When is an information infrastructure? Investigating the emergence of public sector information infrastructures

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Abstract
Drawing on the notion of information infrastructure as a relational concept, this paper endeavours to highlight the links between data standards and institutional facts. Although social science studies have emphasised the interplay between socio-technical factors, the author suggests that such approaches have overlooked the role that institutional facts play in the development of information infrastructures. An in-depth, qualitative case study of a recent episode of institutional change within the criminal justice system of England and Wales reveals how institutional facts are entangled with data standards through iterative sets of constitutive rules that are mirrored by their associated logical messages in an isomorphic fashion.
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> For example, we (i.e. police and Crown Prosecution Service) consider a case to be a number of one-to-many defendants (charged) with one-to-many offences, what does Interpol consider a case to be? It becomes a problem to reach an agreement at the international level to achieve standardisation between and among disparate systems.
> Crown Prosecutor, Member of the Compass Design Authority, London, March 26th, 2007

Introduction
In the study of information systems there has been little interest in the notion of institutional facts despite the claims of approaching information and communication technologies (ICTs) in general and information infrastructures in particular from a socio-technical perspective. So far, the study of data standards and standardisation procedures in the context of information infrastructures has taken a technological slant at the expense of the institutional perspective to the point that it has looked at their development from a narrow technological perspective to emphasise the irreversibility of the (technical) installed base and the role of technology as an ally (Monteiro & Hanseth, 1995; Hanseth & Monteiro, 1997; Hanseth & Lyytinen, 2006). When the institutional context has been taken into account (Chae & Poole, 2005), extant approaches to information infrastructures have appeared devoid of the institutional arrangements and cognitive imageries that inform designers in the process of developing large-scale information systems. Needless to say, such shared cognitive frames and imageries have far-reaching implications as they

create the background condition for action and sense-making (Ciborra & Lanzara, 1994).

Triggered by this conceptual oversight, this paper endeavours to study the development of an information infrastructure in the criminal justice system in England and Wales. The rationale for choosing this specific domain of activity stems from the pervasiveness and weight of the institutional dimension in this peculiar field compared with other public domains. Writing about the judiciary that encompasses the prosecution function in Italy, Lanzara (2009a, p. 23) maintains:

> As a critical public sector in contemporary democracies, justice exhibits specific characteristics that make it quite an interesting field for studying ICT development for e-Government and the electronic delivery of public services. The judiciary is a normatively thick public domain, with a heavy regulative status and a bulky legacy system that make it quite recalcitrant to innovation.

By taking a recent episode of institutional change as a case in point, this paper argues throughout that institutional facts play a pivotal role in the evolution of the underlying electronic messaging system that supports police–crown prosecutor interactions.[1] By pointing to institutional facts, the intention is two-fold: first to acknowledge that designers' cognitive imageries coalesce around a set of constitutive rules whereby something (X) is taken to stand for objective knowledge (Y) in the specific context of systems design (C). Second, the purpose is to critique those approaches to information infrastructures that merely look at data standards and standardisation procedures from a narrow technological angle in order to understand the social context in which information infrastructures are deployed (Avgerou & Madon, 2004). Indeed, technological issues do matter. Yet social and technological issues are deeply entangled as developers and designers alike draw on institutional facts that are enacted and re-enacted in daily work practices. This, in turn, entails that institutional facts and institutional practices are profoundly interrelated because the process of objectification typical of institutional facts derives from the continuous enactment and re-enactment of a set of social practices within a specific context. Yet they refer to two separate facets of institutionalisation, namely the ostensive or cognitive (institutional facts) and the performative aspects (institutional practices).

More specifically, institutional facts are seen as those facts that are ontologically subjective and epistemologically objective because they collectively exist in individuals' (i.e., developers'/users', public officers' and citizens') minds as objective knowledge (Searle, 1995). Hence, there is a sharp distinction between brute facts (X) and institutional facts (Y) as the latter derive from the former by the application of a constitutive rule within

some context C (Fletcher, 2003). For example, in the field of criminal justice in England and Wales, such facts encompass the fact that the police conduct the investigations while the Crown Prosecution Service (CPS) is responsible for prosecuting the criminal cases investigated by the police and that, due to statutory charging, there is now an early and more influential involvement of the CPS in the charging process. Thus, the approach taken here is distinctively Searlian and is grounded on the cultural–cognitive institutional pillar (Scott, 2001) that stresses the importance of constitutive rules in the process of institutionalisation in order to dissect the very background where information infrastructures are cast. If, as it has been widely acknowledged, infrastructures represent the backbone upon which something else operates (Star & Ruhleder, 1996), then the study of the twin concept of information infrastructure is inextricably bound up with an overarching set of institutional facts that are broadly shared within a specific context because such facts create the invisible substrate information in which infrastructures are a part of. Although it is possible to combine regulative, normative and cultural–cognitive approaches to institutions (Scott, 2001) as indeed the cognitive and cultural orientations that institutions embody interlock with ethical, legal and administrative mechanisms that support them (Kallinikos, 2006), in what follows institutions will be conceived as systems of constitutive rules (Searle, 1995) or to put the concept another way as 'crystallizations of meanings in objective form' (Berger & Kellner, 1981, p. 31) to highlight the fact that institutional facts are the building blocks of social institutions. At the same time, the approach taken here diverges from the concept of 'information habitat' (Kallinikos, 2006) to the extent that the latter fails to appreciate the role of institutions in the process of change. Although there is agreement that information requirements drive the development of information infrastructures, technological change can also derive from new institutional arrangements aptly built into information infrastructures.

