Visible Collective and Self-Management Along with Secret Gardens: The Landscape For Distributed Innovation Organizations In Competitive Environments

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Key point: Crowd-based distributed innovation systems exposed to competitive forces require an organizational design that highlights knowledge of some contributors while rendering both the content and the existence of IP-related knowledge invisible.

Abstract

"HYPERLOOPTT is an open organization changing the world as we know it" (HYPERLOOPTT website)

Abstract

Hyperloop Transportation Technologies, Inc. (HYPERLOOPTT) is a global crowd-based innovation startup competing in the hyperloop industry. HYPERLOOPTT distinguishes itself from the competition by not simply engineering a hyperloop but also designing sociotechnical systems and practices that enable them to push the use of a distributed innovation system to the extreme. HYPERLOOPTT faces two sources of competition: against other organizations in the hyperloop industry, and against other claims on the time of its largely part-time contributors. We conducted an ethnographic analysis of the coordination practices of the organization, concluding that HYPERLOOPTT is effectively competing on both fronts by creating the means for visible collective and self-management of knowledge as well as by secretly walling in intellectual property, making the walls and their contents invisible. The invisibility of IP walls seems to avoid inhibiting collaboration among part-time contributors since their lack of awareness reduces any frustration that might arise if they knew important information for their work was being withheld. We draw implications for theory on distributed innovation systems in market-oriented organizations.

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Use of distributed innovation systems, where innovation is sourced from a varied network of internal and external actors, continues to grow in importance (Kornberger, 2017). While distributed innovation systems, defined broadly, receive much attention in the open innovation, open source development, virtual organization, and meta-organizations literatures (cf., Brabham, 2013; Kane and Ransbotham, 2016; O'Mahoney and Ferraro, 2007; Lakhani and Panetta, 2007), Kornberger (2017) has recently argued that there is relatively little focus on how these systems are designed. This lack of knowledge about organizational design is particularly experienced when the organization is developing complex ill-structured technology which requires intensive collaboration about highly-skilled professionals, instead of sourcing solutions from individual contributors to highly modularized tasks. Moreover, much of the literature has failed to discuss the impact that profit-seeking market competition plays in the design of the organization since the same factors that contribute to open organizations, such as open sharing, may serve to destroy a profit-seeking organization's competitive advantage (e.g., Barney, 1991). Therefore, we address the following research question:

> ***How does an organization, using a distributed innovation system, design itself to address the tension between an open system for distributed innovation and a closed system for intellectual property protection?***

Using an extant framework of organizational design mechanisms found in distributed innovation systems (Kornberger 2017), we apply this framework to our ethnography of an organization using a distributed innovation system within a highly competitive marketplace. Hyperloop Transportation Technologies, Inc. (HYPERLOOPTT) is a technology company. The company is only four years old; the founders founded the company with the intent of changing how transportation systems worldwide are designed, built, funded, maintained, and used. Part of HYPERLOOPTT's business model is its openness; it encourages any creative and highly skilled part-time professional anywhere in the world to join them in creating the transportation of the future. Eight hundred individuals and companies have "joined the movement," contributing 10-40 hours a week to do the engineering, business development, technology development, marketing, human resources, and project management work, all in exchange for future equity in the organization. Another 50,000+ individuals monitor progress via various social media sites, offering business development opportunities and suggestions. We focus on the work of the individuals primarily conducting the engineering innovation of the organization since this is the core intellectual property of the organization.

Applying Kornberger's (2017) framework of design mechanisms, we surface two complementary design mechanisms which entice and manage the intense collaboration among a largely part-time, non-employee, workforce in the face of competitive challenges. The first mechanism is what we refer to as visible collective and self-management. This mechanism keeps contributors motivated by making the work of relevant others visible – where relevant is defined by the contributors themselves and visibility is the openness of knowledge-sharing. In that way, contributors meet their internal motivational needs of learning, stimulation, self-selected work and meaningful work since they can see how they are contributing to the development of the larger product for which they only have time to contribute a small part. The second mechanism is that senior management does not simply place walls of access exclusion around what they consider to be emergent proprietary knowledge, but they make the walls invisible so contributors are not aware that they are being locked out since locked-out walls could undermine the impression of open knowledge-sharing. We refer to this mechanism as “secret gardens” after the 1911 Frances Hodgson Burnett children’s classic since both the walls and the existence of the garden itself are initially not known to Mary, the novels’ main character.

The existence of these two design mechanisms – visible threads and secret gardens – are meant, in accordance to Kornberger (2017), to shift the managerial challenge of open organizations “from being focused on the efficient allocation of internal resources” to “a concern with organizing ‘the open,’ that is, designing structures and systems for coordinating work outside company walls” (p. 14).The visible threads are meant to replace the role of management’s visible hand of coordination (Chandler, 1977) by allowing contributors to self-manage their own coordination. The secret gardens are meant to replace the walls which defend power-shaping identities of acceptable professional behavior (Brown et al., 2010). HYPERLOOPTT’s secret gardens acknowledge that knowledge-sharing must be limited to avoid inopportune use, but recognize that the limitation itself can demotivate contributors. In sum, we suggest that, in the face of competition, design mechanisms that explicitly take the nature of the competition into account provide a richer appreciation of how the open-closed tension can be managed. Implications for organizational theory are drawn.

Conceptual Development

Distributed innovation systems include “decentralized problem-solving, self-selected participation, self-organizing coordination and collaboration, ‘free’ revealing of knowledge, and hybrid organization models” (Lakhani and Panetta, 2007: 98). Most exemplar distributed innovation systems are purely open organizations such as open source software development projects, innovation challenges, user innovation communities, and knowledge co-creation communities such as those that created Wikipedia (cf., Kornberger, 2017; Malhotra and Majchrzak, 2014). We offer a distinction to clarify our presentation: organizations leveraging a distributed innovation system at their strategic core (versus as just an aspect of their R&D or marketing) are distributed innovation organizations (DIOs). HYPERLOOPTT's uniqueness from more typical DIO examples is that it faces two market forces that most other open distributed innovation organizations do not: competition between organizations, and competition for talent to keep technological progress moving as rapidly as possible.

Competitive profit-seeking firms increasingly design complex products using distributed innovation systems. Salesforce.com's AppExchange, for example, uses a distributed innovation system to competitively serve the online software-as-a-service market. Highly competitive marketplaces with complex products have high turbulence; ambiguously interpreted information (Castells, 1996); uncertain innovation trajectories (von Hippel, 1998); instability in supplier and customer-base, making proof of concepts difficult (Souder and Moenaert, 1992); exiguity or absence of comparable organizations as referents (e.g., Labianca et al., 2009) and may include misappropriation of information from one competitor to the next (Ho, 2009; Hoetker, 2005). As such, between-organization competition is likely to have a substantial effect on the basic organizational design.

