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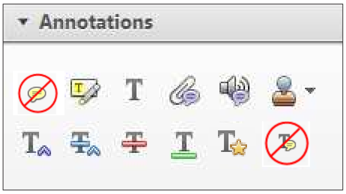

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The Anthropophagic Organization: How innovations transcend the temporary in a project-based organization

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Abstract

This article shows how innovations in projects may be diffused successfully within a large project-based organization (PBO) and how they 'live on' through their adaptation. We draw on the metaphorical notion of *anthropophagy*, literally 'human cannibalism', which is used to explain the appropriation of otherness resulting in ongoing organizational life. Prior organization literature has stressed the difficulties of the transition from the temporary to the permanent, especially the failure of database-oriented approaches, and argued that these barriers may be overcome with repeatable standardized templates. In contrast we show that multiple innovations may be adopted within the same PBO, which manifest as differentiated, combined forms. Cases in the large energy and engineering company, Petrobras, show a systematic innovation process involving subject experts, but centrally a database containing records of 1104 mandatory and discretionary innovations. The article analyses these data, process documentation and observations of 15 completed innovation projects. The article argues that in addition to technical factors the anthropophagic attitude motivates adopters to take on the innovations of others with the appetising prospect of appropriation and adaptation.

Keywords

anthropophagy, boundary objects, innovation, knowledge transfer, project-based organization, temporary organizations

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Introduction

When in eternal lines to time thou grow'st,
So long as men can breathe, or eyes can see,
So long lives this, and this gives life to thee.

William Shakespeare, *Sonnet 18*

What stimulates an appetite for innovation? From projects to organizations, the transfer of the ephemeral innovation to the permanent practice is said to be difficult (Hobday, 2000; Scarbrough et al., 2004; Davies & Brady, 2015). This view has emerged from a widespread perceived failure of technical approaches, where 'lessons learned' and 'post project reviews' information is stored in databases, intranets and other collaborative software (McDermott, 1999; Newell, Bresnen, Edelman, Scarbrough, & Swan, 2006; Newell, Scarbrough, & Swan, 2001). These artifacts that are developed to serve as boundary objects (Carlile, 2002; Sapsed & Salter, 2004) with the promise of knowledge capture and transfer have been disappointing in their results, and effective boundary objects have only been temporarily so (Sapsed & Salter, 2004). Where project-to-business learning is reported to have occurred it has done so through 'repeatable solutions' (Brady & Davies, 2004; Davies & Brady, 2000), standardized processes that follow a somewhat linear diffusion path of singular innovations. This is effectively a 'roll-out' of successful project outcomes.

This 'copy exactly' approach is quite different to the adaptation and modification of innovations observed by Boland, Lyytinen and Yoo (2007), who use the metaphor of 'waves' and 'wakes' of heterogeneous innovations that manifest in differing trajectories and forms. In Boland et al.'s study the organizations that had produced this heterogeneity had all worked temporarily with the Gehry architectural practice; they were exposed to new techniques and knowledge and took these forward through multiple idiosyncratic paths in their own firms and projects. Technologies indeed worked as boundary objects in facilitating the process.

Our guiding question in this paper is whether this same effect is possible in the same project-based organization (PBO), rather than inter-firm diaspora, and through what processes and conditions is this achieved? In this paper we present findings that differentiated innovations, transferred and transformed within its parts, do indeed occur in the same organization via projects and the processes that we will outline, and that these in effect prolong their life. Innovations that we might expect to be applied and forgotten continue to live on in the permanent organization, we believe by virtue of this adaptive ability. Our evidence here is drawn from an organization in a less-studied country, Brazil, an emerging economy that nevertheless boasts one of the world's largest energy companies, Petrobras, a typical PBO, renowned for advanced engineering and innovations in cutting-edge areas such as deep drilling and extraction. We find in Petrobras successes in transfer of innovations and use of databases that contrast with the negative lessons of the studies in the prior literature.

How was this achieved? We argue that there are three requirements: (1) apposite organizational processes, involving subject experts, and senior management decision-making; (2) data, in spite of the disappointment in the literature we find and explain how database usage is determining in our case; and finally and importantly (3) anthropophagy, an attitude and behaviour that motivates the adoption and adaptation of innovations originated elsewhere. Anthropophagy, literally 'human cannibalism', is a metaphor long established in the humanities to represent a Brazilian cultural proclivity to enthusiastically take on ideas and living resources from notional others. However, while taken on, the ideas are also reconfigured and transformed. There is a duality of openness but also resistance to 'alien' ideas in the creation of new forms that reflect contributions from both transferors and transferees. While this attitude is not restricted to Brazil, we find it contains clues

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to the puzzles of project-to-business transfer and the temporary to the permanent. L
'eternal lines' alluded to in his 18th sonnet, database entries are bound to time
interaction with living users.

The paper is structured as follows: we first review existing research on the le
PBOs and its possible solutions, the perceived problems with IT artifacts and dat
then motivation and the literature on anthropophagy. We then discuss the data ar
research, followed by the case study section, which describes the analysed data
innovation process and a nested case-within-the-case study. We then analyse t
these for the literature in the Discussion section, followed by the Conclusions.

The Learning Paradox of PBOs and Possible Solutions

Interest in PBOs has grown in the past decades (Blindenbach-Driessen & Van den Ende, 2006; Davies & Brady, 2015; DeFillippi & Arthur, 1998; Gann & Salter, 2000; Hobday, 2000; Keegan & Turner, 2002; Lindkvist, 2004; Lundin et al., 2015; Sydow, Lindqvist, & DeFillippi, 2004;). PBOs are organizational forms that create temporary arrangements and systems through which firms provide services to their clients, developing customized projects, such as engineering, construction and systems development firms, and consultancies. These may be consortia that exist to service a specific project and are then disbanded (Hobday, 2000) or they may be firms that consistently organize their operations through projects, but are anchored to a permanent centre. This paper focuses on this latter type.

The PBO seems to offer positive conditions both for creating new knowledge and to foster creativity and innovation: often involving autonomous and multidisciplinary teams; holding less cumbersome hierarchy; and able to find solutions in a short and intensive period of time (Bakker, Boros, Kenis, & Oerlemans, 2013; Sydow et al., 2004). PBOs achieve innovations as they create and re-create organizational structures depending on the demands of each project (Hobday, 2000).

Yet the temporary nature of projects raises tensions and questions (Bakker, 2010; Janowicz-Panjaitan, Bakker, & Kenis, 2009). In spite of the innovative advantages of project organization the PBO form also has disadvantages in capturing innovations and learning from project to project (Hobday, 2000; Scarbrough et al., 2004). The PBO has an internal diffusion problem, often leaking the benefits of innovation and new knowledge, which flow more easily through communities of practice that extend beyond, rather than within, firm boundaries (Brown & Duguid, 2001; Lindkvist, 2005).

PBOs face a recurring tension between the always-immediate demands of the project and the opportunities for learning and disseminating best practices and innovations (Sydow et al., 2004). To make the temporary aspects of a project become part of a permanent learning process for the organization, Davies and Brady (2000) argue that managers need to understand 'economies of repetition'. To learn from projects, organizations undertake some patterns of activities that can be predictable and repeatable, leading to a more efficient and effective performance. This means that in PBOs, economies result more from this repetition of similar types of projects than from scale or scope. In a related paper, Brady and Davies (2004) discussed two modes of learning: the project-driven and the business-led modes. In project-driven learning, knowledge transfer occurs across projects and within the organization as a whole. In business-led learning, the senior management, responsible for organizational changes and the overall strategy, must receive feedback of important project-based learning to refine and extend the firm's capabilities and routines (Brady & Davies, 2004). The trick here is to operationalize 'repeatable solutions' so that successful innovations in a project may be re-enacted throughout the organization in multiple contexts. Similar to the observations of Winter and Szulanski (2001) on consumer and leisure service business chains and franchises, this entails 'replication' and the desire to 'copy exactly' (Szulanski & Winter, 2002) or 'drag and drop' (Sapsed & Salter, 2008).

