence of the lack of efficiency), they struggled to pin down their strategic recommendations.	High Teams managed to resolve major issues including which stakeholders were more likely to benefit from particular options, who should pay for them, and who had the wherewithal to provide the additional funding. Teams were receptive to borrow the options logic constructs to frame the discussions.
Satisfaction	Moderate Some participants demonstrated their discontentment with the time-consuming process and with pointless conversations.	Moderate Participants did not perceive the design for evolvability proposition as unnecessarily redundant and bureaucratic. Some of them even highlighted the usefulness of having a design for evolvability champion.

Table 1: Qualitative comparison of the usability of the front-end strategizing process between the two groups

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