The second market force affecting distributed innovation systems is competition for talent (Putnam et al., 2014). Employee-organization relations are shifting from an exchange of labor and security towards forms of contingent work tied to temporary organizational needs (Barley and Kunda, 2001, 2004; Burke and Morley, 2016; Morris et al., 2016; Soundararajan et al., 2017). Competition for talent strengthens as individuals have more choices on how to spend their non-work time (and in some cases, their work time). Organizations like HYPERLOOPTT are particularly prone to competition for talent when the talent is part-time and presented with many opportunities for participation (Kane and Ransbotham, 2016; Wang et al., 2013). Constraints on skill, specialization, and innovativeness further limit the pool of appropriate talent. For organizations where growth is essential, ways to quickly identify and attract available talent becomes a competitive advantage (Benkler, 2017; Nickerson et al., 2017). Organizational competitiveness for talent therefore requires soliciting the right talent, at the right time, for the right task.

Organizational Design Mechanisms

Kornberger (2017) describes three design mechanisms as structuring the activities of both management and the "crowd" in an open organization. These three are interface design, architectures of participation, and evaluative infrastructures. As we consider the effects of market forces, we also expand this framework.

Interface design. Borrowing from Galloway (2012), Kornberger defines interface design "as a medium that organizes the exchange between two or more heterarchically distributed elements" (2017: 180). Examples of interfaces range from portals and websites to communication technologies and coordination norms. Interfaces are "meeting points," imposing a structure that "enables, but also governs and disciplines, the communication among subsystems" (Langlois and Garzarelli, 2008: 9). Interfaces foster the transmission and translation of information, leaving assimilation and integration outside the scope of interface design.

Taking the market forces into account may lead to a reconsideration of the precise role that interfaces play. For example, standardized coordination interfaces may not be as important as implied by other research (e.g., Dubé and Robey, 2009; Malhotra et al., 2007), since people are able to co-create without perfect translations and shared understanding as long as they can scaffold through iterative proposal seeds (Harvey, 2014; Majchrzak et al., 2012). Successful coordination interfaces are likely to be ones that make it as simple as possible to interact with the organization. Contributors will need to "acquire immediate benefits … have their intuitions confirmed quickly or learn something they did not already know. If not, they [will] quickly abandon the [organization]" (Markus et al., 2002: 191). Ideally, once having made a knowledge contribution, individuals are motivated to stay and thread their knowledge with the knowledge left by others. A variety of coordination mechanisms other than interfaces may support the threading, from boundary objects (Nicolini et al., 2012), to public visibility of others' information for later revisiting (Baralou and Tsoukas, 2015; Leonardi, 2014; Van Alstyne and Brynjolfsson, 2005). Examining how these mechanisms support the threading, then, becomes an important design element for distributed innovation systems.

Participation and meaningfulness. The second design mechanism describes the division of work to ensure that stable work is accomplished even with fluid actors, is attractive to people with a variety of motivations and commitments, and maintains low integration costs, such as with modular tasks (Baldwin and Clark, 2006).

Taking market forces into account suggests that, under conditions of high uncertainty, high complexity of systems, and contentious interdependencies, modularity is difficult to implement, jeopardizes cost control, and makes it difficult for individuals to pursue meaningful work and visualize the systemic outcomes they are creating (Levitt and Scott, 2017). This may particularly be the case when the workers are part-time contributors over the internet. "Justification" (Lepisto and Pratt, 2017) is an alternative approach for triggering meaningful participation. In settings with meaningful overarching goals, participants' own meaning-making can create the justification. Still other approaches to the design of participation architectures may be needed to efficiently channel the participation of contributors (Faraj et al., 2011), for example, by using external talent primarily to complement core activities rather than perform core activities (Boudreau and Lakhani, 2013). However, some external contributors may only want to contribute to the core activities (Selander and Jarvenpaa, 2016), requiring a DIO to heighten the appeal to the justification perspective. Moreover, where the technologies under development are complex, modularization can be difficult.

Evaluation and monitoring progress. The final design element is how work is evaluated and monitored. Online rankings, ratings, and "likes" represent one way for contributors to distributed innovation systems to convey their assessments of others. For example, Threadless asks customers to indicate if they will buy a product, which management uses as an indication of the market value of the design (Brabham, 2013; Lakhani and Panetta, 2007). Stack Exchange contributors are rated for the number of accepted answers they provide. The more complex, uncertain, and interdependent the system being developed, however, the more difficult it is to design an appropriate evaluative infrastructure: individual contributions become less important than collectively co-created outcomes (Majchrzak and Malhotra, 2013) and collectively co-created outcomes are difficult to track back to individual contributions (Füller et al., 2014). How evaluation can be conducted in such contexts is an important element of study.

Not only will market competition drive has progress is monitored, but the design of the evaluation infrastructure needs to reflect competition for talent, with evaluation metrics taking into account the value of the contributor to the organization (Solansky et al., 2014), as well as the value of the organization to the individual. Thus, a DIO must find ways to evaluate contributions of individuals so that contributors offering their talent can be best utilized. The organization must also find ways to provide contributors with fungible assets to justify their time.

Analytic Questions

Kornberger's (2017) framework offers a design-centric analytical tool for understanding cases where management and the crowd need to co-exist, co-develop, and co-deploy activities. At the same time, market forces related to the presence of competitors and the competition for talent expose market-driven firms developing emergent markets with complex technologies to challenges beyond those highlighted by Kornberger. Therefore, we ask the following analytic questions in our case study:

1) *How are the interfaces designed to respond to the market forces of competing organizations and competing for talent?*
2) *How is participation encouraged given these market forces?*
3) *How is progress monitored and evaluated given these market forces?*

Research Method

We adopted an ethnographic approach with two authors joining HYPERLOOPTT (the third intentionally did not collect data to facilitate reflection). We focused on one portion of the company – the engineering contributors designing the high-speed transportation system – most directly related to HYPERLOOPTT's core mission. We report on 18 months of ethnography (see Table 1 for data sources), commencing at "Concept 0," when the company was beginning to define its engineering design, and continued as the company successfully conducted multiple feasibility studies with clients.

[Insert Table 1 About Here]

We began with a “complete rendering of the story within the text” (Eisenhardt et al., 2016: 2007) by preparing a document describing HYPERLOOPTT and the issues they were confronting. The story of the organization was iteratively developed with the three principals of the organization: the CEO, COO, and Global Operations Director. Through these iterations, we gained a shared sense of the organization in terms of its purpose, strategic vision, culture, partnerships, challenges, and accomplishments to date. We also shared the story with selected others in the organization to confirm its face validity. This iteration (Miles and Huberman, 1994) helped us to make our conceptual leap (Klag and Langley, 2013) through the identification of the design mechanisms through documents, observed experiences, and interviews with more than one person, and aided our later critical interpretation of the case.