The remainder of this paper unfolds in the following fashion, the next section introduces the concept of information infrastructures and reviews the literature on the social studies of information infrastructures by looking specifically at those studies that adopt a relational perspective on information infrastructures; the section after that discusses my methodology and in-depth case study. In particular, it emphasises how a recent episode of institutional change has impinged upon the Criminal Justice System Exchange (CJSE), the CJSE being the dominant information infrastructure for the exchange of electronic case files between the police and the CPS in England and Wales. The penultimate section draws the main findings deriving from the case study by highlighting its core theoretical contribution. The last section investigates its practical implications with regard to criminal justice and, more in general, the digital culture underpinning the Internet.

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[1]Note that in England and Wales public prosecutors are referred to as crown prosecutors.

Background: the concept of information infrastructure

In the field of information systems, information infrastructures have received considerable attention in the context of large-scale enterprise systems (Ciborra, 2000), telecommunication networks (Graham, 2000; Shin *et al.*, 2006), technological and human components (Braa *et al.*, 2007) and databases (Bowker, 2005). Despite the burgeoning amount of research being dedicated to this topic, information infrastructures have not yet acquired a univocal connotation. For example, Hanseth & Monteiro (1997) have used the term to refer to integrated solutions based on the ongoing fusion of ICTs such as the National Information Infrastructure. Thus, according to these scholars information infrastructures describe national and global communication networks like the Internet and more specialised solutions for communications within specific business sectors (Hanseth & Monteiro, 1997).

Other scholars, otherwise, have used the term with a more local nuance to refer to technological networks of advanced telecommunication infrastructures for local communities providing them with advanced telecommunication services like broadband and multimedia applications (Graham, 2000; Shin *et al.*, 2006). Yet other scholars have used the term in its broadest sense, meaning the technological and human components, networks, systems and processes that contribute to the functioning of a specific information system (Braa *et al.*, 2007) or argued that information infrastructures involve the development of classification systems that stretch beyond technological platforms to include users' communicative behaviours and taken-for-granted practices (Bowker & Star, 1999; Bowker, 2005). It is in this vein, for example, that information infrastructures have recently been conceived as systems of standardised practices and modes of communication that emerge in relation to a particular set of technical artefacts within organisational boundaries (Gal *et al.*, 2008). Indeed, some scholars have gone as far as claiming that an information infrastructure is fundamentally a relational concept that needs to be defined in relation to situated practices (Star & Ruhleder, 1996).

This paper takes stock of the insights emerging from these different streams of research. In particular, it deploys a relational view of information infrastructures whereby the relationship between the cognitive and technical aspects of information infrastructures are investigated. It also builds on Ciborra's (2000) methodological slant who, after critically investigating the literature on the management of corporate information infrastructures, concluded that one needs to use case study research to understand the variety of *ad hoc*, partial moves that characterise the development of an information infrastructure in context. Drawing on these different research streams, this paper endeavours to study not what an information infrastructure is but rather when it emerges as advocated by Star & Ruhleder (1996). In what follows, the notion of information infrastructure is used to refer to communication networks that link disparate public sector organisations such as the police, the CPS and the magistrates' courts, while the associated practices and modes of communications that provide the context where such information infrastructures are embedded will be labelled as institutional practices.

Social studies of information infrastructures: the relational perspective

Following in the footsteps of Star & Ruhleder (1996), several scholars have endeavoured to emphasise the relational character of information infrastructures (Hanseth & Monteiro, 1997; Hanseth & Monteiro, 1998; Monteiro & Hepsø, 2002; Chae & Poole, 2005; Kallinikos, 2006). Through a series of studies of information infrastructures in the health-care sector, for example, Hanseth & Monteiro (1997) have stressed the distinguishing trait of information infrastructures, namely the diffusion of data standards and their relations to the surrounding actor-networks. By looking at how any given element of an information infrastructure constrains other components, that is, how it inscribes a certain pattern of use, Hanseth & Monteiro (1997) have argued that standards can be 'classified' on the basis of their 'power of inscription': the stronger the inscription, the more the socio-technical network is aligned and the more effective the inscribed programme of action is. Rather than studying the degree to which a (technical) inscription succeeds in enforcing a desired behaviour (Monteiro & Hanseth, 1995; Hanseth & Monteiro, 1997), this paper endeavours to show the role of institutional facts with regard to the design of new standards and logical messages as, in attempting to develop new information systems, designers arguably draw on the institutional aspects of pre-existing systems (Chae & Poole, 2005).

A further insight in the study of the socio-technical nature of information infrastructures comes from Hanseth & Monteiro's (1998) analysis of the relationship between institutionalisation and information infrastructures. Drawing on Jepperson's (1991) notion of institutionalisation as a process whereby a social pattern reveals a particular reproduction process, Hanseth & Monteiro (1998) argue that institutionalised practices and information infrastructures are closely interrelated as the former are inscribed into the latter over long periods of time, thus being mutually adapted to each other into large, convergent actor-networks. Given their recalcitrance to change, Hanseth & Monteiro (1998) suggest four distinct intervention strategies for introducing change in such irreversible actor-networks spanning from backward compatibility to univalent and polyvalent gateways that function as boundary objects between different communities of practices. Although insightful with regard to the themes explored in this paper, Hanseth & Monteiro's (1998) conceptualisation of institutional practices does not account for the fact that such practices are bound to change over time through endogenous or exogenous

mechanisms establishing new conventions for resolving coordination problems (Leblebici *et al.*, 1991).

