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Federally sponsored multidisciplinary research centers: Learning, evaluation, and vicious circles

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ABSTRACT

Despite the increasing investment in multi-year federally funded science and technology centers in universities, there are few studies of how these centers engage in learning and change based on information submitted from various agents in the oversight and evaluation process. One challenge is how to manage and respond to this evaluative information, especially when it is conflicting. Although the center can learn and adapt in response to this information, it can also become subject to a vicious circle of continuous restructuring and production of documentation to address various and potentially inconsistent recommendations. In this paper we illustrate the effects of such a dynamic based on our experiences as external evaluators of the $25 million NSF-funded Learning in Informal and Formal Environments (LIFE) Center. The case study presents an analysis of annual reports and strategic planning documents along with other sources of evidence to illustrate the evolution of center organizational approaches in response to evaluations by external review panels, center evaluators, program managers, and other external stakeholders. We conclude with suggestions for how evaluators may help centers ease the cost of learning and reduce the likelihood of a vicious circle.

1. Introduction

The existence of research centers has been an essential characteristic of research universities in the U.S. and a driver for the emergence of innovations in America (Geiger, 1990). Multi-institutional multidisciplinary research centers, or what Friedman and Friedman (1984) called "Organized Research Units" or ORUs in a broad context, not only add to the research and educational role of departments, but also promote interdisciplinary collaboration (Stahler & Tash, 1994). Considerable research has been conducted on ORUs to study the interdisciplinary and inter-institutional collaboration mode, to identify the barriers and catalysts to their development, and to evaluate the outcomes of developing research centers (such as Corley, Boardman & Bozeman, 2006; Youtie, Libaers, & Bozeman, 2006; Corley, 2007; Geiger, 1990; Gray, Johnson, & Gidley, 1986; James, Eric, & Katara, 2001; Maglaughlin & Sonnenwald, 2005). Also, the broader literature in science policy references different types of university-based research centers. Some centers are self-funded by the university and often have a similar evaluation structure to performance appraisal systems of the principal faculty. Some have sponsors that require basic activity and outcome reporting metrics to be generated by the center. There is also a class of large, multi-year government funded science and technology centers, which employs multi-faceted evaluation inputs and requirements. These inputs and requirements may include strategic plans, annual reports, external evaluators, advisory groups, external peer review panels, and program manager review. It is the latter type of center that we explore in this article.

Scholarly efforts remain limited in theorizing or providing conceptual frameworks to study how the academic managers of these types of research centers learn and respond to evaluative information from varied stakeholders. The objective of this article is to draw on the growing body of literature on research centers, highlighting in particular the relationship between the sponsor's funding and evaluation of these centers, as well as the potential for sponsor–center interactions to result in a "vicious circle" of management change. We illustrate this type of vicious circle interaction through a longitudinal case study of a U.S. National Science Foundation (NSF) Science of Learning Center (SLC). We begin with an overview of the literature on research centers in the context of the literature on learning organizations and the potential for the dynamic of a vicious management circle to be produced.

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2. Background

Friedman and Friedman (1984) made an early attempt to analyze the rapidly growing research units in universities. They reviewed the history and developments of organized research units and explored factors that contribute to – or impede the success of – ORUs. They noted that the difficulty of developing ORUs may result from the university's inertia to change existing organizational structure and the competition for prestige between existing departments and the new organizational structure (ORUs). They also highlighted that successfully managing ORUs not only requires constant support from funding agencies, universities, and faculty members, but also requires the right choice of leaders, and the "locus within the organizational structure" to "maximize opportunities for students and faculty members from different departments and colleges" (Friedman & Friedman, 1984, p.29).