HYPERLOOPTT Background

HYPERLOOPTT was selected to address our three analytic questions because it is both a DIO and strongly affected by market forces. HYPERLOOPTT is a globally distributed technology start-up created with the purpose “*change the face of mankind for the better, and together build the next breakthrough in mobility*” (HyperloopTTp://www.hyperloop.global/about). To change transportation requires a series of disruptive technologies and practices including a hyperloop (a pod traveling through a quasi-vacuum tube), delivery mechanisms (such as station and pylons), technologies to make the system self-funding (such as vertical gardens on the pylons and advertising windows on the capsule), as well as new practices for insurance, government regulations, project management and construction.

The hyperloop is a transportation vehicle envisioned to hit speeds of over 700mph. A full-scale functional hyperloop at costs that can be self-funded does not yet exist and requires innovation in many complementary technological components. In particular, current scaled-down versions of a hyperloop are very expensive to operate and thus it takes even more innovation to make the hyperloop operate at a price point that will pay for itself. To do so, in absence of other referents (e.g., Labianca et al., 2009), requires simultaneously designing the hyperloop and its complementary components while also redesigning the concept of a transportation system. As just one illustrative example, HYPERLOOPTT's CEO has raised with potential customers the possibility of funding transportation based on alternative monetization strategies, disrupting how the public thinks about the tradeoffs between transportation options (Collins, 2015). Evidence of HYPERLOOPTT's progress in executing on its mission includes (at the time of this writing): 27 internally-developed design patents pending; 49 corporate partnerships, eight feasibility studies with governments, a testing track and capsule being built in Toulouse France, $31.8M cash investments, $26M man-hours and services, $22M land rights, and $29M committed in-kind investments. As succinctly stated in HYPERLOOPTT's marketing material:

> *We are a collective of people who are dedicated to making the most of our time here on earth. We are not just a company. We are a company fueled by a movement, powered by the brightest and most passionate [of] minds… We are a global community of over 800+ people from over 40+ countries who believe that all of us is better than one of us.*

Hobday (1998: 689) describes complex operating systems as "highly customized, engineering-intensive goods which often require several producers to work together simultaneously, [whose] dynamics of innovation ... are likely to differ from mass produced commodity goods." Compared to other studies on complex operating systems (e.g., Hobday, 1998), HYPERLOOPTT's uniqueness has roots in the choice to develop this new system *and* its market as part of a partially open DIO. HYPERLOOPTT consists of 12 paid staff, 800 contributors (individuals and organizations) from 48 countries working a minimum of 10 hours a week in exchange for stock options, and approximately 50,000 followers who provide input on marketing and business opportunities, latest technologies, and feedback on designs. HYPERLOOPTT is not only a DIO, but an extreme one with an employee-involvee ratio of 1:10,000 (cf. Borg and Söderlund, 2013). On the engineering side of the company, contributors are highly trained professional engineers (many with PhD's), project managers, government officials, policy experts, transportation specialists, designers, physicists, and space scientists. The interdependent nature of HYPERLOOPTT's complex system is seen throughout the work. In a group discussing designs to reduce excessive g-forces, members included those with knowledge of NASA's design of capsules, nano-technology, psychology, and medicine.

HYPERLOOPTT is organized with a senior management team consisting of the CEO, COO, CFO, Global Operations Director, and CMO; a chief engineering council; and 55 part-time team leaders identified either from personal and professional networks of senior managers or self-nominated from the crowd of interested supporters. In addition to the team leaders, there are hundreds of contributors, self-nominated or recruited from the crowd who have signed the stock-option and contributor agreement, agreeing to engage in at least 10 hours a week of work, and assigned to an engineering or support team. These contributors may be representing themselves as individuals or an organization for which they are employed.

The market environment of HYPERLOOPTT is highly competitive. While it was the first hyperloop transportation company, it is only one of several competing firms in the emerging market of smart and fast transportation systems. Compared to its competitors, HYPERLOOPTT is the only firm using an open DIO approach, the only one to work with local governments in customizing transportation solutions, and the only one not simply building the technology, but creating the market as well as an ecosystem of developers, implementers, and service support companies. Thus, HYPERLOOPTT is firmly engaged in managing both inter-organizational competition as well as competing for talent.

Case Analysis of HYPERLOOPTT's Organization Design Mechanisms to Support Engineering

We examine HYPERLOOPTT using Kornberger's (2017) three design mechanisms as foundations.

Design Mechanisms to Support Coordination Interfaces

Coordination interfaces evolved over the time of our 18-month ethnography from a traditional organizational design based on modular elements of the hyperloop to supplementing and largely replacing the original design with one emphasizing visibility of knowledge sharing.

At the beginning of our observation, the founders had just completed a feasibility assessment of the hyperloop concept. They had just completed the creation of a large organization chart with 80 hierarchically-organized teams of which 40 were engineering-related. The teams were modular decompositions of the hyperloop including pylon, propulsion, pod, and systems control teams. Each team was staffed and led by part-time engineering contributors who had joined through self-nomination from the crowd or identified from personal or professional networks of the senior management team. Team leaders were generally located in industries adjacent to hyperloop (since a hyperloop industry did not yet exist) including project construction, project management, aerodynamics, aerospace, and transportation.

The founders initially applied principles of Agile Scrum (Schwaber, 2004) in which teams were three to seven members and expected to complete small work packages called 'sprints' in three-week periods. Team leaders were referred to as hyperleaders, "establishing guardrails, empowering teams and resolving blockers, *not* us[ing] command and control" (posted in Culture group, FB@W, June 17 10:12 AM, italics are ours). Hyperleaders were expected to define sprints, lead weekly teleconferences with team members, and attend weekly integration team meetings with other hyperleaders. All coordination at the time was done through individuals' personal email, Slack accounts, WhatsApp accounts, or text messaging.

At the time of our first meeting with the company principals, there were three employees working full-time for HYPERLOOPTT: the CEO, COO, and Global Operations Director. Senior management expressed confidence in using the rigidly specified structure for several reasons. First, it ensured that each globally distributed, part-time contributor knew precisely where s/he fit in the organization. Second, the organizational design informed the hyperleaders about who to include in emails and teleconferences. Third, the design informed all contributors of the hierarchy of approvals for engineering design and business decisions. Fourth, senior management reported that this structure helped to segment information-sharing so that no one individual knew too much about the engineering design, which could put HYPERLOOPTT's IP at risk.

Beginning in the third month of our observation, several changes occurred. First, contracts for a feasibility study with Slovakia created a need to make engineering designs and design assumptions more concrete, making it necessary to engage with the interdependencies between the hierarchically organized modular engineering design teams. These interdependencies were not explicitly modeled on the organization chart and were too detailed to be handled by a single integration team meeting once a week.

Also, during the third month of observation, Facebook agreed to provide its enterprise collaboration tool – Facebook at Work (FB@W, rebranded in 2016 as Workplace) – in exchange for stock options. FB@W includes notification as soon as someone responds to an individual's comment, ease of creating groups, and a toggle to make a group open to all versus closed and secret (those not in the group are not even aware that the group exists).