Monteiro & Hepsø (2002), on their part, have extended the socio-technical perspective of actor-network theory (Callon, 1986; Law, 1992; Latour, 2005) with symbolic and ritual elements. By showing how symbolic, technical and social mechanisms are interrelated in the construction of an orderly information infrastructure, they maintain that designers, managers and users alike privilege standardisation over fragmentation on the basis of taken-for-granted assumptions about the benefits of standardisation vis-à-vis the costs associated with fragmentation. However, in their analysis, they have overlooked the role of sets of constitutive rules of the form 'X counts as Y in context C', (Searle, 1995) which arguably underlie symbolic and ritual elements in the creation of a patterned order.

Drawing on a somewhat similar train of thought, Chae & Poole (2005) have integrated actor-network theory and structuration theory to provide a more fine-grained analysis of how information infrastructures and institutional features interact in the structuring of organisational information systems. By focussing on action and performance, they distinguish three forms of agency (material, human and disciplinary) and contend that, in developing new systems, designers draw on pre-existing information systems broadly construed as techno-institutional ensembles. Chae & Poole's (2005) conceptual framework strikingly mirrors Pentland & Feldman's (2008) concepts of ostensive and performative aspects of organisational routines, the former conceived as abstract ideas/patterns embodied in people's minds, the latter as situated performances. In other words, there seems to be a conceptual overlap between these two groups of scholars' frameworks to the extent that both groups study the relationships between the material aspects of technology, as well as the ostensive and performative aspects of organisational routines, which, according to Chae & Poole's (2005) terminology, should be labelled as disciplinary and human agency, respectively. Yet Chae & Poole's (2005) emphasis on action and performance seems to privilege the performative aspects of the material, structural and human agents involved in the development of large-scale information systems at the expense of their ostensive or cognitive aspects, thus neglecting a deeper understanding of the relationships between the cognitive and technical aspects of information infrastructures. Hence, to frame the issue in K. E. Weick's terms, rather than studying cognition through action, this paper turns Weick's poignant epistemology upside down as it presumes that institutions have a social mind of their own (Douglas, 1987) that affects designers' actions so much so that designers ask themselves 'how can I know what I enact ''till I see what I think?'''

Kallinikos (2006), on the other hand, has drawn on Bateson's relational concept of information (Bateson, 1972) to maintain that the digitisation of the referential reality in general and information items in particular,

that he calls 'technological information', is contributing to the emergence of an 'information habitat', which is entangled, at multiple levels, with other information sources in the broader information space, thus forming a background against which current economic, social and organisational developments take place. However, this paper argues that besides such information requirements, there are broader institutional arrangements at work that are built into information infrastructures in a layered fashion.

Although remarkable, these studies ignore, to a degree, the role that institutional facts play in the development of complex information infrastructures. By investigating the relationship between the ostensive aspects of institutional facts (i.e. abstract ideas or patterns) and technical/digital artefacts (Pentland & Feldman, 2008), this paper discusses, in depth, the emergence of information infrastructures in the public sector. To be sure, Pentland and Feldman's research does not use the qualifier 'ostensive' in respect to institutional facts but with regard to organisational routines though these two scholars acknowledge Searle's (1995) related ideas (Pentland & Feldman, 2005, p. 795). In addition, although these two scholars refer to such ostensive aspects as being often diverse, multiple and conflicting (Pentland & Feldman, 2008, p. 246), I here use the qualifier 'ostensive' with regard to people's embodied and *shared* cognitive understandings because I take issue with their assertion of conflicting ideas or patterns: if designers do not achieve a common idea or understanding of an institutional fact or for that matter a routine, what are they going to inscribe in the technical artefact? In what follows, I maintain that the overwhelming feature of public sector information infrastructures is their embeddedness within their institutional context and that, despite the claims to be more concrete with regard to the specifics of technology (Hanseth & Monteiro, 1997), extant approaches to information infrastructures do not adequately account for the role and influence of institutional facts to the point that they overlook how such facts are built in the technology in a layered fashion.

Methodology
This paper is part of a European-funded project in which six in-depth case studies were conducted across Denmark, England and Wales, Finland, France, Italy and the Netherlands under the AGIS framework. The AGIS programme ran from 2003 until 2007 and replaced earlier projects with the purpose of helping legal practitioners, law enforcement officials and representatives of victim assistance services from the European Union member states and candidate countries to set up Europe-wide networks, as well as to exchange information and best practices, thus enhancing cooperation in criminal matters and in the fight against crime.

The Research Institute on Judicial Systems based within the National Research Council at the University of Bologna operated as the key project coordinator but

several other Universities took part in the project including Aarhus University (Denmark), the London School of Economics (England), Nanterre University (France) and Utrecht Law School (Netherlands). The project lasted for 2 years (2005–2007) and endeavoured to describe, study and compare four specific areas of research concerning: (1) the use of ICTs in case investigations; (2) the use of ICTs for case management; (3) ICT interoperability between public prosecutor's offices, courts, police and prisons; (4) the use of ICTs for sharing prosecutorial information between countries.