Consistent with Friedman and Friedman's research, Stahler and Tash (1994) pointed out that conflicts exist between centers and departments with respect to "faculty time," "internal funding support," "research infrastructure," and "prestige", which may result in unintended outcomes of "professional envy," "a distortion of a university's values," and the failure to encourage collaboration (pp. 543–544). In addition, they asserted that centers need to be managed to fit into the existing organizational structure, while also overcoming the resistance to be terminated (Stahler & Tash, 1994). The organizational structure factor has also been explored by a variety of scholars (such as Hara, Solomon, Kim, & Sonnenwald, 2003; Sá, 2008). For example, Huxham and Vangen (2000) argued that the assumptions of traditional leadership theory face several challenges in the scientific collaborative environment due to the lack of formal leaders, ambiguous membership, and the difficulty of establishing common goals among organizations and individuals.

Cummings and Kiesler (2005) found that in multidisciplinary and multi-organizational relationships, "the distance and organizational boundaries" can reduce the possibility of utilizing effective coordination mechanisms such as "direct supervision, face-to- face meetings, seminars, courses" (Cummings & Kiesler, 2005, p. 706). In other words, they argued that organizational boundaries (i.e., the number of organizations participating in the projects) will make the coordination more difficult in the coordination process. On the other hand, scholars also find that advanced information technology may facilitate the sharing of important data and instruments, and mitigate barriers to communication among geographically distributed scientists (Finholt, 2003).

Multi-year research centers have a need for learning as they evolve from the institutionalization of the center in the early years, to the fostering of flexibility and collaboration in the middle years, and eventually to the refining of support for the most fruitful research directions in the later years. Therein lies the interest from an evaluation standpoint in how research centers absorb and respond to information from performance data, external reviews and knowledge sources. The literature on learning organizations offers insights in this regard. This literature suggests that it is important to take a systems perspective to promote organizational adaptability. Organizational learning is more than just the aggregate results of individual learning; it is how learning is embedded in organizational level mechanisms (Senge, 1990). Learning in an organizational perspective is most associated with the ability of the organization to align with (or adapt to) its environment (Fiol & Lyles, 1985).

Important to understanding the ability of the organization to learn is the nature of knowledge and information that comes into an organization. Much has been written about the management of knowledge (including evaluation-related knowledge) and how it is packaged and diffused within and across complex organizations (Lam, 2000; Nonaka & Takeuchi, 1995). Knowledge can be packaged to promote explicit sharing of evaluation information through, for example, reporting of activities and outcomes or the tacit sharing of knowledge in networking meetings, intensive site visits, team-based activities, and visiting positions. This type of knowledge is often contrasted with tacit or contextual knowledge. The latter type of knowledge is often acquired through learning-by-doing, or experiential learning and accumulation of knowledge through adjusting to unpredictable circumstances (Arrow, 1962). Despite this traditional juxtaposition, there are substantial interrelationships between the two. Thus even the transfer of explicit knowledge through documents usually requires some related contextual information packaged with it to enhance understanding and interpretation, so there should not be too contrasting a distinction between the two types of knowledge (Amin & Cohendet, 2000).

Organizational effectiveness is sometimes highlighted as a measure of organizational learning although effectiveness is not always evidenced as a measure of learning, in that an organization may learn but ultimately take an incorrect path (Huber, 1991). Despite the potential for organizational learning, difficulties in acquiring and acting on knowledge are possible. One factor is that the complexity of the organization means that the results of individual actions are subject to delayed feedback (Senge, 1990). Another factor is that actions may address instrumental problems in a single-loop manner while situations may call for more long-term change in the manner of double-loop learning (Argyris, 1977). Moreover, if organizations are in a justification mode, as is the case with newly formed federally sponsored research centers, their epistemic style emphasizes the need to amass information to support the organization rather than to promote adaptation and change (Choo, 2006). Indeed, much of the work on organizational learning is based on long-standing organizations, in contrast to the temporary establishment of many federally sponsored research centers that are created to investigate new areas of science. One of the contributions of this work is its investigation of organizational learning in response to evaluation-generated information in the context of a newly formed organization.

To promote change into an organization in an environment that has the potential to reinforce justification styles, the role of an information change agent can facilitate learning by acting as a boundary spanner. A boundary-spanning communication usually concerns communication of knowledge across boundaries within and external to an organization. Boundaries can limit the transmission of knowledge by introducing misrepresentation, omitting certain information, blocking or reducing the speed of transmission, and fostering inward looking predispositions (Tushman, 2002).