HYPERLOOPTT's FB@W implementation was structured by an HYPERLOOPTT contributor to align with the 50 groups in the organization chart (and included non-engineering groups such as marketing and business development). Thirty of the 80 HYPERLOOPTT teams were not included as they were either comprised solely of external partners or were working on tasks which the CEO felt needed to have the IP more carefully protected than even a "secret" group would allow. Thus, about 300 out of the 635 individuals were on FB@W at the time. (The number has fluctuated since then as contributors are added or become inactive.)

Forty-seven of the 50 groups were secret, meaning that the group included only those team members formally associated with the team with others not able to see the existence of the group, know who were members, or review the posts to the group. Only three groups were open to all. These were for general information dissemination: *Press*, *Whatever You Want* (which was primarily a place to share social news and chat), and *Announcements* (such as from the COO). Senior management approved all requests for joining a group to ensure further IP protection.

In the fourth month, soon after setting up FB@W, contributors started to post suggestions in the general group, *Whatever You Want*, for improving FB@W. Since these suggestions were quite specific, one of the FB@W administrators created a *Suggestions for FB@W Improvements* group open to all contributors. Contributors also started posting suggestions in the *Whatever You Want* group specifically about improvements to HYPERLOOPTT, which led to the creation of a new open group named *Suggestions for Improving HYPERLOOPTT*. Around the same time, engineers began surfacing cross-team engineering issues as specific suggestions in the

Suggestions for Improving HYPERLOOPTT group, such as the need for discussions about a design assumptions document. This led to the creation of a *Design Assumptions* group open initially to only the 15 engineering hyperleaders permitted to join. Thus, FB@W groups started expanding almost immediately, and also, almost immediately, surfaced as a tool for cross-team knowledge-sharing, coordination and integration. Regardless, many hyperleaders felt that FB@W was not sufficiently safe for sharing IP and that the IP-related work needed to occur either through email or Slack.

As FB@W usage by engineers increased over the next three-month period, engineers created new FB@W groups on issues that were typically more complex than could be accomplished in a short three-week sprint by any single team alone and required cross-team discussions (such as discussions about how to handle g-forces in 700mph capsule that may have to twist and turn around mountains). These "issue-specific" groups served as coordination interfaces between different functional divisions of the hierarchically organized engineering teams. Over a short six-month period, the initial 50 FB@W groups – initially segregated based on the hierarchically organized organization chart - grew to more than 150 groups (210 at last count). Each group was administered by a hyperleader who volunteered to facilitate the FB@W group and group teleconferences.

Some hyperleaders administered many groups, depending on the number of integration issues that arose in the hyperleader's functional area of responsibility. While three to seven contributors still were assigned to each of the functional teams, the FB@W groups, which initially included only those on the team, now expanded to an average of 15 contributors with some secret groups having over 100 members(!). Even though senior management rarely suggested the creation of groups, they also rarely denied permission of contributors in creating new groups. Nonetheless, for the sake of IP protection, each additional group was initially given a closed permission. All new groups include senior management as members for monitoring purposes.

Despite the policy indicating FB@W as the "go-to online collaboration platform for HYPERLOOPTT" (per an onboarding document), a few engineers did not use the platform, preferring Slack instead, with others preferring their personal emails. A sizeable number of contributors – including one of the co-founders, the entire marketing department, the head of project management, and the entire business development department – rarely posted anything on FB@W, using google drive and What's App to coordinate. This did not bother the senior management because they felt flexibility of technology use is essential to entice those with the special talent to participate; if contributors were forced to learn a new tool, the founders reasoned, the contributors might not participate. The company's email policy was similarly flexible.

One unexpected coordination value that emerged explicitly from the use of FB@W is what HYPERLOOPTT calls the self-monitored talent pool-to-task matching process. It was a source of great pride to the HR director at HYPERLOOPTT because there seemed to always be someone in the community waiting to perform new tasks that others including hyperleaders responsible for an individual did not know the individual would be interested and capable of performing. The pool-to-task matching process emerged as follows:

> *An engineer sent a FB@W private chat to the FB@W administrator, asking for help to find someone with a particular capability. The administrator used the request as an opportunity to create Request for Help Workgroup, and moved the chat request into this new Workgroup (disguising the name of the requestor). Within minutes, another contributor indicated his desire to help. However, when the contributor indicated he had extra time and wanted to help, the administrator was contacted by the hyperleader over that individual, raising concerns that the individual was being stolen away from her team. This issue resolved itself over time since responses to each request were so quickly filled*

> *that hyperleaders began to take less ownership over the contributors on their team, allowing them to do other work if they wanted.*

Given the number of coordination tools – F@W, personal email, personal Gmail, WhatsApp, corporate email, Slack, Google Drive, etc. – team leaders and senior management took to checking all of them, receiving notifications into their inboxes. In sum, unlike some prior suggestions for virtual team work (e.g., Dubé and Robey, 2009; Malhotra et al., 2007), coordination was accomplished not through a single IT system, but many.

Design Mechanisms to Support Participation and Work Meaningfulness

From the start, HYPERLOOPTT used a participation contract as a motivation device for contributing to HYPERLOOPTT. The oft-repeated phrase from the CEO is:

> *Instead of hiring people for 60 hours/week, I would rather have 10 hours of an expert working on his passion and have someone else perform the other tasks.*

A large stock option pool was made available to collaborators who signed the contract. Most of the contributing engineers worked only the minimum of 10 hours a week when there was work that fit their expertise or interest. For example, the solar power team leader worked early on to develop the solar specifications, and then simply monitored the capsule and track designs to see if solar issues arose that needed his attention. Some engineers had substantial flexibility (such as consulting), were retired, between jobs, or had another source of income, and were able to spend substantially more than 10 hours a week. They all worked remotely. HYPERLOOPTT has an exhibit hall in the U.S., but engineers rarely use it because they are globally distributed. For example, the capsule hyperleader is located in Austria, the safety hyperleader is located on the U.S. east coast, and one of the system architects is located in Hawaii.

Design mechanisms were structured not simply to encourage participation based on the extrinsic motivation of the stock options, but for other reasons as well. From the interviews and transcripts of discussions among Engineering hyperleaders, motivators other than the stock options were repeatedly mentioned. These included:

> "*changing the world,*" "*being part of something that's cool,*" "*it allows me to be with a new startup since I've only been with large companies,*" "*I'll learn something new,*" "*I'll be challenged and get to do something creative instead of my day job.*"

The stock options were often mentioned as an aside: "*oh yeah, and it would be nice to be rich one day*." One engineer reported that he hoped he might be offered a paying job (he was later) when HYPERLOOPTT began making money. Other engineering hyperleaders said they joined to be able to play roles that they could not in their current or former employment. For example:

> *They [i.e., the founders] originally asked me to be a programmer, but I've done that and do that in my day job. I wanted to do something more strategic, which is why I have the role I have at HYPERLOOPTT of strategic partnerships.*

Since learning and creativity were important to many of the HYPERLOOPTT participants, the match between skills and interests of the contributor and the needs of HYPERLOOPTT were highlighted. Initially senior management spent substantial effort ensuring that junior and senior professionals were working together on a team so they learned from, and stimulated, each other.