Drawing on an interdisciplinary approach that goes beyond the legal literature, the project stressed the need to pursue judicial cooperation in the area of criminal law while fostering mutual knowledge of European legal and judicial systems, as well as best practices and technological solutions. During the project life span, academics and practitioners met for as many as four times in Bologna to draft the interview guides, discuss preliminary research findings in order to develop the unfolding research agenda and validate its core results. The project also led to a conference to disseminate the information collected, to pass on knowledge of immediate use in carrying out professional activities, as well as to increase the number of practitioners, academics and policymakers who would take advantage and profit from the research.

Given the broad remit of the project, this paper specifically focuses on ICT interoperability between crown prosecutors' offices and police. Based on an in-depth, qualitative case study (Benbasat *et al.*, 1987; Eisenhardt, 1989; Yin, 2003) of a recent episode of institutional change, in this paper I endeavour to describe the role that institutional facts play in the development of information infrastructures. Although the AGIS project in question lasted for 2 years, I spent approximately 15 months in the field where I interviewed and re-interviewed CPS and police staff at various locations within London and Humberside with the aim of understanding recent institutional changes impinging on CPS–police interactions. Such locations were specifically selected because the former is where the main CPS headquarters are based while the latter was the first area where the police systems interfaced with the Compass Case Management System (CMS) in use within crown prosecutors' offices. I conducted two focus groups in Humberside, as well as 20 semi-structured interviews for an average of 2 h each and spent a substantial number of days in the CPS headquarters to observe the unfolding of daily tasks and discuss emerging issues with several practitioners. Both interviews and focus groups were digitally recorded and transcribed. An exclusive range of carefully selected practitioners were interviewed and re-interviewed including, among others, members of the Compass Design Authority Team, Business Consultants, District and Duty Prosecutors, Police Officers, as well as Heads of Business Change in charge of the Criminal Justice Information Technology (CJIT) programme. Table 1 outlines my various informants.

My orientation to data collection and analysis was exploratory and iterative as I spent a considerable amount of time reviewing background documentation and observing prosecutors' interactions with police officers in various sites. This allowed for some flexibility in data collection as several themes emerged but only a few were examined more deeply as relevant. In particular, the unit of analysis was the recent introduction of statutory charging that brought about a significant institutional change in police–CPS work practices whereby prosecutors have been granted early charging decisions. I deemed this institutional change worthy of attention as it can be considered an episode of institutionalisation in the making.

Building on Ciborra's (2000) methodological insights, in what follows I interweave data with theory (Kallinikos, 1999) on the assumption that data are never truly 'raw' as they are always subjected to editing and transformation either by man or his instruments (Cf. Bateson, 1972, p. 24). Spurred by these epistemological and ontological insights, I assumed that reality has a non-foundational nature in accordance with the naturalistic paradigm of enquiry (Guba and Lincoln 1996). Thus, rather than formulating a set of hypotheses to be tested against an objective reality 'out there', this paper relies on such qualitative data collection methods as observations, interviews and focus groups in order to gather data from multiple sources and develop converging lines of inquiry (Yin, 2003). As well as triangulation of data sources, this paper relies on informant triangulation as three core informants provided me with the bulk of the empirical material, namely a Duty Prosecutor, a Member of the Compass CMS Design Authority and a Business Consultant. To the extent possible, this approach to data gathering was replicated across sites and when conducting focus groups to cross-check the credibility of the data so collected. Far from being biased, my contextual findings were identified a posteriori because 'one can argue that a posteriori categories are less likely to be biased by the researcher's own fantasies, since the categories tend to emerge from, and remain closer to, the data' (Barley 1990, p. 234). Thus, what follows is an in-depth account of the role that institutional facts play in the development of information infrastructures that is based on a structured dialogue between Searle's (1995) notion of institutional fact and the data provided by various informants where all contextual findings were deeply scrutinised and validated by legal practitioners and business consultants alike.

The technologies in use within the criminal justice system in England and Wales

The CPS is the government department responsible for prosecuting criminal cases investigated by the police in England and Wales. The CPS was established in 1985 by the Prosecution of Offences Act on the basis of a clear separation between the prosecution and investigation

Table 1 List of informants

Role	Date	Duration	Location
Compass CMS design authority team member	24/05/2006	4	CPS Headquarters
Business consultant, compass team	24/05/2006	2	CPS Headquarters
Duty prosecutor	03/07/2006	2	Croydon Police Station
Two Duty prosecutors/One administrator	10/10/2006	4	Charing Cross Police Station
Compass CMS design authority team member	10/10/2006	2	Charing Cross Police Station
Detective constable (DC)	24/10/2006	2	Sutton Police Station
Duty prosecutor	24/10/2006	2	Sutton Police Station
CJIT benefits manager	08/12/2006	2	CPS Headquarters
Business architect	13/12/2006	2	Police Information Technology Organisation
Head of business change (NSPIS custody and case preparation)	14/12/2006	2	Police Information Technology Organisation
Detective inspector, case worker manager, NSPIS administrator and head of information systems (Focus group)	22/01/2007	3	Scunthorpe (Humberside)
District crown prosecutor, CPS performance manager, detective inspectors (Focus group)	22/01/2007	3	Scunthorpe (Humberside)
Compass CMS design authority team member/business consultant	26/03/2007	4	CPS Headquarters
Compass CMS design authority team member	13/04/2007	2	Bologna
Business consultant	13/04/2007	2	Bologna
Duty prosecutor	14/04/2007	2	Bologna
Compass CMS design authority team member	12/10/2007	2	Bologna
Duty prosecutor	12/10/2007	2	Bologna
Business consultant	13/10/2007	2	Bologna

functions, the former being a prerogative of the CPS, the latter falling within the police remit.