In a sense this standardized model of innovation roll-out is akin to diffusion of innovations in consumer markets (Rogers, 1995) or diffused adoption of singular technologies and processes within similar organizations (Cooper & Zmud, 1990; Fichman & Kemerer, 1997). However, Boland et al. (2007) observe different dynamics in the case of architect Frank Gehry's projects, where exposure to innovations in design engineering and construction had led the architecture practice's collaborators not only to learn and repeat, but to go further. Boland et al. report that the diffusion dynamics are more akin to 'waves' and subsequent 'wakes' of innovative activity. Innovations performed in these wakes are differentiated, modified and reconfigured versions of the originals. Rather than a linear 'rolling-out' of homogenized innovation templates, the trajectories instead follow multiple paths. These are naturally occurring and spontaneous in that people in organizations that were exposed to the original innovations find principles, techniques, resources or heuristics in them that prove useful for solving problems in new contexts.

However, while Boland et al. observe this effect in distinctive project partner firms, it is not clear whether this same differentiated wave effect may be observed, or even produced in the *same* PBO. Can the adaptive wave effect be effectively *managed* into being and what conditions enable it? Our empirical study is motivated by these issues, which is guided by the following research questions:

- How are innovations transferred within a large project-based organization? Specifically, how are they identified and through what processes are they diffused?
- How do innovations manifest in their adoption?

Following these questions we turn to the literature on the use of IT and the notion of boundary objects in PBOs, since there is debate over the role of these IT objects in the type of knowledge transfer we have been discussing.

Information Technology Artifacts and Database Approaches

Because of PBOs' difficulties in project-to-project learning, many organizations have implemented activities to convert tacit knowledge into codified knowledge (Nonaka & Takeuchi, 1995), potentially transforming the temporary into the permanent. A common strategy is to implement a post-hoc project review process and try to capture and codify this knowledge into a database to make it available for other project teams. Usually, in large firms, these databases are computerized and there is a corporate intranet to facilitate the access. With this facility it is expected that knowledge will be shared across projects (Kotnour, 1999; Sharp, 2003).

However, the effectiveness of this strategy has been challenged in the literature. Critics argue that the knowledge captured has a questionable value to users or that teams do not know that there is useful knowledge in the database to help them (Dixon, 2004; Keegan & Turner, 2002; Newell et al., 2006). Database approaches fail as they rely overly on a perspective where knowledge is seen as an object that can be 'owned': an 'epistemology of possession' (Blackler, 1995; Cook & Brown, 1999; Marshall & Sapsed, 2000). Codification of knowledge will always be incomplete (McDermott, 1999; Prencipe & Tell, 2001; Sapsed, Bessant, Partington, Transfield, & Young, 2002; Scarbrough et al., 2004).

Along this reasoning, the 'objects' literature (Cacciatori, 2008; Carlile, 2002; Sapsed & Salter, 2004) has characterized database systems as central 'boundary objects' (Star & Griesemer, 1989) to analyse how learning can bring enduring benefits in PBOs. Boundary objects are purported to support collaborative work, being adaptable to the requirements of each context as they have no inherent meaning in themselves: They are 'empty vessels to be filled with whatever is the preferred local beverage' (Sapsed & Salter, 2004, p. 1519). Project databases for learning purposes are an oft-used example.

Cacciatori's (2008) study shows that simple artifacts can act as 'boundary objects across occupations and as memory devices across projects' (Cacciatori 2008, p. 1591). Their temporal capacity is stressed as 'points of juncture in a widely distributed memory system, enabling project-based firms to balance preservation and adaptation of knowledge'. As pointed out by Cacciatori (2008), we know little about the temporal dimension of boundary objects, particularly on their role of allowing knowledge preservation and adaptation within projects and PBOs. Sapsed and Salter (2004) showed the limitation of project tools as boundary objects in large-scale projects across dispersed organizations. While the absent factors in this case of failure, namely, regular face-to-face interaction among participants and the lack of legitimate authority are shown to let the IT artifacts 'lapse' as boundary objects, one can imagine alternative circumstances where large-scale IT artifacts are used intensively and are supported by the absent factors in this case as well as others.

Similarly, the cases from Newell et al. (2001, 2006) appear to be rooted in the processes and management surrounding the IT artifacts, for example, project workers feeling overly pressured on current tasks to spend time interrogating the database (that may yield insights to execute those current tasks), or difficulties in finding useful information, which may be a design or content issue.

To some extent these concerns are less attributable to the IT artifact, such as databases, than other factors related to management and environment, and there is a longstanding tendency for IT artifacts to 'disappear' from information systems research as researchers focus on surrounding processes and effects (Orlikowski & Iacono, 2001). Rather, there is no evidence of *intrinsic* problems with databases, but a failure of procedures, support and motivations. Social tendencies may subvert technologies designed with the best intentions for collaboration, such as the distributed nature of technologies aimed at knowledge sharing; for example, intranets in Newell et al.'s (2001) study, which reinforced divisions between local groups.

Because of our interest in intra-firm variation of innovation, we wonder what are the conditions that engender *successful* cases, which show how IT objects *can* play a role in knowledge transfer in a large-scale organization, and whether this represents only standardized replication or the possibility that IT objects may support variation. We include the following sub-question to our guiding research question:

- What role do information technology artifacts play in the transfer of innovations?

Our sense following from this review is that effective innovation transfer through IT objects is likely to need motivational and behavioural support.

Behaviour and Anthropophagy

While organizational processes to support knowledge transfer and the technical characteristics of IT artifacts are important, there is another missing ingredient that we feel may explain successful innovation adoption across an organization. This is the behavioural dimension and the area of *motivation*.

We know that there are motivational barriers to knowledge transfer (Bresnen, Edelman, Newell, Scarbrough, & Swan, 2003; Hall & Sapsed, 2005). The human qualities and frailties of desire, egos, and incentives play a key role in knowledge sharing (Brown & Starkey, 2000; Hansen, Nohria, & Tierney, 1999). Szulanski (2003) has argued that ‘stickiness’ of knowledge is partly determined by unwillingness on the part of the transferor, because of a perceived loss of control over innovations and the recognition for them. Equally on the transferee side there is the ‘not invented here’ (NIH) instinctive reluctance to accept innovations from other departments, even in the same company. Katz and Allen (1982) showed that the NIH syndrome works to the detriment of performance as a project team’s communication with external sources of ideas declines, usually as a result of stable project team membership over time. This can be the case in PBOs where core teams tend to stick together over a series of projects and become less interested in other inputs. Szulanski argues that a close relationship between the source and the receiver reduces these barriers to knowledge transfer. Yet even with the regular contact recommended by Sapsed and Salter (2004), we still feel there is an attitudinal variable that affects the transfer and adoption of innovations.

Considering the tropical nature of our case organization we began to apply a theory long established in Brazil but deriving from the humanities disciplines: *anthropophagia*, usually translated into English as anthropophagy, literally, the eating of human flesh. This theory, introduced by the writer Oswald de Andrade in 1928, became influential in the 1930s in representing Brazil’s relationship to other cultures, referred to by the anthropologist Claude Levi-Strauss, and the philosopher Albert Camus, who had met Andrade:

> The French writer did not comment further upon Andrade’s theory, but understood it properly, for his terse definition—*anthropophagy as a vision of the world* —implies the perception of *anthropophagy as a metaphorical definition of the appropriation of otherness*. (Rocha, 2013)

Andrade’s theory, drawing on historical examples (including the reported case of the first bishop to arrive in Brazil, implausibly named Bishop Sardine, who was eaten) was in truth a provocative play on colonialist perceptions of Brazil but had some resonance. Beyond the visceral metaphor, this idea of ‘the appropriation of otherness’ has been applied to literature in the 1930s, the Tropicalia movement of the 1960s, as well as other forms of cultural importation, which signifies a genuine openness to foreign, alien or other ideas but importantly represents a defence against colonialism, in that the ingestion and digestion of foreign ideas is in reality a combination or synthesis.

