

Organizational capital in boundary-spanning collaborations: internal and external approaches to structure and authority

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Abstract

Despite a large body of scholarship elucidating mechanisms for aligning participant behaviors with public service goals in boundary-spanning collaborations, the most challenging of these collaborations – those lacking common goals and resources – have received relatively little attention from public management scholars. This study investigates approaches to structure and authority by leaders of this sort of collaboration, specifically by leaders of cooperative research centers involving government, industry, and university actors. The findings demonstrate external approaches to structure and authority when such controls are perceived by leaders as valuable for eliciting participant contributions yet difficult to develop internally, and internal approaches when such controls are perceived as valuable for eliciting contributions yet unattainable externally. These findings have implications for public management research and theory and more broadly for organization and network research and theory, as well as for public policy and management practice. The paper concludes with a set of propositions to test in future research.

Keywords

Organizational design, network management, collaborative governance, boundary-spanning collaboration, strategic human resources management

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1. Introduction

Policies and programs at all levels of government in the US have focused for decades on facilitating collaboration among organizational and individual actors spanning multiple boundaries for coordinated problem solving. Because these arrangements pose challenges to the coordination of disparate actors with their own resources and goals, a body of scholarly work has emerged focused on elucidating explanatory mechanisms for aligning participant behaviors with public service goals in boundary-spanning collaborations, including explanations emphasizing resource interdependence (Van de Ven & Walker 1984), goal congruence (O'Toole 2003), and formal (Brown & Potoski 2003) and informal (Rethemeyer & Hatmaker 2008) structures and authorities. The types of collaborations addressed in this body of work cover numerous areas of provision (O'Leary et al. 2006), but the most critical collaborations for management scholars to address are those for which neither resource interdependence, goal congruence, nor structures and authorities are easy to come by, making the inducement of contributions from participants possessing mission-critical expertise and other critical resources a formidable management challenge (Page 2003).

One area in which this challenge seems especially formidable is in the management of boundary-spanning collaborations focused on scientific and technical research involving participants from government, industry, and academia (Bozeman & Boardman 2003). The federal government and many state governments implement policies and programs addressing problems requiring scientific and technical remedies by establishing public-private cooperative research centers that have become well-known for a confluence of management constraints precluding the facilitation of goal congruence and resource interdependence among participants and limiting the internal development of the structures and authorities required for coordinated problem solving

when common goals and resources are lacking or absent (Boardman & Bozeman 2007, Boardman & Ponomariov 2007).

This study investigates approaches to structure and authority for a purposive sample of cooperative research centers involving government, industry, and university participants established by the US National Science Foundation (NSF).² Organizational structure and personnel authority are conceived as resources in their own right, as “organizational capital” (Barney 1991, Barney & Wright 1998) for NSF center leaders to develop internally and/or to access in the external environment when goal congruence and resource interdependence are viewed as lacking or absent. The decision to pursue an internal, external, or a combined (internal and external) approach to structure and authority is thusly conceived as an organizational boundary choice (Chesbrough & Teece 1996, Poppo & Zenger 1998) in which center leaders (i) make ties to external structures and authorities when such controls are perceived as valuable for eliciting participant contributions to center goals yet difficult to imitate internally and (ii) develop structures and authorities internally when such controls are perceived as valuable but are unattainable externally.

Inquiry into the internal and external approaches to organizational capital in public-private cooperative research centers is critical to both public management practice and theory. For public management practice, the conceptualization of structure and authority as resources to access in the external environment as well as to develop internally may not be specific to boundary-spanning collaborations focused on scientific and technical research. The contingencies by which NSF center leaders approach organizational capital may provide broader practical insight insofar that the provision of public goods and services, including but not limited to that

² NSF centers are boundary-spanning, university-based research units that involve full-time academic faculty from multiple university departments (and therefore from multiple academic disciplines) across multiple universities as well as researchers from private industry and government laboratories. NSF centers are typically geographically dispersed and can involve little if any shared or common infrastructure and equipment across sites, depending on the research foci and the number and locations of the institutions involved (Bozeman & Boardman 2003). The basic nature of NSF centers used for this study, and comparable arrangements outside the NSF at the federal and state levels, is addressed in section 2 below.

stemming from scientific and technical endeavors like research, is increasingly knowledge-intensive and boundary-spanning (Government Accounting Office 2007). For public management theory and more broadly for organization and network theories, systematic assessment of collaborations lacking common goals and resources as well as the internal structures and authorities for inducing participant contributions in their absence addresses a contingency that has received relatively little attention in the management literature. While past research and theory have conceptualized structure and authority as resources per se (Barney 1991, Barney & Wright 1998), organizational capital has yet to be conceived as a resource to access in the external environment.

Inquiry into internal and external approaches to organizational capital in public-private cooperative research centers is also critical to public policy. Centers like those at the NSF are established to address some of the most salient problems that society faces today, for instance for investigating remedies to diseases like cancer, for developing surveillance technologies for the remote detection of weapons of mass destruction, and more broadly to facilitate US economic competitiveness (National Academies of Science 2007).³ The energy technologies the Obama Administration posits as fundamental to global economic recovery, environmental stewardship, and US national security, moreover, likely will be developed conjointly by government, university, and industry participating in cooperative research centers or comparable arrangements (Block & Miller 2008). Thus understanding how to organize and manage boundary-spanning research centers has direct implications for the implementation of numerous national and subnational policies focused on a broad array of social and economic problems.

This effort is organized as follows. The next section describes NSF centers as both networks and organizations to elucidate their potential for low levels of goal congruence, resource

³ According to the Research Centers Directory, there are almost 16,000 university-based and other non-profit research centers in the US and Canada, more than 8,000 government-based research centers in the US and Canada, and over 13,000 non-US research centers in 160 countries. The Directory lists 37,000 research centers worldwide. See <http://library.dialog.com/bluesheets/html/bl0115.html>.

interdependence, and internal structure and authority. Based on these descriptions, section 3 outlines the analytic framework for the study, which specifies expected patterns between different levels and types of goal *incongruence* and resource interdependence and different approaches to organizational capital (i.e., internal, external, both) by NSF center leaders. Section 4 discusses the study design, including case selection, inferential logic, and related considerations; this section also discusses the methodology, which is multi-case and qualitative due to how little general knowledge exists about approaches to structure and authority in NSF centers and comparable arrangements. Section 5 presents the findings, which demonstrate two basic patterns. First, leader perceptions of different types of goal incongruence in NSF centers correspond with different approaches to structure and authority, some internal and some external. Second, in the instances in which leaders perceive faculty dependence on their center for particular types of resources, neither internal nor external approaches to structure and authority in NSF centers are evident.⁴ Section 6 concludes with implications for research and theory and for policy and management; this section also specifies propositions to test in future research featuring expanded data and quasi-experimental design.

2. NSF centers as collaborative networks, as organizations, and their potential for coordinated problem solving

NSF centers share attributes characteristic of both collaborative networks and formal organizations. Like collaborative networks, by definition all NSF centers are boundary-spanning.⁵ Unlike networks but similar to formal organizations, NSF centers typically have static or fixed

⁴ However, there are exceptions to this general pattern based on the professional idiosyncrasies of individual center leaders, especially past career experiences in other centers and/or industry.

⁵ Though NSF centers vary widely in terms of research foci (Stahler & Tash 1994) and policy goals (Bozeman & Boardman 2003), all are “problem focused,” emphasizing not the extension of knowledge in a particular field or discipline per se, but rather the production of new knowledge and technology to address social and economic problems (Boardman & Gray 2010). This focus on problems rather than disciplines sees that most NSF centers are also boundary-spanning, involving faculty from multiple disciplines (and thusly from multiple academic departments and universities) and from multiple sectors (including industry, universities, and government). Boundary-spanning collaboration is regarded as the primary justification for funding centers, at the NSF and elsewhere (Becker & Gordon 1966, Ikenberry & Friedman 1972).

leadership and attempt to develop structure and authority where before there was very little.⁶ However, leaders of NSF centers face a confluence of management constraints that increase potential for low levels of the resource interdependence and goal congruence required for coordinated problem solving within networks and organizations focused on non-routine and knowledge-intensive work like scientific and technical research, which proves challenging because this type of work is not amenable to the internal complexity and formalization upon which managers and leaders typically rely in the absence of common goals and resources (Ouchi 1980).