Within the context of university-based center management, one of the most important organizational boundary spanning activities involves the relationship between the science center and the sponsor or funding agency. The sponsor seeks communications from the center to understand how the center is operating, to suggest improvements, and gather and assemble information for justifying ongoing center funding. Sponsor correspondence in relation to the center often involves requests for explicit communication, such as through activity and outcome quantitative reporting, as well as seeking an understanding of how the center is operating through qualitative reporting, to effect program improvement and ensure that program goals are maximized (Shapira & Youtie, 1998). The ability to engage in straightforward communication between science center and sponsor can be restricted even though reporting mechanisms and opportunities for exchange are frequent; examples of such mechanisms include strategic planning reports, annual reports, quantitative summaries of activity and outcomes, regular meetings between sponsors and senior center investigators, and annual external reviews. The straightforward flow of exchanges between the center and the sponsor may be limited by the different goals of each organization,

the formalized mechanisms of exchange available to both parties, and the lack of time and other demands on center and sponsor personnel (Boardman & Bozeman, 2007).

To address communication issues between organizations, boundary spanning individuals and organizations may be included in the process. Examples of such organizations include additional external partners, external consultants, external evaluators, and boards of advisors. Boundary spanning organizations can facilitate knowledge transmission across boundaries by taking on scanning, brokerage, liaison, medication, and expert analytic roles (Guston, 2001). Even though such additional knowledge sources can be helpful, and indeed some are involved as a result of sponsor requirements, there is at least one caveat associated with their involvement. Diminishing returns can be realized from the increased use of these organizations in that greater complexity can result from their involvement in the functioning of the center.

Counter-productive mechanisms and complexity-producing outcomes in organizational bureaucracies have long been documented in organizational behavior and public administration theory. This literature has raised many examples of efforts to improve outcomes actually resulting in increased bureaucratization or other suboptimal organizational situations (Crozier, 1964; Merton, 1957). Within the management and organizational theory literatures, there is an additional dynamic known as a vicious circle, which is defined as "action loops with counter-productive results" (Masuch, 1985, p. 16). In this case, an action loop is something that happens when a given action leads to a series of other actions that ultimately re-create the original situation. As Masuch outlines, "with the recreation of the original situation, the loop can repeat itself, and a network of activities can emerge that can develop and maintain its own identity in a given environment (Masuch, 1985, p. 15)". The actors in the vicious circle seek to improve their situation, but every action taken actually moves the organization further away from the desired state. Masuch illustrates how the feedback mechanism actually amplifies a problem, transforming it into an even worse state rather than leading to positive change or desirable states. This situation is said to be the result of a lack of knowledge of the situation.

This article examines the effect of efforts to promote organizational learning in federally sponsored university-based science centers. We suggest that efforts to promote learning through multiple boundary spanning input points and organizations – such as the funding sponsor, advisory boards, and external review panels – can create a vicious circle in which centers undergo ongoing efforts to re-write and re-organize research. The role of external evaluators in this situation can be both facilitative in helping the center to efficiently address concerns, and reinforcing in adding to the complexity of the center's knowledge environment. Illustrating this dynamic is a case study of the NSF-funded Learning in Informal and Formal Environments (LIFE) Center. It can be expected that the latter condition will bring about increasing organizational complexity in the center's response, which has the potential to generate a new round of review and comment, followed by additional and more complicated center responses.