Anthropophagy has more recently been introduced to the organization studies literature (Islam, 2011; Spicer, 2004; Wood & Caldas, 2002), serving as a metaphor to denote the appropriation and creative reinterpretation of organizational practices, reasoning and structures, especially for developing countries. Mimicry and other forms of imitation are a recurrent behaviour in the innovation literature on catching-up and emerging economies, especially so in the East Asian countries (Bell & Pavitt, 1993; Hobday, 1995; Lee & Lim, 2001). Anthropophagy as a form of mimicry implies identification with the indigenous primitive as well as admiration of the incoming other (Islam, 2011). It appears a more proactive form of imitative development, different to the classical Asian ‘reverse engineering’ to (re)produce products identical to imports, in that the processes and outcomes deviate from their original templates. There is an unwillingness to take on management practices and ideas in their pure form, in favour of some local creativity (Islam, 2011; Wood & Caldas, 1998). It is this spirit that we find in our empirical case that we will set out.

Data and Methods

The research was designed as an exploratory case study within Petrobras – Petroleo Brasileiro S.A. This subject was selected since the research questions require a large PBO within which innovations would be expected to occur, and ideally one with strategies and management for inter-project capture and transfer, including IT artifacts. Petrobras fulfils all these requirements; it operates in a number of advanced technology fields and as an internationally competitive company, it has activities, facilities and influence all over the continent-sized nation of Brazil that are organized through projects. We were able to secure privileged access to significant data to allow the depth needed for a single case study (Eisenhardt, 1989; Yin, 2014).

The unit of Petrobras analysed for this study was 'Engineering', itself a PBO with 8,000 people working in 227 on-going projects in several states across Brazil in 2011 and an amount of investment around $47 billion.[1] It was the first unit of the company to formally design processes of learning and transferring practices across projects, especially regarding innovations.

We collected data as follows: documentation for qualitative analysis; participant observation with field notes on 15 projects' innovation activities between January 2010 and April 2011; and a database with 1,104 innovation records. The primary source documents of internal processes related to the management processes for innovation, its adoption and diffusion, as understood by Petrobras and the Engineering unit. Data collected included prescriptive documents on the activities, roles and responsibilities for the processes, as well as checklists from the management units. The observation took place during the steps of identifying and registering the innovations within the projects; during the meetings with the experts for the approval of the innovations for the internal diffusion process; and during the events realized for the dissemination of the approved innovations.

Engineering created and maintained a database that provided detailed information on the innovations' records and approval. The innovations registered in the database were classified into two groups: discretionary and mandatory. The discretionary innovation may be adopted by other projects, but its use does not become compulsory. Although it was successfully adopted by the project that registered it on the database, new adoptions will occur only at the discretion of each potential adopter who may review the information. The mandatory innovation, on the other hand, *must* be adopted by other projects defined by experts during its approval, directed towards a more permanent knowledge base for the organization. For the purposes of this study, the 1,104 innovations analysed are those that have finished their process of analysis by the company and are ready for the internal diffusion. At this stage they are available to database users. Innovations that were still being analysed by the experts during data collection were not used as data for this study.

The study involved three stages. First, we analysed the internal documents, which describe and set the standards for the process. All these documents could be accessed on the Engineering department intranet together with general information about the projects. The purpose of this analysis was to understand how the formal process was intended to flow, from these largely prescriptive documents.

Second, we selected the projects to be observed among the 227 projects running concurrently with the research. The criterion for selection was to observe any project developing the innovation process from the beginning to the end, during the year of 2010. There were 15 such projects observed that were undertaking this process, with different sizes and structures, including refineries, platforms and pipelines. By the end of 2010, three of these projects had a delay in their schedule and only finished the process by 2011. The last had finished by April 2011, when the data collection was concluded. The intention was to observe how the actual processes that were designed to capture and transfer innovation were enacted, since formal and actual processes may deviate (Hobday & Brady, 2000). We made notes on the interactions within meetings regarding decision-making on approving innovations. We observed how, for example, experts would telephone engineers who had worked on the projects being considered, to check on missing information, often related to specific technical dimensions to enable easier re-enactment, or health and safety issues. We noted any disagreement and resistance to the flow of decisions, the influence of particular actors, and divergence from formal procedures.

The third stage consisted of extracting and analysing the 1,104 innovation records from the database containing the knowledge and experiences from the projects. Information was gathered

Table 1. Petrobras' profile.

Activities	Scale
Investments	R$104.41 billion
Net revenue	R$304.89 billion
Net profit	R$23.57 billion
Shareholders	798,596
Global presence	17 countries*
Number of employees	86,111
Daily output	2,539,000 barrels of oil equivalent

*Not including representative offices.

on main characteristics, structure, management and project innovation process. This data represented the *outcomes* of the innovation approval decision-making process, and the *inputs* to the innovation adoption process. Guided by overarching research questions on processes of transfer, and the use of the database by the wider organization, with this large dataset we were able to see general patterns such as numbers of innovations approved and rejected, numbers made mandatory, and information on other projects' and divisions' adoptions of innovations through comments and notes, on, for example, divisions where adopted.

The Appendix describes the main characteristics of the projects observed in this study. It includes the information about the innovation registered in the database by the project teams (main areas and type of innovations) as well as the meetings and activities that we observed during the data collection.

The Case Study Organization: Petrobras

Petrobras – Petroleo Brasileiro S.A. – is a leading company in the oil and energy industry ranking among the ten biggest energy companies in the world.[2] It ranked fifth in 2011 and third in 2010[3] (the period of data collection). Petrobras is a publicly traded corporation, whose majority stockholder is the Government of Brazil. As an oil and energy company, it operates in the following sectors: exploration and production, refining, oil and natural gas trade and transportation, petrochemicals and derivatives, electric energy, biofuel and other renewable energy source distribution. Table 1 sums up information about Petrobras' profile and refers to 2013 fiscal year result data, with the last update on May 2014.

Petrobras is the Brazilian company with the largest investments in science and technology, especially in CENPES (Research Center Leopoldo Americo Miguez de Mello), a leading applied research centre. CENPES works with various national and foreign research and development (R&D) institutions, including integrated technological partnerships with universities and research centres. These connections have reinforced the organization's innovation activities to the point that by the early to mid 1990s Petrobras was playing a leading role in the international industry in creating and applying totally novel technologies. For example, it repeatedly broke world records in production and drilling water depths (Dantas & Bell, 2009).

The innovation processes

Petrobras set up an Innovation Process Department to establish a system of identifying, recording and transferring innovations. The essential sequence is shown in Figure 1 with key actors at each

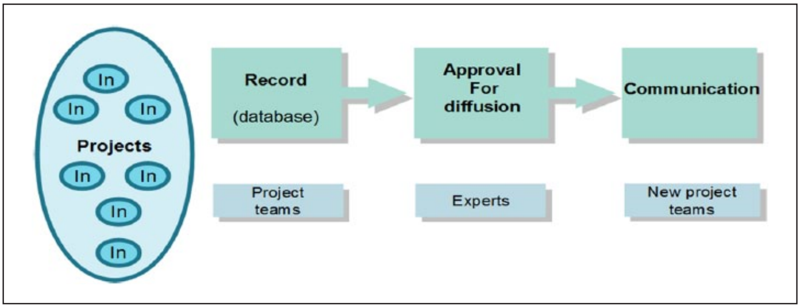

Figure 1. The innovation diffusion process.

stage. Recording of the innovations began not in a post-project review, but were recommended at regular points throughout the project. The project life cycle consists of five phases (phase I: opportunity identification; phase II: conceptual project; phase III: basic project; phase IV: implementation and works; phase V: shutdown), and a review would take place in the transition point between each stage. This is because memories are short, and also because people often move between projects and so their contributions may be lost if reviews only occur at the end. Project managers selected a team to identify the experiences from the project that had promise as innovation for adoption elsewhere, and these were gathered in form documents. In practice, it was difficult to hold multiple reviews on all projects, especially involving people working 'in the field, not at a comfortable desk at the office' as a team member reported in the Diesel Hydro Treating Unit/IERV project during its final dissemination event, who complained that project workers 'do not have time to stop working to explain to someone else how to do my job' (personal communication, 8.10.10). Nevertheless, there were penalties for those who did not take part in the review procedure.