2.1. NSF centers as dysfunctional collaborative networks⁷

Cases for this study were drawn from two of the best-known and longest-standing centers programs at the NSF: the Engineering Research Centers and Industry/University Cooperative Research Centers programs.⁸ Both of these programs are intended to facilitate research collaborations spanning the boundaries between universities, government, and industry to facilitate work in areas requiring scientific and technical input from multiple disciplines and from multiple perspectives – specifically to address problems that extant organizations (i.e., academic departments, government laboratories, and private companies) are either unable or unwilling to address unilaterally given their respective resource and risk capacities. Thus, in impetus, NSF centers are quite similar to collaborative networks as generally depicted in the public

⁶ Though NSF centers vary widely in terms of research foci (Stahler & Tash 1994) and policy goals (Bozeman & Boardman 2003), all NSF centers programs publicly solicit for proposals from teams of university faculty. Accordingly, each center grant that is awarded from its inception is university-based and to be lead by the principal investigator(s) who submitted the original grant proposal. Moreover, proposals for all NSF centers programs are required to address internal organization and management, including horizontal and vertical differentiation and authority lines. For examples of center proposal solicitations and awarded proposals, visit the NSF web sites for the two NSF centers programs used for this study: the Engineering Research Centers Program and the Industry-University Cooperative Research Centers Program.

⁷ The characterization of NSF centers as “dysfunctional” collaborative networks is not to suggest that centers cannot be or are not successful at achieving intended scientific and technical outputs and attendant social and economic outcomes. Indeed, NSF centers have achieved many successes in these regards (Bozeman & Boardman 2004). Rather, the use of this descriptor is intended to suggest that NSF centers may and have been documented to lack fundamental mechanisms by which collaborative networks are known to function.

⁸ The NSF has established public-private cooperative research centers since the early 1970s. Program and center case selection criteria are discussed in section 4.

management literature (Agranoff 2003, Agranoff & McGuire 2001, Mandell 2001, Nelson 2001, O'Toole 1997a, O'Toole 1997b).

Another similarity between NSF centers and collaborative networks is the absence of formal authorities. As collaborative networks generally operate outside the rational-legal basis for authority, NSF centers typically do not exercise personnel authorities over researchers, most of whom have full-time, tenure-track appointments in university departments (Bozeman & Boardman 2003). NSF centers thus, again like networks, are faced with the challenge of aligning the behaviors of participants across institutions and sectors with center goals without formal reward (or sanction) for participant contributions (or the lack thereof). Accordingly, center leaders must perform similar roles as perform network managers, including but not limited to the manipulation of existing social structures (Kickert et al. 1997).

However, there are important differences between NSF centers and collaborative networks that help to elucidate the managerial constraints faced by center leaders. Though resource interdependence explains the impetus for and implementation of many networks for public service provision (Rethemeyer & Hatmaker 2008), the perspective's overarching assumption – that participants engage with one another because none singularly has the resources needed to achieve its own goals – generally does not hold for NSF centers. The research conducted in NSF centers in many instances does not constitute the core activities for academic (Boardman & Bozeman 2007, Boardman & Ponomariov 2007) or industry (Feller et al. 2001) participants. Thus, in contrast to networks, the balance of resource dependence in NSF centers is weighted towards center leadership (Bozeman & Boardman 2003). Though center participants typically can function and pursue their respective research agendas without center resources, the center typically cannot do so without the involvement of particular participants.

Other differences between NSF centers and collaborative networks further elucidate the managerial constraints faced by center leaders. Though on its face the center model – i.e., collaborative research involving university, industry, and government personnel, overseen

annually by the NSF (or other government agencies) by way of external evaluators and annual site visits – seems similar to some of the network governance modes identified by Provan and Kenis (2007), centers lack the mechanisms that help these different governance modes to function. For example, to the extent that the NSF may be a core resource provider for its centers, NSF centers could be interpreted as “lead organization-governed networks” (Provan & Kenis 2007), which have asymmetric power distributions among network participants due to a particular organization’s control over network-critical resources. However, due to potential low levels of faculty dependence on NSF centers for resources, neither the NSF nor any of the university or industry participants in NSF centers wields such power (Bozeman & Boardman 2003). Moreover, while NSF centers have both targeted funding and lead administrative organizations that are separated from the collaborative work of university, industry, and government participants (i.e., the NSF), the types of boundaries spanned by these centers ensure low levels of goal congruence (Boardman & Bozeman 2007), thus differentiating them from “network administrative organizations.”⁹

2.3. *NSF centers as dysfunctional organizations*¹⁰

Differences in the modes of provision to which collaborative networks and NSF centers represent alternatives suggest that centers are as much exercises in organizational design as they are networks. While networks operate in a context where bureaucracy no longer provides the primary mechanism for provision, NSF centers operate in a very different context, in which unstructured, individual investigator or “small” science (Polanyi 1962) no longer constitutes an adequate mechanism for provision. Thus, NSF centers are explicit attempts to organize

⁹ Provan & Kenis (2007) show this mode of network governance to have separated administrative bodies and targeted funding but to require high “goal consensus” among participants to function successfully.

¹⁰ The characterization of NSF centers as “dysfunctional” organizations is not to suggest that centers cannot be or are not successful at achieving intended scientific and technical outputs and attendant social and economic outcomes. Indeed, NSF centers have achieved many successes in these regards (Bozeman & Boardman 2004). Rather, the use of this descriptor is intended to suggest that NSF centers may and have been documented to lack fundamental mechanisms by which organizations are known to function.

participants by developing structure where before there was very little, rather than attempts to move towards collaboration but away from organizational complexity and formalization.¹¹

Insofar that all NSF centers are university-based, they introduce higher levels of structure to scientific and technical research than can be found in typical university settings (Friedman & Friedman 1982). For instance, NSF centers are relatively hierarchical and centralized (i.e., when compared to departmental laboratories), with a leader setting goals, evaluating performances, and overseeing project selection for center research, typically but not always with the aid of an external advisory board (Bozeman & Boardman 2003). Thus, unlike collaborative networks, which may have rotating managers due to resource interdependence, NSF centers, much like conventional organizations, have static leadership that does not change due to the mission-criticality of any particular participant's expertise or resources.

However, there are differences between NSF centers and formal organizations that further elucidate the managerial constraints that center leaders face. Unlike organizations, the extent to which leadership in NSF centers has the authority to govern organizational behavior is limited. It is a matter of policy at the NSF that centers draw most if not all faculty from university departments, specifically faculty who are tenure-track. Other center faculty may hold full-time positions in private firms or government laboratories. Accordingly, NSF center leadership cannot exercise formal personnel authority and is precluded from meaningful engagement in a number of organizational design activities, including the articulation of enforceable rules and procedures for governing participant behaviors and the use of contracts and other mechanisms to formalize personnel obligations to the center (Crow & Bozeman 1995).

Even if center leaders could exercise increased authority, the non-routine and knowledge-intensive nature of scientific and technical research limits options for internal structuration.

¹¹ The characterization of collaborative networks as movements away from structure and authority is a generalization, one to which there are exceptions. For instance, Rethemeyer and Hatmaker (2008) demonstrate resource interdependence in networks to result in "hilly" rather than "flat" terrain in terms of the informal hierarchies that emerge based on control over resources. This is discussed further below.

Therefore a fundamental management objective of center leadership is goal congruence to assure participant contributions in the absence of formal authorities and structures (Ouchi 1980), which can prove challenging when organizational environments are “complex” (Meyers et al. 2001). Yet, NSF centers are complex in ways that seem to assure low levels of goal congruence, both among center participants and between center participants and center leadership. Not only do center participants from different disciplines have competing operant goals related to their individual research agendas, in public-private research collaborations there are also divergent goals across institutions and sectors regarding the dissemination of research findings.¹²

3. Framing organizational capital decisions in NSF centers: leader perceptions of goal incongruence and resource interdependence

Per the above characterizations, two overarching expectations frame leader responses to the potential dysfunctions of NSF centers as collaborative networks and formal organizations.¹³ The first is that different types of goal *incongruence* will correspond with different organizational capital decisions in NSF centers, including the development of internal structures and authorities, ties to external structures and authorities, or both. The second is that high levels of resource interdependence and/or goal congruence (i.e., low or no goal *incongruence*) in NSF centers will mitigate the need for organizational capital by center leaders.

