



Research article

# Conceptions of control and IT artefacts: an institutional account of the Amazon rainforest monitoring system

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## Abstract

Based on Fligstein's (1990) work on 'conceptions of control' (broad managerial paradigms), this paper provides an analysis of the ways in which information technology (IT) artefacts shape and are shaped by institutional contexts. Specifically, we report on primary and secondary empirical data that spans a 44-year period pertaining to the uses made of the Amazon rainforest monitoring system (a set of satellite-based geographic information systems). This paper argues that: (1) the process of institutional change is conflictual, emergent and contested; (2) the design and use of IT artefacts tend to reflect the currently dominant conceptions of control; (3) that IT artefacts that emerge within a specific conception of control can be later reconfigured to serve the interests of other conceptions of control; (4) and finally, IT artefacts might unintentionally reinforce alternate conceptions of control and lead to institutional change.

*Journal of Information Technology* (2009) **24**, 320–331. doi:10.1057/jit.2009.12

**Keywords:** institutional theory; conceptions of control; institutional change; geographic information systems; globalization; Amazon rainforest

## Introduction

One important theme to emerge in both organizational and information systems literatures over recent years has been a consideration of how institutional contexts come to shape the development and use of information technology (IT) artefacts<sup>1</sup> (Orlikowski and Robey, 1991; Robey and Boudreau, 1999; Walsham and Sahay, 1999). Such concerns have led scholars to draw on notions from new institutional theory so as to better understand the enduring nature of institutions (Avgerou, 2000; Currie and Guah, 2007; Noir and Walsham, 2007; Hayes, 2008). This paper seeks to contribute to this important and under-developed research theme, and specifically argues that institutionalization should be understood as a historically located and highly contested process. Our analysis is based on the uses made of the Amazon monitoring system, which is a set of radar and satellite-based monitoring systems that are currently used by the Brazilian government to track deforestation. Our case will reveal that the differing configurations and uses of this IT artefact can be explained

by considering the ways in which the alternate institutional values became dominant at different periods of time.

Theoretically we primarily draw on Fligstein's (1990) conceptions of control to examine the emergence and establishment of Brazil's Amazon rainforest monitoring system. The case will highlight that the meaning and use of the monitoring system has shifted significantly over 44 years, from a system which was first used to assist in the economic development and the military security of the Amazon region to, more recently, protecting the ecology of the rainforest. We will argue that the trajectory of the Amazon monitoring system can be usefully understood in relation to the intercalation and overlapping of different conceptions of control, managerial paradigms that encapsulate the conceptualization of what is the Amazon rainforest (e.g. unproductive land or national patrimony) and consequently how to manage it (e.g. exploit or preserve) (Fligstein, 1990). Based on this analysis, our paper will argue that the relationship between IT artefacts

and institutions should be conceptualized as conflictual, emergent and dialectical (Hayes, 2008), and further, that literature on institutional theory needs to better attend to the emergent and conflictual practices that shape and are shaped by IT.

This paper is organized as follows. The next section reviews the literature that informs our analysis, namely neoinstitutional theory and information systems. The third section outlines our methodological approach. We then present our empirical base. The fifth section discusses the case with regard to the relationship between IT artefacts and institutional contexts. This is followed by a brief conclusion.

### Institutional theory and IT artefacts

Neoinstitutional theory emerged in the late 1970s and 1980s in response to a growing disenchantment with economic and rational theories that depict actors as strict followers of a universal atemporal rationality (Barley and Tolbert, 1997). In contrast new institutionalism conceives of actors as being embedded into institutional fields that possess widely shared interpretive infrastructures 'that constitute the nature of reality and the frames through which meaning is made' (Scott, 1995: 40). In this context, instead of suggesting the existence of an absolute reality and universal rationality, neoinstitutionalists tend to highlight the arbitrariness and cognitive nature of institutions and their role in the process of the social construction of reality (Berger and Luckmann, 1967). Consequently, new intuitionism proposes that notions such as rationality, efficiency and legitimacy should always be considered in relation to an institutional field located in time and space (Meyer and Rowan, 1977; DiMaggio and Powell, 1983).

Literature pertaining to the relationship between IT artefacts and organizations has only emerged quite recently (Butler, 2003; Lamb and Kling, 2003; Adler, 2005). One theme in this literature explores why despite there being no clear rationale for such investment to lead to increased efficiency and return on investment many organizations still invest in IT (Avgerou, 2003; Noir and Walsham, 2007). For example, Avgerou (2000) presents the case of a Mexican oil company that had recently been privatized that despite the unsatisfactory financial returns continued to increase their investment in IT. She explains that it was only possible as computers have become 'taken-for-granted as fixtures of contemporary organizations' and as such a key legitimating element in the company's effort to become a modern market-oriented organization.

A second theme in the IT and institutionalization literature has considered IT innovations (King *et al.*, 1994; Chatterjee *et al.*, 2002; Silva and Figueroa, 2002; Butler, 2003). Notable in this literature has been the notion of 'organizing vision' as the main enabler of successful IT innovations. An organizing vision is 'a focal community idea [...] for organizing in a way that embeds and utilizes [a specific] information technology in organizational processes and structures' (Swanson and Ramiller, 1997: 460, emphasis in the original). Drawing on this concept, Currie (2004) analyzes the case of Application Services Provisioning (ASP), a business and technological model

that provides software over wide area networks. She argues that ASPs have failed to establish themselves due to the incapacity of their supporters to generate a coherent and stable community-wide organizing vision, namely, a specific use for the technology within existing organizational structures and practices.