Once innovations were identified, particular technical groups such as mechanics, civil engineering, cathodic protection, environment, etc. would reflect on their project experiences in turn. The technical orientation of these discussions may be an advantage over other approaches to reviews, which are often project management-oriented. In Engineering, project managers did not attend these reviews. Discussions were always driven by the degree of novelty offered by the technique, installation or practice, and its potential for benefit in other circumstances. This was not an exercise in assigning blame or unpicking management problems, which is sometimes how project reviews are viewed. Following substantial discussions – often over a period of up to two months – a large evaluation event was held to assess collectively the innovations to be recorded in the database. These events involved presentations and subsequent discussions seen as opportunities to learn and reflect for a broad group representing the projects' disciplines (including project managers at this stage). Finally the innovation records were approved or not approved for the database.

The next phase involved subject matter experts, who were designated by their disciplinary departments, which all had regular meetings related to innovation and development. This was the first 'bottleneck' faced by the Innovation Process Department (IPD), since initially many experts took too long or simply did not complete their assessments, considering these activities 'an extra job' (personal communication from Department Manager). This is an experience familiar from the prior literature, yet in this case the IPD persisted with various tactics to encourage engagement including individual training initiatives and additional support; regularly scheduled meetings with the IPD with the specific purpose of assessing the records; mobilizing higher-level managers for sponsorship; and, at a later stage, an organizational plan to acknowledge the experts' contribution, which was considered a key motivator that raised the experts' visibility.

The outcome of these expert review meetings was either approval of the innovation for wider adoption, a request for its review, or rejection. In making these judgements experts would regularly call a proposal's author to clarify some information, or another personal contact to compare with a similar experience. The experts' reviews were replete with multitudes of details, concerned with measurements, understanding scale, the nature of resources and tools used and the surrounding conditions of the innovations, all to assess how applicable they would be in other contexts. Proposals were rejected if lacking technical accuracy and/or reliability but in most cases because they were excessively costly or because they were considered not sufficiently innovative, since authors of proposals may not be as aware of the wider technical frontier as the experts. Rejections were communicated as learning opportunities to the authors.

Expert groups included those responsible for processes that might need updating if innovations were approved for mandatory adoption, such as standards, manuals, documents and procedures. Experts themselves often took responsibility for making changes, indicative of their influence. Mandatory innovations generally took time to approve because of the need to create instructive documents and modify existing procedures. The average time for a mandatory innovation was over a year – 379 days – while the average approval time for a discretionary innovation was less than two months – 54 days. Senior management took the process seriously and attended some meetings, especially where innovations were to be discussed that might also be adopted in projects outside Engineering. In these latter cases interested stakeholders from beyond the Engineering boundaries were also invited to participate.

Diffusion, adoption and adaptation

Each project manager was responsible for the new adoption of a mandatory innovation, for the changes needed in the project and for the learning processes which were necessary for that innovation to be adopted. The Engineering management units considered the database to be the main communication channel for the diffusion process, as spontaneously stated during the observation of meetings with project managers. Its use was encouraged and disseminated through training, through events or activities to record the project innovations or to communicate those that were already approved. Once approved, innovations were publicized via the intranet or presented at an event exclusively for this purpose, termed a 'dissemination event', as happened with the Coker Unit REDUC[4]/IERC and the Jacket Offshore Platform PMXL1/IEMX projects, which sought the support of the IPD. The project managers of both units were aware of the importance of the process as they had already seen useful innovations in the database. They proactively asked to develop the dissemination events of their projects as they knew there were other projects that might benefit from their experiences. There was also guidance for the projects to identify innovations in the database and to use them as an input during the risk management phase before the project began. However, it is significant that many of the project managers requested dissemination events themselves, which demonstrates an open attitude and hunger for knowledge about the innovations. While experts were rewarded for their participation in the approval stage, there were no such rewards or recognition for adopters or penalties for failure to adopt.

Dissemination events were held either after a project had finished registering their innovations, or to prepare for a project in its initial stages. In the first case, the project manager identified similar projects within the same enterprise (division overseeing similar projects, refineries, for example) and the IPD identified other units and projects facing similar constructions or processes. For example, after the project of the semi-submersible platform P-51 had registered its innovations, a dissemination event presented them to the project teams of the semi-submersible platform P-56, a very similar structure, organized by the manager of the P-51 project. Similarly, the project of

Naphtha Coker Unit of Duque de Caxias Refinery (REDUC) organized a dissemination event after registering their innovations, with the IPD, the organizers identified the refineries that were about to start similar projects for naphtha coke (derived from petroleum coke) and invited their project teams to attend the event. The manager of P-56 explained the benefits of the process and his motivation:

> We don't want to waste time. We can't waste time because we have done it a lot. We are always reinventing the wheel, you know, and then we find out someone did the same in another project. And sometimes, to make it worse, sometimes it happened in another project of Marlim Sul, in our own yard. And then when we see it, we think 'Ouch! We could have used it here!' Ok, maybe we would need to change something but we certainly didn't have to do all that job. (dissemination event, 09.03.10)

At the dissemination events, engineers who had worked on the innovations gave presentations on all those that were approved in the database, supported by the experts, followed by questions and discussion. For example, a refinery about to start the construction of a unit would hold an event before the earthworks. An outstanding case happened within a project from the Petrochemical Complex of Rio de Janeiro (COMPERJ). This project developed a pioneer work in Petrobras, as it had to construct and assemble seven parallel pipelines simultaneously within the same track. A dissemination event was organized to analyse and discuss successful and applicable innovations. The event included experts from COMPERJ, innovating engineers from previous projects, representatives from the group of onshore pipelines, as well as delegates from equipment and materials suppliers. A central challenge was the building of COMPERJ's pathway for the pipe ducts as stated in meetings between project managers and the executor group event. The event served to agree innovations that could be adopted to minimize cost and time in this complex project. For the first time, a project at the beginning of phase I (opportunity identification) asked for a dissemination event. A project leader said:

> We came to IPD because we have a unique project. We haven't done it in this way. At least not here in Petrobras. We have laid many kilometres of pipelines but now we have to lay down seven parallel pipelines in the same track all at the same time. It is something crazy! So we want to talk to everyone who is available – project teams, experts, suppliers, everyone – and we want to discuss with them. We need IPD help for that. We want to hear these people's ideas and we want to see what innovations they have. Because then, then we have to decide internally which we can use or not. All the proposals discussed at the event shall undergo critical analysis in the study of constructability, which will confirm the viability or not of these techniques and if we will have to adapt any of them and which adaptations we can do. (personal communication, 21.10.10)

The foregoing passages have shown a systematic, attentive and judicious program of approving and managing the diffusion of mandatory innovations with examples of successful adoptions. What then of the discretionary innovations, those that were examined and approved for inclusion on the database but not deemed to be required on all relevant projects? In the next section we present a brief nested case study that illustrates the internal 'wave' effect of diffusion of innovation within Petrobras, as well as the adaptation that occurs.

Adoption and adaptation example: the GASTAU project and its successors

The GASTAU project built a massive gas pipeline, the Caraguatatuba–Taubaté, which connects the gas treatment unit Caraguatatuba to its counterpart Monteiro Lobato in the city of Taubaté. This pipeline (28 inches in diameter and 96 kilometres long) was designed to transport natural gas from

Figure 2. Images of the GASTAU inflatable coverage.

the Mexilhão field in Santos Bay at a rate of 20 million cubic metres of gas per day. The scale of the project was considerable: GASTAU crosses six different cities in the state of São Paulo (SP), Caraguatatuba, Paraibuna, Jambeiro, São José dos Campos, Caçapava and Taubaté, where it interconnects with other pipelines. GASTAU itself used over 8,000 pipes and generated approximately 3,000 direct jobs (information on the GASTAU project derives from personal communications with its project managers, the enterprise manager immediately above them in the organizational hierarchy, and the project management support team, as well as corporate documentation from the intranet made available to the researcher).