3.1. Key mechanisms

3.1.1. Perceptions of goal incongruence by NSF center leaders

The framework for this study is depicted in Figure 1. It addresses two types of goal incongruence, both documented in NSF centers (Bozeman & Boardman 2003, Boardman & Bozeman 2007). The first type is similar to that depicted in the public management literature between the formal goals of policy officials and the operant goals of public managers

¹² For example, though universities typically value “open” science and the publication of results in peer-reviewed journals, industry and sometimes government value more proprietary or restricted modes of dissemination (Merton 1959).

¹³ This study does not assume the dysfunctions found by prior study (reviewed in section 2), but rather addresses them in the case studies below.

implementing policies. While center leadership is attuned to the policy goals of the NSF (e.g., technology transfer to industry), the researchers participating in the center are focused on their own academic careers (e.g., generating and publishing new knowledge). The second type of goal incongruence has to do with competing operant goals among participating faculty. NSF centers are designed to facilitate collaboration among faculty who have different disciplinary backgrounds and institutional affiliations, and thus who have different research agendas. While this type of goal incongruence is common at policy implementation (Pressman & Wildavsky 1984), seldom is it emphasized in either organizational or network studies due to the roles that structuration and resource interdependence can fulfill to align participant behaviors with collaboration goals.

<Insert Figure 1 about here>

The framework emphasizes perceptions of goal incongruence by NSF center leaders. In contrast, prior assessments of organizations focused on scientific and technical research, typically private firms, operationalize goal congruence as decentralized decision making rights and pay-for-performance (e.g., Laursen 2002, Laursen & Foss 2003). While these factors are included in the current analysis (discussed below), leader perceptions are emphasized because center approaches to structure and authority typically are decisions made by center leaders, based on their observations of the motives and goals of participants. Even if inaccurate, perceptions inform decisions about NSF center management.¹⁴

3.1.2. Perceptions of resource interdependence by NSF center leaders

The framework also addresses resource interdependence – specifically, the dependence of participating faculty on the center for different types of resources – which has been documented as lacking or absent in many NSF centers (e.g., Bozeman & Boardman 2003, Boardman &

¹⁴ Few studies explaining organizational structure and management practice use direct measures of goal incongruence. Neither the current study nor the literature compares reports of goals among organizational members and leaders. This may be appropriate for organizations as “leader driven” as are NSF centers and other organizations focused on research (Ettlie et al. 1984, Davis et al. 2010). However, there are studies that assess directly value congruence in organizations, though these studies typically are not intended to explain organizations but rather organizational outcomes (e.g., Amos and Weathington 2008).

Bozeman 2007). Despite these prior findings, leader perceptions of resource interdependence are addressed explicitly because such perceptions may be reason for leaders not to take any approach towards organizational capital. If participating faculty depend on the center for resources for their own research, then little structure and authority may be required to facilitate coordinated problem solving, even when there is goal incongruence (Ouchi 1980).¹⁵

Because most faculty participating in NSF centers work full-time for academic departments harboring traditional expectations for research productivity, the center resources upon which faculty participants may rely could include one or more of the essential factors of production for scientific and technical research, including funds for research and salary as well as access to faculty collaborators (human capital), student research assistants (labor), and equipment and infrastructure (capital). Faculty will probably not depend on centers for resources interpreted more broadly, e.g., for organizational processes (Daft 1983), since these are made available to them by their “home” academic departments. As with goal incongruence, leader perceptions of resource interdependence are emphasized because approaches to structure and authority in NSF centers are first and foremost leader decisions, informed by observation of the motives and goals (and needs) of faculty participants.

3.1.3. Structures and authorities for governing behaviors in NSF centers

The premise of this paper is that NSF center leaders approach organizational capital based on the internal imitability versus the external availability of the structures and authorities that they view as requisite to coordinated problem solving. The first internal option is to develop some semblance of complexity and formalization within the center, despite the knowledge-intensive and non-routine nature of scientific and technical research (Ouchi 1980). Such attempts

¹⁵ Thus resource interdependence constitutes an “alternate explanation” of structure and authority in NSF centers. The explicit consideration of alternate explanations is required for “good” case study as defined by Arneson (1993) and Yin (1994). The perception of resource interdependence is addressed explicitly in the framework, despite findings of past case study of NSF centers finding low or no resource interdependence (Bozeman & Boardman 2003, Boardman & Bozeman 2007), because faculty dependence on centers for resources, not the opposite, is the direct operationalization of the mechanism for an absence of organizational capital in NSF centers. Such “directness” is necessary since the absence of structure and authority constitutes the alternate outcome in the framework depicted in Figure 1.

at internal structuration in NSF centers may be similar to attempts by private companies focused on scientific and technical research, including vertical differentiation and matrix management (Souitaris 1999, Laursen 2002, Laursen & Foss 2003). However, the unique constraints of NSF centers as networks and as organizations (see section 2) may limit center leadership to less formal internal structures, e.g., “role structures” that assign tasks to researchers in center projects but fall short of the articulation of formal rules for behavior (Rethemeyer & Hatmaker 2008). Another internal option is to hire researchers who are full-time employees of the center and over whom center leaders may exercise formal personnel authorities (e.g., hire, fire, promote), essentially creating internal authority.

NSF center leaders may also access external structures and authorities by establishing relationships with the academic departments that exercise direct control over faculty participants. Informally, such relations may work to reduce role conflict for center faculty by aligning center and department goals for shared faculty. Formally, center-department ties may see center input into departmental tenure and promotion decisions, among other types of decisions pertinent to the career advancement of faculty participating in centers. Thus, organizational structure and personnel authority may be conceived by center leadership as resources in and of themselves, as “organizational capital” (Barney 1991) or as “capabilities” (Amit & Schoemaker 1993) to access in the external environment, rather than as something to develop internally.

3.2. Hypotheses for goal incongruence, resource interdependence, and organizational capital

The general expectation guiding this paper is that NSF center leaders will develop organizational capital under conditions in which they perceive low levels of both goal congruence and resource interdependence (Ouchi 1980) in the center. How NSF center leaders respond to such conditions may be likened to boundary choices in organizations. On one hand, center leaders may create structure and authority internally. On the other hand, leaders may attempt to leverage

external structures and authorities by establishing ties to the organizations where faculty participants have full-time appointments.¹⁶

3.2.1. Expected patterns for organizational capital and perceptions of goal incongruence in NSF centers

The expected patterns for leader perceptions of goal incongruence and organizational capital in NSF centers are summarized in top half of Table 1 (the shaded area). Goal incongruence among center faculty is expected to elicit the development of internal complexity and formalization in NSF centers, because the resource or capability is not available outside the center.¹⁷ Only the center leader has the unique task of coordinating the goals and attendant activities of the precise set of personnel represented by center participants.

<Insert Table 1 here>

Goal incongruence between center leadership and faculty is expected to elicit both internal and external approaches to organizational capital in NSF centers. Internally, center leaders may create new positions and with them new personnel authorities, e.g., new positions for non-academic research faculty over whom personnel authority may be exercised. These full-time personnel may be hired to contribute to some of the industry-related goals of centers that are not aligned with the goals of academic faculty and their departments (Arreola et al. 2003). Externally, center leaders may establish ties with the university departments where academic faculty participating in centers have full-time appointments. Here, organizational capital is available

¹⁶ It should be noted that there are important differences between the traditional conceptualization of organizational boundary choices and the conceptualization of structure and authority as organizational capital for center leaders to develop in-house and/or to access externally. The decision between internal and external approaches to organizational capital in NSF centers is not as directly a function of the comparative costs of either option as it is a direct response to the types of goal incongruence and resource interdependence, if any, perceived by center leaders.