The CPS has headquarters in London and York and is structured in 42 geographical areas that map onto the 43 police areas considering that London has two police forces (i.e. the City of London and the Metropolitan police) that count as one prosecuting area. Indeed, the overall government thinking is for a joined-up criminal justice system where probation and court services, as well as police and CPS work alongside each other, thus creating, in effect, 42 locally based criminal justice systems.

The 'joined-up' notion has also permeated the ICT domain of this setting. In the early 1990s, for example, the Integrating Business and Information Systems group was established to bridge the information domains between and among the criminal justice agencies through the creation of intelligent forms or 'i-forms' that allowed for the electronic exchange of basic data. By the same token, the introduction of the Government Secure Intranet, an e-mail system that allowed messages, documents and data to be distributed electronically, while being protected by appropriate levels of security, ensured the interconnection of several tiers of government (Bellamy & Taylor, 1996; Bellamy, 1999; Bromby, 2004).

More recently, the trend toward joined-up management has been dramatically enhanced through an ambitious programme that aims at moving from paper files to electronic case files. Directed by the Modernising Technology Unit, formerly known as CJIT organisation,

as part of the Office for Criminal Justice Reform, this programme has set out three goals: (a) make sure that the criminal justice agencies (i.e. police, CPS, magistrates' courts and crown courts, prison service and probation service, youth justice board) have the ability to communicate securely via e-mail; (b) ensure that all criminal justice agencies have electronic access to shared case file information; (c) deliver a secure portal to enable victims to track their cases on-line.

At the very centre of this programme sits the CJSE, a cross-organisational hub that securely routes messages about prosecution cases from one part of the criminal justice system to the intended recipients (Mitchelhill, 2006), thus working as a routing mechanism that allows for case progression within the criminal justice process and systematic updating of stored case files. At its bare minimum, the CJSE is a messaging system that relies on two components, a messaging framework and a router to allow data sharing. The basic idea is that the police, through their systems, should be able to send their case information to the CJSE, which would route this information both to the CPS and the magistrates' courts. The magistrates' courts, in turn, should send the results of court cases back to the CJSE, which would route them back to the police and update their database, the Police National Computer. This information exchange is outlined in Figure 1.

In Figure 1, the CJSE is represented by the rectangle in the middle. As mentioned above, it securely routes

messages about prosecution cases from one part of the criminal justice system, translates them, and then guarantees delivery to the intended recipient (Mitchelhill, 2006). The police systems, in addition, consist of two applications, Custody and Case Preparation, these applications being part of the National Strategy for Police Information Systems (NSPIS) whereas the magistrates' courts use an application called Libra and the CPS, a CMS called Compass. As described by a Crown Prosecutor, the interaction and interdependencies among these systems can be depicted in this way:

> Once the defendant has been charged, the information on the defendant passes from NSPIS Custody to NSPIS Case Preparation. This information includes data about the defendant, the offence, the date of the first hearing, as well as information about witnesses (Ws), victims (vs), exhibits

Legend
CJSE: Criminal Justice System Exchange
CPS: Crown Prosecution Service
MCs: Magistrates' Courts
NSPIS: National Strategy for Police Information Systems
PNC: Police National Computer

Figure 1   An overview of the CJIT landscape.

and statements. All of that information can then be passed through the CJSE to Compass and a bit of that is also passed to the magistrates' court system (i.e. defendant, offence and the first hearing). After the first hearing and subsequent hearings, the magistrates' courts through their Libra application can pass back to the CJSE the results of that hearing which go to the police system which then uses that information to update their database (Police National Computer). On the other hand, the hearing results are not transferred electronically to Compass as they are recorded on a paper file by the lawyers or caseworkers at court and administrative staff manually enters that information into Compass when they come back to the office (Business Consultant).

This electronic exchange of case files is summarised in the Figure 2.

The successful transmission of electronic case files across the criminal justice agencies' interfaces has required the introduction of appropriate data standards that ensure interoperability between and among different information systems (Iannacci, 2009). In particular, two sets of standards have been adopted in England and Wales: (a) generic, electronic government interoperability framework standards that define generic personal details such as address, national insurance number, etc.; (b) domain-specific standards that are specifically geared to the criminal justice system domain such as the criminal prosecution reference (CPR) number, organisation unit codes, offence codes, result codes and case codes, the CPR number being an alphanumeric number that globally identifies offence-defendant pairs (Criminal Justice System, 2009).