GASTAU produced a number of innovative solutions that were necessary due to its complexity and the need to 'avoid impacts on the progress of the work while minimizing environmental damage', as reported by the project manager (dissemination event, 16/06/10). The main challenges of the project stemmed from its non-standard nature: although Petrobras installs a great many pipelines the standard procedures were not feasible for GASTAU because of the adverse conditions faced in its construction, specifically topography, climate conditions and environmental constraints.

For example, the project was developed in rough terrain with slopes up to 40 degrees of tilt, where even specialist engines on tracks, known as side booms, designed especially for this type of pipe-laying challenge, needed the support of other machines to perform the work. These side booms weighing on average 60 tons were anchored with steel cables to a tractor installed at the top of a hill. The pipeline also had to make five crossings of large rivers and three crossings of highways with over a million cubic metres of material removed in earthmoving activity. Other complex subtasks included building a tunnel more than five kilometres long in the State Park of Serra do Mar (so requiring environmental sensitivity), and a vertical duct shaft of more than 540 metres depth to connect the tunnel to the surface. GASTAU was the first project in Brazil to implement a vertical duct to house a pipeline.

One GASTAU innovation, 'inflatable coverage', was a special canvas cover with a weather station and generators that provided power to fans to maintain ventilation and to keep the coverage inflated continuously. This process innovation mitigated adverse weather conditions, avoiding typical interruptions to work during rainfall and so reducing costs, as well as containing environmental impacts. Figure 2 shows images of one application of the inflatable coverage.

By April 2011, the 'inflatable coverage' system had already been adopted or was in the process of adoption in three other projects within the Engineering organization. The innovation's 'wake' had reached the southeast (Guararema Compression Station, São Paulo state), the northeast (Abreu Lima Refinery, Ipojuca, Pernambuco state) and the south (Alberto Pasqualini Refinery, Canoas, Rio Grande do Sul), illustrated in Figure 3.

After the innovation was registered in the database, the information followed the regular flow. Experts on the subject of terrestrial pipelines assessed the information and it was approved as a

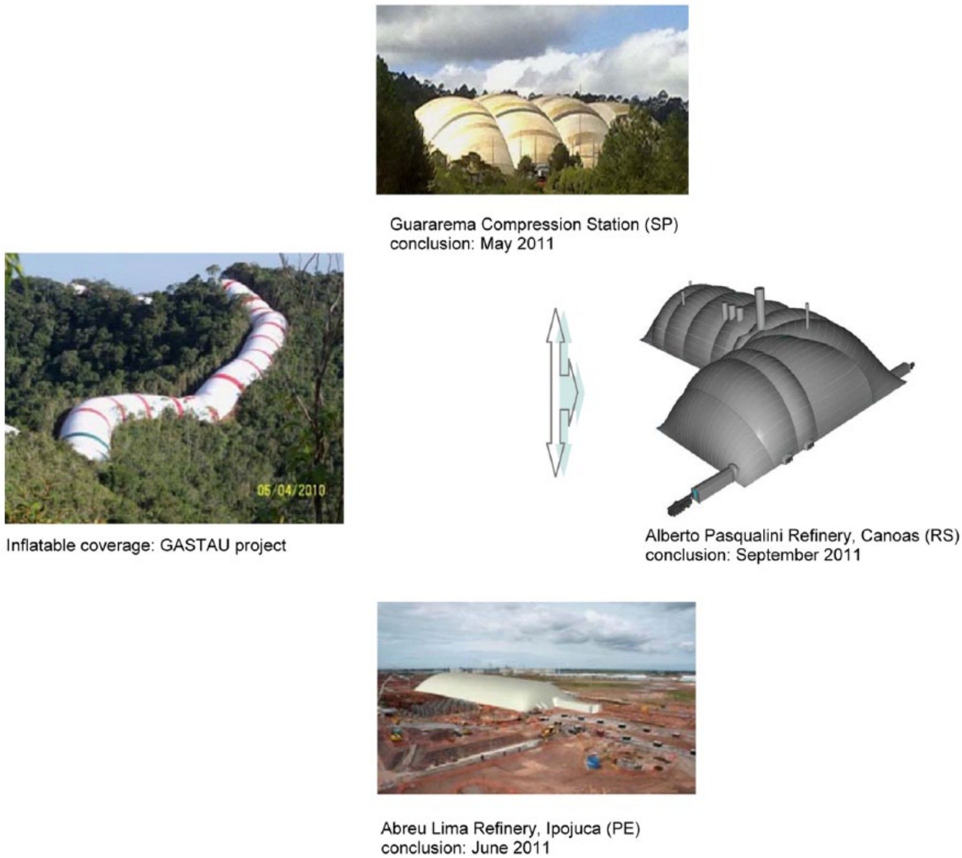

Figure 3. The inflatable coverage innovation and its diffused wake.

discretionary innovation in 28 days. According to the experts, the innovation was 'approved for use in other projects… New conditions have to be carefully studied and evaluated including technical, economical and safety aspects.'

Guararema Compression Station project

It is revealing to note which actors are involved in adoptions, and which are absent. In the Guararema Compression Station project, the adoption of the inflatable coverage combined expert engineers from the GASTAU project with experts from another Engineering unit, 'Technology Development in Construction and Assembly', which operates in the process of 'preservation of knowledge in Supply of Enterprises'.[5] These experts and the Guararema project managers and contractors analysed the advantages and disadvantages of the inflatable coverage adoption and the need for adaptations in its adoption as the local difficulties were not only rain and continuity of work but difficulties of accessing the site because of the terrain. Flash floods regularly generate landslides which sweep away even permanent structures. The adaptations incurred a cost themselves but the project manager said, ‘Even requiring technological improvements, the overall result has been positive. With the use of this technology, the impact of the rain and its consequences was mitigated’ (dissemination event, 16/06/10).

The inflatable coverage for this unit measured 16 thousand square metres in surface area and about 36 metres in height. The experts assessed the adaptations performed during the adoption:

> The equipment for handling loads in the areas covered by this technology requires higher load capacity due to the angle limitation for the spears. An improvement over the previous applications is the shape of the coverage that extends the useful area, taking advantage of the coverage borders.

They recommended that the innovation had to be adapted to the new project’s characteristics:

> It is necessary to develop and consequently improve this technology and also an adaptation to its use; i.e. a re-education, an awareness that any project/work run under this coverage should have its activities, procedures, processes and logistics adapted [to the innovation adopted].[6]

Alberto Pasqualini Refinery

At the Alberto Pasqualini Refinery, the on-site project of Diesel Hydrotreating Unit (UHDT II) also adopted the inflatable coverage in 2011, which would be the biggest coverage so far used by Petrobras in a refinery operational area. It measured 20 thousand square metres in surface area and about 40 metres in height. The adaptations in this version of the innovation included the construction of a synthetic membrane with ultraviolet ray blocker and ventilation with low power consumption. This saved an estimated three months of downtime due to the effects of rain during a 14-month project. The experts from GASTAU and the ‘Technology Development in Construction and Assembly’ unit, together with the engineers specific to the project, again supported it.

Abreu Lima Refinery

At the Abreu Lima Refinery, the Delayed Coker Units (U-21 and U-22) project made two installations of inflatable coverage, which needed adaptation to accommodate the use of drilling machines. The coverage ‘footprint’ measured 30 square metres in diameter and 100 metres long, with the highest point at the centre being 13 metres high, so allowing for the drilling machines. The inflatable coverage leaned on the ground, being completely sealed and inflated by fans. They were assembled on the building site of coke reactors U-21 and U-22. In this area, there were activities of staking, preparation of blocks and superstructure. With the coverage, these activities would be maintained on schedule, even with the heavy rains that are typical of the northeastern climes of Pernambuco.