¹⁷ Following the framework depicted in Figure 1, for parsimony in Table 1 expectations for all of the potential perceptions by NSF center leaders are not addressed explicitly. The perception of goal congruence is not addressed explicitly due to the findings of past case study and evaluation of NSF centers (finding goal *incongruence*, see Boardman & Bozeman 2007, Boardman & Ponomariov 2007); but the explicit emphasis on goal incongruence being followed by one or more approach to organizational capital implies that if these perceptions do not exist, then no approach to structure and authority should be evident.

externally only; the controls that departments exercise over tenure-track faculty participating in the center are not imitable by center leadership.¹⁸

3.2.2. Expected patterns for organizational capital and perceptions of resource interdependence in NSF centers

The expected patterns for leader perceptions of resource interdependence and organizational capital in NSF centers are summarized in bottom half of Table 1 (the un-shaded area). Generally, faculty dependence on the center for one or more of the different types of resources needed for research (see 3.1.2) is expected to mitigate the need for organizational capital in NSF centers, even if there is goal incongruence.¹⁹ Thus, in centers with resource-dependent faculty coordinated problem solving among diverse sets of actors is expected to occur much as it occurs in networks for collaborative governance, i.e., with no single actor being able to achieve its individual goals without contributing to the broader goals of the network (Rethemeyer & Hatmaker 2008).

3.3. Antecedents to perceptions of goal incongruence and resource interdependence

3.3.1. General organizational characteristics of NSF centers

¹⁸ Though the external approach to organizational capital seems similar to resource “brokerage” activities (Rethemeyer & Hatmaker 2008) and to the manipulation of existing social structures towards achieving particular goals (Kickert et al. 1997) in collaborative networks, the conceptualization of structure and authority as capital to access externally elaborates the management repertoires of leaders in boundary-spanning collaborations faced with constraints similar to those found in NSF centers. For instance, while establishing ties with the university departments and other organizations that exercise direct controls over participating faculty on its face seems like brokering of the use of a shared resource, departments are not participants in centers, have divergent goals for academic faculty, and are not reliant on the center for access to or use of faculty (Morris et al. 2002). Moreover, departments can restrict faculty from participating in centers (Geisler 1995). Thus in making external ties to departments, NSF center leaders are not mediating the use of a shared resource as much as they are attempting to reduce role conflict for center faculty and to participate in the management of academic careers, which may help to legitimize to departments the contributions of academic faculty to center goals. Moreover, while establishing ties with the organizations exercising personnel authorities over center participants seems like the manipulation of existing social structures to achieve center goals, it is the organizational boundary of the center that is redefined. For NSF centers, and for other boundary-spanning arrangements facing similar organizational constraints, structure and authority are core competencies (Barney 1991) that exist in the external environment that are not wholly or easily imitable internally. However, leaders of NSF centers may of course attempt to manipulate the structures and authorities of departments once ties to these external controls are established (discussed further in section 6).

¹⁹ Following the framework depicted in Figure 1, for parsimony low levels of resource interdependence are addressed only implicitly; the explicit emphasis on the perception by NSF center leaders of faculty dependence on the center for resources being followed by no approach to organizational capital implies that if these perceptions do not exist, then some approach to structure and authority will be taken, dependent on the type of goal incongruence perceived.

Figure 1 depicts the perception by NSF center leaders of some (but not all) types of resource interdependence as consequences of general organizational characteristics, including organizational technology and organizational size. Organizational technology in organizations or organizational units focused on scientific and technical research as a core activity may be “radical,” i.e., relatively divergent from existing knowledge and practice, or “incremental,” i.e., focused on the application of existing knowledge and practice (Tauber 1974, Ettlíe et al. 1984, Dewar & Dutton 1986). The expectation is that leaders of NSF centers pursuing relatively radical research will be more likely to perceive faculty dependence on the center for access to human resources (see Table 2), because this type of research is more likely to require contributions from faculty with diverse backgrounds and training (Gibbons et al. 1994), who typically are not available in discipline-based university departments (Siegel et al. 2003).²⁰ However, this expectation is tentative given that faculty dependence on the center for resources of any type is plausible only when center research is central to or at least closely aligned with the discrete research agendas of the individual faculty participating in the center.

<Insert Table 2 about here>

Organizational size is addressed in terms of personnel and funding. The expectation is that leaders of larger centers in terms of faculty counts will be more likely to perceive faculty dependence for access to human capital and labor, i.e., collaborators and students, respectively, while leaders of larger centers in terms of funding will be more likely to perceive faculty dependence for access to funds and equipment (see Table 2). However, as with organizational technology, these expectations are tentative; if NSF center leaders do not perceive center research as central to or closely aligned the research of participating faculty, then no relationship between organizational size and resource interdependence is expected.

²⁰ This organizational feature is also expected to increase perceptions of goal incongruence, see the discussion of center multidisciplinary in section 3.3.2.

Organizational environment is excluded from the framework because ERCs and IUCRCs are exposed to comparable external constraints and opportunities for structure and authority. Both types of center are university-based and reliant predominantly on academic faculty; both are required by the NSF to develop industry and government partnerships; and both must meet similar reporting and other requirements for the NSF, on a similar timeline. More broadly, both ERCs and IUCRCs are exposed to the same institutional environment for federal support.

3.3.2. Boundary-spanning characteristics of NSF centers

Figure 1 depicts perceptions of goal incongruence by center leadership not as a direct result of general attributes like organizational technology and size, but rather of related boundary-spanning features. One such feature is the multidisciplinary nature of center faculty. The extent to which center research diverges from existing knowledge and practice may influence center leaders' perceptions of goal incongruence, because the creation of new fields of knowledge and practice requires the integration of different disciplinary knowledge and skills (Gibbons et al. 1994). Accordingly, NSF centers with "radical" organizational technologies may span more disciplinary boundaries than centers performing research that does not diverge from existing knowledge and practice. Thus, given the general mission of the ERC program to create new fields for new industries rather than to serve existing industries, the leaders of ERCs may be more likely to perceive goal incongruence among participant faculty due to high levels of multidisciplinary nature. However, leaders in IUCRCs with high levels of multidisciplinary nature too should perceive this type of goal incongruence. In contrast, any NSF center, whether an ERC or IUCRC, with lower levels of multidisciplinary nature should be less likely to elicit leader perceptions of goal incongruence among faculty (see Table 3).

<Insert Table 3 about here>

Another boundary spanned by NSF centers is the university-industry boundary, which is related to the perception of goal incongruence between center faculty and center leadership. While all of the centers included in this study are required by the NSF to have industry partners,

the nature of each center's industry partnerships can vary in ways that affect the extent to which center leaders perceive incongruence between faculty and the broader policy goals of the center. For instance, centers' industry partnerships may entail specific projects for specific companies, or they may entail open access to center research by all industry partners (Lal et al. 2007). Similar, private companies may partner with centers to gain general access to "upstream" modes of knowledge, or they may do so for technical assistance (Santoro & Chakrabarti 2002). Accordingly, project selection decisions in centers may be driven predominantly by industry, by center faculty, or by some combination. It seems likely that center leadership will perceive incongruence between faculty and center goals when project selection decisions are made predominantly by industry. In contrast, faculty-driven project selection should not elicit this type of goal incongruence.

Table 3 shows an expected pattern between center multidisciplinary and faculty dependence on the center for access to human resources, for cases in which NSF center leaders view center research as central to the individual research agendas of participating faculty. Though it seems plausible that for faculty participating in centers with industry-driven project selection processes that there must be faculty dependence on such centers for access to the funds and/or capital (e.g., equipment, infrastructure) they require to pursue their individual research agendas, this scenario seems likely only in cases in which the organizational size of the center is relatively "large" in terms of net assets (see 3.3.1).

The framework also addresses the boundary-spanning characteristics of NSF centers at the individual level of analysis, specifically whether center leaders have past career experiences in industry and/or in other centers. For instance, a center without the boundary-spanning characteristics at the organizational level hypothesized to coincide with perceptions of goal incongruence (see Table 3) may be led by an individual who no less perceives goal incongruence of one type or another, perhaps due to prior experiences in another center with boundary-spanning features at the organizational level. Thus, approaches to organizational capital

in NSF centers may be as much a function of the personal idiosyncrasies on NSF center leaders, e.g., past career experiences, as of organizational level antecedents like a multidisciplinary faculty or an industry-driven project selection process.