A third research theme relates to the inscription of institutional values into IT artefacts and the role of these artefacts as (re)producers of institutional orders (Kling and Iacono, 1989; Nicolaou, 1999; Scott, 2003; Gosain, 2004). Many commentators see institutions as being resilient to change and consequently have tended towards stability (Zucker, 1977; Powell and DiMaggio, 1991; Scott, 2001). In relation to technology, Hasselbladh and Kallinikos (2000) argue that institutionalization usually includes the development of abstract ideals into discourses and then concrete techniques of control (forms of codifications including software packages) that allow little space for interpretive flexibility. In this way they suggest that the context of institutions find their way into the design of IT artefacts, which in turn also become institutional carriers that help to support and reproduce certain institutional arrangements.

The fourth theme in the literature considers the role of IT artefacts in change processes. IT artefacts are understood as both enablers and constrainers of institutional change (for a review on change see Dacin *et al.*, 2002; Greenwood and Suddaby, 2006). The best known example of this is Jane Fountain's (2001, 2006) study of e-government in the USA. She argues that the introduction of IT artefacts connected to the Internet have brought major institutional change to the public sector by enabling the sharing of informal information and knowledge across the government's traditional boundaries. These changes have contributed towards the building of a 'virtual state' with a significantly different institutional environment. Drawing on Giddens (1986), a number of other information systems writers have also examined the enabling and constraining features of institutions (Barley and Tolbert, 1997; Barrett and Walsham, 1999; Barrett *et al.*, 2001). For example, Barrett and Walsham (1999) and Barrett *et al.* (2001) pointed out that the introduction of IT in the Indian forestry sector and in the London Stock Exchange led to major institutional changes due to 'globalizing tendencies' such as the separation of time and space, disembedding mechanisms and institutional reflexivity (Giddens, 1990).

Several studies have signalled the importance of accounting for the dialectical, conflictual and emergent nature of institutional change (Robey and Holmstrom, 2001; Hayes, 2008). Fewer studies have considered how the conflictual relationship between institutions and IT may evolve over time (for an exception, see Currie and Guah, 2007). For example, Hayes's (2008) case study of workflow technology in a High Tech Optronics company highlighted that the workflow system was drawn upon by different groups to try to ensure their institutional values became dominant. He argued that there are always competing views and values within and between institutions and consequently through ongoing negotiations and conflicts, there is always the possibility for alternate institutional values to become dominant.

### Conceptions of control and dialectics

Fligstein's (1990) book entitled 'The Transformation of Corporate Control' provides an institutional account of the changes in America's largest corporations over the last century. His analysis, like DiMaggio and Powell's (1983), challenges the mainstream evolutionary economic theory that believes that the USA naturally created technological efficient firms by managing them according to an universal extemporal rationality. In contrast, Fligstein shows that the USA's largest companies have taken their current shape due to a succession of dominant conceptions of control. Conceptions of control are institutionalized widespread 'totalizing world views that cause actors to interpret every situation from a given perspective' (1990: 10). They 'operate both as cultural templates for structuring new actions (i.e., what behavior make sense) and a set of structures limiting the possibilities of action (i.e., what others are doing, thereby structuring what reactions are possible)' (Fligstein and Brantley, 1992: 287). Conceptions of control can be understood as an institutional logic as conceptions are also 'sets of "material" practices and symbolic constructions' available to individuals so as to make sense of their environment (Friedland and Alford, 1991: 248). However, while institutional logics provide the 'cognitive maps' to activities that range from bureaucracy to religion, conceptions of control are akin to managerial practices as they relate to the desire of individuals and organizations to control their environment. Examples of Fligstein's conceptions of control include the manufacturing conception that sees the organization as an engine that has to efficiently transform raw materials into finished products. Fligstein's financial conception of control views organizations as a portfolio of assets that seek to obtain the highest return on investment. He argues that the financial conception of control has become dominant.

As this paper focuses on the contested and emergent nature of institutionalization, we also draw on literature from a dialectical perspective. This literature highlights the conflictual and tentative nature of institutionalization, and attends to the ways in which structures of power between powerful actors may become taken-for-granted in this process (Robey and Holmstrom, 2001; Seo and Creed, 2002; Suddaby and Greenwood, 2009). As Blackler and Regan (2006: 1858) suggest:

Institutional change ... should be analyzed as a contested ascent from the abstract to the concrete. In this case the contest was firstly, between alternative images of what kind of practices might be desirable. Secondly, it was between the established institutional arrangements of the past and the social and cultural infrastructure associated with them, and the tentative, possible institutions of the future.

Informed by Fligstein's writing on conceptions of control, dialectical perspectives of institutional change and the literature in IT and institutions, this study will examine the ways in which the Amazon monitoring system was shaped over a 44-year period to support different conceptions of control, and how it was reconfigured to work within new institutional contexts. We will contend

that the process of institutional change (shifts in conceptions of control) do not happen in a linear fashion, but are instead conflictual and emergent, and consequently we may find different conceptions of control competing for dominance or relevance at any given time.

### Research methodology

The case study that forms the empirical base of this paper concerns the history of the Amazon monitoring system, a set of satellite-based remote sensing systems currently used by the Brazilian government to estimate deforestation rates in the Amazon rainforest. In order to interpret and integrate the primary and secondary in a single in-depth case study, this study has adopted a subjectivist position, in particular the interpretive tradition of IS research (Walsham, 1993, 2006). As we report on the different ways in which the Amazon rainforest monitoring system manifest itself over 44 years, we adopt a combination of the historical and dialectical method for institutional research (Suddaby and Greenwood, 2009). We attempted to reconstruct history based on secondary data and by asking interviewees to narrate their version of the trajectory and current use of the Amazon monitoring system: a history that they were in most cases close observers or even the protagonists to (Czarniawska, 2004). During and after the data analysis, the researchers also maintained contact via email and telephone with key informants in order to confirm their interpretation of the data and elicit further information.