Given this overwhelming trend toward joined-up management (Wastell *et al*., 2004), the question of when
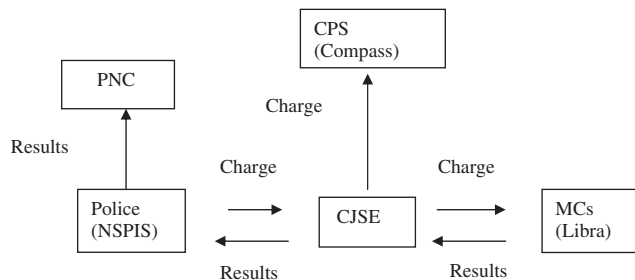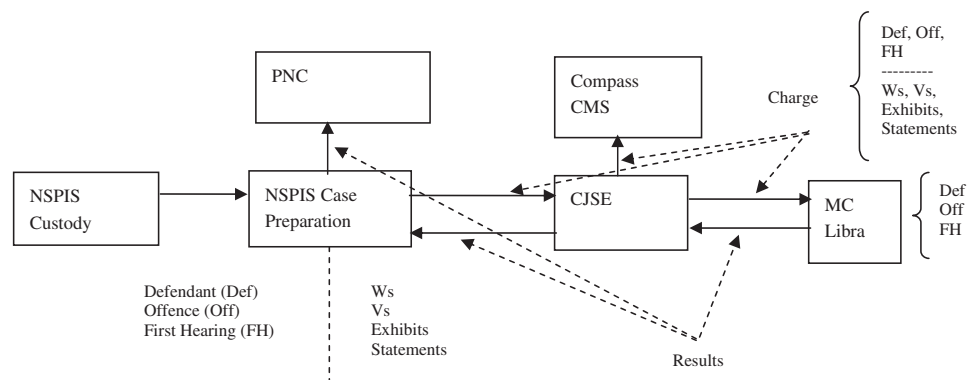
Legend
CJSE= Criminal Justice System Exchange
CMS= Case Management System
Def= Defendant
FH= First Hearing
MC= Magistrates' courts
Off= Offence
PNC= Police National Computer
Ws= Witnesses
Vs= Victims

Figure 2   Outline of the types of files exchanged electronically within the criminal justice system in England and Wales.

not what is an information infrastructure (Star & Ruhleder, 1996; Ciborra, 2007) is raised to understand the links of information infrastructures with institutional facts. The implicit claim developed is that, in public sector projects such as this one, ICTs become information infrastructures in relation to institutional facts.

The emergence of new institutional actors: the duty prosecutor

As it was mentioned above, the applications in use within the criminal justice system rely on the CJSE whereby case information is exchanged between and among several systems. A complex institutional setting acts as a background upon which the CJSE has been cast. For example, to date Compass, the CMS in use within the CPS, has been updated twice a year to account for legislative changes, business changes and user requests. Not only does Compass have to adapt to changes in the institutional environment; the underlying CJSE has to adapt too. The CJSE is therefore struggling to keep up with legislative and procedural changes considering that every time that there is a substantial change in the law or in the organisation of the criminal justice system, the CJSE needs updation.

An illustrative case of the effects of changes in the law and the organisation of the criminal justice system in England and Wales, which have affected the CJSE is the introduction of statutory charging. The CPS now has the responsibility to determine the charge in all but the most simple and straightforward cases as specifically outlined in the Director of Public Prosecutions' Guidance, the Director of Public Prosecutions being the CPS head. Statutory charging was introduced in response to recommendations made by Lord Justice Auld in his 'Review of the Criminal Courts in England and Wales' published in October 2001, which expressly recommended 'earlier and more influential involvement of the CPS in the process to the point where, in all but minor, routine cases or where there is a need for a holding charge, it should determine the charge and initiate the prosecution' (Auld 2001; Chapter 10, Para 44). Legislation introduced in the Criminal Justice Act 2003 made it a legal requirement. The statutory charging scheme is a joint scheme between the CPS and the Association of Chief Police Officers. Statutory charging aims at 'narrowing the justice gap', that is the attrition rate between the total number of offences recorded and the number that results in a person being convicted, cautioned or the offence being taken into consideration. The specific aims of statutory charging may be summarised as follows: the elimination at the earliest opportunity of hopeless cases that represent a fruitless expenditure of resources by the police on enquiries and file preparation and by the CPS on review and consultation, the production of more robust prosecution cases and the elimination of unnecessary or unwarranted delays in the period between charge and disposal (Brownlee, 2004).

Indeed prior to the Auld report, both the Narey and the Glidewell reports attempted to improve the situation by suggesting that CPS lawyers should be permanently located in police administrative support units providing pre-charge advice. Yet the role of the CPS remained essentially overly dependent on early investigative decisions taken by the police. Not only did the police omit any considerations of whether a charge was necessary in the public interest; the police were also undertaking a precautionary approach that often led to choosing the most serious of the charges which, if compounded by delays in obtaining evidence and slow corrective actions by the CPS, could have negative repercussions on the criminal justice system as a whole (Brownlee, 2004).

Statutory charging was first implemented as a pilot in February 2002 at nine locations in five CPS areas across England and Wales. The evaluation of its impacts in terms of discontinuance rates and case progression showed that conviction rates had improved in six of the nine pilot sites and post charge discontinuance and charge reduction rates had fallen in all areas. Despite the fewer charges, detention rates did not fall. Given these positive results, the Attorney General announced that the government intended to bring forward legislation (i.e. the Criminal Justice Act 2003) to effectively transfer from the police to the Director of Public Prosecutions, acting through local crown prosecutors labelled duty prosecutors, the responsibility for deciding whether there is sufficient evidence to charge a detained person in relation to the majority of offences.