4. Study design and method

Because little prior work has been conducted on structuration and management in NSF centers, and because NSF centers demonstrate organizational constraints that deviate from those found in conventional networks and organizations (see section 2), the design and method for this study is necessarily multi-case and qualitative.

4.1. NSF center case selection

This study analyzes the structure and management of 21 NSF centers. Cases were drawn from the ERC and IUCRC programs due both to their similarities and their differences. On one hand, both types of center operate in the same organizational environment. On the other hand, the organizational technologies and boundary-spanning characteristics of ERCs and IUCRCs can be (but are not always) quite different. However, it is important to clarify that this study is not a comparison of NSF programs. While some structural and managerial differences across the cases may fall along programmatic lines, the current analysis is focused as much on explaining intra-program differences across center structures and management.

Criteria for selecting a “theoretically representative” (Strauss & Corbin 1997) sample of cases included organizational technology (i.e., program affiliation) and common antecedents to structuration and management in organizations, including size, age, and boundary-spanning characteristics (e.g., disciplinary, institutional, sectoral, geographical). Most of these variables are introduced above (see section 3).

The IUCRC program currently has more than 50 active centers. Twenty IUCRCs representing the programmatic range for center size, age, and multidisciplinary were contacted to participate in this study. Of these, 12 agreed to participate. Though a substantial proportion (40%) of the contacted IUCRCs did not participate, the centers that participated are representative

of program ranges for size, age, and multidisciplinary. In terms of age, the program range is 1-26 and the program inter-quartile range is 3-10. For the IUCRCs that participated in this study, the range for size is 2-26 and the inter-quartile range is 4-8. For size, the program range is 2-68 and the program inter-quartile range is 9-27. For participating IUCRCs, the range for size is 8-68 and the inter-quartile range is 20-30. In terms of center multidisciplinary, there was not much variation. Across the IUCRC program, the number of disciplines represented by center faculty ranges from 1-5. For the IUCRCs included in this study, the range is 1-5.

The ERC program currently funds 12 active centers. Because this number is much smaller than for the IUCRC program, each active center was targeted as a case study. Thus, center size, age, and multidisciplinary were not explicit considerations in ERC case selection. The response rate for the ERC solicitations was much higher than for the IUCRC solicitations – of the 12 active ERCs, 9 agreed to participate in the study. The ERCs that did not agree to participate do not differ greatly across the case selection criteria from those that did choose to participate. The range in age for ERCs participating in the study was 1-9, the range in size was 25-100, and the range in multidisciplinary was 3-9.

4.2. Multi-case comparison

This study employs a multi-case methodology drawing on in-depth, semi-structured interviews with center leaders as well as on documentation for each case center, including annual reports and Web sites. Thus, this study corroborates findings by triangulating across perspectives and data types, exceeding the criteria for “good” case study as laid out by Arneson (1993) and Yin (1994). Also consistent with case study methodology, this study accounts for alternate as well as expected patterns (Yin 1994).

Center leaders were solicited for interviews via email. Each interview lasted 1-1.5 hours and was conducted via telephone. The interviews were recorded using a professional online service. Summaries of the transcripts were sent to interviewees, who were invited to correct inaccuracies. Only in two cases did interviewees identify inaccuracies. No specialized software

application was used to organize, code, and analyze the interview data, since the study was not aimed at developing grounded theory.

The interviews were coded by the author and an additional researcher (a university professor with experience evaluating NSF centers) to ensure reliability. Coding occurred in multiple phases. The first phase was relatively “open” (Lee 1999), guided by organizational and management theories (see section 3). In the second phase of coding, “core” variable codes were developed. The codes were proposed following the method proposed by Glaser and Strauss (1967).

5. Qualitative findings

5.1. Patterns for boundary-spanning characteristics and leader perceptions of goal incongruence

The case findings support the expected patterns for the boundary-spanning characteristics of NSF centers and perceptions of goal incongruence by NSF center leaders, with one exception based on a past career experience and two unanticipated (though explainable) exceptions. Table 4 summarizes the general patterns for this component of the qualitative analysis.

<Insert Table 4 about here>

Leaders of NSF centers with 4 or more academic disciplines represented by center faculty generally perceived goal incongruence among center faculty, while center leaders employing industry-driven research project selection processes generally perceived incongruence between faculty goals and the policy goals of the center. Buttressing these patterns, leaders of NSF centers with both an industry-driven project selection process and a relatively multidisciplinary faculty generally perceived both types of goal incongruence, while centers with just one of these boundary-spanning attributes generally elicited leader perceptions of the expected type of goal incongruence, but not of the unexpected type.

Another support for the expected patterns for boundary-spanning characteristics and leader perceptions of goal incongruence is that the patterns do not fall exclusively along programmatic lines (i.e., ERC v. IUCRC). Many of the ERC leaders interviewed perceived goal

incongruence among multidisciplinary faculty, but not in terms of incongruence between faculty goals and center goals, and many of the IUCRC leaders interviewed perceived incongruence between faculty goals and center goals, but not among center faculty. While this pattern seems a function of each program's discrete research mission – insofar that the ERC program has a more “radical” research mission than does the IUCRC program (see 3.1.2. above) and, subsequently, ERCs may tend to draw on more disciplines for faculty than draw IUCRCs – there were enough exceptions to the program-based pattern to suggest that it is the boundary-spanning characteristics of centers that operate to affect leader perceptions of goal incongruence in NSF centers. Specifically, of the IUCRCs in the sample that were relatively multidisciplinary (i.e., 4 or more disciplines), all employed faculty-driven project selection processes, whose directors conceptualized goal incongruence among faculty but not between faculty goals and center goals. Similar, of the ERCs in the sample that drew on relatively fewer disciplines (i.e., 1-3 disciplines), all employed a predominantly industry-driven project selection process, whose directors perceived goal incongruence between faculty and leadership but not among center faculty.²¹

Of the 21 cases, there were two types of exception to the general patterns for boundary-spanning characteristics and perceived goal incongruence by NSF center leaders. One was an instance of perceived incongruence between faculty goals and the broader policy goals of the center, despite a project selection process that is predominantly faculty-driven. This exception may be explained by the fact that this particular NSF center leader, currently an IUCRC leader, had more than a decade earlier in his or her career participated in another NSF center, an ERC, wherein the inducement of academic faculty to engage with industry was reportedly “a major challenge.”

The other type of exception was unanticipated at the outset of the study. Two of the NSF center leaders interviewed had highly multidisciplinary faculty but did not perceive goal

²¹ These exceptions to the program-based pattern for perceptions of perceived goal incongruence occurred at the margins, i.e., for the most multidisciplinary IUCRCs included in the study (4-5 disciplines each) and the least multidisciplinary ERCs (2-3 disciplines each).

incongruence among the operant goals of these faculty, e.g., based on differing research goals and epistemologies across different disciplines and fields. For one of these centers, the explanation seems that there is perhaps no goal incongruence of this type, specifically that faculty recruitment and/or self-selection into the center convened a group of “like-minded researchers” with similar or the same goals regarding center processes and outputs. For the other exceptional center, explanation for the lack of leader perception of goal incongruence among center faculty drawn from seven different academic disciplines may be that that this particular center is relatively young, still in the first two years of funding – perhaps too early for the center leader to assess the extent to which faculty behaviors and goals are aligned with one another and/or with the broader policy goals of the NSF.²²

5.2. Patterns for leader perceptions of goal incongruence and organizational capital in NSF centers

The case findings generally support the expected patterns for perceptions of goal incongruence by NSF center leaders and their development of structures and authorities for managing personnel internally and/or ties to structures and authorities externally, with two exceptions based on personal idiosyncrasies related to past career experiences and two types of unanticipated exception based on the internal development within centers of different types of non-academic research positions (e.g., post-doctoral fellows v. full-time research faculty) and different types of advisory boards (e.g., faculty v. industry). These exceptions are the result of the exploratory nature of this research, but remain consistent with the general expectations for internal and external approaches in NSF centers (see 3.2. above). Table 5 summarizes the general patterns for this component of the qualitative analysis.