The primary data consist of 71 interviews collected in Brazil between June 2007 and April 2009. The informants included 8 officials from National Institute for Space Research (INPE), 11 from the Ministry of Environment (MMA), 14 from the federal environmental agency (IBAMA), 9 from Secretary of Environment from the state of Mato Grosso (SEMA-MT) and 8 from environmental non-governmental organizations (NGOs). Most interviewees were officials directly involved in the conception, development and/or use of one of the configurations of the Amazon monitoring system, including three ex-ministers of environment down to local forest rangers in the rainforest region. Most interviews were held in Portuguese in four different regions of Brazil. When possible the interviews were chronicled using a voice recorder, otherwise, extensive notes were taken and the conversation translated directly in English as soon as the interviews finished.

Secondary data sources consist of the Brazilian law (past and present), newspaper archives (*Veja* and *Folha de São Paulo*), reports from governmental agencies (MMA, INPE and SEMA-MT) and NGOs (Greenpeace, WWF, ISA and ICV), technical documentation concerning the Amazon monitoring system and academic papers about the economic, political and environmental history of the Amazon (see references in the account below). Our understanding of the system was further developed through observing the use of both the front-office (user interface available on the internet<sup>2</sup>) and the back-office (classification of deforestation, composition of maps) of the monitoring system. One of the authors was also trained how to operate both the front and back office systems.

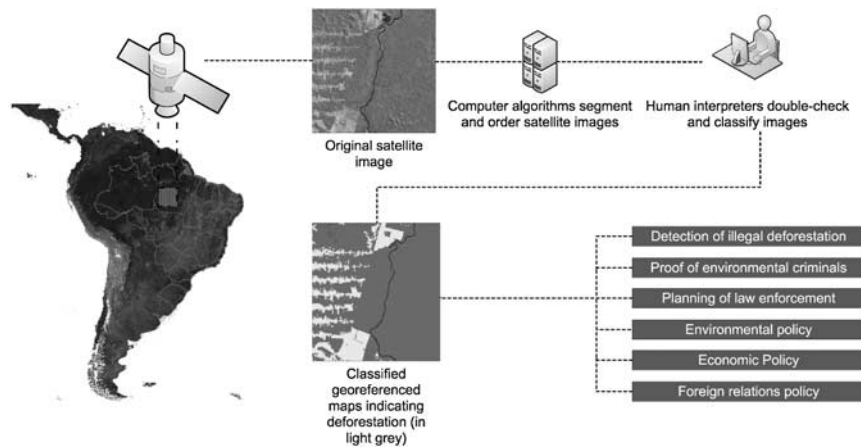
### The Amazon rainforest monitoring system

The empirical focus of this paper is the Amazon rainforest monitoring system which comprises of a family of similar systems. They have three main features in common. First, all systems relate only to the Brazilian portion of the Amazon rainforest (which the largest). Second, they were all developed by the Brazilian government, with INPE (Institute for Space Research) playing a key role in most systems. Finally, all systems work based on similar technological principles, namely, they are geographic information systems that obtain data via remote sensing technology, in particular satellite optical images (see Figure 1).

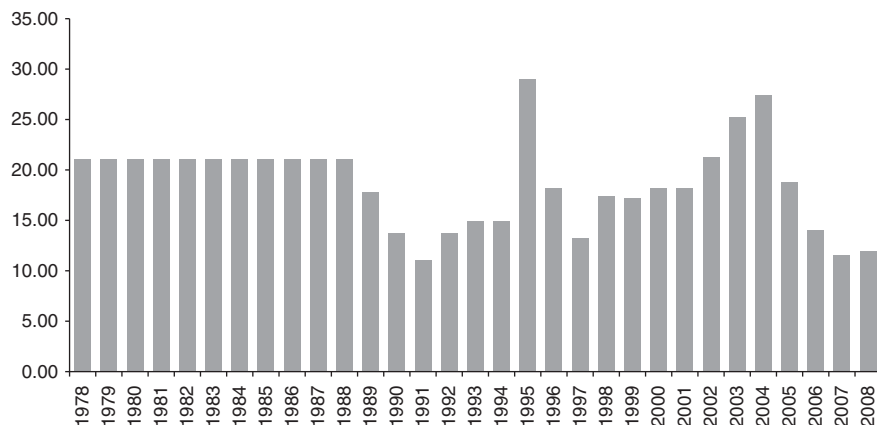
The origins of the Amazon monitoring system date back to 1961, when the Brazilian government created a department which a decade later became INPE. In 1973 INPE installed a reception base for the USA satellite Landsat, becoming one of the first countries outside the USA-USSR to receive satellite images. Early reports highlight that the rationale for the heavy investments in remote sensing technology was to support economic development across Brazil, but in particular within the Amazon region. Indeed, one of the first uses of the monitoring system was to check if the subsidies provided by the central government to those

people colonizing and transforming Brazil's 'immense and unknown inland' into productive agricultural areas through the planting of crops and the establishment of grazing pasture were effective.

In 1988 the monitoring system changed considerably in scope with INPE's creation of PRODES. While the justification of the previous monitoring system was centred on the economic development of the Amazon, PRODES centred on the protection of the rainforest. However, despite the change in rhetoric, PRODES was designed in a way that made it unpractical for environmental protection efforts. Indeed, PRODES detected deforestation only once a year, and the map showing the detail of the deforested area was considered sensitive by the government and as such access was limited. The data generated by PRODES was the total sum of deforestation in km<sup>2</sup> divided by state. As most states in the Amazon have areas bigger than countries like the UK and Spain, this data was not specific enough to allow the environmental protection agencies to plan their activities, let alone ascertain the exact location of illegal deforestation in order to take legal action. It is not surprising then that deforestation rates (as detected by PRODES) remained as high during the 1990s as in they were in the 1970s and 1980s (see Figure 2).



**Figure 1** General principle behind the systems that compose the Amazon monitoring system.



**Figure 2** Deforestation rates of the Brazilian Amazon rainforest between 1978 and 2008 calculated using the Amazon monitoring system (Sources: Fearnside, 2005; INPE).