3. LIFE center case study

3.1. Center overview

In September 2008, the National Science Foundation (NSF) issued a press release announcing the creation of three Science of Learning Centers (SLCs).[1] The centers were to be awarded $36.5 million each (later reduced to roughly $25 million in the face of budget constraints) over a 5-year period (2005–2009) to conduct basic research and act as focal points for national interests in research on learning. Among the three centers was the Learning in Informal and Formal Environments (LIFE) Center. The press release notes that the LIFE Center, a partnership between University of Washington, Stanford University, and SRI International:

> "will advance and use the scientific understanding of neural processes and principles associated with the cognitive, linguistic and social dimensions of learning in formal and informal environments to guide educational practices. The Center for LIFE has assembled a collaborative and interdisciplinary team that will develop a coherent, integrated perspective on learning through "conceptual collisions" among diverse sets of concepts, methodologies, and research traditions. The Center will create learning environments that will prepare people for future learning and develop new kinds of assessments that measure these kinds of outcomes."

The next sections will describe the nature of the planning and evaluation system of the SLCs. Elements of the SLC evaluation system at the level of the program and the center will be described through the lens of the LIFE center. The LIFE Center's evolving response to feedback from the SLC evaluation system is portrayed in terms of changes to the center's very purpose, its research agenda, and management and organizational structure.

3.2. Planning and review

As with many federally funded research centers, the LIFE Center along with the other SLC's were set up to be learning organizations, with an extensive planning, feedback, and evaluation system associated with each center. Each SLC is required to develop an annual strategic implementation plan. Reviewed for approval by the sponsor, the strategic implementation plan is considered important in that it provides the framework of expectations against which the center is judged.[2] In the case of the LIFE Center, the sponsor requested the center to re-write or substantially revise its annual strategic implementation plan such that this framework was sufficiently delineated. At the end of a given year, the center produces an annual report that describes its accomplishments, both in terms of metrics (such as number of peer reviewed publications), qualitative descriptions of major activities, and alignment of these activities to the center's strategic implementation plan.

On an annual basis, the sponsor conducts a site visit in which a panel of external scientific peers reviews the center. The sponsor structures these reviews to address criteria such as strategic priorities, achievements and contributions, organization and management, student support, translation of research into practice, evaluation, center added value, and a strengths/weaknesses/opportunities/threats (SWOTs) analysis. In terms of strategic priorities, a typical question is "How are the projects in the implementation plan aligned with, and likely to achieve, the center's stated purposes and strategic priorities as outlined in the Strategic and Implementation Plan (SIP)."[3] The sponsoring program managers are part of the external review in the way they structure the agenda and questions, so the review panel is not entirely external to the sponsor, though it does incorporate substantial outside feedback. The program itself undergoes

[1] Press Release 04-137 learning about learning: NSF Awards $36.5 million for three centers to explore how humans, animals and machines learn. national science foundation, September 30, 2004.

[2] Manual for Center Evaluators: Science of Learning Program, March 2007, internal document.

[3] Year 5 Annual Site Visit Report, LIFE: Learning in Informal and Formal Environments Center, July 23–24, 2009.

periodic evaluation by a Committee of Visitors (COVs). After conducting a number of interviews and reviews of documents, the nine-member COV reported, "The Science of Learning Centers Program is a major success. It exemplifies NSF's special responsibility for making high-risk/high-return investments on behalf of the nation. The topic of the SLC Program is of the highest importance and the magnitude of the challenge it poses is great."[4] This report also reiterates the learning nature of the SLCs, describing the program as "a sophisticated "learning-by-doing" project in its own right, building knowledge within NSF that should be valuable for future innovative programs of this kind".[5] In addition to this formal process, centers typically have an external advisory board and receive informal feedback from the sponsor's program managers on the centers' progress. These activities influence the allocation of the subsequent year's funding along with changes or requirements that the sponsor may place on the center.