> *A challenge in member selection is to be able to balance senior and junior professionals [in allocation to teams]... Having too many seniors creates challenges when basic tasks need to be executed and there is the tendency of looking for a higher position in the structure and less flexibility in following new procedures. Having too many juniors doesn't give the organization depth of experience and knowledge with standard procedures etc… Part of the selection [from the crowd] is also learning how to balance the roster… This is more accentuated in these type of organizations, from what I saw so far, because of the large pool of people that could be selected and that want to participate.*

Maintaining the right mix of talent on the roster and ensuring that such a mix was used appropriately for the teams and projects took considerable COO time. Needs for technology development often shifted as technology capabilities in the marketplace changed, as partnership and client opportunities emerged, and as the market and media became more sophisticated about a hyperloop. Potential new contributors frequently submitted their resumes through the company website, during speeches made by senior leaders, and on the recommendations of leaders already at HYPERLOOPTT. When these potential contributors offered their services, there might not be an immediate need, but a potential future need. Moreover, while hyperleaders were relatively stable, the level of activity among team members varied unpredictably as new jobs, family, or expanded job responsibilities affected the 10-hour a week contribution; in addition, some team members "*drifted away*" if they had difficulty finding a match to their interests and skills. Therefore, while hyperleaders provided the seniority in functional teams, as well as in each of the cross-team groups, fostering a continuation of a junior-senior match, matching skills and interests on the one hand and organizational needs on the other hand continued to be difficult to do efficiently and accurately.

Initially, only contributors who could be immediately assigned to a team leader were allowed to join HYPERLOOPTT. At some point, that was felt to limit innovative thinking and the door was opened to let people join who could define their own tasks. This led to a number of people being allowed to join HYPERLOOPTT who did not have an immediate task to work on, which was later found to be problematic, leading to continued conversations about how to ensure that new contributors have tasks to work on immediately. Today, HYPERLOOPTT only allows in contributors for whom there is a need specified by a hyperleader.

Several engineers and a recruiting contributor referred to cultural fit as part of the difficulty in matching new contributors to organization needs. Senior managers reviewed resumes for contributors with substantial experience in specific pre-defined capabilities (e.g., computational fluid dynamics for bridge engineers). Resumes passing the technical screen triggered a phone call to ensure s/he will work in exchange for stock options. The cultural screening occurred next, either by recruiters, the COO, or the hyperleader. They were looking for:

> *... fervent champions of new and better ways to deliver tomorrow's innovations today, problem-solvers who believe that all of us is better than one of us, and are the ones who step forward to make things happen* (March 22 2017 HYPERLOOPTT Culture statement).

Our interviews with engineers identified additional traits needed to work at HYPERLOOPTT: commitment to 10 hours per week, comfort with using FB@W, comfort with working with part-time engineers from around the world, passion about the technology, sufficient self-motivation to not await direction, being other-centered, and being humble in learning from others despite one's own extensive expertise. In the words of one senior manager:

> *HYPERLOOPTT probably requires a new level of skill set: for example, being able to execute and perform with a lower level of information, develop intuition on what could work, learn how to align fast with your colleagues, etc.…*

Changes were made to the HYPERLOOPTT website to accommodate this increased recognition of the importance of these cultural traits in deciding who should participate in HYPERLOOPTT. The website indicated HYPERLOOPTT wants collaborators (not simply contributors) who understand:

> *The future of work is powered by purpose. We are a global team working together to make our commute and the planet a little better. We believe in shared responsibility and shared profit. Collaborating at HYPERLOOPTT means working with the best minds on a part or full-time basis for stock options.*

If an individual submits a resume, the website then asked applicants:

> *Why HYPERLOOPTT? What do you care about and wish you could do more of, and why? What would you like to contribute to HYPERLOOPTT? Where should you sit on this journey?*

Design Mechanisms to Support Progress Monitoring and Evaluation

Evaluation is always difficult to conduct for highly innovative collaborative work. Managers find specifications difficult to define in advance, and the precise nature of contribution difficult to assess individually. The CEO saw his mission as one to build up HYPERLOOPTT's brand name, industry, and competitive advantage so that stock options will be financially rewarding for contributors and that physical evidence of the contributors' hard work is made visible in terms of formal agreements with clients.

Engineers were simultaneously engaged in two challenges: 1) exploring a future vision of an idealized transportation system, industry, and ecosystem for world-wide use in the future; and 2) meeting near-term goals by exploiting already-existing and recently developed technology components (i.e., checking out potential partners and commercially available components, and designing and supervising customized feasibility tests for clients). This double-sided nature of the innovation allowed for both exceedingly clear metrics of evaluation (e.g., 'was the feasibility study completed on time with a satisfied client?') as well as exceedingly unclear measures (e.g., 'how might we include a new technology in the development of the propulsion system?')

One design mechanism used by senior management for the particularly unclear measures is the use of competing teams. Sometimes the competing teams were established because there are enough technical engineering resources available to have two teams work on the same topic. Sometimes the competing teams were established because there were multiple options available to solve a particular engineering problem and proceeding down multiple paths fostered exploration. Finally, sometimes competing teams were established purely for IP protection:

> *We decided what is our very core technology and we analyzed how protected we are from an IP standpoint. We agreed that the [XX] is our core technology and that 2 teams are the very core of it. In those 2 teams, new IP could be generated every day, so it's hard to constantly protect them from a legal standpoint. We decided to keep these 2 teams completely separated from the rest [and unknown] but have a gatekeeper in between the 2 teams and the rest of the engineering contributor community. The engineering community can ask questions of the gatekeeper who will decide every time if he can pass the information and answers from the two teams to the rest of the engineering community. This process will continue until an IP is filed and patented (provisional) or an exclusive license is acquired. The members of the two teams are properly instructed to respect this procedure*.

Having contributors publicly rate other contributors, as done in many open communities, was dismissed as not applicable to the HYPERLOOPTT context given collaboration was conducted in the spirit of a movement and because of the interdependencies involved. Instead, if a contributor could not be counted on to perform at high quality, the contributor was simply not assigned tasks or not included in discussions, similar to more traditional organizations.

The only formal evaluation system used at the individual level was for the number of hours worked. Initially, people self-reported hours; as the number of contributors grew, an automated tool ('Lucy') using natural language analysis of an email sent to Lucy was developed which collected, aggregated and announced to the whole team who did what for how many hours per week. As part of quality control, hyperleaders approve the hours reported before stock options are assigned

In conclusion, Table 2, column A, summarizes HYPERLOOPTT's organizational design in terms of Kornberger's (2017) three design mechanisms of coordination, participation, and evaluation.