In 2000 there was another change to the monitoring system. The state of Mato Grosso created SLAPR, a system that according to Fearnside (2003) was the first control mechanism that led to a reduction in deforestation in the Brazilian Amazon region. The system has been updated between 2002 and 2006 so as to better identify and combat deforestation. DETER, a new component of the monitoring system developed by INPE in 2004, is able to detect the precise location of deforestation within days. More recently, IBAMA developed SisCom, a GIS that integrates data from INPE's and Mato Grosso's systems with other legal information, such as properties under embargo due to illegal deforestation. Furthermore, in contrast to the previously strict data control of PRODES, whereby the satellite images showing the location of deforestation were available only under authorization of the military, today all monitoring systems can be accessed over the internet by anyone interested in environmental protection of the Amazon.<sup>2</sup>

Following the creation of these new configurations of the Amazon monitoring system, there has been between 2004 and 2008 a consistent decrease in deforestation rates and a sharp increase in the number of fines for illegal deforestation in Brazil's Amazon region (see Figure 2). Even though it is very difficult to attribute this reduction to the new design and use of the monitoring system, different interviewees pointed out that change in economic conditions could not explain this change alone.

In summary, in the last three decades the Amazon monitoring system has changed dramatically in its scope, justification, use and effects. But how was it possible and how can we explain these radical shifts?

### Contextualizing the monitoring system

In order to understand the broader social context in which the Amazon system is embedded, we draw upon Fligstein's (1990) notion of 'conceptions of control' (widespread managerial paradigms). We argue that in the period under analysis (1964–2008) the Brazilian government has managed the Amazon region from three different conceptions, namely, the military, the economic and the ecological conceptions of control (see Table 1). Further, we will explain that these three conceptions of control have shaped the nature and use of the Amazon monitoring system. For simplicity we divide the history of the monitoring system around three key milestones: the military *coup d'état* in 1964, the creation of PRODES in 1988 and the

creation of SLAPR in 2000, two of the most important configurations of the Amazon monitoring system.

### 1964–1988: military and economic dominance

The military conception of control represents the world-view usually held by the armed forces, and sees the nation as a territory that must be defended from all kinds of threats to its economical, political and territorial independence (Page and Redclift, 2002). Different interviewees suggested that military concerns with the Amazon rainforest were central to both the decision to colonize the region and to create the Amazon monitoring system during the rule of the military junta, between 1964 and 1985. During this period there was growing concern the region was under imminent threat of being invaded by other nations. Commentators suggest that the Amazon represented a large section of unspoiled land that other countries may have sought to exploit for food production and the extraction of raw materials to fulfil the requirements of their increasing populations. Therefore, the military government believed if it did not colonize the Amazon region, other countries certainly would (Reis, 1965; Kolk, 1998).

It was also during the military rule that the Brazilian government started to invest in satellite remote sensing, the technology that is the basis of the Amazon monitoring system. Different scientists and senior government officials considered military concerns as being the principal reason for investing in satellite technology during the 1970s. The military government perceived their lack of knowledge about the Amazon basin as a military weakness, and considered the use of satellite technology as a way to redress this. As a senior INPE scientist explained:

The Amazon is one of the main reasons why the government has set a long-term goal to invest in orbital remote sensing. During the 1970s the Amazon was seen as a vast and mostly unknown area. To give you an example, just to build a highway crossing the rainforest they had to create the indigenous reserve of Xingù to relocate the indigenous populations that they [the government] did not even know were there! [...] The lack of knowledge was big, and in addition to that, the fear of the international greed was consistent.

The constant preoccupation with maintaining Brazilian sovereignty over the Amazon highlights the strength of the military conception of control at this time.

Table 1 The military, economic and ecological conceptions of control

Conception of control	Ideal	Aims
Military	An independent and strong Brazilian state	Protect Brazil's Amazonian region against threats to its economic and political sovereignty
Economic	A wealthy and prosperous Brazilian Amazonian region	Develop Brazil's Amazonian region by expanding and modernizing its economy
Ecological	A sustainable society	Preserve Brazil's Amazonian environment



However, the military government also believed that national security could be enhanced if Brazilian people colonized the Amazon region. This led to economic and demographic growth and suggests the presence of the 'economic conception of control'. The economic conception of control in broad terms is concerned with the economic growth of the country, as defined by the achievement of certain numeric indicators (e.g. GDP, per capita income and budgeted surplus). The economic conception of control is closely related to the notion of developmentalism, namely, a set of ideologies that regard development in the sense of economic growth and institutional modernization as a good in itself without questioning the fact that those models of modernity are a product of developed nations and that they often collaborate to the perpetuation of post-colonial forms of domination. Fligstein's (1990) financial conception of control has important similarities and differences to our economic conception of control. On the one hand, the financial like the economic conception of control manages the organization based mainly on abstract quantitative indicators such as ROE (return on invest) for the former, and GDP (gross domestic product) for the later. This tendency of using numeric financial and managerial tools in the Brazilian government has been the case particularly in the last 20 years, with a series of efforts to 'modernize' the public sector (Abrucio, 2007). On the other hand, public sector organizations emphasize the importance of 'espousing the right beliefs, establishing correct structures and following the appropriate processes' where '[w]hat is "right", "correct", or "appropriate" depends on the broader institutional-cultural context' (Tsoukas and Pappoulias, 2005: 82). In sum, for the economic conception of control the means (politically correct discourses and practices) are as important as the ends (economic growth as measured by the GDP).

During this time period there was a strong synergy between the military and the economic conception of control. The governmental slogan of the 1970s *Integrar para não entregar* (translated as: *integrate the region economically to avoid giving it away to other countries*) recalled by different interviewees is a good example of this. At the same time, this combination of economic and military concerns were also embedded in the monitoring systems, given their justification in terms of national security and their application to assess the natural resources of the region and verify if the subsidies for agriculture and cattle ranching (and indirectly, deforestation) were having the effects desired.