In order to check the needs to adapt the inflatable coverage, managers of the Delayed Coker Units U-21 and U-22 project requested a preliminary risk analysis (APR), which was executed by experts from all involved areas inside the refinery, as well as a constructability study following the signing of the contract. This study confirmed that the use of inflatable coverage produced benefits to the progress of the work. The Abreu Lima project involved no personnel from the initial GASTAU project, showing that this was an adoption of an innovation first developed over 2000 kilometres away, implemented and indeed adapted to local needs by an entirely different workforce. This indicates the power of the processes and the data made available as well as the willingness of the project managers and engineers to use this innovation for their own purposes.

These three differing manifestations of the inflatable coverage system show varying degrees of involvement from the initial innovators, but all show enthusiastic adoption and modifications from

Table 2. Adopted innovations summary by type.

19 MI	5	Adopted by 1 other project from different unit
	4	Adopted by 2 other projects from different units
	2	Adopted by 1 other project within the same unit
	6	Adopted by 2 other projects within the same unit
	1	Adopted by 3 other projects within the same unit
	1	Adopted by other units (no data on where or number)
27 DI	1	Adopted by 1 other project from different unit
	10	Adopted by 1 other project within the same unit
	6	Adopted by 2 other projects within the same unit
	3	Adopted by 3 other projects within the same unit
	7	Adopted by external contractors

the local units of the Engineering organization and its contractors. The technical knowledge was partly diffused through experts, through professional contacts and networking, through deliberate diffusion processes, but also through the documentation on the database. This non-mandatory innovation was diffused and accepted voluntarily and spontaneously and resulted in three distinctive versions at three locations at considerable distance from its point of origin.

In the Appendix we include a table of 46 innovation records from the database, which are all innovations that were adopted successfully throughout the organization, many from geographically and organizationally separate units; 19 of these are mandatory, yet remarkably, 27 are discretionary innovations, summarized in Table 2. These were like the wake of the GASTAU inflatable coverage, not rolled out by corporate decree to achieve economies of repetition, but identified in project workers' own search activities and voluntarily taken up.

Discussion

We began this paper with two discrepancies that we find in the literature on the temporary organization. While the PBO is argued to hold benefits for innovation, it has disadvantages in making those innovations count in the permanent organization (Hobday, 2000; Scarbrough et al., 2004; Bresnen et al., 2003). The most reliable route for successful transfer of innovation is through economies of repetition, where advances from innovative projects are repeated across the organization and embedded in firm capabilities (Brady & Davies, 2004; Davies & Brady, 2000, 2015). Yet this transition appears counter to novelty and so we enquired whether intra-firm innovation diffusion could occur, in the same manner as the waves and wakes observed by Boland et al. (2007). Are multiple manifestations of innovations possible in the same firm?

The second complication of the literature is the puzzle of IT artifacts and their apparent failure to help the process of transfer. We asked whether the well-known failure cases were attributable to IT objects per se or whether there may be alternative outcomes under other conditions. It seemed to us the two complications of adaptive diffusion and IT objects are related, or at least their solutions may be related.

The Petrobras case shows that a PBO that can indeed transfer innovations successfully from one project to multiple others. It shows the processes by which this is done, which include a central role for a database, and while these produce mandatory practices the outcomes are not only simple replications but adaptations that constitute innovations in themselves. How was this achieved?

The success of the Petrobras experiences depended on a number of factors. First, the importance of subject matter experts in the process, consistent with Blindenbach-Driessen and Van den Ende

(2006), who also noted that the availability of experts increased the effectiveness of project teams. Petrobras experts were heavily involved in scrutinizing the novelty and wider applicability of the innovation before it was approved for the database. This gave a gravitas to the process, and particularly to the quality of the content of the records, because users knew that they had undergone technical examination from advanced specialists. While much of the organizational knowledge literature downplays hierarchy and status (Takeuchi & Nonaka, 2000; Tsoukas, 1996) in this case there is a kind of humility and receptiveness that recognizes the value of accumulated knowledge, which relates to the behavioural factors we discuss below. There are, however, costs to this involvement of experts including, as Lindkvist (2005) argued, that the mix of experts with highly specialized and diverse competences makes it difficult 'to establish shared understandings or a common knowledge base' (Lindkvist, 2005, p. 1190), which has the effect of slowing down the process as in Petrobras, as well as the logistics of scheduling intensive work with highly-paid senior engineers with many demands on their time.

However, this technical orientation differs from post-project reviews that are seen as perfunctory exercises focusing on management lessons such as sources of delay or overspend. Examples from the literature show project workers dismissing databases because of a lack of confidence that they hold quality, relevant data, such as Newell et al. (2006). This can be viewed as a matter of content production and editing and the Petrobras case shows a different outcome where content is carefully produced and authoritative.

The hazards and failures of database approaches to transfer in the literature are attributed to the epistemology of possession where knowledge is perceived as an object (Blackler, 1995; Cook & Brown, 1999; Marshall & Sapsed, 2000), neglecting social contact and processes or lacking legitimizing support from senior management (Bresnen et al., 2003; Sapsed & Salter, 2004), yet these failures are not intrinsic properties of databases themselves, but rather that databases are not sufficient and are likely to fail without the management and support structure around them. One can notionally design a system where (1) a database fulfils a necessary role of storing and effectively legitimizing knowledge, which has been rigorously judged and designed to benefit broader applications, (2) management processes and structures are maintained which ensure social contact to publicize and reinforce the data as well as to facilitate its input and access, and (3) senior management visibly supports the process. The Petrobras case shows empirically how these conditions may be operationalized, even with the inevitable frictions, delays and costs.

The case also showed that the processes were not all smooth and straightforward; there were bottlenecks and low prioritization problems familiar from the literature, yet these were mitigated by the persistence of a dedicated team in the IPD, as well as active support from senior management. Nevertheless, the protracted lead-time for approval, especially for mandatory innovations, may mean that the innovation is outmoded by the time it is published. From the total number of 1,104 innovations, 112 (10.1%) were made mandatory while 992 (89.9%) were discretionary.

The temporary and the permanent

The bifurcation of innovations into mandatory and discretionary may be analysed according to their resulting permanence or temporariness. These are shown in Table 3. Innovations become permanent practices through the process analysed above, whereby domain experts and senior managers adjudge and approve innovations and commit them to the database. This also entails adjustments to existing procedures to accommodate the newly approved process. To support this implementation, managers disseminate the processes actively throughout the national organization. Once through this passage the innovations may be in use through subsequent projects indefinitely.

However, the process of mandatory adoption can be stymied. This occurs when an innovation has begun the mandatory journey but superior alternatives become available before it reaches final

Table 3. Processes and permanence.

	Mandatory Innovations	Discretionary Innovations
Permanent	Experts and senior managers change processes, documents, databases, and disseminate through organization. Innovations are made standard operating procedures	Widespread diffusion due to effectiveness, cost advantages. Perhaps overlooked by formal channels but gain exposure through dissemination and publicity
Temporary	Experts and senior managers start the process of making mandatory, but innovation is superseded by alternatives, e.g. lower costs, political reasons, personnel loss, etc.	Effective for local use but lacking diffusion dynamics, unsupported outside of context of application

approval. If a lower cost or more effective practice surfaces that challenges the candidate innovation it is dropped, achieving mandatory and permanent status for only a short time, even if achieves final approval. There is also a political aspect to these outcomes where supporters of the rival innovation will advance its cause, often in cases where personnel have moved or changed interests, and the original innovation lacks its initial support. These are complications that can occur with the type of 'top-down' 'business-led' learning outlined by Brady and Davies (2004), where the path from vanguard to repetition may be in jeopardy in the absence of committed senior management.