In the new system, police custody officers continue to play a key role because they operate as 'gatekeepers' to the new charging scheme. It is the custody officer who must first determine whether there is sufficient evidence to detain a person. It is only when a custody officer decides that there is sufficient evidence to detain that the statutory charging scheme is brought into effect and the case must be referred to a crown prosecutor for a charging decision to be taken. Central to the new scheme is a new power for the Director of Public Prosecutions to issue guidance to custody officers as to how detained persons should be dealt with and as to what the police must do to facilitate CPS decision-making on charging, this guidance being mandatory not advisory (Iannacci, 2008).

As well as formal charging decisions, the Director of Public Prosecutions' Guidance emphasises the importance of early consultations between police investigators and duty prosecutors. Custody officers are required to direct investigating officers to consult a duty prosecutor as soon as is practicable and after a suspect is detained in custody. During these consultations, the prosecutor is expected to identify whether a case is likely to proceed and to advise on lines of enquiry and evidential requirements. Decisions on all charging matters are recorded in writing on an *ad-hoc* form called the 'MG3' form (i.e. Manual of Guidance 3) which contains two

sides: the front side is a 'request for a charging decision' and must be completed by the investigating officer whereas the back side includes the charging decision and must be filled out by the duty prosecutor (Brownlee, 2004).

Crucially, all charging decisions are based on a review of the evidence in a context where the duty prosecutor and the investigating officer meet on a face-to-face basis. The extent of the evidence that needs to be supplied depends on the circumstances of the case. Whenever possible all charging decisions should be based on the full evidential and public interest tests. If there has been a full admission by the detained person, the key witness statements and an oral summary of the interview will suffice. If it is expected that the case will proceed to the crown court or be the subject of a contested summary trial then the prosecutor must be supplied with key evidence, as well as any unused material that might undermine the case and the previous record of the suspect. Should the full evidence not be available, the duty prosecutor will apply the 'threshold test' to make the charging decision. In this particular case, the duty prosecutor must agree an action plan with the investigating officer whereby the latter will gather further evidence by a pre-arranged review date. The 'threshold test' entails a charging decision based on a reasonable suspicion against the suspect of having committed an offence, not a realistic prospect of conviction (i.e. sufficiency of evidence) (Brownlee, 2004). Whenever the 'threshold test' is applied, a specific date must be agreed between the duty prosecutor and the investigating officer for a review of the case in accordance with the full code tests (i.e. sufficiency of evidence and public interest), these tests setting out the general criteria to regulate the discretion of crown prosecutors.

Institutional change and CJSE evolution

All these changes have deeply impacted the CJSE that acts as a backbone for the information exchange among the criminal justice system agencies. After all the duty prosecutor (X) *is* a new institutional actor (Y) that, within the prosecution context (C), is granted early charging decisions on the basis of collective assumptions, premises and expectations (Berger & Luckmann, 1967; Searle, 1995) inscribed in the rule of law. My data suggest that the CJSE has been affected by these institutional changes. Before statutory charging was introduced, the police had to send charge information to crown prosecutors who could only decide whether to prosecute or dismiss the case. The police were sending the charge from the NSPIS systems where the evidence was first collected to Compass. Due to statutory charging, the police now have to coordinate the charging decision with crown prosecutors. This has created the need for a bi-lateral exchange of information between NSPIS and Compass. To allow for this exchange of information, the underlying messaging system has been transformed from a system where only the police were sending charging information to a

two-way system where the information is being exchanged from/to the police to/from crown prosecutors. Duty prosecutors now need evidential material at a much earlier stage as they are involved in the charging process at the initial stages of the investigation. A new version of the link between Compass and the NSPIS systems has therefore been designed to pivot around three 'charging messages' that reflect the newly introduced statutory charging scheme:

> The first message, called 'charging message one or CM01' is the request from the police to the CPS for a charging decision which basically contains the information about who the suspect is, the unique reference number in the case, the reason for the arrest and all the other bits and pieces of information included on the MG3 form. Should the police want to send some case material at the same time that they are requesting a charging decision, they can use the existing logical messages from the interface. When the CPS duty prosecutor receives the request for a charging decision and does the work that is necessary within Compass, he/she can then send a response back to the police using 'CM02 or charging message 2' and that, at a very simple level, might just be something that says 'charge the defendant or the suspect with the following offence' or 'no further action (NFA)' or 'further investigation'. Then, within the life of a case, if the CPS response is 'further investigation', an action plan will be agreed between the (investigating) officer in the case and the duty prosecutor so that, at the end of the investigation, the police will come back to the CPS with another CM01 (or request for a charging decision). The CPS will give a response back again using CM02 (i.e. charge or further investigation or NFA). Eventually, when the defendant or suspect is charged with an offence, the final message that the police will send will be 'charging message 3 or CM03' which confirms the details of who the suspect is, what the offences the suspect has been charged with are and when the first hearing will take place (Compass Design Authority Team Member).