[Insert Table 2 About Here]

Discussion

Two New Organizational Design Mechanisms for Managing Market Forces

We examined the organizational design of a competitive distributed innovation organization developing a complex technology using members of the crowd as collaborators for the core technology. We identified two mechanisms that emerged from the organization over time that were not discussed by Kornberger (2017) which we call visible collaborative self-management and secret gardens. We defined visible collective and self-management as an intertwined set of practices to: 1) allow contributors to NOT rely exclusively on a single coordination tool (cf., a centralized computer-mediated communication device) but instead to select whichever communication tool they preferred to supplement the centralized tool as long as they could enroll others into using it, 2) allow contributors to NOT passively accept the tool, but actually change the centralized tool by starting, as needed, new closed and open groups on issues they felt required collaborative discussion and invited whom they wanted into the group, 3) match their own talent to others' declared needs, 4) announce needs for talent, and 5) become eventually promoted to a team leader even as they remained part-time. A sixth (6) practice of organizing discussions by relevancy came about because contributors used the FB@W groups to help organize their discussions. Since any contributor could see the existence of a closed group (closed groups are groups for which their existence is shown on FB@W but for which permission is required, as opposed to open groups are open to anyone registered on the FB@W site for the company), they could ask the group leader for permission to join (a request rarely denied). As such, the groups became used by contributors to distinguish between relevant and irrelevant knowledge-sharing, thereby helping contributors to focus their limited time. For example, the "social announcement" group was delisted from many of the engineers' notifications so that they could ignore those exchanges; in contrast, engineers set notifications to be informed of any additions made to the FB@W engineering groups they belonged to.

Together these six practices that form the visible collective self-management mechanism provides not simply visibility of the work being conducted, as others (Kane and Ransbotham, 2016; Leonardi, 2014; Majchrzak and Malhotra, 2013; O'Leary et al. 2011) have already suggested, but more importantly a way for the contributors to collectively manage their work together and individually. Such self-management increases one's task meaningfulness (Lepisto and Pratt, 2017; Mitnick and Ryan, 2015), and therefore a desire to stay involved.

A second design mechanism that emerged is one we refer to as "secret gardens". We define secret gardens as knowledge-sharing occurring online in places not made available to most of the contributors and not even known by most contributors as existing (e.g., Van Alstyne and Brynjolfsson, 2005). These places may be groups marked on FB@W as "secret" which do not show that the group exists (vs "closed" which indicates that the group exists but requires permission), or they may be separate forms of communication tools used, such as a shared google document used during proposal preparation. The secret gardens were initially started by the founder to protect intellectual property. By not even informing others of the existence of these "secrets", contributors could avoid being frustrated in achieving meaningful work since they were not aware of information being withheld. In the occasional times in which they learned of the existence of a secret group, such frustration surfaced. Three alternative approaches to this frustration emerged. In one case a liaison was appointed between the secret group and other engineers, with the liaison being entrusted with the task of filtering relevant information both to and from the groups. In a second case, the frustrated contributor decided to become inactive until the information could be released (e.g., patented). In the third case, which was most often observed and the one promoted by the founder, the frustrated contributor simply accepted the need for secrets and continued his development work making assumptions about answers to questions. The mechanism of a secret garden then allowed intense collaboration to continue without the presence of obvious walls. Fault-lines, which usually emerge in the presence of such walls (Thatcher and Patel, 2011) were avoided, enhancing collaboration.

How HYPERLOOPTT Adjusted Each Design Mechanism To Respond To Market Forces

In addition to the two new design mechanisms, adjustments to each of Kornberger's three design mechanisms were needed as well in order to respond to market forces. These adjustments are shown in Table 2, column B.

Coordination interfaces. HYPERLOOPTT used a heterarchically distributed structure through which the company intentionally made visible the thread of knowledge developed as contributors worked to revolutionize the transportation industry. Differently from other cases exposed to market competition, HYPERLOOPTT not only relied on external part-time workers for exploiting potential efficiencies (see also Barley and Kunda, 2004; Moisander et al., 2017), but as the *only* possible way to acquire the necessary talent to face the unseen challenge of revolutionizing the transport system. The internet provided a set of solutions able to act as interfaces (Langlois and Garzelli, 2008; Van Alstyne and Brynjolfsson, 2005) to this talent. Effective and efficient engagement was key both for the competitiveness of the organization and for its ability to attract top talent, especially as most of the contributors were part-timers operating in exchange for stock options. The information technology (IT) systems, by making *visible* the knowledge threads created by contributors, did not represent just effective means for finalizing the contributions (e.g., Täuscher, 2017) but, rather and more importantly, were used for collective and self-management in a manner similar to open source software development and Wikipedia (Kane and Ransbotham, 2016). The coordination interfaces allowed

HYPERLOOPTT to respond to pressures exerted by direct competitors by not just having high quality and quantity talent, but also effective coordination their knowledge.

HYPERLOOPTT, as with many other complex operating systems (MacCormack et al., 2006, 2012), started its venture assuming that the organizational structure would mirror, the (expected) product breakdown structure (pylon, propulsion, pod, etc.). However, as the project unfolded its inner complexity, additional uncertainty affected task division and allocation. Distinctions between functionally decomposed and horizontal projects (Levitt and Scott, 2017) became increasingly porous, leading to overlapping memberships and fewer functional distinctions and more cross-functional issue-based discussions.

IP protection walls were raised in the form of secret gardens when intellectual property was at stake. In this case, senior management took a hand in creating walls, but the IT system served as an invisibility cloak in the sense that competitively sensitive workgroups were not even made aware of to others. This is unlike traditional skunkworks within organizations where the walls are obvious. These hidden walls ended up being enforced with the use of different collaborative IT tools used by different workers. This finding is in line with the research showing that IT can connect geographically separated people but also fragment interaction and separate groups (Van Alstyne and Brynjolfsson, 2005), and in contrast with the expectation of standardized coordination interface predicted by traditional virtual team research (e.g., Dubé and Robey, 2009; Malhotra et al., 2007). The cloaking allowed the organization to manage the exigency of being open to new temporary workers from the marketplace, while developing and protecting intellectual property from (some of) those external part-time contributors; to distribute and retain innovation by being open and close simultaneously (cf., Cunha and Putnam, 2017; Putnam et al., 2016). Competing in an arena where innovation is key amplifies the importance of IP protection.

Hence, the distribution of access rights and privileges builds secret gardens that eventually shape layers of inner sanctums through which knowledge is created and shared.

Participation and meaningfulness. At the beginning, HYPERLOOPTT set up an architecture of participation (Baldwin and Clark, 2006) that was based on a pre-set time of commitment (hours per week) in exchange for stock options, regardless of role or external organizational affiliation. This is profoundly different from many DIOs, in which the winner takes it all, including long term contracts (Schlagwein and Bjørn-Andersen, 2014), while other non-winning contributors are not rewarded at all (i.e., Threadless, Netflix Prize). This is perfectly consistent with the logic of competing for talent attention (Kane and Ransbotham, 2016) and relies on the appeal of its challenging mission and vision. In competing for talent, the competition for attention relates to an individual trade-off between job stability and the sense of realization. The possibility offered by HYPERLOOPTT to individuals to see the threads of knowledge from around the world (in the open projects) and do this with only a part-time commitment without quitting their "day jobs" is a primary motivation for the talent. As one of them stated: *"I'm paying attention to HYPERLOOPTT because I can do it part-time and don't have to quit my day job*." So, HYPERLOOPTT is able to face competition for talent by organizing itself to explicitly make the threads of knowledge visible as workers pursue its difficult mission.