Each center also has an external evaluation team that develops qualitative and quantitative information to address the effectiveness of the center's administrative structure and scientific impact of the center. The LIFE Center has an external evaluation team which includes this article's authors. The external evaluation is focused on three aspects: (1) quality and quantity of scientific research, (2) interdisciplinarity and collaborative relationships, and (3) capacity building for future research and trainees. In addition, the external evaluation explores changes over time in outreach activities, external partnerships, diversity issues, and management issues. The evaluation in the early years of the center tracks the institutionalization of the center through qualitative interviews, document review, and case studies. The middle years of the center evaluation focus on the development of interdisciplinary and collaborative relationships and capacity building for future research and trainees through surveys of faculty researchers, students, and external partners coupled with social network analysis of the results. The later years examine scientific research outputs through bibliometric and curriculum vitae analysis of center members in relationship to baseline output before the establishment of the center and comparison groups of research in the same domain as, but not part of, the LIFE Center. In addition, qualitative interviews were conducted with leading science of learning researchers who were not part of the center. The results of the evaluation were summarized in formal reports submitted to the center annually and also to the sponsor. In addition, the evaluation team gives informal observations and comments. These were especially more prevalent in the latter 2 years of the center's operation, following the sponsor's recommendation that there be a less differentiated and more ongoing relationship between the evaluation team and center management.[6] The center evaluators are also subject to oversight by the sponsor and are assessed in the annual external site review panel which usually includes an evaluation specialist in its membership.

3.3. Center evolution

We briefly chart the evolution of the center over time with specific emphasis on changes in mission, research, and organizational restructuring over the first 5 years of funding for the center from October 1, 2004 to September 30, 2009. These changes are juxtaposed against the information that the center received from the sponsor, the external evaluation team, and other organizations (see Table 1).

3.3.1. Purpose and mission

The center's initial mission was to research learning in formal and informal (i.e. outside of the classroom) contexts. The initial purpose of the center, which emphasized this connection between formal and informal environments evolved into an emphasis on lifelong learning from birth to adulthood by the second year and interdisciplinary "conceptual collisions" in the third year. In response to concerns from the sponsor about the lack of a well defined research agenda, the fourth and fifth years restructured the center mission around the concept of social learning.

3.3.2. Research agenda

In parallel with this change in purpose and mission, and in response to the sponsor's continuing concerns about the lack of focus and definition in the research agenda, the center effected an annual restructuring of its research thrusts. The center began with three strands that examined brain-based research, informal learning, and formal learning. In the second year, this research structure dramatically changed to six initiatives that emphasized points of encouragement for multidisciplinarity collaboration. In the third year of the center, the research structure shifted to three components and clusters that addressed adaptability and assessment, social and cultural processes, and developmental and biological learning bases. The fourth year marked a major change in the organization of the research to three strategic driving questions focused on the social foundations of learning, transitions between formal and informal learning, and the fit between the design of formal learning environments relative to what is known from the science of learning research. This change was an effort to move forward the sponsor's recommendations to have a more well-defined research agenda. In the fifth year, the strategic driving questions became initiatives and a fourth initiative related to center-wide integration was added. Each initiative was elaborated with two strategic driving questions. The aim of this change was to demonstrate further definition of the research agenda.

3.3.3. Management

In terms of management, the LIFE Center's initial structure involved a Leadership Council comprised of 11 principals (co-PIs) and a director (the author of a well-regarded National Research Council policy report) recruited from another university. One of the members of a partner organization served a co-director. Most of these LIFE Center principals had worked together before or were otherwise familiar with one another, which facilitated the creation of the center. The LIFE Center's 11 person leadership team structure was influenced by the literature on innovation and the use of flat organizational hierarchies. Interviews with some LIFE Center team members suggested that this approach facilitated an early level of trust during proposal development. As a result of annual recommendations from the external evaluators, and sometimes from the sponsor and the advisory board, the center instituted several changes to its organizational structure to become more hierarchical and concentrate administrative burdens in a smaller number of individuals. By the fifth year, the center had a new director who was appointed by the sponsor. Although the center maintained a 13-member leadership team, it instituted a smaller Executive Management Group to deal with administrative issues.

Many of these changes involved multiple and annual re-writes of the strategic plan at the request of the sponsor. In addition, the center was asked to hire a strategic planning consultant in the early years to connect mission and vision with research thrusts and move toward synthesis and impact, institute an internal evaluator in the third year to help with the re-writing, and take part in an

[4] Report of the Committee of Visitors for the Science of Learning Centers (SLC) Program, June 12, 2009, p. 1.
[5] Ibid.
[6] LIFE Center Evaluation Work Plan, May 4, 2005.