#### 1989–2000: emergence of ecological concerns

Towards the end of the 1980s a new conception of control emerged that questioned the legitimacy of both the military and the economic conceptions of control. This ecological conception of control is primarily concerned with the long-term sustainability of human life on Earth. While the economic conception of control 'downplay[s] discontinuities and crises, especially in the ecological arena', the ecological conception recognizes the impact that human activities have on the environment and perceive risks – hazards generated by modernization – as management's

core problem (Shrivastava, 1995: 119). According to this conception of control, the government should preserve the environment by adopting 'ecologically sustainable organizational designs and practices' (*ibid*: 127).

In 1985 the first civil president since 1964 came to power and thus ended the military control of the country. During this period of transition between the military and democratic regimes, Brazil suddenly found itself as a global environmental villain due to its policy towards the Amazon. Even though today the idea that deforestation is damaging to our global environment is taken for granted, it was not the case then. Indeed, as late as the end of the 1960s the reports of major international bodies did not even mention the large-scale deforestation as an environmental issue. Furthermore, with the exception of a few pioneers, such as John Muir, John Ruskin and Sir Arthur George Tansley, the process of almost complete extinction of primary forests in western Europe passed unnoticed (Guha, 2000; McNeill, 2000). It was only in the 1970s, following the emergence of environmentalism (or 'risk society'), that the new environmental NGOs and other members of the international community started expressing their concern about the future of the Amazon, the 'world's lungs', and specifically started criticizing the colonization project carried out by the Brazilian government (Kolk, 1998; Keck, 2001).

Initially, the Brazilian government resisted international pressure, but towards the end of the 1980s cuts in international loans and internal political pressures forced the government to change the official discourse towards the Amazon (for a detailed account, see Kolk, 1998). Among a series of environmentally friendly measures adopted during that period is the creation in 1989 of IBAMA (the body responsible for environmental protection in Brazil), the launch of the programme *Nossa Natureza* (translated as: *our nature, the first program aiming at protecting the Amazon rainforest*) and the suspension of some subsidies to agricultural activities in the Amazon region. Brazil's environmental commitment was even documented in the new constitution where the Amazon rainforest is defined as a 'national patrimony' that must be protected. PRODES, the monitoring system, was also part of the new environmental policy. Since 1988, PRODES has released data each year about the extent of deforestation in Brazil's Amazon region.

Despite the official 'greening' of the Brazilian government, accounts from different interviewees and secondary data sources highlighting high deforestation rates during the 1990s (see Figure 2) suggest that the change in the official discourse at the end of the 1980s did not represent any significant change in the way the Brazilian government has viewed and managed the Amazon rainforest. Thus, for many, the decision to change the environmental law and to create the Amazon monitoring system was mainly an attempt by the Brazilian government to convince the international community that they were adopting environmental policies for the Amazon. Indeed, when asked about the motivations behind the creation of IBAMA and the monitoring system, a very senior politician explained that:

During the 1980s the international community became concerned with the Amazon. IBAMA was created by

putting together different pre-existing bodies as an answer to this pressure. It was a way to prove that we have the competence to manage the Amazon. The use of satellite images to monitor deforestation. [...] was to demonstrate to the international community our preoccupation with the environment.

This suggests that the design and initial use of PRODES was not actually intended to be for environmental protection. In contrast, the government seems to have made further investments in the Amazon monitoring system in order to take advantage of the institutional myth embedded in technology (Avgerou, 2003; Noir and Walsham, 2007), and use it as a symbol of national scientific knowledge to mitigate the accusations that Brazil did not have the expertise to protect the Amazon. This suggests that during this period, despite the emergence of the ecological conception of control at discursive level, the monitoring system was still largely being used for the aims set by the military conception of control.

#### 2001–2008: ecological dominance

After years of false starts and military dominance, around 2001 the government started devising a genuine policy to protect the rainforest. This led to the institutionalization of the ecological conception of control and the deinstitutionalization of the military conception. In 2007 the government proposed the creation of a new international fund to exchange reduced greenhouse emissions from deforestation for financial help. Brazil had so far always refused any mechanism linking international money to the preservation of the Amazon on the basis that it did not accept that Brazil's Amazon region was the concern of any other nation. Indeed, it had long been held that any international interference represented a threat to the country's sovereignty. Furthermore, the ecological conception of control was strengthened by the reconfiguration of the monitoring system after 2000 which allowed for the reduction in deforestation as well as establishing an open data policy.

As well as financial incentives, there were several other reasons for institutional change. First, different interviewees explained that over the last decade many Brazilians (especially the political class) take for granted the importance of the environment and consequently preserving the rainforest. Second, many Brazilians are concerned about climate change, and the negative consequences such as the increase in the number of floods and droughts in the country. Third, since the election in 2003, Lula has brought some of the main critics of the previous administration's Amazonian policies into his government. As was explained by a senior scientist at INPE:

When Lula became president his first Minister of the Environment [Marina Silva] invited members of different NGOs to join her Ministry. These were the same people that INPE previously would not give deforestation data to. One of the reasons was because they thought data may be put into foreign hands. However, after Lula became president we would give it to the Ministry who would then give it to the NGOs. Later, INPE's Director ordered that the data be made publically available on the Internet.

While this open data access policy makes sense within the ecological conception of control, it was unthinkable within the military era. Such institutional change can be understood as a process of ongoing contestation between different conceptions of control. First, in April 2008, there was a clash between a military General and a government Minister over the demarcation of an indigenous reserve (Serra do Sol). Second, and most importantly, many recent policies of the Ministry of Agriculture and the Ministry of National Integration suggest that the economic conception of control is dominant in some areas of government. Economic plans, such as PAC (Plan for Acceleration of Economic Growth) include measures with high environmental impacts such as the construction of asphalt highways crosscutting the rainforest (Laurance *et al.*, 2004). Further, environmental NGOs claimed that the surge in deforestation rates in the second half of 2007 (after 3 years of steady decline) was due to the increase in the price of soya beans and other agricultural commodities and the lack of capacity or political will of the government to counterbalance this market force. This suggests that even though the ecological conception of control has gained considerable force in the last 10 years, it coexists and is continuously contested by a weakening military and a strong economic conception of control.

