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**Sustaining Highly–fragile
Collaborations: A Study of
Planning Mega Infrastructure
Projects in the UK**

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Sustaining Highly-Fragile Collaborations: A Study of Planning Mega Infrastructure Projects in the UK

This study discusses the sustainability of highly-fragile, consensus-oriented developments which rely on voluntary contributions of resources. The research is grounded on a dataset of interorganizational controversies that arose during the planning of four mega infrastructure projects in the UK. It uses Design Structure Matrices to qualify the decomposability of the design structures and of the structures that govern high-level decisions to set performance expectations. The analysis shows that fixed deadlines, tight budgets and equity concerns constrain efforts to decentralise governance and seek local consensuses. Time constraints also bring to the fore mutual-gains bargaining and compromise-seeking despite genuine efforts to engage in deliberative decision-making and effective collaboration. Hence, I argue, sustaining these pluralistic enterprises is per se a measure of positive performance. The study suggests four mechanisms that allow carrying the parties along as the development inches forward: loosening local targets, global buffers, flexible designs in use; and an umpire—an actor accountable to all parties and empowered to settle disputes.

Introduction

The production of long-lived large infrastructure such as railways, airports, and recreation facilities is a form of public-private partnership central to contemporaneous debates on how to invigorate sluggish economies.¹ Prevailing perceptions that these so-called mega-projects frequently underperform complicate the debate, and have fuelled two views. One argues that management systematically underestimate cost and schedule targets due to strategic misrepresentation and optimism bias (Wachs 1989, Flyvbjerg, Bruzelius and Rothengatter 2003), lack of upfront planning (Morrow, McDonwell and Arguden 1988, Morris 1994), or use of rigid buyer-supplier contracts under conditions of uncertainty (Stinchcombe and Heimer 1985).

The opposite view—that plans fail because management is hostage to ‘scope creep’ (Shapiro and Lorenz 2000) and ‘escalation of commitment’ (Ross and Staw 1986) and thus unable to tame powerful stakeholders and control for discontinuities in

¹ The public debate gained traction right after the financial crisis in 2008 (e.g., Krugman 2008); see Copeland, Levine, and Mallett (2011) for a literature review.

the environment, this is managers cannot plan, is common too (e.g., Altshuler and Luberoff 2003, Hall 1982, Miller and Lessard 2000, Szyliowicz and Goetz 1995).

However, mega-projects are not unitary organizations led by management but collaborative networks led by coalitions (Lundrigan, Gil and Phanish 2014). The resources necessary to develop a new scheme (e.g., land, finance, planning consent, political support and knowledge of needs in use) are controlled by independent parties who volunteer them in exchange for rights to directly influence the performance expectations. Hence, at the core, mega-projects create large arenas of collective action (Ostrom 1990, Hargrave and Van de Ven 2006) or pluralistic enterprises (Shipilov et al. 2014) in which stakeholders with divergent interests seek consensus for the goal and the plan to achieve it before the suppliers can be brought in to get things done.

As such the networks formed to plan long-lived infrastructure face the challenges that are potentially endemic to various forms of voluntary, consensus-oriented collaborations including open source communities (von Hippel and Krogh 2003, O'Mahony and Ferraro 2007), communities of scientists (Tuertscher, Garud, and Kumaraswamy 2014), new business ecosystems (Baldwin and von Hippel 2011), and collaborative networks formed to provide public services (Ansell and Gash 2008).

In voluntary, consensus-oriented interorganizational collaborations, governance cannot rely on authority hierarchies (March and Simon 1993), market mechanisms (Ouchi 1980), or 'system integrators' (Brusoni, Prencipe, and Pavitt 2001) to control for free riding, reduce shirking, and resolve controversies. Rather, the authority to make decisions and rule collection action is shared and must attend to different local stakeholder concerns to preserve a democratic process (Rothschild and Russell 1986). Unilateral decision-making and leveraging power imbalances marginalize actors,

produce distrust and weak commitment, and create risks that disenfranchised actors defect the collaboration (Susskind and Cruikshank 1987, Pratt and Foreman 2000)

Collaborations that harness the benefits of institutional pluralism entice voluntary contributions of resources needed to resolve complex problems (Garud and Karnoe 2003, Gray 1989, Kratz and Block 2008, Philips, Lawrence and Hardy 2000, Logsdon 1991). Inclusive collaborations also give legitimacy to the solutions (Suchman 1995) and generate robust outcomes (Hargadon and Douglas 2001). The challenge is to make the collaborations work. If the actors belong to different communities of practice they exist in different ‘thought worlds’ (Dougherty 1996), and thus face epistemic gaps (Brown and Duguid 1991, Puranam, Raveendran and Knudsen 2012). Heterogeneous actors are also likely to frame situations differently and thus to propose different solutions to shared problems (Gray 1989).

Resource interdependency, a prior history of working relationships, a collective identity, trust, and the presence of conveners with authority are antecedents to enable actions that allow people to collaborate effectively (Gray 1989a, Hardy, Lawrence, and Grant 2005, Lawrence, Hardy, and Phillips 2002, Ring and Van de Ven 1992, Thomson and Perry 2006). Actors who are strangers to each other can also collaborate effectively if they invest in self-organizing actions such as crafting a unifying goal and co-locating stakeholders (Beck and Plowman 2014), or creating working groups with overlapping memberships and relationships (Garud, Gray, and Tuertscher 2014).

We know less about sustaining consensus-oriented collaborations which do not benefit from the preconditions for collaborative action, and have limited resources to commit to deliberative decision-making and actions that encourage social norms of trust, equity, and reciprocity to flourish. These ‘ineffective collaborations’, Lawrence, Hardy and Phillips (2002) state, do not aim at achieving innovative solutions but

rather at ‘negotiating stakes in some fixed pot of resources, rapidly solving some temporary problem, or simply gaining legitimacy in the eyes of a third party’.

This, I argue, is a fundamental problem faced by the networks formed to plan large infrastructure. Devolution of government and property rights spread the control over interdependent resources across independent actors. Hence actors have agency but cannot exercise it fully and must negotiate (Pfeffer and Salancik 1978). Achieving goal congruence between policymakers, agencies, and professional communities of practice is hard work (Meyers, Riccucci, and Lurie 2001). The difficulties in achieving goal congruence are amplified by rigid deadlines, tight budgets, and issues as controversial as compulsory land acquisitions and property blight—“plurality of objectives held by pluralities of politics makes it impossible to pursue unitary aims...planning problems are wicked problems”, Rittel and Webber (1973) say.

This wicked but important societal problem brings us to the question motivating this study: *how to sustain a constrained, consensus-oriented development that relies on voluntary contributions of resources from autonomous and heterogeneous parties?*

This inductive research adopts a multiple case study approach with embedded units of analysis (Eisenhardt 1989, Yin 1984). Case studies allow researchers to incorporate contextual and temporal dimensions, which makes them suitable to explore novel ideas (Eisenhardt and Graebner 2007, Siggelkow 2007). The research site consists of four mega-projects in the UK. The UK legal and political system gives individuals and organizations opportunity to contest plans for new schemes, and impedes the promoter(s) from controlling all the resources. To complicate matters, the mega-project planning process is constrained by rigid electoral and regulatory cycles².

² In the UK, the gap between general elections cannot exceed five years; and regulated monopolies tend to operate under obligations to produce a new capital plan every five years.

The units of analysis are controversies that arose in the course of planning the mega-projects between promoters and local resource-rich stakeholders with divergent interests but unified by a higher-level goal, this is between actors supportive of the scheme. Controversies are situations in which people disagree, and thus illuminate the “scene of the battle” (Latour 1986) and how people resolve conflicts (Coleman and Ferguson 2014). In mega-projects, unresolved controversies either create pinch points and thus risks of impasse, or risks of late changes in performance expectations.

This study shows that fixed deadlines, tight budgets, and equity concerns constrain efforts to decentralise mega-project governance. They also bring mutual-gains bargaining and compromise-seeking to the fore despite genuine efforts to engage in deliberative decision-making and seek local consensuses. The tension that ensues between negotiating tough and collaborating effectively makes the governance of mega-projects a struggle and limits the efficacy of social norms of collaboration.

Hence, I argue, the sustainability of highly-fragile collaborations rather than being taken for granted is a measure of positive performance. I propose that four mechanisms combined are critical to carry the actors along as a new development inches forward: i) loosening local performance targets (budget, timescale); ii) building sizeable buffers into the global performance targets; iii) espousing flexible designs in use; and iv) having an umpire to put an end to controversies which face-to-face dialogue has failed to resolve, and design and technology cannot eliminate efficiently.