Evaluating and monitoring progress. HYPERLOOPTT cannot adopt the same evaluation and monitoring systems as other community-based open systems. A "like" on FB@W does not have the same meaning as a "like" on Tripadvisor since HYPERLOOPTT's work is so interdependent. Since there is zero possibility of individual "realization" from "small," and "fast" tasks (e.g., Cunha et al., 2017), the self-efficacy of "*changing the world,*" "*being part of something cool,*" et similia results is the "compelling account" that is central to the justification perspective of the human action (Lepisto and Pratt, 2017). Here again, HYPERLOOPTT's strategic use of visible threads of knowledge helps to manage this issue of evaluation by publicly displaying what people are working on, encouraging people to respond to *Requests for Help* to match their skills to tasks, and by not assigning work to those with poor quality.

Theoretical Implications

Although distributed innovation systems have gathered substantial scholarly attention during the last decade, organizational designs structuring these systems have been given less (Kornberger, 2017). The current research contributes in several ways. To the literature on how to design open crowd-based organizations, the HYPERLOOPTT example challenges assumptions that such forms should always be "organic" by nature (*à la* Burns and Stalker, 1961) since there was clear management intent in the design to make some knowledge visible and hide cases where knowledge needed to be hidden. Moreover, the opposite extreme is too simplistic, of requiring "mechanistic" design features when distributed innovation organizations are exposed to market forces (Sine et al., 2006). Participation was organic in the sense of visible collective and self-management. Protection of IP through secret gardens was more mechanistic . The walls of secret gardens are quite distinctive from the invisible walls noted by Brown et al. (2010) who argued that invisible walls are constructed as "silent hierarchies" based on the defense of power. In a similar manner, the visible collective and self-management used by HYPERLOOPTT is quite different from Kornberger's (2017) notion of making talent visible since, for HYPERLOOPTT it is less important *who* makes a contribution than *what the contribution is and how the* *contribution is used for collaborative self-management.* Tasks are not separately divisible, and contributions are needed which engage further contributions so that collaboration toward the long-lasting mission continues.

To the literature on knowledge management of complex projects, the multiple coordination tools used by HYPERLOOPTT which created many different interfaces should be noted and is quite distinctive from the existing literature (e.g., Dubé and Robey, 2009; Kogut and Zander, 1992; Malhotra et al., 2007). The need to compete for external talent was surely a factor: if part-time contributors are to be able to offer help to HYPERLOOPTT, they will ideally spend as little time as possible learning the company's tools. More importantly, though, may be the sense of control and priorities communicated to the part-time contributor when they were encouraged to use their own tools. The message might be: you are important to HYPERLOOPTT for all that you bring to HYPERLOOPTT; that is, we want you for who you are now, not to become someone we limit, constrain, and outfit with tools. Finally, the use of one's own tools created walls between projects, but invisible walls since one contributor might never be aware of the knowledge created by other contributors.

To the broader literature on the design of innovative organizations, we explain one way in which such organizations can face the new, progressive challenges created by the future of work, specifically when it comes to the engagement of contingent workers (Barley and Kunda, 2004; Barley et al., 2017; Moisander et al., 2017; NRC, 1999). Under the pressure of competitiveness, the possibility to distribute innovation among external agents (Barlow, 2008; Prpić et al., 2015) can grant the organization the possibility to engage any number of contributors (e.g., Malhotra and Majchrzak, 2014; McCabe, 2016). Differently from other contexts (e.g., Anonymous - an international hacktivist network), the non-modular nature of the collaboration among such talent requires visibility into their work. Faraj et al. (2011) refer to organizational designs without modularity as generative when resources provided to the organization (in terms of new contributors) do not simply meet predefined modular tasks. HYPERLOOPTT started with a more traditional modularized structure, with the organization design mirroring the expected product design (MacCormack et al., 2006; 2012). In embracing modularity, HYPERLOOPTT started with a cognitive search that later shifted towards the exploitation of the contributors' experiential learning (e.g., Berends et al., 2016). The exchange of knowledge and experience among contributors made complex, previously underestimated, contentious interdependencies between tasks more visible and salient (e.g., Levitt and Scott, 2017), and therefore difficult to ignore. That let HYPERLOOPTT morph to a more complex structure leveraging integration teams. HYPERLOOPTT shows that, as knowledge sharing and knowledge production tends to weave around (multi-disciplinary, interrelated) themes rather than single modular components, the avenue of simplification fails and one of "complexification" (Tsoukas, 2017) is highlighted. We posit that mechanisms governing crowd-based competitive DIOs should fully embrace the foreseeable (*ex ante*) and experienced (*in itinere*, e.g., task interdependencies unfolding) complexity of the system under design; they should "complexify" their organization's design, rather than just increase the complexity of their participation interfaces.

To the broader literature on open innovation (Felin and Zenger, 2014; Nickerson et al., 2017), we present an extreme form of open innovation, leveraging *visible* self- and collective management under the strict need to make the walls protecting intellectual property invisible. In HYPERLOOPTT, the interaction between an organization design oriented to balance innovation and defense of intellectual property against the presence of engaged contributors generating new challenges creates the need for simultaneous visibility and invisibility. This dynamic (re)configuration of external contributors observed in HYPERLOOPTT overtakes the idea of crowdsourcing as a series of single, modularized, challenges (i.e., Lakhani and Panetta, 2007; O'Mahony and Ferraro, 2007).

Study limitations

Ours is a single case approach with an, as yet, unique setting of a distributed innovation organization confronting both inter-organizational competition and a war for talent. Further, we based our research on an organization which is still ongoing and, therefore, potentially subject to further investigation. Consequently, there are many open questions and opportunities for future research. How long will collaborators engage (cf., Jarvenpaa and Majchrzak, 2016)? Are there evaluation methods that have not been tried? Might there be a standardized coordination interface which could work? Moreover, in order to achieve depth of analysis, we have not discussed the many other aspects of HYPERLOOPTT outside of the engineering department. In this vein, we encourage the development of future research and practice to seed management strategies for DIOs.