<Insert Table 5 about here>

²² The “laissez-faire” approach these two NSF center leaders take towards center structure and management is addressed in 5.2. below.

NSF centers leaders who reported goal incongruence among center faculty discussed internal approaches to goal alignment, specifically by way of internal complexity and formalization, while center leaders who reported incongruence between the operant goals of faculty and the broader policy goals of the center discussed both internal and external approaches. Buttressing these patterns, leaders of NSF centers who perceived both types of goal incongruence generally reported a comprehensive approach, while center leaders perceiving just one type of goal incongruence generally reported the expected approach, but not the unexpected approach.

5.2.1. Findings for NSF center leaders perceiving goal incongruence among center faculty: internal approaches

NSF center leaders who reported goal incongruence among the operant goals of multidisciplinary faculty discussed internal approaches to organizational complexity and formalization in centers. Attempts at internal formalization predominantly entailed prospective documentation of the contributions expected of center faculty by center leadership for specific projects, though this documentation was limited to the articulation of “role structures” that assigned tasks to researchers for particular center projects; i.e., none of these center leaders considered such documentation as an enforceable contract. Attempts at internal complexity by center leaders perceiving goal incongruence among multidisciplinary faculty entailed vertical differentiation, albeit minimally given the non-routine nature of research, by establishing faculty (not industry) advisory boards overseeing center project selection and portfolio planning, sometimes using techniques such as matrix management.

All but one of the NSF center leaders reporting goal incongruence among center faculty denied accessing external structures and authorities, i.e., by making ties to the university departments and other organizations from which center researchers are drawn. The exception was someone who had prior experience in another public-private cooperative research center with an industry-driven project selection process, who admitted that his or her current outreach to university departments to be based on this earlier experience (wherein there was a “rift” between

center faculty and the technology transfer goals of the center) rather than driven by any similar problems in his or her current center.

Because the creation of internal personnel authorities by hiring researchers without full-time appointments in university departments would not help in any direct manner to coordinate the activities of a multidisciplinary center faculty, there was no expected pattern between this practice and the perception of goal incongruence among center faculty. Yet, all center leaders participating in this study (no matter what types of goal incongruence perceived, if any) reported hiring post-doctoral fellows, typically recent doctoral graduates beginning their academic careers. However, in most cases these hires were not full-time employees of the center, but rather hired through the university and managed directly by a specific department-based faculty member participating in the center. Thus, discussion of the creation of internal personnel authorities in centers is reserved for the creation of full-time research faculty positions that are center-based and intended to alleviate incongruence between the operant goals of faculty and the broader policy goals of the center and the NSF (see 5.2.2. below). In contrast, the universal mentoring of post-doctoral fellows for the centers included in this study signifies the alignment of center faculty behaviors with traditional education and training goals of universities and the NSF.

5.2.2. Findings for NSF center leaders perceiving goal incongruence between center faculty and center leadership: internal and external approaches

NSF center leaders who reported incongruence between the operant goals of faculty and the broader policy goals of the center discussed both the development of structures and authorities internally as well as accessing external structures and authorities. Attempts at internal complexity by these center leaders entailed vertical differentiation, albeit differently than that established by center leaders in response to goal incongruence among multidisciplinary faculty (see 5.2.1. above). Instead of establishing faculty advisory boards to coordinate diverse groups of faculty with different disciplinary backgrounds, center leaders perceiving incongruence between faculty goals and the policy goals of the center established industry (versus faculty) advisory boards. The

purpose of the industry boards, broadly interpreted across the centers included in this study, is to keep faculty research aligned with the needs and goals of the private companies and government laboratories participating in the centers; the chief task of the industry boards is project selection for the centers.

Because the creation of internal personnel authorities by hiring researchers without full-time appointments in university departments may help to align the general behaviors of centers with the broader policy goals of centers and the NSF, there was an expected pattern between this practice and the perception of goal incongruence between center faculty and center leadership. In addition to hiring post-doctoral fellows (which all center leaders participating in this study reported), center leaders perceiving this type of goal incongruence reported the creation of full-time research faculty positions that are center-based and intended to fulfill what a number of interviewees referred to as the “industry support roles” (e.g., technology development and transfer) that department-based faculty are reluctant to fulfill due to the emphasis of university tenure and promotion committees on fundamental research and peer-reviewed publications. In contrast to most of the post-doctoral fellows participating in centers, these non-departmental research faculty positions typically were employed directly by the center, with the center leader exercising traditional personnel authorities (e.g., hire, fire, promote).

All but one of the NSF center leaders reporting incongruence between the operant goals of center faculty and the broader policy goals of the center reported the creation of internal personnel authorities, e.g., by hiring non-departmental research faculty over whom personnel authorities could be exercised. The exception was someone who had prior work experience in industry, who thought it “industry’s job” to develop the absorptive capacity to utilize center-based research and faculty “if they want to get anything out of the center.” However, this center leader admitted that he or she would probably create this type of position given additional resources.

NSF center leaders perceiving incongruence between the operant goals of faculty and the broader policy goals of the center additionally reported accessing external structures and

authorities by making ties to the university departments in which center faculty have full-time academic appointments. These center leaders typically explained the decision to make ties to university departments in one of two ways. Some of these center leaders reported “passive” and “informal” ties to departments by communicating the accomplishments of academic faculty on behalf of the center to department chairs, sometimes with a formal letter but more typically less formally, for instance via email. The content of these communications included accomplishments related to publication in both traditional and non-traditional outlets (e.g., relatively “applied” journals or conference proceedings focused on a particular industry), mentoring of graduate students and post-doctoral fellows, participation in industry outreach activities (e.g., industry workshops, site visits), and technology development and transfer. According to these center leaders, the general purpose is to “keep departments informed” of the numerous activities and accomplishments that are not traditionally tracked by departments and university tenure and promotion committees exercising formal structures and authorities over faculty and, potentially, to legitimize such center-related work by department-based faculty to these bodies.

Other center leaders reported relatively “interactive” and “formal” ties to the university departments from which they draw academic faculty, including input into departmental decision making regarding the careers of academic faculty participating in the center, e.g., related to teaching loads, course buy-outs, as well as “appropriate” and “relevant” outlets for publishing center-related research. In some cases, these center leaders had input into tenure and promotion decisions, though not formal participation on such committees for center faculty. In all of these cases, the center leaders interacting with departments were either faculty members in the departments themselves or faculty members in departments within the same school or university subunit (e.g., college of engineering). According to these center leaders, the general purpose was not only to legitimize the center-related work of department-based faculty to the departments and committees exercising formal structures and authorities over academic faculty, but also to work

with these bodies to manage faculty time commitments (especially for junior faculty) and to reduce role conflict.

One of the NSF center leaders reporting goal incongruence between center faculty and center leadership did not report any ties – formal or informal, active or passive – to the university departments from which his or her center drew academic faculty. This exception did not consider it his or her role to “intervene” in the activities of university departments. However, this center is still in its nascent years, having just started its second year of funding at the time of this study. In contrast, the NSF centers with ties to the structures and authorities of university departments were relatively older centers, ranging from 4 to 9 years of program funding on a 10 year NSF funding cycle.

5.2.3. Findings for NSF center leaders perceiving both types of goal incongruence: a comprehensive approach

NSF center leaders who reported incongruence both among the operant goals of a multidisciplinary faculty and between the operant goals of faculty and the broader policy goals of the center reported a comprehensive approach to the development of structures and authorities internally. These centers seem to rely on both types of advisory boards discussed above (i.e., faculty and industry), both types of internal personnel authorities discussed above (i.e., post-doctoral fellows, full-time research faculty), as well as to formalize faculty roles on specific center projects, also discussed above (e.g., prospective documentation of project participation). Additionally, NSF center leaders perceiving both types of goal incongruence reported a comprehensive approach to accessing external structures and authorities for governing the behaviors of participating faculty, including both interactive and passive ties to the university departments from which center faculty were drawn.