The rest of this paper is organized as follows. In §2, I review literature on collaborative development, and the complications caused by the misalignment of organizational and design structures. After discussing the inductive approach in §3, I proceed to analysis in §4. Section 5 discusses the contribution to understanding how to sustain highly-fragile collaborative developments. Section 6 concludes.

Interorganizational Collaborative Development

Interorganizational collaborations enable to find solutions to complex problems wherein a single actor rarely has all the information-processing capacity and resources to solve the problem (Gray 1989, Fjeldstad et al. 2012, Hargrave and Van de Ven 2006, Hardy, Phillips, and Lawrence 2003). As Beck and Plowman (2104) state “the growing interconnectedness of and interdependencies among people and organizations make collaboration a growing necessity”.

As said, even strangers to one another can collaborate effectively if they can afford to invest in self-organizing actions to encourage the development of social norms of trust, reciprocity and a higher-order shared identity. Furthermore, the lack of acute epistemic gaps allows for meritocracy-based authorities to govern collective action without undermining democratic participation (O'Mahony and Ferraro 2007). And even if the actors have dissimilar backgrounds, they can seek consensus through knowledge exchange supported by boundary organizations (O'Mahony and Bechky 2008), face-to-face interaction (Hardy, Lawrence, and Grant 2005), and boundary infrastructures, e.g., models, prototypes, and working groups (Tuertscher et al. 2014).

However, achieving effective collaboration gets complicated when the actors lack the time to engage in deliberative decision-making, and a tension ensues between ‘getting things done’ vs. ‘getting things perfect’ (Gersick 1994). Consensus building cannot be rushed (Susskind and Cruikshank 1987, Tomson and Perry 2006) as holding lengthy talks is necessary to allow actors with divergent interests to make sense of complex problems and communicate to coordinate collective action (Weick and Roberts 1993). Time pressure also amplifies risk perceptions ‘when demands for action are beyond the control of the parties to a deal’ (Ring and Van de Ven 1992), which gives rise to power battles and politics (Eisenhardt and Bourgeois 1988).

When autonomous actors share a higher-level goal but lack the time to seek consensus bargaining and compromise-seeking come to the fore. These mechanisms are common in negotiations when people fail to develop a common construction of the problem, but *are not* effective forms of collaboration (Lawrence, Hardy, and Phillips 2002). They exempt the parties from following established norms (Garud et al. 2014), but fostering cooperation in multiparty negotiations is hard (Gray and Clyman 2003). Deal-making requires ditching prior commitments to performance expectations, which leads to ‘framing contests’ (Gray, Purdy and Ansari 2015) and makes the performance of the social group undefinable and ambiguous (Lundrigan et al. 2014).

Autonomous actors can still be tempted to join an ineffective collaboration to advance individual agendas at limited cost, but are unlikely to make significant commitments to forge a congruent goal that could override differences (Van de Ven 1976). In a development context, we next discuss the role of the design structure.

Design structure and interorganizational collaborative development

The modular design structures that undergird open source communities and new business ecosystems cater for differing individual preferences with limited trade-offs—modular designs reduce interdependency between choices, which attenuates rivalry between individuals’ preferences for the final design and encourages voluntary participations (Baldwin and Clark 2006, Baldwin and von Hippel 2011).

In contrast, pluralistic developments of non-decomposable structures violate the mirroring precept of design theory which posits that, ideally, tightly-knit teams under a single authority should develop monolithic designs to reduce coordination problems and facilitate information exchange (see Colfer and Baldwin 2010 for a review).

When loosely coupled actors share a right to directly influence an indivisible design, the *design in process or in-the-making* conflates the two qualifying properties of an Ostrom’s (1990) shared resource—this is, it juxtaposes low excludability (from

participation of claimants) with high rivalry (of interdependent choices for the final design) (Gil and Baldwin 2013). Hence the risk is high of the development unravelling if some parties free ride or skirt commitments by refusing to compromise and insisting in claims wholly disproportional to their own individual stakes.

Ostrom's work, grounded in cash-strapped collective action arenas formed to govern natural resources, offers nonetheless reasons to be optimistic. It shows it is a struggle to govern constrained collective action arenas where interests-based negotiation cannot be wholly eliminated (Dietz, Ostrom, and Stern 2003). Still, some 'ineffective' collaborations become sustainable after decentralising governance and adopting robust self-organizing actions³, and thus encouraging norms of mutual trust, reciprocity, and equity to flourish (Ostrom 1990, Ostrom, Gardner, and Walker 1992).

Sustaining a highly-fragile collaboration is a central problem in planning mega-projects. To succeed, many heterogeneous, resource-rich stakeholders unified by a superordinate goal must collaborate to develop a set of monolithic long-lived assets for shared use. A railway can be decomposed into functional components such as tracks, rolling stock, and stations. Likewise, an airport terminal includes buildings, runways and walkways. But physical constraints and technology keep some components tightly coupled and the components themselves are hard to divide in use.

Hence, mega-project planning brings many heterogeneous actors into immature collaborative networks where a conflation of competing interests and accountabilities, resource constraints, indivisible designs, and the high stakes that are associated to the longevity of the infrastructures make it a struggle to seek local consensuses. Still,

³ Ostrom (1990) provides eight principles to create a robust collective action arena; collective action can be sustained even if some principles are violated, but the collaboration becomes more fragile

many mega-project planning processes succeed. Hence their study can further our understanding of sustaining highly-fragile, consensus-oriented collaborations.

RESEARCH DESIGN, SAMPLE, AND METHODS

This research uses a comparative case study design (Eisenhardt 1989) in which cases are treated as a series of independent experiments that confirm or disconfirm emerging theoretical insights in replication logic (Yin 1984). For this study, data collection and analysis were focused on decisions to set the goals of components, and corresponding budgets, timescale, and design requirements (so-called project scope).

To advance theory and yield more generalizable and robust insights (Yin 1984) I built a diverse and polarised sample as recommended for process-focused inductive studies (Siggelkow 2007). Specifically, I selected four mega-projects for which I got unprecedented access to top managers: Heathrow's airport terminal two (T2); London Crossrail, a high-capacity underground railway; London 2012 Olympic park; and the UK's second high-speed railway (HS2) (cases summarised in Table 1).

--Insert here Table 1 --

This sample allowed varying three fundamental attributes of the mega-project planning process. First, the cases differ in the level of decomposability of the infrastructure design structures. Figure 1 illustrates this in a stylised way.

Figure 1 – Stylised representation of different infrastructure design structures

An Olympic park is suggestive of a decomposable design structure. It comprises a set of loosely-coupled venues, for example stadium and velodrome; the assets are

monolithic and share the same underground utilities. But the latter systems are ‘slaves’ that are designed to pick up the effects of changes to the high-value venues.

In contrast, the design structure of a railway suggests much less decomposability. The stations are located far apart but are not fully decoupled. All the stations connect to the same high-value components including tracks and control and signalling systems, and must accommodate the same train cars. Hence many higher-order design decisions for the stations such as footprint and equipment choices are tightly coupled. In turn, an airport campus suggests a hybrid design structure. Some components are tightly coupled, for example, the tunnels and passages that connect the concourse buildings, but other components such as the car park and hotel are loosely coupled.

We could expect design decomposability to facilitate the decomposability of the planning problem and thus attenuate rivalry in the stakeholders’ local preferences.

The sample also varies in the membership of the collaborations. The HS2 scheme is entirely publicly financed. Hence high-level decisions in planning mainly involve the central and local governments and public agencies that own interdependent assets. In contrast, Heathrow T2 is wholly financed by its private owner, BAA⁴. But as a private monopolist, BAA must share system-wide rights to develop with the industry regulator and the main user group, STAR Alliance (STAR), a global airline network.

The other two cases involve public and private finance. Crossrail is financed by government but for the stations located on private land. Most Olympic venues were also publicly financed, but the International Olympic Committee, the brand-owner and standard-setting body, was financing the outfit of the venues for the Games.

The more heterogeneous the communities of practice participating in development, the more controversies we could expect due to differing institutional

⁴ In 2012 BAA changed its name to Heathrow Ltd; we keep to the BAA name for the sake of simplicity

logics, preferences, priorities, and beliefs (Carlile 2002), and thus more difficulties in building shared local goals and bridging differences over the plans to achieve them.