Table 1
LIFE center changes over time in purpose, research organization, and management structure.

Area	Year 1	Year 2	Year 3	Year 4	Year 5
Center purpose/mission	Purpose: "To understand and advance human learning through a simultaneous focus on implicit, informal and formal learning, ... [to] guide the design of effective new technologies and learning environments" Mission: "To conduct scientific research, engage in research collaboration across disciplines, and engage in partnerships with practitioners"	"To unlock the mysteries and powers of human learning as it occurs in informal and formal settings from infancy to adulthood"	(1) "To identify and investigate underlying principles of how people learn from a variety of methodologies and disciplines by sparking 'conceptual collisions' among these viewpoints", and (2) "To foster research and education collaborations with individual and institutional partners in the field"	"To develop and test principles about the social foundations of human learning in informal and formal environments, including how people learn to innovate in contemporary society, with the goal of enhancing human learning from infancy to adulthood"	Same as Year 4
Center research thrusts	3 Strands (1) Implicit learning and the brain (2) Informal learning (3) Formal learning and beyond	6 Initiatives: (1) Expertise, transfer, assessment (former strand 3) (2) Learning within, across settings (3) Interactivity and learning (4) Issues of self, other, identity (5) Language, bilingualism, representational systems (6) Learning sciences interdisciplinary research.	3 Components/clusters (1) adaptivity, transfer, and assessment (2) social, cultural, and interactive processes (3) development and biological bases of learning.	3 Strategic driving questions (1) 'Social foundations' of learning (2) Transitions between formal, informal learning (3) Fit between designed learning environments and science of learning findings	3 Initiatives, 6 Strategic Driving Questions A new fourth initiative – vehicles that promote center-wide integration
Center organization	Center Director Leadership Council of 11 co-PIs; Scientific Review Board (research project selection); Technical Review Board (technology design, human interface); ECO (education, collaboration, outreach) Program Board; Student Leadership Group	Same as Year 1 with the addition of an internal evaluation	Center Director Leadership Council of 12 co-PIs; Management task force (4 members); Internal evaluation	New Center Co-Director; Executive Management Group; Internal evaluation absorbed into ECO	Center Co-Director was named Director; Executive Management Group changed; Matrix organization: 4 initiatives by 4 networks (Language, Social Cognition, STEM Learning, Technology Mediated)

Source: Document review of LIFE center strategic plans, annual reports, various years.

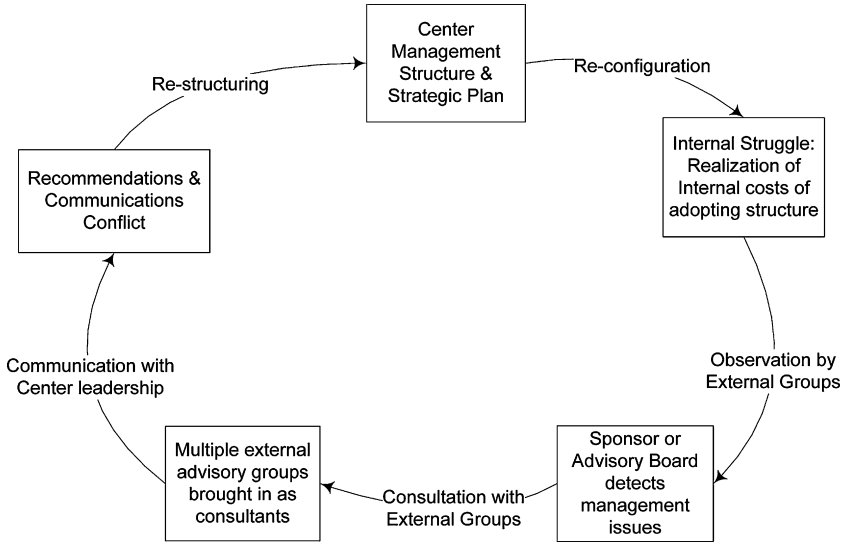

Fig. 1. LIFE center changes as a vicious circle.

extra assistive external panel in the fifth year to promote a more well-defined research agenda.