5.2.4. Findings for NSF center leaders perceiving neither type of goal incongruence: a “laissez-faire” approach

Another notable pattern is that NSF center leaders who did not perceive goal incongruence of either type, or who perceived it but thought it unimportant (see 5.2.2.), generally did not report internal or external approaches to structure and authority. These respondents generally communicated a laissez-faire approach to center structuration and management and, beyond determining the allocation of center resources to specific projects, reported imparting few if any requirements on center faculty. These centers rely exclusively on tenure-track faculty and post-doctoral fellows and reported no attempts at internal complexity, formalization, or authority and generally had no deliberate or strategic connections with the academic departments from which they draw their human resources. Some (but not all) of these centers exhibited the sources of goal incongruence discussed above, namely relatively high levels of multidisciplinary and/or industry-driven project selection and funding processes. Thus, individual discretion – e.g., the extent to which goal incongruence is perceived by center leaders, or is perceived as important by center leaders – seems to matter as much to structure and authority in this type of public-private cooperative research centers as matter the typical antecedents (e.g., boundary-spanning, general) emphasized in organization studies.

5.3. Patterns for resource interdependence as a potential alternate explanation

Resource interdependence is of course another potential explanation of structure and management in boundary-spanning collaborations (Van de Ven & Walker 1984), one that is not mutually exclusive with perceived goal incongruence per se. However, like prior studies of NSF centers (e.g., Bozeman & Boardman 2003), this study supports the characterization of resource dependence in centers being weighted heavily towards center leadership, whereby faculty participants may pursue their individual research agendas and goals without center resources, but centers cannot pursue their goals without contributions from particular participants.

Though about half of the 21 centers included in this study allocate to at least some of their department-based faculty “summer pay,” not one of the center leaders interviewed suggested that this pay was necessary or sufficient for aligning faculty behaviors with one another and/or

with the broader policy goals of the center. Specifically, one center leader reported “summer pay is enough to get [department-based faculty] in the door, but it doesn’t make any difference after they’re in.” Another center leader similarly characterized the research resources (including research funds, but additionally access to equipment and collaborators, etc.) that centers offer participating faculty as insufficient for eliciting contributions to center goals: “our faculty are very successful in their own right and do not rely on [the center] for funding or access to industry and collaborators.” The case studies revealed no discernible patterns between the approaches to structure and authority in NSF centers and whether or the degree to which department-based faculty received resources from the center.

6. Discussion and conclusions

While the findings for leader perceptions of goal incongruence and the approaches leaders take to structure and authority in NSF centers (see 5.2.) have implications for theory and thus for future investigation of particular types of boundary-spanning collaboration, the findings for boundary-spanning characteristics and perceptions of goal incongruence by NSF center leaders (see 5.1.) have implications for policy and management. This section elaborates these implications and includes discussion of weaknesses and future research.

6.1. Implications for research and theory

The conceptualization of structure and authority as resources per se is not new. Business management scholars (e.g., Rosen 1972) and economists (e.g., Arrow 1962) developed the concept decades ago, and during the 1990s it re-emerged in studies of strategic human resources management in private firms (e.g., Barney 1991, Barney & Wright 1998). These literatures generally emphasize the tacitness of organizational capital (Evenson & Westphal 1995) and collectively suggest that it is not transferrable across organizational boundaries (and thus is critical to competitive advantage, see Lev & Radhakrishnan 2004).

In contrast, organizational capital in public-private cooperative research centers and boundary-spanning collaborations facing similar managerial constraints is more explicit. As

demonstrated by the NSF centers addressed in this study, some boundary-spanning collaborations lack even the most basic authorities and structures for inducing individual contributions to collaboration goals, which becomes problematic when resource interdependence and goal congruence are “low.” In response, collaboration leaders may access such controls externally by establishing ties with the organizations exercising direct structures and authorities over collaboration participants. In this sense, organizational capital, at least in its explicit (versus tacit) conceptualization, becomes somewhat “transferrable” across organizational boundaries. Accordingly, a proposition requiring further inquiry using larger and more general datasets than used in the current study emerges: When boundary-spanning collaborations for public service provision lack the typical mechanisms for aligning participant behaviors with collaboration goals, i.e., common goals and resources as well as the structures and authorities for inducing participant contributions in their absence, structure and authority constitute critical resources to access in the external environment when these cannot be developed internally.

<Insert Table 6 about here>

However, the extent to which external structure and authority can be characterized as resources for collaboration leaders to “acquire” should not be overstated. Though the NSF center leaders in this study who report making external ties to university departments (see Table 6) did so because departmental structures and authorities were not imitable internally, in many cases these ties were mere “one-way” communications intended to legitimize faculty contributions to center goals. In other instances, center-department ties, though relatively “interactive” and sometimes formalized, at the most can be interpreted as boundary decisions whereby center leaders intend to participate in the career development of academic faculty working on behalf of the center. Thus external organizational capital, here departmental structures and authorities for governing faculty behaviors, is different than more tangible external resources (e.g., equipment) insofar that access does not entail acquisition and thus free use of the resource, here by NSF center leaders.

Importantly, none of the NSF center leaders engaged in this sort of activity discussed the potential for manipulating departmental or more broadly university requirements for tenure and promotion; nor did any of these center leaders discuss negotiating the shared use of common faculty as an expectation for center-department ties. While these findings imply that accessing external organizational capital perhaps constitutes a distinct collaborative network management activity, one different than manipulating existing social structures (Kickert et al. 1997) and resource brokering (Rethemeyer & Hatmaker 2008), whether or not this is the case remains an open question for future research using data for a broader range of boundary-spanning collaborations than considered here, with similar managerial constraints including but not limited to collaborations focused on knowledge-intensive service provision (like research). To speculate, it seems likely that the external approach to organizational capital described in this study may be a precursor to structure manipulation and resource brokerage activities as depicted in prior examinations of collaborative networks.

6.2. Implications for management and policy

The most immediate implication for management and policy derives from the findings for boundary-spanning characteristics and leader perceptions of goal incongruence. The degree of multidisciplinary and influence of industry in NSF centers revealed two distinct types of incongruence perceived by center leaders – that among the operant goals of center faculty and that between the goals of center faculty and the policy goals of center leadership, respectively (see Table 7). What this implies for the implementation of public programs and policies by way of boundary-spanning collaborations, including but not limited to public-private cooperative research centers, is that there should perhaps be more emphasis at implementation on management challenges that arise when resource dependence among collaboration participants with incongruent goals is not evenly distributed. While there are studies on the importance of inter-personal and inter-organizational trust to collaboration structuration and success (e.g., O’Toole 1997a), trust perhaps “works” to elicit contributions to collaborations in the absence of

formalization only when participants are bonded by common goals and/or resources. Given the increasing knowledge-intensity and thus boundary-spanning nature of public service provision, increasingly the management constraints faced by NSF center leaders may come to characterize other areas of provision.

<Insert Table 7 about here>

The reason potential management and policy implications for the findings for approaches taken to structure and authority in NSF centers (Table 6) are not discussed is because the extent to which internal and external approaches to organizational capital affect the performance of boundary-spanning collaborations goes unaddressed here. The purpose of the current analysis was not to account for collaboration success per se, but rather to explore systematically structural and managerial variation across boundary-spanning collaborations with low levels of the typical coordinating mechanisms (i.e., resource interdependence, goal congruence) to incorporate into future studies evaluating outcomes and impacts.