And third, the sample varies in the extent to which the planning process was constrained by tight deadlines. The London 2012 immovable deadline put massive pressure to get things done. The other schemes faced no immovable deadlines, but pressure was still high whether due to politicians' will to see things done before general elections (the cases of Crossrail and HS2 first phase), or due to the fixed regulatory cycles in the case of BAA. Amplifying the pressure to get things done was a prior history of unsuccessful attempts to bring the Olympics to the UK (three failed bids) and to get Crossrail approved (two failed attempts). The more pressure to get planning out of the way, the more strained we could expect the collaborations to be.

Units of Analysis

The embedded units of analysis were incidences of controversies over high-level decisions for developing particular components and their sub-elements. Thirty-five controversies were identified after asking our respondents about the most challenging interorganizational divergences they faced. Thus the controversies that respondents cognitively filtered into the sample challenged the sustainability of the collaboration.

How to solve sharp controversies triggers difficult dilemmas: should the parties search for a solution commensurate with existing performance targets or can they relax them to facilitate the search? Should development proceed if the parties cannot converge? And which stakeholders have legitimacy to influence the final decision?

Seeking answers for these questions was essential to understand how to sustain a highly-fragile collaboration. The inclusion of the HS2 scheme in the sample allowed observing one scheme that was going through planning, and for which data could be gathered concurrently with ongoing efforts to resolve the differences. HS2 was also

important because time pressure was much less for the second phase than for the first phase, and thus more effective collaboration was expected in the second phase.

Data Collection

Data collection started in 2011 when I got access to the top managers of the Olympic Delivery Authority (ODA), the public agency established to develop the Olympic park after the victory of the UK bid in 2005. The ODA top management team included a chairman, a chief executive, and seven executive directors. This team reported to the Olympic board that included the leading coalition of promoters: the national and London governments, the British Olympic Association (BOA), and LOCOG, the operator of the games and the International Olympic Committee (IOC)'s watchdog. The ODA attended the Olympic board meetings, but had no power of veto.

Between 2011 and 2014, I leveraged the access granted to the ODA top managers to, first, access top managers of other organizations that shared the right to directly influence the performance expectations for the Olympic park; and second, to negotiate similar levels of access to the other schemes using the logic described above.

For all cases, I also interviewed directors of the suppliers contracted to produce a detailed design, build, and project manage the works. In a snowball fashion (Biernacki and Waldorf 1981), I interviewed people who had intimate knowledge of the controversies and how they got resolved. This allowed to take a processual approach to theorization (Langley 1999, Van de Ven and Poole 2002) and to develop reliable theory (Miller et al. 1997) about sustaining highly-fragile collaborations.

In total 121 formal interviews were conducted, each between one and two hours, and tape recorded. Non-disclosure agreements were not signed, but I always asked permission to use quotes and whether the source should be kept anonymous; some respondents gave us free rein to use the transcripts whereas others asked not to record parts of the conversations and disallowed the use of particular quotes. Follow-up

interviews were conducted to probe deeper into particular issues, double check a verbal account, and bridge late gaps in the empirical database.

To gather extra data and allow for member checks (Lincoln and Guba 1985) the emerging findings were shared with respondents, and senior managers were invited to give presentations to classes of graduate-standing students, field questions from the audience, and stay for lunch. Overall I welcomed 13 guests, and for each visit, produced detailed hand-recorded notes of the seminar talks and lunch conversations.

To improve the accuracy of our data and the robustness of the conceptual insights (Jick 1979) the verbal accounts were triangulated against archival sources (Miles and Huberman 1994). The publicly-funded projects are well documented online *whilst* they are happening, and many documents produced by the promoters and their agents enter the public domain through the Freedom of Information act. I also examined minutes of board meetings, formal communications, design change logs, and technical reports announcing performance targets and plans to achieve the goal. In the case of BAA, I examined annual capital plans, master plans, and consultation documents. The controversies between BAA and STAR were documented in reports produced by the regulator and in formal exchanges between BAA, STAR and the regulator.

Information in the internal project documents was played against reports produced by third-parties. Hence, I combed through reports produced by the National Audits Office, Parliamentary committees, government watchdogs, and other third-parties. Other sources of data were articles and interviews with top managers in professional outlets, e.g., New Civil Engineering, Construction News, and articles in the national press, particularly for controversies that had fallen in the public domain.

Methods

This inductive study was guided by a core question: how to sustain a highly-fragile collaborative development? This, in turn, triggered subsidiary questions: how

do their governance structures look like? What are the sources of the controversies? And what mechanisms carry the parties along? Following recommendations for inductive reasoning (Ketokivi and Mantere 2010), for each case factual accounts were produced. These provide a contextualised, chronologic understanding of the mega-projects and guard against account bias (Miles and Huberman 1994) and tendencies for revisionism and self-aggrandizement in recollections (March and Sutton 1997).⁵

To qualify the mega-project planning problem, I used ‘Design Structure Matrices’ (DSMs), a tool from design theory that allows representing a complex system into a square matrix by capturing interdependencies between its constituent elements (Steward 1981). DSM has been used to represent detailed design production processes (Sosa, Eppinger, and Rowles 2004, MacCormack, Baldwin and Rusnak 2012), but less so to qualify front-end planning processes. I expected that a qualitative DSM analysis could help to qualify the planning problems, discern the resource interdependences, and shed light on the collaborative governance structures.

The cells along the diagonal of the DSMs represent higher-order decisions (the names of the decisions are listed to the left of the rows to keep the matrix compact). In turn, the off-diagonal entries indicate the presence of interdependency between decisions. If the DSM has an entry in row *i*, column *j*, the decision concerning element *i* has a direct impact on the decision concerning element *j*. Hence the decisions represented in the diagonal cells have inputs entering from the top and bottom decisions, and outputs leaving from the left and right sides.

The empirical accounts suggested that planning a mega-project required the managers and elected leaders of different parties to engage in cross-boundary

⁵ Four detailed factual narratives, one for each focal case, were produced using a Harvard-style teaching case presentation, and circulated for comments.

communication, an extreme case of task interdependence (Thompson 1967). Some controversies were caused by rival preferences for the goal of a component. Lack of local goal congruence interacted directly with budget issues. Hence, the DSMs capture both the local goals of the components and the corresponding capital budgets.

The lack of local goal congruence invariably cascaded a level down into controversies over the design requirements that hinged on the availability of particular resources. Thus the DSMs were decomposed into a system of hierarchical decisions. The aim was not to exhaustively represent the planning problem, but to illustrate high-level interdependencies. To this purpose, two design requirements were captured: 1. the capacity of the component, a requirement that affects operational cash flow; and 2. the footprint of the component, a requirement that affects how much land is necessary. The data also revealed controversies a level further down related to sub-elements of a component such as aesthetics, and the DSMs illustrate these too.

To further investigate how to sustain a constrained collaborative development I built companion matrices to illustrate the distribution of the right to directly influence the high-level decisions. These matrices were important to make sense of the nested layers of governance forums created to discuss and try to resolve the controversies.

Once the structure of the DSMs and organizational matrices was nailed down, I proceeded to qualify the sample of planning problems. Concurrently, open coding and tabular displays of the raw data (Strauss and Corbin 1990) were used to refine the emerging insights and seek generalisations beyond the small-N study (Tsoukas 2009). To this purpose, I reviewed the transcripts and extracted quotations, or ‘thought units’ (Miles and Huberman 1994) about the controversies. Secondary data was useful to verify interview data and thus provide a validity check on the empirical findings.

As I iterated between data analysis and theory development, I gradually discerned: 1. an overarching pattern in the governance structures and goodwill to collaborate; and 2. four mechanisms employed to resolve sharp controversies. I stopped iterating between data and theory when theoretical saturation was reached.

I proceed next to analyse the data before discussing the conceptual framework. Figure 2 illustrates the DSM and organizational matrices for two cases, whereas Table 2 illustrates a summary of a tabular display produced to analyse the quality of the collaborative environment and how salient controversies were resolved.

<Insert Figure 2 and Table 2 here>

Analysis

The analysis is structured by explaining first the empirical regularities that suggest efforts to decentralise mega-project governance across a network of local working groups; overseeing the local groups is a top governing body that must ensure the local components cohere into a whole commensurate with the global performance targets. The analysis then looks at four mechanisms to sustain these highly-fragile collaborations where the urgency to get things done brings to the fore interests-based negotiations without dislodging, however, efforts to engage in effective collaboration.

The Polycentric Governance of Mega-projects

Polycentricity is an intuitive approach to structure large collective action arenas that decentralises governance across a nested structure of centres of decision-making and power and shared rules (Ostrom 1990, 2005). In robust implementations, local groups gain autonomy insofar they keep to higher-level rules. If the local groups fail to converge, they agree to defer the problem to higher-order bodies who in turn commit to work with the local claimants for searching a mutually acceptable solution.