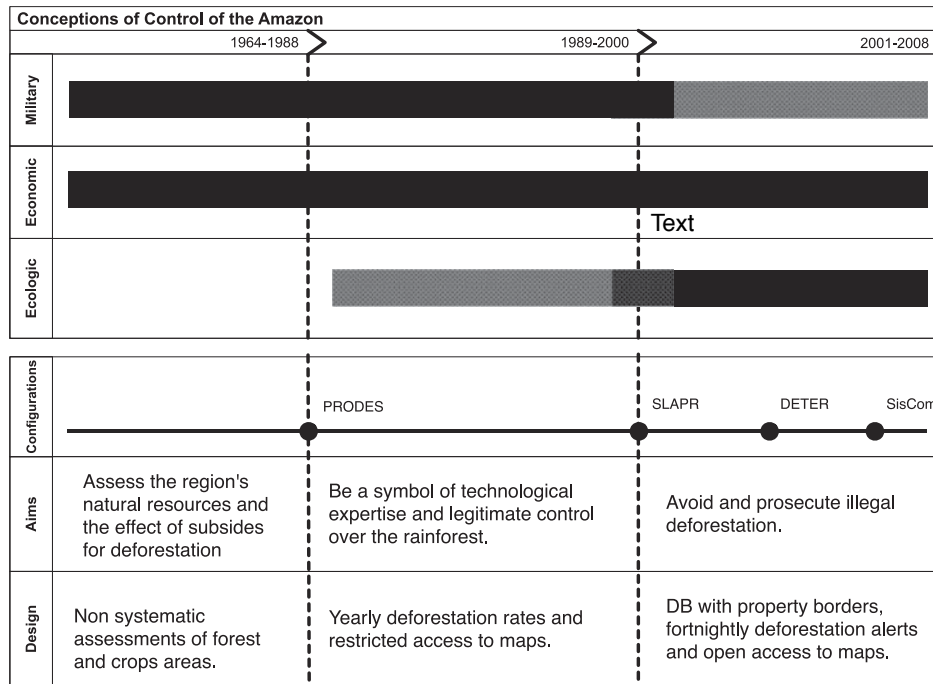
#### Discussion

Our case outline has highlighted that the ambitions, design and use of the Amazon monitoring system have shifted significantly over the last 44 years. Throughout the 1970s and 1980s the monitoring system was used as a tool to support deforestation so as to best utilize 'natural resources'. Such use can be understood within the context of an institutional field dominated by the alliance between military and economic conceptions of control. Similarly, as the military conception of control was still dominant throughout the 1990s, the changes to the system at the end of the 1980s did not provide for a reduction in deforestation. Finally, since 2001 the monitoring system has been reconfigured to assist in reducing deforestation. This reconfiguration was possible due to the deinstitutionalization of the military conception of control, and the institutionalization of the ecological conception of control across Brazilian government (see Figure 3).

This penultimate section will explain these shifts in the use of the Amazon monitoring systems as being largely due to dialectical processes of institutional change within the Brazilian government and between other interested governmental and nongovernmental groups inside and outside Brazil. Specifically, this section provides a discussion of IT artefacts and institutions in relation to three themes: how institutional change takes place, how IT artefacts (re)align themselves to institutions and how IT artefacts may be implicated in the process of institutional change.

#### Institutional change as an emergent and conflictual process

The emergence and receding of our three conceptions of control over the 44-year history of the Amazon monitoring system reported in this paper demonstrates that such institutional change can be understood as being emergent



**Figure 3** Conceptions of control and the Brazilian Amazon monitoring system.

and conflictual. Drawing on Fligstein (1990), this first subsection will critically examine how pressures outside of the Brazilian government led to change.

Our case highlighted two key events that occurred in the late 1980s that were implicated in the shift from a military to an ecological conception of control. The first event related to the perceived threat to the sovereignty of the Amazon declining due to improvements in Latin American political relations. The second event related to the growing awareness among scientists, environmentalists and international governments of the importance of the Amazon region with regard to global environmental sustainability. This culminated in the World Bank and the Inter-America Development Bank suspending the payment of loans to development projects in the Amazon region until Brazil agreed to reduce deforestation (Kolk, 1998). In Fligstein's (1990) longitudinal analysis of American industry, he points to the dramatic changes in economic conditions during the great depression in the 1930s as being the key events that saw companies more aggressively looking for new markets. This reflected the shift from the manufacturing conception of control to the sales and marketing conception of control. In our case, the two events rendered it infeasible for the Brazilian government to ignore such international criticism and economic sanctions. This left Brazil unable to maintain its military-orientated strategy for the Amazon region.

Cumulatively, these two events triggered a 'moment of crisis'. Fligstein argues that crisis are the moments in which 'major groups are having difficulty reproducing their privilege as the rules that have governed interaction are no longer working', the institutional fabric tears up and institutional change can happen (Fligstein, 2001: 118). This moment of crisis was brought about due to global influences that destabilized the military conception of

control. It resulted in Brazil developing a policy that sought to convince the international community that it would reduce deforestation. This led to the establishment of the ecological conception of control (at least at a discursive level). This change in government policy is akin to the implementation of anti-trust laws that forced American companies to diversify their investments by establishing a broader portfolio of products and companies (Fligstein, 1990), and cumulated in the dominance of the financial conception of control. The shift in dominance to the ecological conception of control represents a form of coercive isomorphism (DiMaggio and Powell, 1983), where powerful actors (i.e. the USA and Western Europe) imposed a certain institution (i.e. environmentalism) over the weaker members of its institutional field (i.e. the developing countries) through coercive measures (i.e. cuts in loans). It also helps us better understand how powerful global actors can influence and shape societal and organizational change (Robey and Holmstrom, 2001).