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Tables and figures

Figure 1 Basic framework for organization capital decisions in NSF centers²³

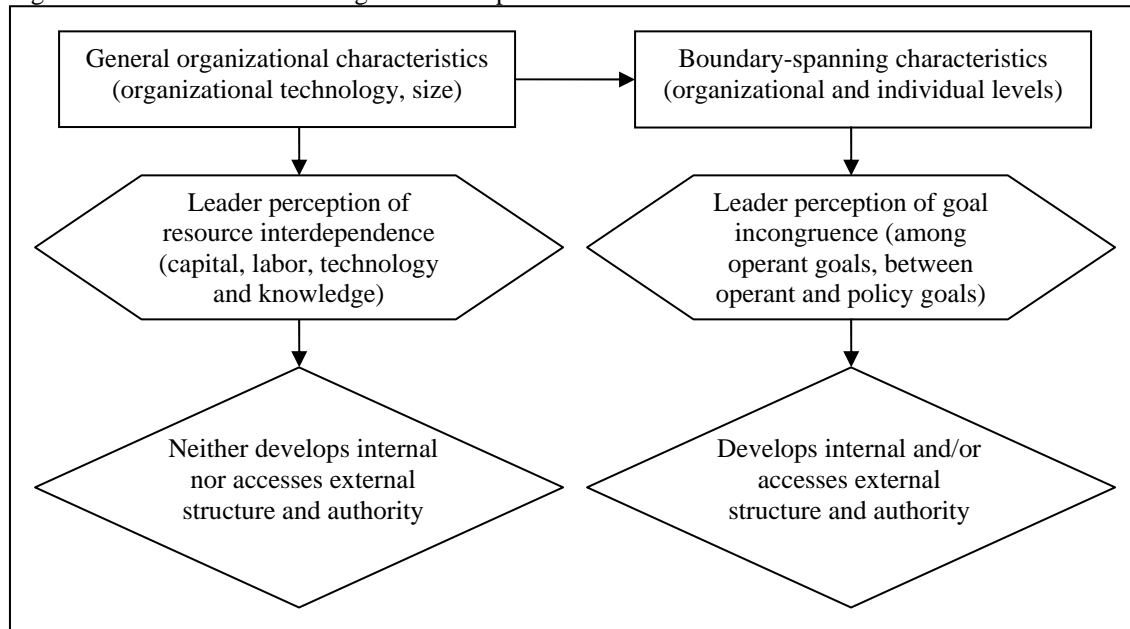


Table 1 Expected patterns for organizational capital in NSF centers and leader perceptions of goal incongruence and resource interdependence

| Perception(s) by NSF center leader | | | Approach(es) to organizational capital | | |
|------------------------------------|--|--|--|----------------------------|---|
| Goal incongruence among faculty | Goal incongruence between faculty and leadership | Faculty dependence on center for resources | Develop internal personnel authority | Develop internal structure | Make ties to external structure and authority |
| No | No | No | No | No | No |
| Yes | No | No | No | Yes | No |
| No | Yes | No | Yes | No | Yes |
| Yes | Yes | No | Yes | Yes | Yes |
| No | No | Yes | No | No | No |
| Yes | No | Yes | No | No | No |
| No | Yes | Yes | No | No | No |
| Yes | Yes | Yes | No | No | No |

²³ For parsimony, the framework does not address explicitly all potential perceptions by NSF center leaders. The framework explicitly addresses perceptions of goal incongruence and resource interdependence but only implicitly addresses the inverse, i.e., perceptions of goal congruence and of low levels of resource interdependence. The reasoning for this approach is discussed throughout section 3.

Table 2 Expected patterns for general organizational characteristics and leader perceptions of goal incongruence and resource interdependence in NSF centers

| General organizational characteristics | Perception(s) of goal incongruence | | Perception(s) of faculty dependence on center for resources | | | |
|--|--|--|---|--|--|---|
| | Goal incongruence among center faculty | Goal incongruence between center faculty and center leadership | Dependence on center for funds (research, salary) | Dependence on center for human capital (faculty collaborators) | Dependence on center for labor (student research assistants) | Dependence on center for capital (equipment and infrastructure) |
| Organizational technology aimed at creating new fields | Yes* | No | No | Yes** | No | No |
| Organizational size (funds) | No | No | Yes** | No | Yes** | Yes** |
| Organizational size (personnel) | No | No | No | Yes** | Yes** | No |

*Expected to be mediated by center multidisciplinaryity (see Figure 1, Table 3).

**Tentative, based on the perceived centrality by NSF center leaders of center research to faculty research.

Table 3 Expected patterns for boundary-spanning characteristics and leader perceptions of goal incongruence and resource interdependence in NSF centers

| Boundary-spanning characteristics | Perceptions of goal incongruence | | Perceptions of resource interdependence | | | |
|---|--|--|---|--|--|---|
| | Goal incongruence among center faculty | Goal incongruence between center faculty and center leadership | Dependence on center for funds (research, salary) | Dependence on center for human capital (faculty collaborators) | Dependence on center for labor (student research assistants) | Dependence on center for capital (equipment and infrastructure) |
| Center multidisciplinaryity | Yes | No | No | Yes** | No | No |
| Industry driving center project selection and funding decisions | No | Yes | No* | No | No | No* |
| Center leadership has prior NSF center experience | Yes | Yes | No | No | No | No |

*The expectation of no pattern does not mean that this type of goal incongruence cannot coincide with resource interdependence, rather that resource interdependence is expected to be a function of organizational size rather than industry-driven project selection per se (see Figure 1, Table 2).

**Tentative, based on the perceived centrality by NSF center leaders of center research to faculty research.

Table 4. Findings for boundary-spanning characteristics and leader perceptions of goal incongruence in NSF centers

| | | Center multidisciplinary | |
|-----------------------------------|------------|--|--|
| | | <i>4-11 disciplines</i> | <i>1-3 disciplines</i> |
| Industry-driven project selection | <i>Yes</i> | <ul style="list-style-type: none"> • Incongruence among operant goals of center faculty • Incongruence between operant goals of center faculty and the broader policy goals of center leadership | <ul style="list-style-type: none"> • Incongruence between operant goals of center faculty and the broader policy goals of center leadership |
| | <i>No</i> | <ul style="list-style-type: none"> • Incongruence among operant goals of center faculty | -- |

*These are general patterns, some of which were interrupted by idiosyncrasies across center leaders, e.g., based on past career experiences.

Table 5. Findings for leader perceptions of goal incongruence and organizational capital in NSF centers*

| | | Incongruence among operant goals | |
|---|------------|--|--|
| | | <i>Yes</i> | <i>No</i> |
| Incongruence between operant and policy goals | <i>Yes</i> | <ul style="list-style-type: none"> • Internal approaches: <ul style="list-style-type: none"> ○ Formal personnel authorities: full-time research faculty ○ Informal personnel authorities: temporary post-doctoral fellows ○ Complexity: industry advisory board ○ Complexity: faculty advisory boards ○ Formalization: documentation of individual project roles • External approaches: <ul style="list-style-type: none"> ○ Interactive ties to departments ○ Passive, “one way” ties to departments | <ul style="list-style-type: none"> • Internal approaches: <ul style="list-style-type: none"> ○ Formal personnel authorities: full-time research faculty ○ Informal personnel authorities: temporary post-doctoral fellows ○ Development of internal complexity, i.e., industry advisory boards • External approaches: <ul style="list-style-type: none"> ○ Interactive ties to departments ○ Passive, “one way” ties to departments |
| | <i>No</i> | <ul style="list-style-type: none"> • Internal approaches: <ul style="list-style-type: none"> ○ Complexity: faculty advisory boards ○ Formalization: documentation of individual project roles ○ Informal personnel authorities: temporary post-doctoral fellows | <ul style="list-style-type: none"> • Internal approaches: <ul style="list-style-type: none"> ○ Informal personnel authorities: temporary post-doctoral fellows |

*These are general patterns, some of which were interrupted by idiosyncrasies across center leaders, e.g., based on past career experiences.

Table 6. Summary of general expectations and findings for leader perceptions of goal incongruence and organizational capital in NSF centers

| Expected patterns | General findings | Specific deviations |
|---|---------------------------|---|
| Leaders perceiving goal incongruence among multidisciplinary faculty pursue internal approaches to structure and authority | General pattern confirmed | Leader career experiences interrupt general pattern |
| Leaders perceiving goal incongruence between faculty and leadership pursue both internal and external approaches to structure and authority | General pattern confirmed | Leader career experiences interrupt general pattern |

Table 7. Summary of general expectations and findings for boundary-spanning characteristics and leader perceptions of goal incongruence in NSF centers

| Expected patterns | General findings | Specific deviations |
|---|---------------------------|---|
| Leaders of relatively multidisciplinary centers perceive incongruence among faculty goals | General pattern confirmed | Leader career experiences and a counter-finding based perhaps on center age interrupt general pattern |
| Leaders of centers with industry-driven research portfolios perceive goal incongruence between faculty and leadership | General pattern confirmed | Leader career experiences and a counter-finding based perhaps on center age interrupt general pattern |

<INSERT TABLES FOR RESOURCE DEPENDENCE HERE>