Planning a mega-project creates a large collective action arena, and in agreement with theory, we uncovered systematic efforts to decentralise governance across a top

governing body and a network of local groups, the latter open to participation by local, resource-rich stakeholders; excluded from the local groups are NIMBYs⁶ and resource-poor actors (these are merely consulted); the promoters' agent is a member of all the governing bodies in a boundary spanning role (Tushman 1977).

In the Olympics case, for example, the promoters and their agent, the Olympic Delivery Authority (ODA), agreed to spend two years in planning after the victory of the London bid⁷. The conflation of time pressure with tensions between developing for the games vs. leaving a sustainable legacy challenged effective collaboration—'there isn't one [Olympics] where people haven't got at each other's throats', warned a seasoned top official. But in London2012, the top governing body prided itself of succeeding to encourage the development of norms of collaboration after investing substantial resources in co-location, inviting all key stakeholders to participate in the planning meetings, and leveraging an ideology around national pride to build a 'esprit-de-corps' as one official put it. Still, the intent to collaborate did not eliminate the need for tough multiparty negotiations throughout planning; one manager said:

It's continuous negotiation, a tough, tough environment because of the limited flexibility to make changes; it's a very difficult process. ...it really comes down to our understanding that one of us cannot be successful without the other... that drives you.

To attenuate managerial complexity, efforts were incurred to create a governance structure that mirrored the modular structure of the park. Within solution spaces constrained by the bid pledges, the local groups received substantial autonomy. The local groups were large and thus the ODA appointed a local sponsor to facilitate the talks for each group; one sponsor said, "It's important to have this fulcrum...design is subjective...so I act as a referee, I try to sort out disputes... being the cheerleader".

⁶ Not-in-my-back-yard (NIMBY) refers to opponents to plans for a scheme that would be close to them

⁷ The 2-4-1 strategy boiled down to two years to plan, four years to construct, and one year to handover

As it turns out, the presence of a local convener did not preclude sharp controversies from arising. The local groups systematically insisted that the budgets were too tight (the deadline was immovable). But a major slippage of the local target could compromise the global budget unless it was offset with savings elsewhere. Thus, the top governing body had to invariably step in the local planning talks.

Interestingly, the lower decomposability of the HS2 design structure did not preclude efforts from the scheme's promoter (the Department for Transport) and its agent (HS2 Ltd) to decentralize governance. Evidence also suggests genuine efforts to encourage collaboration. Each city offered a particular set of challenges to seek consensus, and thus for each city, a working group was created with the city leaders and other local claimants; one HS2 official appointed to convene one group said:

It's always about face-to-face interaction and having the right people in the room who are the decision-makers and who know the facts. ... how people move and where the city is going. ...and who will give the facts in an unmitigated, unwritten way.

The city leaders wanted grandiose stations seamlessly integrated with public transit systems and the urban fabric, and long tunnels to minimise property blight. To sharpen and justify their preferences, the cities commissioned master plans; to create additional contexts where to discuss the issues and create knowledge (Nonaka 1994), the city leaders formed boundary groups open to the HS2 officials but not to all local claimants. A similar motivation led the government to create another boundary group, the HS2 Growth Taskforce, with overlapping memberships with the other groups.

Resolving the high-level plan for each station required to weave together decisions on the budget, capacity, footprint, and the integration with the surroundings. Unlike the Olympics case, local autonomy was limited both by performance targets set ex-ante as well as by technical constraints imposed by a system-wide technical directorate such as a non-negotiable footprint (100m x 500m) for the future stations.

As in the Olympics case, the local working groups struggled to bridge their differences. The stations aimed to catalyse urban regeneration, a consensual goal, but the local groups argued that the government was not supplying enough money. To keep planning on time and within budget whilst preserving equity in capital allocation, the HS2 officials found it tempting to recommend plans to the Secretary of State which had not been fully endorsed by the city leaders. The ultimate decision-making power rested a level above with the Cabinet⁸; one HS2 Ltd official explained:

HS2 Ltd, if you like, are the infantry out there; actually doing what they're told by [central] government. So HS2 Ltd get all the fights, appear to have all the fights, are the bad boys, but they're really only doing what they're instructed to do

Crucially, however, the top governing bodies had less decision-making power than could be assumed *prima facie*. De jure, the promoters had power to impose a reasonable solution after a local group failed to converge. But invariably, our findings suggest, the top governing bodies would rather rekindle multiparty negotiations with the top ranks of the local hierarchies. This was true for T2 ('if something gets talked, it gets changed because if they [BAA] don't listen, it will get escalated and then they get embarrassed, said a STAR person), as well as for the publicly-financed schemes:

You could exercise emergency powers to make HS2 its own planning authority, so nobody has legislative or statutory control over what we're doing ... [but] that would flout democratic processes...it would be a pretty bold decision [HS2 senior official]

Preserving deference in voluntary, consensus-oriented collaborations mitigates the risk of defection (Ostrom 1990, O'Mahoney and Ferraro 2007). In turn, decentralising governance creates opportunities for face-to-face interaction and for social norms of collaboration to flourish despite tough negotiations, and thus adds to make a large collective action arena robust and self-sustainable (Ostrom 2005).

⁸ The UK Cabinet is the collective decision-making body of the UK Government, composed of the Prime Minister and the most senior ministers who head the government departments.

But all cases show that sharp controversies remain unresolved in spite of actions aimed at encouraging effective collaboration and evidence-based decision-making. The conflation of urgency, stakeholder heterogeneity, and intractable sub-problems makes it hard to set ex-ante robust local targets. And decisions to relax local targets generate high propagation costs (Sharman and Yassine 2004) by either setting a precedent or causing delicate trade-offs. The lack of time to seek consensus and deliberate brings tough interests-based negotiations to the fore, which makes the collaboration highly-fragile. We turn now to discuss four mechanisms for sustaining these strained collaborations. Figure 3 illustrates the logic emerging from the analysis.

Gauge robustness of global buffers to shield legitimacy in the eyes of 3rd parties from local deals and umpire's judgment
Figure 3—Sustaining Highly-Fragile Collaborative Developments

Loosening Performance Targets

Mega-projects do not unfold in competitive markets. Rather, they inch forward as a coalition competes for limited resources and fends off opposition in the environment (Szyliowicz and Goetz 1995, Altshuler and Luberoff 2003, Lundrigan et al. 2014).

In ambiguous collective contexts, early commitments give legitimacy to resource acquisition plans (Stone and Brush 1996). This is also the case in our setting. To acquire the necessary resources, the promoters rush to commit to global performance targets; the decision to do so is often taken against advice from technocrats; one said:

“they [politicians] love announcing projects...our guidance is ‘no matter what your press people say...don’t be drawn towards providing a spot figure; it’s foolish, you’ve just created a hostage to fortune to yourself’.

Once global performance targets are announced, collective action becomes constrained. Our findings confirm claims that promoters suffer from optimism bias (Flyvberg et al. 2003)—as one respondent put it ‘early on, people’s eyes are much bigger than their stomachs’.⁹ As planning unfolds, pressure mounts to relax the local cost targets to allowing for more scope or to relax the local timescales to allowing for more time to deliberate. The top governing bodies dislike local slippages because they compromise equity (‘if we do that, what’s that going to mean for somebody else?’ said one official), and potentially compromise global performance targets. Still, in all our cases, slippages in local targets were essential to resolve sharp controversies.

The Aquatics centre is a good example. The budget was set at £75m in 2004 prices, a figure wholly insufficient to deliver an iconic venue. When planning was re-set after London won the bid, local pressure to let the budget slip rapidly mounted. One year in planning, the budget had duplicated and continued on a rise. Unilateral attempts by the Olympic Delivery Authority (ODA), the promoters’ agent, to bring the costs down infuriated local claimants who used political backchannels to force the ODA’s hand. By 2008, the budget had spiralled to near £242m (final prices) and a public outcry ensued—‘the history of the aquatics centre shows’, said a Parliamentary report, ‘that the games’ organisers seem to be willing to spend money like water.’

The Heathrow T2 case provides a second example of the use of slippages in performance targets to sustain a highly-fragile collaboration. In this case, BAA, the

⁹ Wachs (1989) and Flyvberg et al. (2003) go far to argue that promoters deliberately ‘lie’ or ‘strategically misrepresent’ the targets; as it happens, the claim has gone viral but supporting evidence is scant; when boldly challenged, one respondent said “if you weren’t optimistic, you wouldn’t get into this sort of job... but in 40 years of work I can’t think of a single incident where people deliberately falsified the number...people are usually very conscientious about these things”

airport owner, clashed with the main user, the STAR alliance, over the superordinate goal at the onset of planning in 2006. BAA framed the scheme as a replacement of old buildings, whereas STAR craved a modern airport campus. Divergences notwithstanding, BAA chose to announce a £1-1.5bn scheme to open in 2012.