The case study of the Amazon monitoring system also contains empirical findings that extends Fligstein's (1990, 2001) understanding of institutional change in two ways. First, it shows that such shifts cannot be entirely understood as coming about due to a 'moment of crisis', but also due to an ongoing strengthening of the ecological conception of control, not only among the international community, scientists and environmentalists, but also with more affluent and politically influential sections of Brazilian society. This gradual strengthening suggests that understanding changes in the balance between conceptions of control requires a longitudinal analysis (such as with Beck's (1992) 'risk society'). The dominance of the ecological conception of control points to some more productive aspects of globalization. This contrasts Robey and Holmstrom's (2001) more pessimistic view,



where they consider globalization privileges economic criteria and thereby restricting social needs.

Second, while Fligstein (1990) suggests that a certain institutional field is usually dominated by a single major conception of control, our case has shown that conceptions of control can coexist in symbiosis (e.g. military and economic) or conflict (e.g. economic vs ecological) potentially for significant periods of time. Synergy was evident between the pressures for military sovereign control and economic development that framed the colonization of the Amazon region. Contestation is currently evident in the competition for dominance between the ecological and the economic conceptions of control, as while the idea that the Amazon should be preserved is taken-for-granted, the actual governmental practices towards the Amazon are still an arena of contestation as they have to mediate the demands of the global influences coupled with the specific needs of landowners, farmers and related industries who seek to maintain their existence in the Amazon. Further, while we agree with commentators who argue that institutions tend towards stability (Zucker, 1977; Powell and DiMaggio, 1991; Scott, 2001), our analysis further implies that even apparently stable conceptions of control are always in states of synergy and/or contestation. This also suggests that the apparently schizophrenic behaviour of the government towards the Amazon is actually the outcome of internal synergy/struggle between different conceptions of control at a global, national and local level (Robey and Holmstrom, 2001). Consequently, we suggest that institutional change should be viewed as being a tentative, emergent political outcome of ongoing relations and negotiations between many different local and global interested groups (Blackler and Regan, 2006).

#### Aligning artefacts and institutions

Conceptions of control also provide a theoretical lens to understand the processes whereby the institutional context shapes the design and use of IT artefacts (Orlikowski and Barley, 2001; Currie and Guah, 2007; Hayes, 2008). Our longitudinal case shows a considerable degree of alignment between the conceptions of control that was dominant at a specific moment of time and IT artefacts. Furthermore, the case also revealed the relation between IT artefacts and conceptions of control is neither static nor predictable, as IT artefacts may emerge in accordance with a certain conception of control (e.g. military) and later be reconfigured to reflect a succeeding conception of control (e.g. ecological). The recognition of this phenomenon has three implications for the understanding of IT in institutions.

First, we suggest institutional theory can provide an important theoretical lens to provide a historical understanding of the ways in which specific IT artefacts come about and change over time (Orlikowski and Barley, 2001; Currie and Guah, 2007; Hayes, 2008). In our case, the development and early use of the Amazon monitoring system was framed by broader social phenomena (such as the cold war). Understanding such framing helps us to make sense of why specific organizational practices were enacted (such as subsidies for deforestation) at that time. Indeed, such practices now look incomprehensible in

relation to the current conception of control, and further highlight the importance of avoiding presentisms.

Second, there have been many studies reported in the literature that have considered the ways in which the visions of designers are materialized in software applications and the ways in which this may shape or constrain (or not) possibilities for action (Kling and Iacono, 1989; Akrich, 1992). Indeed, such a view of how technology may be implicated in institutional change resonates with Kallinikos (2004), who argues that IT not only passively offers novel information but 'invit[es] particular modes of understanding and action that involve both the framing of the reality to be addressed, the determination of particular tasks and the sequential patterning' (p. 19). We suggest that institutional theory offers important insights that can help researchers to recover the synergy/contestation that surrounded those conceptions of control that were pivotal in shaping the visions of developers of information technologies at particular moments in their history. Along with Currie (2004) we too argue that it is important for institutionalist research to explain how visions became institutionalized and de-institutionalized over time (Swanson and Ramiller, 1997). We suggest that conceptions of control provide a powerful lens to understand institutionalization and deinstitutionalization over time. Further, we would urge future research to conceive of institutionalization and deinstitutionalization as an ongoing and highly political process rather than being static states that we move between.

Third, institutional theory also helps better understand the ways that IT artefacts may 'drift'. Ciborra (2000) points out that IT artefacts, such as information infrastructures, tend to drift, namely, 'they deviate from their planned purposes for a variety of reasons often outside anyone's influence' (p. 4). He explains that technology intrinsically tends to drift due to some force from inside that manifests itself when it is put to use, '[t]hus, the idea emerges of technology with a certain degree of autonomy and inner dynamics; of technology both as a drifting system and as a organism to be cultivated' (*ibid*: 32). However understood through institutional theory, drift can also be conceived of as not necessarily being arbitrary, but arising as a consequence of contestation between conceptions of control which may lead to shifts in an institutional field. In our case, this was evident in the Amazon monitoring system's transformation from being a symbol of military dominance to a way to protect the environment. Such drift came about as a result of the institutional hijacking of the monitoring system by those supporting new values and interests. Consequently, we suggest that while drift provides important conceptual insights, such insights can be deepened if an institutional analysis is undertaken over the *longue durée*. Such an analysis allows us to take into consideration the organizational, societal and global pressures for change (Giddens, 1986; Robey and Holmstrom, 2001).