Conclusion

We examined the organizational design of a competitive distributed innovation organization developing a complex technology using members of the crowd as collaborators for the core technology. We identified two mechanisms that emerged from the organization over time which we call visible collective self-management and secret gardens. We learned that the design of the organization needed to entice talented contributors into engaging in self- and collective management, not simply welcome them; engage them in visible collaborations so that contributed knowledge could be woven together; and allow contributors to use the collaboration tools that they are most comfortable using. While the literature suggests the idea of a visible hand of management controlling the crowd (Chandler, 1977), we suggest instead that, with complex organizations developing complex products and markets, even managerial roles (i.e. our hyperleaders) can be played by contributors sourced from the crowd and that visible hands are less needed than visible self- and collective management by the crowds. We also learned that the value of cloaking walls in invisibility is twofold. First, to create porosity between groups so that interdependent tasks are better coordinated. By cloaking the walls such that they are not seen as barriers, contributors can work together seamlessly where they can see each other's work – unconstrained work flows around that which is cloaked. Second, in the case of strict IP needs, to be so invisible that contributors continue their work without feeling constrained by the knowledge they do not know. In an organization competing for the time and contribution of high level talent, constraints are demotivating.

In sum, then, the example of HYPERLOOPTT helps to make concrete the very real paradoxes faced by open distributed innovation systems as they move from a realm of openness to competition. The practices used by HYPERLOOPTT provide initial steps toward theorizing about such future systems and practical management advice.

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Table 1. Sources of data

Source	**Format**	**Focus of Content**
Hyperleaders for Engineering Integration, Systems Structure, Pylon Design, Tube Design, Project Management, Pod Design, Station Design, Power, Safety. Hyperleaders for non-technical design: Marketing, Human Resources, Culture, Animation, Business Development, Media, Global Operations, Strategic partnerships.	Repeated (3-10 each) semi-structured interviews 1 to 5 semi-structured interviews each Total hours: 95	Why participants joined, how they learned about HYPERLOOPTT, goals they hoped to accomplish, roles played in the organization, changes seen in the organization since joining, and background on the reasons for changes.
Review of all approximately 500 posts from engineering contributors (not hyperleaders) and 10 one-hour interviews.	Log data and 10 one-hour interviews	Speed of response, requests, post contents.
25 hours of semi-structured interviews with CEO; 5 hours with COO.	Repeated interviews	Strategic vision, cultural values, expectations, progress.

Review of documents: Onboarding website, non-disclosure agreement, commitment contract, press releases, press descriptions of HYPERLOOPTT, organization chart, HYPERLOOPTT executive summary.	Organization documents	Participation architecture; market forces; responses to market forces.
Review of Design drawings, system architecture, design assumptions, project management documents, risk assessments, scope of work, requests for work.	Engineering documents	Responsibilities and tasks of teams.
Listening to 80 engineering related meetings, each lasting between 45-120 minutes.	Observations of Teleconferences	How engineering is organized.
Reviewing the 5,000 posts on the collaboration technology, including events, group descriptions, likes, chat messages, comments, replies, and votes.	Observations of posts on the collaboration technology	Comments related to organization design, and how the technology is used by members.

TABLE 2: Case Study Findings	**A. HYPERLOOPTT's Design Mechanisms**	**B. How Design Mechanisms Appear to Respond to Market Forces**	**C. Theoretical Implications and Questions for Research**
Coordination Interfaces	The initial rigidly specified organizational structure mirrored a "large-scale, linear, 'horizontal' project" (e.g., MacCormack, et al. 2012), with limited coordination expected. As the interdependencies unfolded, groups created as residuals (i.e., Suggestions of Improving HYPERLOOPTT) acquired centrality, hosting cross-team engineering issues. That triggered the creation of new groups on-the-fly in the ratio of +200%. Information technology (IT) systems were able to support such an organizational reconfiguration. Multiple IT systems for coordination; not just one. Groups separated with gatekeepers to protect IP.	IP protection for between-org competition by having so many different coordination platforms with some more open than others. Also, IP protection enforced by secret vs. open groups with most secret, and separate groups. FB@W help contributors know where they should be putting their time to help with competition for contributor attention (Kane and Ransbotham, 2016). Multiple IT systems for coordination make it easier for contributors to use coordination tools they are most familiar.	Being organic by nature, crowd-based forms are supposed to be able to deal with extreme uncertainty. The exposure to market forces urges the organizations to cloak walls in invisibility in the form of "mechanistic" design features. When crowd contributors can assume different roles in terms of coordination, a kind of "onion" structure arises, with each level of coordination bounded by its own wall. Do open organizations in competitive environment require the study of new organizational forms? The IT collaborative tool has to respond to the contributors' exigencies, and not only to the organization's original design/aim/structure. Coordination can be achieved via the usage of multiple platforms, working together in a polysynchronous way rather than a traditional unifying platform (Baraolu and Tsoukas, 2015). To what extent does the organization have to choose/design the tool or let the contributors design them? Is there a way for testing the complementarity of such multiple platforms? The need to attract and coordinate talent under the pressure of being competitive pushed the creation of secret gardens through "mechanistic" design features. The resulting organizational form denies the simplification of modularization and rather embraces the idea of "complexification" (Tsoukas, 2017). Can the HYPERLOOPTT be generalized?

Participation Architecture	Preference for 10 hours of an expert vs. 60 hours of a non-expert; don’t define tasks for people, let them define the tasks for themselves (in contrast to Open Source focus on tightly defined tasks). Hyperleaders tasked with match between needs and skills, adding to their responsibilities. Importance of teams doing something always for commitment. Hi-touch virtual community: participation is collaborative, non-modular. Importance of culture in deciding the right fit (instead of just performing tasks).	Regardless of role, external organizational affiliation, contributors involved in stock compensation at same rate. Contributors were sought who are drawn to the overall mission, not a task; justification of their participation (Lepisto and Pratt, 2017) became an important source of attracting the right contributors from the public. Using between-organization competition in the media to capture interest of potential contributors. Clarify for public that collaborative participants are desired and this is NOT crowdsourcing.	Getting the attention of potential contributors is crucial for open organizations. Such an attention implies two aspects: 1) the engagement of contingent workers (‘brains’) under the constraints of contributor agreements and limited visibility of output/contributions; 2) Task allocation according to skills/expected duties schemes instead of narrowly defined tasks. How can open organizations compete for the best brains when uncertainty makes task definition volatile and fluid? Matching skills/interests and tasks is primarily human, time-consuming and difficult with the two market forces. Can artificial intelligence (AI) play a role in helping? Architecture of participation are not meant to reduce complexity but rather to increase it in a controlled way (Kornberger, 2017). We go further in the avenue of complexification drawn by Tsoukas (2017) as the knowledge scaffold shapes the whole organizational structure. That grants future further opportunities for individuals to self-select. What is the importance of continued activity to maintain commitment, even when such a continuity is not necessarily required?

Evaluation Infrastructure	Make visible # hours worked and projects worked on. Privately assess quality of individual performance. Competing teams to get the best result.	Competition for people’s attention implies feedback for performance improvement or a mismatch of skills suggesting people should leave. Between-group competition.	Are narrowly defined individualized performance metrics such as by crowdsourcing algorithmic outcomes w/clear evaluation criteria the best way to achieve innovation? What is the role of public peer-review in examining what projects contributors are working on? Competition between teams: how do you integrate the teams’ work? Do the losers leave or come back to play again?