If BAA succumbed to pressure from STAR to change the goal for the concourse buildings, the corresponding performance targets would have to slip. And to finance a greater capital investment, BAA, the regulator, and all airlines using the airport would need to negotiate a steeper increase in the airport fees. As it happened, the parties took three years to converge during which the local targets slipped three times.

The first phase of HS2 provides a third example. In this case, the Mayor of London made it a sine qua non condition for supporting the scheme to receive central government support for a new £27bn London railway (Crossrail 2). The crux of the conflict was disputable evidence suggesting the London underground system bursts unless Crossrail 2 opens before completing HS2. Impasse quickly ensued with some parties reading the Mayor's position as political blackmail and others praising his fight for the interests of Londoners. With national elections nearing, the deadlock has potentially been broken after the UK Cabinet endorsed a £6bn railway for connecting the major northern cities. We turn now to analyse the value of global buffers.

Global Buffers

Compiling risks of cost and schedule overruns is a deep-seated practice when planning any project (Cleland and King 1983). Some risks are technical, for example, escalation in land decontamination costs, others are financial (e.g., spike in inflation), and others relate to the outcomes of the planning talks. Once the risks are nailed down, probabilistic simulations enable to quantify the best- and worst-case scenarios.

The top governing body then faces a judgement call: either they set optimistic global targets which increase the attractiveness of the scheme but also the risk of late

slippages. Or they set robust global targets which impair the cost-benefit analysis, but warrant more certainty to the performance expectations; one civil servant explained:

There's a bandwidth there...if we push it [budget] too far, we won't get the project at all. ...so there's that game that goes on to try and find what the [UK] Treasury's real limits are, and how far can we really push it. ...it's a political decision.

In the T2 case, for example, the profit-seekers ruled out the use of large buffers confident on their ability to neutralise the public backlash from any overruns. And indeed the budget target was allowed to slip multiple times until they fixed a final budget with a 8% provision for risk three years before opening. In contrast, in the other cases, the elected leaders had no appetite to let the budget slip multiple times.

The Olympics case is a good example. The £4.2bn¹⁰ budget that supported the bid was wholly insufficient to leave a sustainable legacy; complicating matters was uncertainty in requirements that was expected to last well past the 2008 games. But by mid-2006, pressure mounted to fix the budget and the Cabinet settled on a large buffer (£2.7bn) on top of a £6.5bn budget (final prices w/VAT); one official said:

Treasury were really, really clear...big envelope and never knock on our door for money...actually they were right...we were then able to make decisions...rather than being petrified because we didn't have enough money to do what we needed to do

The analysis reveals a similar approach in Crossrail and HS2. In both cases, the promoters faced a public outcry caused by slippages in the cost target in early planning that threatened to derail the schemes. To mitigate further risks, the promoters ditched the original budgets for new budgets with substantially larger contingencies.¹¹

Large global contingencies create a buffer, but do not outrightly eliminate local controversies and the need to negotiate. Our findings suggest that promoters self-administer tough scrutiny on the use of contingencies to mitigate the risk of running

¹⁰ Includes £2.375bn public funding to build the Olympic Park plus \$1.044bn for land acquisition and £738m of anticipated private sector finance for Village and Media Centre (2004 prices, no VAT)

¹¹ The Crossrail contingency set up in mid planning mounted to £2.9bn (42% of the initial estimated cost) and the contingency for HS2 was set at £16.1bn (47% of the initial estimated cost)

out of slack later on—‘[contingencies] are there for known risks, not for somebody’s betterment’, said one official. Hence planning talks still unfold constrained by tight budgets and deadlines. (Evidence suggests, however, that self-fulfilling prophecies are hard to avoid in the long run.¹²) We turn now to discuss the role of flexible designs.

Flexible Design Structures

Modular design structures attenuate rivalry in design preferences, but are not free (Baldwin and Clark 2006). To safeguard integral designs for competing scenarios in use, for example by investing in excess capacity or built-in allowances, is also not cheap even if it potentially pays off (Gil 2007). Still, across all cases, we identified controversies that after much haggling were resolved through flexible designs.

The case of the Olympics aquatics centre is telling. The London 2012 bid proposed a massive venue with an aesthetically seductive wave-shaped roof. But as said, the costs quickly spiralled in planning. To back down from the bid pledge was difficult since the concept from the internationally-renowned architect had received worldwide acclaims as a sculptural masterpiece—one ODA official said: “if you challenge these people directly they will just walk away.” Complicating matters was a hard constraint on the minimum capacity. After tough negotiations, the partners agreed to reduce the venue size down to a third without sacrificing the aesthetics, and add temporary modules to raise the capacity from 2,500 to 17,500 seats for the games.

Design flexibility was also handy to resolve controversies between BAA and STAR. For example, the airport operator insisted that all the terminal gates should be ‘open’ to reduce costs and allow passengers to move around whilst waiting for the flights. But some airlines refused to sign off the drawings unless they were offered

¹² The Olympics contingency was practically all used to fund transfers of ODA scope to LOCOG, the collapse of private finance deals, and the security bill; Crossrail plans to use it all too (NAO 2014)

closed gates which they deemed more efficient. The planning talks lasted many months until the issues were finally settled with a concept that left both options open.

The case of the Olympic stadium, in turn, illustrates the difficulties in negotiating flexible designs. The top governing body was divided over whether the stadium in legacy should host a football club or athletic events. A football stadium was more viable in legacy, but doing so would renege the bid pledge. The alternative was to invest 20% more to create a dual-use stadium. But football aficionados pushed back—‘[with retractable seating] you basically live in a compromise all the time’, said one. With time running out, the Olympic board decided to progress with an inflexible design. The infighting between the dissenting parties continued until 2013 when the London and central governments agreed to invest £131m to add retractable seating¹³.

In other incidences of controversies where the actors struggled to converge, they deferred the problem to an independent actor, an *umpire*, and we next discuss its role.

The role of the *Umpire*

An antecedent of effective collaboration is the presence of a legitimate convener with credibility in multiple arenas touched by the problem to draw together autonomous stakeholders (Gray 1989). In the case of mega-projects, it is the promoters’ job to garner support for local goals and corresponding plans. But the pressure to achieve consensuses on controversial issues, juxtaposed with categorical opposition by some local parties, impairs the promoters’ legitimacy and credibility. Thus, as planning unfolds, sharp disputes arise. The political (and legal) fights that ensue between the promoters and i) those who unyieldingly oppose to the scheme; ii) actors displeased with the outcomes of consultations, are outside the focus of this study. The focus here are controversies between rich resource-holders with divergent

¹³ By October 2014, the costs of the stadium conversion had risen to £190m due to difficulties encountered by the contractors to install a roof to cover the athletics track and the retractable seating

interests but unified by the superordinate goal. It turns out that the presence of an umpire was crucial to carry these resource-rich stakeholders along.

We already analysed how BAA and STAR resolved their divergences over open versus closed gates by investing in flexible designs, a solution that BAA strongly fought against because it would force the company to draw £4m from the risk provision. Impasse was avoided after the regulator stepped in. The presence of the regulator was reassuring for both parties; as one BAA respondent said, ‘we’re battling all the time ...if the airlines don't like it, then they can bring in a formal dispute’.

And indeed, the airlines wrote several letters to the regulator pointing a finger at BAA. The airlines wanted flexibility to change things and delay decisions. BAA in turn was impatient to freeze the design—‘our job is to consult, not to get consensus... I can never get consensus on almost anything’, explained the BAA capital director.

In the other cases, the UK Parliament played the role of umpire. The HS2 case is telling. Every actor impacted by the plans could petition against the scheme. Petitioners included local councils and agencies who had been working together with the promoters and shared the higher-order goal. Still, they were unhappy with the local plans and trusted on Parliament to extract more concessions; one official said:

HS2 didn’t persuade us that our points were wrong nor did they persuade us that their points were right. ...[petitioning] gives us the ability to correct what we feel is a mistake. ... that’s ultimately about making your case that your vision is superior.