#### IT shaping institutional change

So far our analysis has pointed to how a dominant conception of control shapes the nature and use of an IT. This section will argue that IT can also lead to new ways of

framing reality, and in so doing bring about institutional change (Choo, 1996; Kallinikos, 2004, 2006).

The monitoring system initially sought to measure the extent and location of deforestation so as to evaluate the success of its economic and military-oriented colonization policies. However later, the same deforestation data became a key resource for scientists and environmental NGOs, as it allowed for them to argue that such deforestation was not sustainable and that it was going to have catastrophic implications for the global environment (see e.g. Fearnside, 1982, 2005; Greenpeace, 2008). Without the data that the monitoring system provided, the severity of deforestation may not have been identified as early as it was (Rajão and Hayes, 2007). Thus, despite the initial design and use of the Amazon monitoring system aligning itself closely with the military conception of control, the deforestation data was also inadvertently fundamental to the establishment of the ecological conception of control. In this sense the monitoring system became a key legitimating element in stabilizing and destabilizing a dominant conception of control (Avgerou, 2000; Noir and Walsham, 2007). Such an analysis suggests that the capabilities of the monitoring system to analyse, store and transmit data provided the possibility for its own reconfiguration and thus was inextricably interlinked with institutional change (Barley and Tolbert, 1997; Barrett *et al.*, 2001). Such change may take on forms far removed from that envisaged by the designers and/or the champions of an IT and thus lead to significantly different institutions (Fountain, 2006).

Although not understood through institutional theory, the possibilities for such reconfiguration were captured in Zuboff's (1988) concepts of informate and automate. She highlighted that while an IT system was put in place to automate work, the system also generated information about work activity that was previously unavailable. Consequently, she argued that IT offers the possibility not only to automate by deskilling and eliminating jobs, but also to empower employees with novel information and leads to new ways of understanding their own work. Such IT led change may lead to the emergence of new work practices and the renegotiation of institutionalized relations between occupation groups (Barley, 1986). Thus IT presents intentional and unintentional possibilities for institutional change (Barrett and Walsham, 1999; Barrett *et al.*, 2001; Fountain, 2001).

## Conclusion

The overall aim of this paper has been to provide an in-depth account of institutional change, and specifically to consider the ways in which IT artefacts are implicated in processes of institutionalization and deinstitutionalization. Through our analysis of the Amazon monitoring system we have illustrated how its emergence and different uses were shaped by global pressures over 44 years. First, the system was shaped by the perceived threats to Brazilian sovereignty. More recently, economic sanctions proved to be an important dimension in bringing about institutional change. What was also interesting in this case was the ways in which global influences led to many Brazilians themselves becoming environmentally aware and thus provided an internal pressure for change. Local pressures

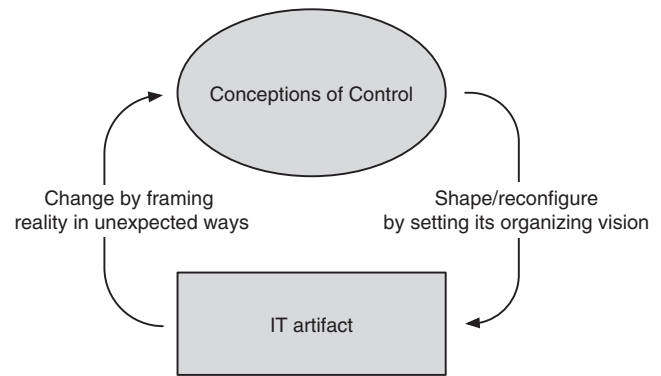


Figure 4 Dialectical relationship between IT artefacts and institutional context.

also influenced the shape and nature of change, as the Brazilian government balanced these global influences with the needs of the local population to be able to sustain their existence in the Amazon region through agriculture. These competing pressures between local and global influences have been very much central to shaping the changes in policy and the use of the Amazon monitoring system over its 44-year history and are likely to continue to shape its future role.

Our analysis was primarily based on Fligstein's (1990) conceptions of control, and shows the value of drawing on institutional theory to understand how global and local pressures are implicated in institutionalization and deinstitutionalization processes. Based on such a theoretical lens, we have argued that institutional change can be better understood if researchers place a strong emphasis on the history of an IT artefact, and by doing so provide a much more detailed understanding of how and why information technologies emerge and how this history is implicated in shaping current practice (Orlikowski and Barley, 2001; Currie, 2004). The ongoing contestation and synergy between alternate conceptions of control highlights the importance of viewing institutions as being provisional and highly political. Such a dialectical approach highlights the significance of understanding how relations of power can become taken for granted over time (Robey and Holmstrom, 2001). Thus, our analysis suggests that the relationship between IT and institutional contexts is a complex dialectical linkage whereby the organization's institutional arrangements shape the design and use of IT artefacts, while also providing possibilities for institutional change (see Figure 4). Indeed, the differing uses of the Amazon monitoring system over the years highlighted how the same IT artefact may align itself with alternate conceptions of control and in doing so is inextricably inter-linked with institutionalization and deinstitutionalization processes. We hope the study reported in this paper will lead to future studies that adopt longitudinal and dialectical approaches to the study of IT and institutional change.

## Notes

- 1 In the context of this paper, IT artefacts are understood as 'bundles of material and cultural properties packaged in some socially recognizable form such as hardware and/or software'

(Orlikowski and Iacono, 2001: 121). In this context, IT artefacts comprise both material affordances (i.e. design features) and established and envisaged uses or organizing visions (i.e. ideal and actual work practices related to the artefact) (Swanson and Ramiller, 1997; Orlikowski and Barley, 2001).

2 INPE's PRODES Digital and DETER, and IBAMA's SisCom can be accessed at <http://www.obt.inpe.br/prodesdigital>; <http://www.obt.inpe.br/deter> and <http://siscom.ibama.gov.br/website/SisCom>, respectively.

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