The temporary nature of these aborted mandatory innovations resembles cases of discretionary innovations that are not adopted. Specificity is the double-edged sword of these innovations in that they were created, tested and executed to solve a particular problem, yet this exclusivity finds it no friends outside the local context of application. Without the publicity that follows effective deployment in multiple contexts the innovation fails the mandatory requirements and fails to attract interest for casual experimentation. The innovations are registered on the system but are not picked up and diffused. They are permanent only in their dormancy.

But discretionary innovations may also become permanent. They lack the institutional support of the mandatory process as they are adjudged to fall short of the most usable innovations, yet develop a momentum of their own. This is simply because of the benefits and value the innovation brings, which is demonstrated beyond its original context. Engineers and managers from fresh projects will become aware of the innovation through the dissemination events, through their community of practice or may have found the information through searching the database in related areas. They are applied to new locations and tasks, possibly modified, and adopted for their effectiveness and/or cost advantages. The diffusion dynamics of these innovations are those that are most similar to market forces. Adoption is not driven by management fiat but pulled through by the demands of project managers and engineers who find value in the innovations.

What is clear is that innovations become permanent practices either because of managerial fiat, or through their effectiveness. In both cases the database and surrounding systems are important to their diffusion, but these objects only mediate the transition; the innovations only 'live on' through the projects that adopt them. Through their constant reuse and application and adjustment their organizational lives are prolonged.

Motivation, adaptation and the anthropophagic organization

Despite the processes and quality of data we recognize that these technical factors are not themselves sufficient. Yet what is clear is the importance of motivation affecting the transfer of knowledge (Hall & Sapsed, 2005; Hansen et al., 1999; Szulanski, 2003) and solutions have remained elusive. We believe the case contains clues on this softer aspect. In contrast to barriers and difficulties found in the literature, such as the 'not invented here' syndrome where project teams become

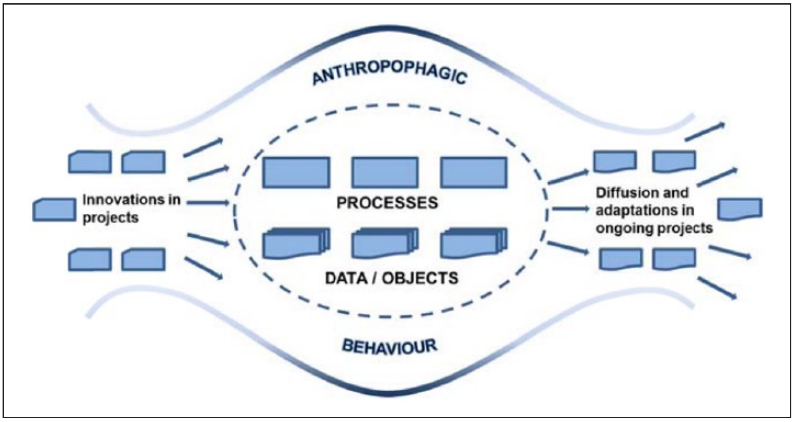

Figure 4. The Anthropophagic Organization.

disinterested in developments and innovations developed externally, adopters were not only willing to take innovations on, but also to advance them in new applications. This we feel is important motivationally and has implications for making the temporary permanent.

Importantly, the modified innovations exemplified in the wake of the GASTAU project show that there is adaptation occurring in the process. This is not the classical imitation documented by the catching-up literature such as reverse engineering of imported products and the learning curve from original equipment manufacture to original design manufacture to original brand manufacture in Asian emerging economies (Hobday, 1995; Lee & Lim, 2001). Instead, in the statements of adopting participants and the behaviour observed we find evidence of openness to new ideas, but also a desire to consume these and contribute to new combined forms. This is particularly striking in the adoption of discretionary innovations with Petrobras, including the GASTAU examples, which were not enforced through templates, and standard procedures, but voluntarily taken up. We believe this openness is linked not only to the credibility of the expert-informed process but also to the drive for adaptation.

Combination is recognized as core to innovation in business, science, technology, as well as arts and culture (Arthur, 2009; Sapsed & Tschang, 2014; Schumpeter, 1942; Simonton, 2004). The instinct to fuse new ideas with old ideas or ideas from different domains is a fundamental drive of advance. This describes the behaviour we have observed in Petrobras, the scrutiny and quality of information not only for mandatory practices, but also to seed discretionary adoptions, the willingness of geographically and organizationally distant units to consume this information, and the outcomes in terms of adapted forms and ongoing trajectories. The anthropophagic attitude is the elusive, motivational ‘ingredient ~~X~~’ that determines the success of the temporary to permanent transition, alongside the managerial and technical objects, receiving, holding and disseminating data.

The overall model is represented in Figure 4. The anthropophagic attitude pervades the processes and the IT objects, influencing the receptivity to the meetings and dissemination events, the access to the databases and their absorption and application in new adapted forms. The three core elements are all important: the objects must contain data that is highly credible, which is ensured by the work of the subject matter experts; this work of evaluations and approval requires rigorous processes, but well-designed and implemented processes are also required for the offline dissemination in a face-to-face capacity. Fundamentally the willingness of the participants to engage is crucial and this is driven by the desire to learn and recreate in new contexts. We find one or more of these factors and nuances to be absent in the failure cases in the literature.

Conclusions

Our interest was driven by puzzles suggested by the literature as well as the apparent success of our empirical case. We found in the Petrobras organization not only successful adoptions of innovation, which appeared to challenge the well-documented difficulties of transferring innovations in the same PBO, but we also observed that this involved a central database in spite of scepticism, and that the innovations were not rolled out as replications, but taken on and modified to match new environments, creating new differentiated forms. It is through this adaptability that the temporary-to-permanent transition occurs, as project workers find value in the innovations to their ongoing work.

As much as the literature rails against epistemology of possession approaches and the need to combine this with epistemology of practice, yet such a combination is left implicit and it is instructive to show where such a combination has been made to work. The Petrobras case shows diligent, persistent processes involving the most erudite engineers, legitimized by senior management. The quality of information is high because of this expert scrutiny and attention to feasibility of applicability in new contexts. The dissemination stage was extensive, so that the innovation records in the database were explained and promoted by experts and those people who had applied them successfully. These stories and potential resources were disseminated through communities of practice in the organization, rather than simply stored in a repository. The three-stage process combined technical gravitas, face-to-face interaction, legitimizing authority as well as the uses of codified data.

Evidence suggests that codified data is increasingly important in contemporary organizational practice and performance, referred to in terms such as 'big data' or 'data science' (Chen, Chiang, & Storey, 2012; McAfee & Brynjolfsson, 2012). It may be that the more critical studies in the literature were investigating an earlier generation of database approaches, and now both the technology and processes have advanced and improved. The emphasis now seems to have shifted from 'database' to 'data', which suggests a new model that is less centralized and static, more pulled by users and responsive to innovation but nevertheless requiring new skills that are scarce. In any case there is a risk of being dismissive of the power of IT artifacts, especially when used in conjunction with effective social and managerial processes as demonstrated in the case study.

The literature emphasizes the competing pressures that undermine transfer initiatives, the demotivating NIH syndrome and the scuppered receptivity through the need to update capabilities. Given all these retarding factors it was remarkable to find the number of successful adoptions throughout the organization, shown in Table 2 and the Appendix. Closer examination showed that these are not replications or repeated solutions however, but adaptations.

Adaptation was necessary in the Petrobras projects because of the widely differing climate and topographical conditions of the continental-sized field of operations. Repeatable solutions would not be sufficient in many cases and allowance was needed for local modification. In a sense this turns the fundamental problem of unique projects on its head, because uniqueness stimulates processes that allow sufficient flexibility to actually apply prior experiences. In this sense prior innovations are not so much templates, but become boundary objects, useful focusing devices that are open to individualized tailoring and manipulation to fit. It is not the objects themselves that provide permanence however; essentially permanence is only realized through activation in the temporary, in ongoing projects. Permanence only in the object is death. To paraphrase Shakespeare, the database records can only be eternal lines to be bound to time if breathing project managers and engineers can see them, and give life to them. Paradoxically the visceral metaphor of anthropophagy works here, since it evokes the belief that spirits live on through their consumption by integration with those dining.