The umpire brings advantages and disadvantages. It is effective to put an end to controversies that dialogue and evidence could not resolve within the time afforded by the environment without undermining democratic participation. But the umpire is a time-consuming, costly mechanism, and a source of late slippages in the performance targets. Its presence also fuels a lot of positional bargaining. One elected leader said:

there are projects that we wholeheartedly support, but we will still put in an objection because there are particular things we want to get out of it....some of this has to do with timing as well. It's often the case that... it's better to object than to wait.

And indeed, in the case of Crossrail, for example, two thirds of the 365 petitions lodged against the scheme were withdrawn after the promoter and petitioners cut private deals. Even then, the Parliamentary process for Crossrail lasted 40 months.¹⁴

The Olympics case is the exception since, in 2005, the Parliament rushed to grant the promoters the necessary planning power. The promoters abstained from exercising it indiscriminately and gave the local authorities voting rights in an internal planning board. But a level above, there was no umpire—'you've got powerful figures all over the place...you can't govern', said one official (Norris, Rutler, Medland 2013). Facing a hard deadline, the option left was relaxing the local budget. But the stadium example shows that some issues were settled not by throwing more money at them, but because people ran out of time; as one ODA official summarised, "that pressure to keep moving forward forces people to either put up or shut up, to make a decision."

In summary, our analysis shows that planning a new large infrastructure creates a large collective action problem that is subjected to decomposition. But the need to preserve equity across local groups under pressure to keep to the global targets limits efforts to decentralize governance and seek local consensuses. Still, top managers have their authority curtailed because suppressing democratic participation would undermine the legitimacy of both local solutions and of the enterprise as a whole. To carry the parties along as the highly-fragile collaborative development inches forward, we uncover three first-order mechanisms: loosening local targets, global buffers, and flexible designs. Resorting to an umpire is an inefficient solution of last resort.

¹⁴ As for HS2, it is unclear how long it will take for the Parliament to consider the 1,925 petitions that were lodged against the first phase. The bill was submitted in late 2013; at the time of this writing, the process missed the original target (May 2015) and is now expected to last until the end of 2016.

DISCUSSION

We return now to our central question: how to sustain a highly-fragile collaborative development? These voluntary-based collaborations are formed to tackle complex problems wherein no single actor or coalition controls all the necessary resources. Hence in contrast to authority hierarchies formed to solve complex problems (Nadler and Tushman 1997, Siggelkow and Rivkin 2005) management cannot unilaterally choose which decisions and tasks they centralise at the top versus delegate to lower levels; and no heavyweight managers exist empowered to overthrow local decisions and to design buyer-supplier contracts suitable to *buy* effective collaboration (Clark and Fujimoto 1991). Governance is, perforce, decentralised.

Polycentric governance encourages local stakeholders to volunteer resources necessary to develop mutually acceptable solutions for local problems (Ostrom 1990). But a decentralized search for interdependent sub-problems tends to slow and get bogged down as the problem's complexity (the number of sub-problems) increases (Ethiraj and Levinthal 2004, Mihm et al. 2003). Complicating matters, the absence of robust performance targets creates difficulties in coordinating local solutions, and time pressure cuts short local dialogue necessary for deliberative, evidence-based decision-making. Hence the risks are high of impasses ensuing and actors defecting. To get things done and remove bottlenecks, people turn to compromises and bargaining, forms of ineffective collaboration (Lawrence, Hardy, and Phillips 2002).

In the case of mega-projects, efforts to exploit their decomposability potential attenuate the misalignment between organization and design structures (Colfer and Baldwin 2010, Sosa, Eppinger, and Rowles 2004), and thus reduce management complexity. At local level, the high-level development choices are tightly coupled—the clusters of off-diagonals 'x' reflect people's difficulties to define a consensual

goal commensurate with an equitable distribution of resources and capable to nest the plurality of local interests. But much less interdependence exists across components. The same applies at the organizational level. Promoters aside, each component is directly relevant to differing local groups. Hence mega-projects create complex problems with interaction patterns characteristic of small-world networks (Milgram 1967, Rivkin and Siggelkow 2007) in which most interactions are local, yet a few interactions exist between elements of the system that are distant from each other.

As governance gets decentralised, opportunities arise for local stakeholders to interact face-to-face with the promoters' agent in small groups. And in collective action, face-to-face communication is essential for a group of autonomous actors with divergent interests to achieve a shared understanding of the problem and consensus (Chen, Chen and Meindl 1998, Ostrom 1990, Hardy, Lawrence, Grant 2005).

Unsurprisingly, the local groups try to optimise locally due to self-interest (Gavetti and Levinthal 2000, Knudsen and Levinthal 2007). But unlike 'rubberstamping hierarchies' (Rivkin and Siggelkow 2003), the top governing bodies cannot sit idle as the local groups seek to make their wishes come true. Hence the challenge becomes not to find local optima but to find *satisficing* (Simon 1969) local solutions that cohere into a whole commensurate with the global targets. To facilitate local searches, nested decision-making forums, or 'trading zones' (Kellog, Orlikowski and Yates 2006) are set up with overlapping memberships. This suggests that people are intuitively tuned to the benefits of 'multiplexing' resources as a mechanism useful to harness the benefits of institutional pluralism (Garud et al. 2014).

Still, seeking consensus is not easy when time pressure is an impediment for effective collaboration to flourish amongst competing groups each one providing a differing legitimating account to back their claims (Creed, Scully, and Austin 2002).

Complicating matters, stakeholder heterogeneity makes it hard to balance meritocracy-based authority with mechanisms that ensure democratic participation as observed in less heterogeneous communities of production (O'Mahoney and Ferraro 2007, O'Mahoney and Becky 2008, Tuertcher et al. 2014). In this challenging context, four mechanisms to sustain the highly-fragile collaborations surface.

Loosening Performance Targets

The consensus-oriented networks formed to plan large infrastructure fail to perform in project management terms (Cleland and King 1983, Morris 1994, Flyvbjerg et al. 2003) since slippages in performance targets inject oxygen critical to sustain a highly-fragile collaboration. If the promoters stick to the original targets, the risk of the collaboration derailing increases disproportionately. Forging ahead without commitments under ambiguity would be noble, but makes it hard to acquire the resources necessary to get the scheme initially off the ground (Stone and Brush 1996).

This insight suggests that we need a more nuanced conceptualization of performance to evaluate constrained, consensus-oriented collaborative developments. For the actors fully committed to the superordinate goal, positive performance seems to a degree to be ploughing through the controversies and staying in the game. Of course performance is enhanced if years or billions are shaved off during planning. But if need be, given the lack of incontestable evidence and time to reach consensus, people are prepared to let the targets slip to prevent the collapse of the collaboration.

Paradoxically, slippages in the global targets put at risk the sustainability of the pluralistic collaboration because they undermine its legitimacy in the eyes of third parties (Suchman 1995). As preserving this legitimacy is one aim of ineffective collaborations (Lawrence et al. 2002), this brings us to the role of global buffers.

Global Buffers

Global buffers built in the global cost and schedule targets create organizational slack (Bourgeois 1981) and thus stoke criticism that they lead to inefficient developments. They also create a (potential) self-fulfilling prophecy (Merton 1948). By suggesting that the development, if need be, may take longer and cost more, the built-in contingencies endogenously influence the outcomes of the local dealings. Furthermore, commitments in large global contingencies make the schemes economically less attractive, amplifying the risk of producing a ‘white elephant’.

But the buffers created by built-in contingencies play an important role too. By creating slack, they enable the promoters to hammer out local deals, and let local targets slip if need be without having to compromise the global targets. Hence the buffers give the collaboration breathing space to cope with individual claims and discontinuities in the environment without undermining the scheme’s legitimacy in the eyes of third parties. As such, they help balance the tension between making premature commitments with keeping to those commitments (Stone and Brush 1996).

Not all mega-projects adopt large global buffers, though. In our sample, BAA looked down on the government’s use of large contingencies which in their view led to ‘over-egged budgets’. Furthermore, since no one knows what the future holds when project timescales span decades, top governing bodies self-administer tough scrutiny on requests to deploy contingency funds. In extremis, large global buffers are effective to placate a credible threat of collapse of the collaboration. But they do not outrightly relax problem-solving and are therefore not a sine qua non condition to sustain a highly-fragile collaboration. This leads us to the role of flexible designs.

Flexible Design Structures

When many autonomous parties share the right to directly influence a one-off design, investing in flexible designs and technologies can eliminate the controversies

caused by rivalry in preferences for the final design of the zero-sum sorts that even robust governance fails to resolve (Gil and Baldwin 2013). Indeed, our analysis shows that when autonomous parties are running out of time to produce more evidence and seek consensus, a flexible design can help the dissenting parties to make inroads.