4. Evidence of a vicious circle

The literature on centers in the context of the learning organization suggests that having change agents that look across boundaries can encourage learning and adaptation. The case study of the LIFE Center suggests that having multiple change agents providing feedback that is not necessarily consistent can create a vicious circle even as it seeks to encourage learning. Although these change agents have the potential to stimulate learning and adaptation, the vicious circle perspective suggests that these agents also have the potential of leading the center further away from reaching a desired state, be it achieving the goals of the program, sponsor expectations, and/or scientific breakthroughs, as the center becomes immersed in ongoing internal structural changes.

This vicious circle occurs when the federally funded research center – in an effort to satisfy sponsors and address sometimes conflicting issues raised by a network of intermediary organizations including consultants, external evaluators, and boards of advisors – continuously undertakes changes to both organization and research agenda. Fig. 1 explores the dynamics that occur in the vicious circle more explicitly in the context of science center development and evaluation. Fig. 1 starts at the top with an existing center management structure and the original strategic plan for the center. Then the internal tensions and recommendations from the sponsor, external evaluations and other knowledge sources drive the reconfiguration of the center management and/or the research agenda. As the new structure is adopted, the center researchers realize that there are internal costs associated with the new structure (some of which they expected and others which they did not expect). This struggle is observed by external groups as a problem and leads to additional suggestions by these groups (such as the sponsor or advisory board) that there are management and/or research agenda problems in the center. Efforts to fix the problem can lead to additional conflicting recommendations that result in further restructuring, perpetuating the renewal of the vicious circle.

To explore and present evidence of a vicious circle, Table 2 summarizes the results of a document review of reports from five sources of feedback and change: the sponsor, external site review panel, external evaluation team, center advisory board, and Student Leadership Group. The table shows that there are some points of consistency, for example the external evaluators' emphasis on administrative burdens was picked up by the external site visitors in Years 3 and 4. Yet there are also some points of inconsistency, for example, the external evaluators' emphasis on a balance between bottom-up ideas and the sponsors' and external site review panels' emphasis on top-down research plans that will lead to synthesis in Years 4 and 5.

Moreover, the table suggests evidence of the dynamic of a vicious circle in terms of the challenge to the center in producing an effective response. Many of the inputs of the sponsor and review panel for a more defined research agenda persist across the years despite the substantial annual changes that the center instituted in its research and organizational structure. Each of these changes is associated with considerable explicit and implicit costs in the center investigators' time in attending meetings, effort in writing and re-writing drafts of the strategic plan, negotiation about whether a particular research area conforms to the center plans, and attention to communication in documents, presentations, and information requests from sponsor, advisory committee, site review, and external evaluation data requests. Interviews with selected investigators estimate this learning cost using an opportunity cost framework of one additional grant proposal a year that could have been submitted, one publication a year that could have been written, or 30–40 percent of the investigators' time in a year (versus the remainder allocated to the pursuit of science).[7]

Indeed, the COV report raises concerns about the cost of what they term the learning-by-doing mode of intensive evaluation that is characteristic of the SLC program. For example the report comments on the annual external site review process as a source of high learning costs. The report argues that the SLC program cycle of evaluation and monitoring may have impeded rather than provided a level of nurturing care that is often associated with a new program. The report recommends that the sponsor "[r]ethink the nature of "evaluation" as applied to SLC Program participants".[8]

[7] Interviews with LIFE principals, June 23–24, 2009.
[8] Report of the Committee of Visitors, op cit, p. 3.

Table 2
Recommendations of external feedback sources to the LIFE center by year.