Yet as much as cannibalism is appropriation of the other, its distinctive and shocking nature is that it is appropriation of the other within the same species. The cases of successful transfer and knowledge leakage to which Boland et al. (2007) refer in their wakes of diffusion are all inter-firm networks, while the adaptations we found exemplified by the GASTAU project and its wake were all intra-firm. Such dynamics are possible, we argue, through the link to motivation. There is great intrinsic reward in creating something new and which solves local problems, rather than repeating a template from elsewhere. Given the processes, data objects and motivational conditions outlined we show how internal wakes or waves can be stimulated.

Limitations and research opportunities

An important caveat to all the foregoing analysis of the Petrobras case is that we have not stressed the considerable financial costs of this process. As impressive as the innovation transfer infrastructure is with its dedicated personnel, protracted employment of expensive subject matter experts, proliferation of dissemination events, training and support, we should conclude that it must be costly indeed. The outcomes are equally impressive and dispersed throughout the organization. Senior management made the original investment with the creation of the IPD; this was sanctioned by Engineering and effectively by the project managers themselves who contributed to processes such as the dissemination events from their own budgets. The view was widely held that it was a worthy investment. We should remember however that Petrobras is a highly resourced firm in the lucrative energy sector and not all organizations will stretch to these levels. We would suggest that similar effects could be achieved on a more modest scale, as long as the three elements are present. This is a heuristic for further research on PBOs with varying levels of cash flow and organizational slack.

As a single case study there are the usual limitations regarding generalizability. The case study has covered multiple projects within this one PBO however, and we have analysed a dataset of 1,104 innovations across a range of engineering fields. Yet in addition to the financial resources there are other specificities. One is the cultural phenomenon of anthropophagy, which thus far has been applied almost exclusively to Brazil. We have distinguished it from other innovation transfer behaviours such as reverse engineering and it does seem a naturally Brazilian attitude, which can be seen in its mashed-up arts and cultural forms, in music like jazz and samba in Bossa Nova, or dance and martial arts in capoeira, or the many variants of football played on beaches, impromptu fields and volleyball courts, adapted to the terrain. Brazilian life is replete with examples of imported ideas given a local twist. While anthropophagy in organizational research on Brazil has been growing in interest we have not seen studies in the wider Latin American continent refer to this cultural tendency in relation to innovation. Superficially Petrobras represents an ‘outlier’ case as a high spender on R&D and large-scale employer of highly educated researchers and engineers, while the literature continues to report that Latin American investment in science and technology is well below international standards (Dutrénit & Katz, 2005). Research on other organizations in these countries that *do* invest in innovation will surely be as instructive, and there are studies suggesting similar behaviour in Argentina, for example (Marin & Bell, 2006).

However, we would argue that this case from an emerging economy is an example where the differing experience from previous studies in advanced industrialized countries is instructive and brings new insights to inform the PBO field, which has become somewhat fixed on a restricted range of country experiences. More studies are needed of the variety of circumstances and experiences of the wider world’s PBOs.

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Notes

1. R$104.41 billion (Brazilian reals). Source: www.petrobras.com.br (2013 data – last update: May 2014).
2. Source: IHS Energy (January 2014) *IHS Energy 50* (2013 rank). The *IHS Energy 50*, formerly the *PFC Energy 50*, has for 15 years served as the ranking of the world's leading publicly traded energy companies by market capitalization. http://www.ihs.com/info/en/a/energy50/50.aspx
3. Source: PFC Energy (January 2012) *PFC Energy 50* (2011 rank). https://www.pfcenergy.com/~/media/Files/Public%20Files/PFC%20Energy%2050/Final_PFC_Energy_50_2012.pdf.
4. A coker unit is an oil refinery processing unit that converts the residual oil from the vacuum distillation column or the atmospheric distillation column into low molecular weight hydrocarbon gases, naphtha, light and heavy gas oils, and petroleum coke (IUPAC, 1997).
5. One of its main attributions is to work on 'technological development in the construction and assembly activities in the Supply unit, in conjunction with the executive managements of CENPES [R&D department], Materials, Information and Communication Technology [ICT], Supply Business Area and external entities.'
6. These are excerpts from a technical assessment issued by 'Technology Development in Construction and Assembly' unit during the implementation of the inflatable coverage at the Guararema Compression Station project.

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Presumably this table will be upright in the final version?

Appendix. Adopted innovations.

Innovation record title	Type	Number of adoptions by other projects	Projects from the same unit	Projects from another unit (geographically distant)	Adoption by external contractors
Controle de Consulta Técnica	M	—	—	—	—
Acesso traseiro para manutenção de CCM'S – painéis auxiliares da compressão de gás	M	1		X	
Documentos técnicos de fornecedores	M	2	X		
Projeto de bandejamento	M	2	X		
Integridade das áreas restritas da estrutura	M	2	X		
Oficina de mecânica da plataforma P-51	M	2	X		
Recebimento do Vaso Flotador	M	2		X	
Estacas Metálicas com Cargas Elevadas	M	1		X	
Análise Mercadológica dos Tipos de Estacas	D	1	X		
Negociação com órgão ambiental	D	1	X		
Metodologia para documentos de Projeto Executivo	M	2		X	
Tempo de resposta – Processo Licitatório	D	1		X	
Interligação dos pátios	D	1	X		
Areia adensada com água e vibrador de imersão em reaterro de áreas confinadas	D	2	X		
Processos Judiciais – proprietários de terra	D	1	X		
Integração dos planejadores – consolidação dos cronogramas	D	2	X		
Controle de energias Perigosas – EBTV em fase de C&M	D	1	X		
Autorização de Subcontratação	D	2	X		
Sistema de água refrigerada nas frentes de trabalho	D	1	X		
Estruturas pré-moldadas do pipe-rack	D	—	—	—	X
Banco de Dados – Reunião	D	1	X		
Bloqueios de Limites de Bateria entre Off-Site e On-Site	M	2		X	
Treinamento com Simulador Dinâmico de Processo (Software)	M	2	X		
Construção de undergrounds elétricos	M	1	X		
Procedimento de acompanhamento do as-built	M	2		X	
BAD – Gestão Democrática e Representativa	M	3	X		

(Continued)

Appendix (Continued)

Innovation record title	Type	Number of adoptions by other projects	Projects from the same unit	Projects from another unit (geographically distant)	Adoption by external contractors
CCR com temperatura interna de 40°C em condição de emergência	M	1		X	
Especificação das Bombas API 610 para o sistema de Água Gelada	M	1		X	
Sistema de Ventilação mecânica das salas que operam em módulo de emergência	M	1		X	
Documentação para preservação na área física	M	1	X		
Diálogos da qualidade – uma ferramenta de divulgação de informações e conceitos técnicos	M	2	X		
Maquetes Eletrônicas Walk Through	D	2	X		
Matriz de Risco – Ponto de Vista Multidisciplinar e Cenário da Obra	D	3	X		
Manual Técnico de Proteções Coletivas	D	2	X		
Barreira natural contra ataque de abelhas	D	2	X		
Arame Tubular – Soldagem de Tubulação de Aço Liga	D	—	—	—	X
Sistemática para Elaboração de Data Book	D	3	X		
Plataforma para cubagem de caminhões	D	—	—	—	X
Gestão de Impactos à Biodiversidade Aliada à Segurança dos Trabalhadores	D	3	X		
Suportação provisória de cabos de solda (bandejamento)	D	1	X		
Inspeções em equipamentos locados	D	—	—	—	
Utilização da Ferramenta na Prioridade dos Sistemas	D	1	X		
Dispositivo de Segurança para Movimentação de Tampa de Concreto	D	1	X		
Aquecimento do almoxarifado de consumíveis de soldagem	D	—	—	—	X
Acesso com uso de Passarela	D	—	—	—	X
Contenção utilizada em atividade de concretagem	D	—	—	—	X