A flexible design does not need to address conflicting interests symmetrically. Rather the design can privilege one scenario in use over a competing one. Still, a flexible design removes a bottleneck by reassuring the party struggling to convince others of the superiority of her argument that the final design eliminates irreversibility and the loss of built-in options. Thus a flexible design structure creates risk-neutral solutions with higher expected benefits for everyone (Baldwin and Clark 2000).

But producing large components that are both modular in use *and* efficient is difficult. Some modular designs also sacrifice performance in use, and thus are contestable. A precautionary alternative is to safeguard integral designs against foreseen scenarios—a limited form of flexibility that works as an insurance policy but is also not cheap (Gil 2007, de Neufville and Sholtes 2011). Hence decisions to invest in design flexibility will be contested under resource constraints and differing planning horizons (Gil and Tether 2012), which brings us to the role of the umpire.

The Role of the Umpire

In the world of sports, the umpire is a referee appointed to settle disputes and thus to ensure that a game is played fairly and stays on time without violating the rules. In collective action, the absence of affordable conflict-resolution bodies is a source of fragility in governance (Ostrom 1990). The absence of a brokering organization also complicates collaboration—a recognised boundary-spanner or conflict resolution body might not have *de jure* authority to settle disputes, but can still be effective if its judgement is trusted and is thus warranted *de facto* authority (Gray 1989).

But in collective action, an alternative forum to resolve conflicts also creates a negative precondition for the parties to self-resolve their differences (Reilly 2001). Thus the umpire is also a source of inefficiency. Untangling empirically the pros and cons of having an umpire in post is further complicated because the umpire is a source of noise in the negotiations. Its existence makes it tempting for some actors to threaten to lodge a petition, putting others on tenterhooks over calling it a bluff, making a concession, or digging in on opposite sides and defer resolution to the umpire.

Bargaining tactics aside, many controversies cannot be self-resolved in a reasonable amount of time. Eliminating the umpire is itself not viable since third-party opponents need a forum to make their case. The umpire thus is a pragmatic mechanism that reassures all the stakeholders affected by the collaborative development that the strained development can still inch forward despite their sharp disagreements. Using the umpire triggers a late cycle of knowledge critique and justification (Garud et al. 2014). Hence the umpire is a solution of last resort.

In summary, evaluating the performance of a highly-fragile collaborative development against initial expectations is unduly harsh. It misses the point that collective action plans (Astley and Fombrun 1983) aim to get the ball rolling, not to offer accurate forecasts. It also ignores that the governance of highly-fragile collaborations is a struggle. Not recognising the need to let the scope evolve over time, and concomitantly to let performance expectations slip, is to ignore the wicked problem of getting things done under pressure without endangering democratic participation; and without expecting social norms of collaboration to fully dislodge mutual-gains bargaining and compromise-seeking in a pluralistic enterprise.

CONCLUSION

The motivation for this study is a conundrum about mega-projects—the vehicles formed to build “the fundamental infrastructures that support civilisation” (NAE 2014), and a grand challenge facing democratic societies: can we say the collaborative networks formed to plan large infrastructure are failing when they appear to lose control of the performance expectations (which is seemingly par for course)?

To shed light on this question, I argue that mega-projects are planned by highly-fragile collaborations, and thus pose a problem that offers opportunity to build theory in collaborative development. Whilst these schemes evince ineffective collaborations (Lawrence et al. 2002), I rather call them highly-fragile since sustaining the collaboration to the end under adverse conditions is itself a measure of effectiveness.

The study starts by showing that the decomposability potential of infrastructure designs allows for a degree of decentralised governance which attenuates management complexity. But the conflation of pressure to get things done, premature committals to secure initial resources, and intractable sub-problems makes it hard to delineate ex-ante robust spaces for local solutions. As local pressure mounts to violate higher-level rules, promoters step in to: i) preserve equity; and ii) balance needs for loosening local targets to keep the collaboration afloat with needs to preserve global legitimacy. Hence there are real limits to decentralize governance whilst autocratic decision-making is not a viable option. In highly-fragile collaborations, performance cannot be evaluated against initial expectations. If the scope cannot evolve, the collaboration is not democratic. And if the scope evolves, the targets must evolve too.

Striking a balance between letting performance expectations slip without letting things (appear to be) get out of control is not trivial. But failure to do so can turn the scheme into a political football and see it trashed in the court of public opinion. Mega-

projects are suggestive of tightrope walking. To prevent fatal falls, three first-order mechanisms surface. Local slippages facilitate the search for satisficing local solutions. Global buffers mask local slippages. And flexible designs allow for coping with competing needs in use. Taken together, these self-organizing actions resolve potentially most controversies that threaten the sustainability of the collaboration.

As a safety net, controversies can be deferred to an umpire—this is disappointingly inefficient. The mere presence of this mechanism is itself a source of much haggling because the landscape of sub-problems is rugged: some sub-problems are more complicated than others, and some stakeholders are more patient and more likely to conform to social norms of collaboration than others. Thus the umpire creates opportunities for free riders to seek concessions disproportional to their stakes.

To attenuate pressure to keep to global performance expectations without sacrificing democratic participation, global completion dates can be made ‘soft’ as opposed to hard to accommodate local slippages (the case of Crossrail and T2), whereas local concessions can be financed from independent budgets to keep the scheme ‘within budget’ (the case of HS2). Still, these practices do not obviate mega-project planning from the pitfalls of committee-based decision-making (Rosenkopf, Metiu and George 2001), and thus from the risk of producing ‘white elephants’.

The most important limitation to the generalizability of the findings is the environment surrounding the cases. The UK legal environment offers a stringent regime of planning laws designed to protect property rights; and the country’s political first-past-the post, so-called winner-takes-all system, gives elected members strong incentives to defend local interests. Even societies modelled after the UK will not have exactly the same institutions and dimension. Thus we can expect differences in the governance structures designed to plan mega-projects and in how they perform.

In conclusion, I argue that mega-projects create large arenas of collective action. Efforts to decentralise governance attenuate managerial complexity. But the collaborations are ineffective due to the conflation of a one-off network of heterogeneous stakeholders, integral designs, irreversible outputs, and limited time to develop local goal congruence. In this context, genuine efforts to encourage social norms of collaboration to flourish cannot fully dislodge tough negotiations.

Challenges notwithstanding, I uncover four mechanisms that combined resolve the most acute controversies, and thus keep these highly-fragile collaborations afloat. But sustainability per se is not a good indicator of effectiveness if the outcome is an infrastructure whose life-cycle costs are disproportional to its usefulness. But when the outputs are long-lived, and the socio-economic implications of ditching the capital investment itself are highly ambiguous, performance cannot be pre-judged in haste.

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Table 1 - High-level description of the sample of cases, interviewees, and archival database