Area	Year 1	Year 2	Year 3	Year 4	Year 5
Sponsor	Strategic plan re-write, Strategic planning consultant engagement		More hierarchical structure, Closer relationship with external evaluators,	New center co-director, More focused research plan	New center director, Alignment mission and objectives with center activities,
External Site Review Panel		More rigor and transparency of the substantive and conceptual underpinnings of their work and their management decisions. Distinguish internal self-study from external evaluation. Center goals should be matched with evaluation activities	More focused research plan, Hierarchical organization	Capable person to address administrative issues, Formal synthesis process, Better mechanisms for linking research and practice, Better definition of the social foundation of learning, Evaluation should use external peer review,	Current center management praised, Better definition of the concept of social learning. Show how center goals are supported by activities, Formal synthesis process
External evaluation team	Extent to which the distributed management structure places undue burden on researcher productivity	Concerns about administrative burden on researchers and difficulties in cross-disciplinary collaboration and working with students.	Need to balance communication internally and with the sponsor	Current center management praised, Need for balance between top-down and bottom-up ideas	Same as Year 4. Clearer articulation of outcomes and student-related impacts
Advisory board			Closer communication between sponsor and center management		Attend to different connotations of the term social learning. Use measures other than co-authorship in the external evaluation. Track student placements. Use web outlets to enhance center visibility.
Student Leadership Group	Need for vision for training, Students lack involvement with center management, research decisions, Enhanced communication about opportunities, Need for cross-institutional courses, opportunities				

Source: Document review of LIFE Center external evaluation reports, external site review reports, advisory board reports, other sponsor communications.

5. Conclusion

This work has examined the evolution of multi-year government funded science and technology centers from the perspective of the SLC program's LIFE Center in the context of the learning organization. Multiple points of learning are important as centers undergo a typical transition from their initial efforts to organize and structure the center to their early efforts to encourage collaboration and innovative research and finally to their later efforts to selectively support the most promising work. Although this article describes one case, and thus has limits to its generalizability, we believe that the description will resonate with other similar situations.

The analysis has shown that the sponsor has instituted multiple evaluation and change mechanisms to foment center learning, such as sponsor ongoing review of strategic plans and annual reports, annual external site reviews, center evaluators, advisory boards, and other mechanisms. Many of these mechanisms are boundary spanning in that they involve, but extend beyond, the domains of either the sponsor or the center, for example the external site review panel or the external evaluator.

The analysis suggests that this learning has not been a smooth process, but rather has contributed to a vicious circle of efforts to repeatedly change the center organizational structure, research agenda, and core mission. These efforts are associated with personnel, travel, opportunity and other explicit and implicit costs.

To what extent does the role of the center-level external evaluator figure into this vicious circle? The role of external evaluators can reinforce the vicious circle by making independent recommendations that do not demonstrate awareness of those of the sponsor or the external review panel. This places the center in a position of conflict and the center may well give less emphasis to the evaluator in favor of a focus on maintaining its sponsor-provided financial support. Moreover, the center evaluators themselves are subject to sponsor and external site review panel oversight to ensure that good and relevant practices are maintained.

The external evaluator can also provide information with the potential to help ease learning costs and diminish the vicious circle. One approach to alleviate this situation is to surface the burdens and costs associated with ongoing change so that these become more apparent to the sponsor as well as to center leadership. The evaluator can implement qualitative interview and observational methods, as was the case with the LIFE Center, to provide this information in an explicit manner. Another approach is to provide systematic information that shows the center's progress toward center and programmatic goals. In the case of the LIFE Center, the evaluators employed survey, bibliometric, and other similar types of quantitative methods. They used techniques such as social network analysis to demonstrate that the center was coming together in collaborative and interdisciplinary ways that transformed investigators' research concepts, data collection methods, and dissemination strategies. Citation analysis further showed that the center had a set of outputs that was becoming very influential in the science of learning. The latter was further supported through interviews (conducted by the evaluators) with leading scientists in the science of learning field.

Certainly the center and the evaluator want to be responsive to recommendations for improvement, especially those from the sponsor. It is important, however, to balance the needs for responsiveness with the cost of learning, and to make these costs apparent, so the sponsor can weigh these learning costs in its programmatic decisions.

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