Cases	London 2012	Heathrow T2	Crossrail	High-speed 2
Higher-order shared goal	Build an Olympic park and catalyse urban regeneration of East London	Build a new airport terminal for the STAR Alliance (STAR)	Connect East and West of London with a high-capacity train	Connect London to Birmingham (1 st phase); Birmingham to Northern regions (2 nd phase)
Key promoters	UK government; London governments; BOA; LOCOG(\$)	BAA, Regulator, STAR Alliance	UK government, London Government	UK Government
Time pressure during planning	Massive ~2 years (05-07) to totally redo planning after the victory of London's bid	High ~4 years (05-08) to plan before starting a new regulatory cycle (quinquennium)	High 4 years (01-05) to redo planning so as to start the Parliamentary process before the 2005 elections 2005-2008 (Parliamentary process)	Massive (1 st phase) ~4 years (09-13) to plan so as to finish the Parliamentary process before 2015 elections Moderate (2 nd phase) ~6-7 years to plan (2010-16/7)
Global target for the project budget	Gradually relaxed 2004, £4.2bn (final prices, no VAT) 2007, £9.3bn (final prices w/VAT) 2013, £8.9-10.2bn (different sources)	Gradually relaxed 2005, £1.0-1.5bn (possibly 05 prices) 2008, £2.0bn (07/08 prices) 2014, £2.6bn (cash prices) (*)	Gradually relaxed 2002, £9.8bn (2002 prices) 2008, £15.9bn (final prices) (¥) 2014, £14.8bn (cash prices)	Gradually relaxed 2010, ~ £30bn (2009 prices) 2012, £32.7bn (2011 prices) 2014, £42.6bn(2011prices)+ HS3, Crossrail2
Global target for the project timescale	Immovable Summer 2012	Relaxed and made 'soft' 2005, open in 2012 2010, open 'gradually' in 2014	Relaxed and made 'soft' 2003, fully open in 2016 2012, 2017-2019	Under pressure 2026, 1 st phase 2030-33, 2 nd phase
Interviews (Units of Analysis)	36 (11 controversies)	19 (5 controversies)	33 (9 controversies)	35 (12 controversies)
Number and description of organizations interviewed	8: London2012 (bid company) ODA (promoters' agent); LOCOG (games operator); OPLC (park operator); Transport for London (TfL); CLM (programme manager); Land Lease (private developer); Network Rail (owner of UK rail infrastructure)	5: STAR Alliance, Air Canada, BAA, HETCo and Balfour Beatty (private design and build companies)	8: CLRL (promoters' planning agent); Crossrail, (promoters' delivery agent); Network Rail; UK Treasury; Transport for London (TfL); Canary Wharf (private funder); Bechtel, Transcend (consultants)	11: HS2 Ltd (promoter's agent); Manchester City Council (MCC); Greater London Authority (GLA); Transport for London (TfL); Borough of Camden; Transport for Greater Manchester (TfGM); Network Rail; UK Treasury; Manchester Airport; CH2MHill, AECOM (consultants)
Archival data: Total number of documents (except news articles) organised by categories	Total Number of Documents: 469 Strategy and planning documents: 260 Financial reports: 6 Formal communication: 5 Newsletters and PR documents: 111 Design documents: 16 Meeting minutes: 71	Total Number of Documents: 114 Strategy and planning documents: 74 Financial reports: 6 Formal communication: 19 Newsletters and PR documents: 8 Design documents: 4 Meeting minutes: 3	Total Number of Documents: 122 Strategy and planning documents: 74 Financial reports: 2 Formal communication: 6 Newsletters and PR documents: 23 Design documents: 9 Meeting minutes: 8	Total Number of Documents: 66 Strategy and planning documents: 22 Financial reports: 2 Formal communication: 20 Newsletters and PR documents: 12 Design documents: 8 Meeting minutes: 2

(*) Inflation in construction prices was nil between 2008-2013

(¥) £15.9.bn (final prices for a completion date around 2016) is about £11.1bn at 02 prices (assuming 3.5% discount factor)

(§) LOCOG, London Organising Committee of the Olympic and Paralympic Games and International Olympic Committee (IOC)'s watchdog; BOA - British Olympic Association

Figure 2- Excerpts of the Design Structure Matrices and Companion Organizational Matrices for the London Olympic Park and HS2 cases

Table 2- Excerpt of tabular display analysing: Quality of the collaborative environment and Mechanisms used to resolve controversies

Case	Quality of the collaborative environment	Embedded controversy	Resolving the Controversies				
			Quality of the negotiation talks	Locus of resolution	Problem-solving	Design flexibility	Loosening targets
London Olympic c Park	Plenty of evidence of intent to collaborate effectively: Listen to stakeholders <i>A lot of it was listening to the communities, the grassroots ... I don't think anyone felt there was a hierarchy. ... there was a very healthy egalitarian challenge ...</i> [ODA Official] Reciprocity <i>I've never pushed to get that [need for greater flexibility] changed or to bypass that because I know exactly what is to sit in their chair [LOCOG Official]</i> Mutual trust <i>This nobly culture -- sitting down on regularly, open, honest non-judgmental relationships, if something isn't going well stick it on the table -- I think it's really important</i> [ODA official]	Olympic stadium	Lack of goal congruence <i>Tough: no willingness to seek compromise</i> <i>What's wrong with leaving an athletics centre ... why do we have to publicly subsidise the richest clubs in the world? why? It's public land ... it costs a fortune to accommodate ... don't renege on your responsibility to public sport</i> [ODA official]	Top governing body <i>We went back to the Board 3 times ... there were no credible [football club] bids - full stop</i> [ODA official]	Mutual compromises under time pressure <i>We needed to move</i> [ODA official]	Yes <i>Foundations sized for worst-case scenario; retractable seats (in last round)</i>	Yes <i>04, £282m (04 prices exc. VAT)</i> <i>07, £422m (cash prices exc. VAT)</i>
			Divergences over sub-element (lighting) <i>Tough: efforts to leverage power imbalances</i> <i>Broadcasters come to the party quite late ... and start saying things like 'we want this and that ... in a scheme of £7bn, the retrofitting isn't a big thing'</i> [LOCOG official]	Top governing body <i>They [IOC] aren't paying the bill</i> [ODA official]	Unilateral concessions <i>We're having to embark on a fairly expensive change</i> [ODA official]	No <i>Need for UK to be seen as leading on broadcast technology</i>	<i>13, £537m (cash prices exc. VAT)</i> <i>14, ~£600m (cash prices excl. VAT)</i>
		Aquatics centre	Sharp divergences over capacity budget, footprint <i>Tough: efforts to leverage power imbalances</i> <i>There was a lot of pressure to keep to the original budget ... the architects wouldn't compromise an inch ... it [budget] wasn't their problem ... they threatened to walk away ... they could have part company from us ... and we party company from them</i> [ODA official]	Top governing body	Compromises and tough negotiation <i>Quid pro quos: e.g., aesthetics stay, but venue must shrink to a third of original size</i>	Yes <i>Temporary 15,000-seats in modular wings</i>	Yes <i>2004, £75m (2004 prices)</i> <i>2007, £182m (cash price exc. VAT)</i>
			Divergences over sub-element (diving boards) <i>Tough: no willingness to seek compromise</i> <i>We [ODA] said we weren't going to change the diving boards ... they [FINA] sent an architect to prove they wouldn't work ... LOCOG was playing a political game telling FINA we can change ... they [LOCOG] wouldn't stand up to FINA, but we would</i> [ODA Official]	Top governing body	Tough negotiation <i>Claimant (Aquatics Federation-FINA) caves in after much haggling, and new evidence</i>	No <i>Why buy this [roof] and don't buy the diving boards? ... I always saw it as a sculpture really</i> [ODA official]	<i>2013, £229m (cash prices exc. VAT)</i>
	Plenty of evidence of intent to collaborate effectively: Shared higher-level goal: <i>the high-level principles, we've never had an issue with</i> [TfL official] ... while I support the Government's aspiration ... the current proposal is inadequate [London of Mayor] Willingness to meet face-to-face <i>I'm very happy to sit down ... want to reassure Manchester supporters about the plan</i> [HS2 top official] Mutual respect <i>They [HS2 Ltd]'ve got an idea of what they want to see and we too ... we're both respecting of each other</i> [Manchester Council official]	London Euston Station	Lack of goal congruence, and sharp divergences over plans <i>Tough: people carrying the cards close to the chest</i> <i>We've asked: can they [HS2 Ltd] share the cost data with us ... and they won't share that with us ... doubtless, they don't want us to be able to prepare ourselves to counter that</i> [LGA official] <i>The process has worked somewhat like tennis. They [HS2 Ltd] will send us a proposal, we review it, pass it back, they look at it, pass it back</i> [TfL official]	Umpire (or late deal) <i>We'll petition because the design as it stands is awful [and] potentially unsafe ... it's not a failure to converge, just failure to agree with each other's visions</i> [TfL official]	Ongoing negotiations <i>Original scheme was a fairy-godmother scheme</i> [HS2 Official] <i>once bill is submitted ... there might be a sort of 'we'd think about this a bit more if you drop that</i> [LGA official]	Yes <i>We asked HS2 Ltd. to make passive provision for Crossrail 2 ... so we can easily plug it into the development</i>	Yes <i>2011, £1.1bn</i> <i>2014, £2.1bn</i> <i>The principle that suggests that all the works at Euston are on the HS2 credit card has been accepted</i> [TfL official]
		Manchester St.	Goal congruence, but sharp divergences over plans <i>Moderate: genuine effort to seek consensus</i> <i>We're engaged with the work that they [HS2] might be doing around station design, they're engaged with us on the wider regeneration program ... our objective is always to try get consensus</i> [Council elected leader] <i>They took our involvement very seriously ... it did feel like we were really part of the process</i> [TfGM official]	Difficult to predict <i>We don't want to petition, we want to do it here (Council elected leader)</i>	Ongoing negotiations <i>If government devolves tax return, the Council can consider to pay for investments</i> [Council position]	Unlikely <i>They [HS2] came up with the option that it was one station next to another ... we see one integrated multi-modal transport hub</i> [Council official]	Yes (inevitable) <i>2011, £350m</i> <i>But Council argues it will increase benefits</i> <i>We aren't an open cheque book</i> [HS2 official]