The design of this new messaging system is a response to the procedural change caused by statutory charging. The introduction of the duty prosecutor brought about a change in work practices, which drastically modified the information flows that have to be supported by the CJSE. The CJSE was originally designed to allow for information flows between and among different police–crown prosecutors' offices that pursue sequential tasks (Thompson, 1967). Now, due to statutory charging, the CJSE had to be redesigned to reflect the need for the reciprocal exchange of information between the police and the CPS. Figure 3 depicts this reciprocal exchange of information between the NSPIS applications and the Compass CMS where the CJSE messaging framework is made up of existing and new logical messages (i.e. CM01, CM02, CM03) allowing for the bi-lateral exchange of digital information between police (NSPIS) and CPS (Compass CMS).

Ultimately, since information infrastructures like the CJSE are deeply entangled within institutional practices, their design and evolution is highly dependent on the institutional context where they are cast.
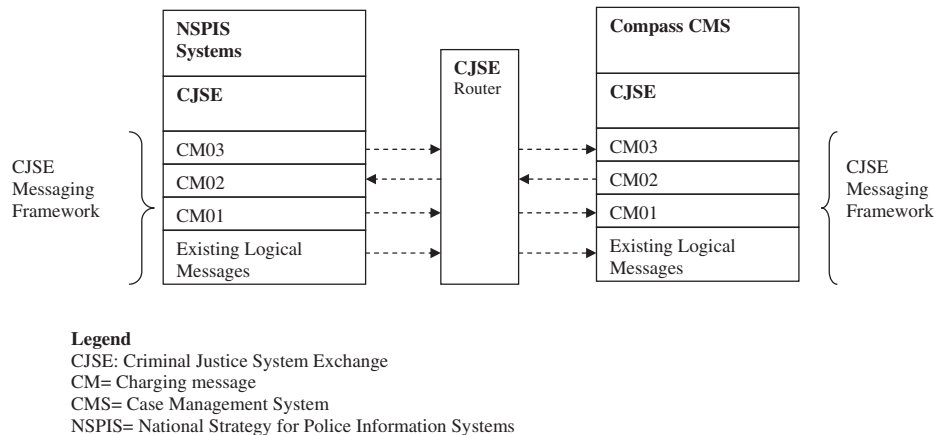
Legend
CJSE: Criminal Justice System Exchange
CM= Charging message
CMS= Case Management System
NSPIS= National Strategy for Police Information Systems

Figure 3 The evolution of the CJSE messaging framework.

Contextual findings

This paper contributes to the extant literature on information systems, in that it endeavours to explain the role that institutional facts play in the development of information infrastructures in public sector projects. Theoretically, even though previous approaches to information infrastructures emphasise the interplay between socio-technical factors, they seem to be too focused on the technical dimension of the installed base at the expense of the institutional installed base (Lanzara, 2009a). When work practices and organisational routines are accounted for, there is very little, if any, reference to institutional facts.

Far from being negligible, institutional facts play a conspicuous role with regard to the design of new data standards and messaging systems in the public sector because, as it was argued throughout, such systems are deeply embedded within a broader institutional context. In my view, what is missing in recent accounts of information infrastructures is the fact that, although there is a widespread acknowledgement that data standards underpin communication networks, there are a host of institutional facts at play that are entangled (Orlikowski & Scott, 2008) within such standards in one way or another. Such facts correspond to iterative sets of constitutive rules of the form 'X count as Y in context C', (Searle, 1995) which are built in the technology in a layered fashion.

Take, for instance, the new institutional figure of the duty prosecutor outlined in the previous sections. The duty prosecutor (X) counts as someone who can make early charging decisions (Y) in a new legislative context (C) fostered by the Criminal Justice Act 2003. These early charging decisions, in turn, translate into three different possibilities whereby duty prosecutors can either charge a suspect or require further investigation or dismiss the case by declaring no further action. Thus, charging a suspect in this new institutional context (X) counts as starting a first hearing in the magistrates' courts (Y) and possibly a trial. By the same token, requiring further

investigation (X) counts as starting new and joined lines of enquiry with investigating officers (Y) with regard to the case at hand. Similarly, declaring no further action (X) counts as dismissing the case (Y) in the early stages of the investigation so as to save investigation costs. It is my contention that such iterative sets of constitutive rules are entangled in the technology in a layered fashion as the CJSE features three distinct logical messages whose data structures mirror such constitutive rules. Put differently, each 'charging message' corresponds to a specific constitutive rule of the type 'X counts as Y in context C'. Since such constitutive rules are iterative, they are bound to reproduce themselves by transforming a previous 'Y' into a new 'X'. But this entails a transformation in the associated logical message so as to produce iterative entanglements between social (institutional) and technical standards considering that each logical message is formatted into XML schemas.

Such iterative entanglements resemble, to a degree, the concept of technological embeddedness recently introduced in the literature (Volkoff et al., 2007). While technological embeddedness has been used to describe the way in which technology introduces a material aspect to organisational practices, the notion of iterative entanglement is specifically associated with the ontological and epistemological aspects of institutional facts as it encompasses collectively shared, objective knowledge that is embedded in technical standards through written descriptors (i.e. data structures, elements and items or attributes). Although some scholars argue that shared mind-sets do not become physically embedded in the technology (Volkoff et al., 2007, p. 833), I claim that such shared cognitive understandings embodied in designers' minds (i.e. institutional facts) explain the emergence of information infrastructures as, in public sector ICT projects, communication networks are bound to emerge and re-emerge whenever constitutive rules forming the 'general structural features of human culture' (Searle, 1995, p. 3) are drawn upon by designers and painted as data standards. Figure 4 outlines this set of iterative
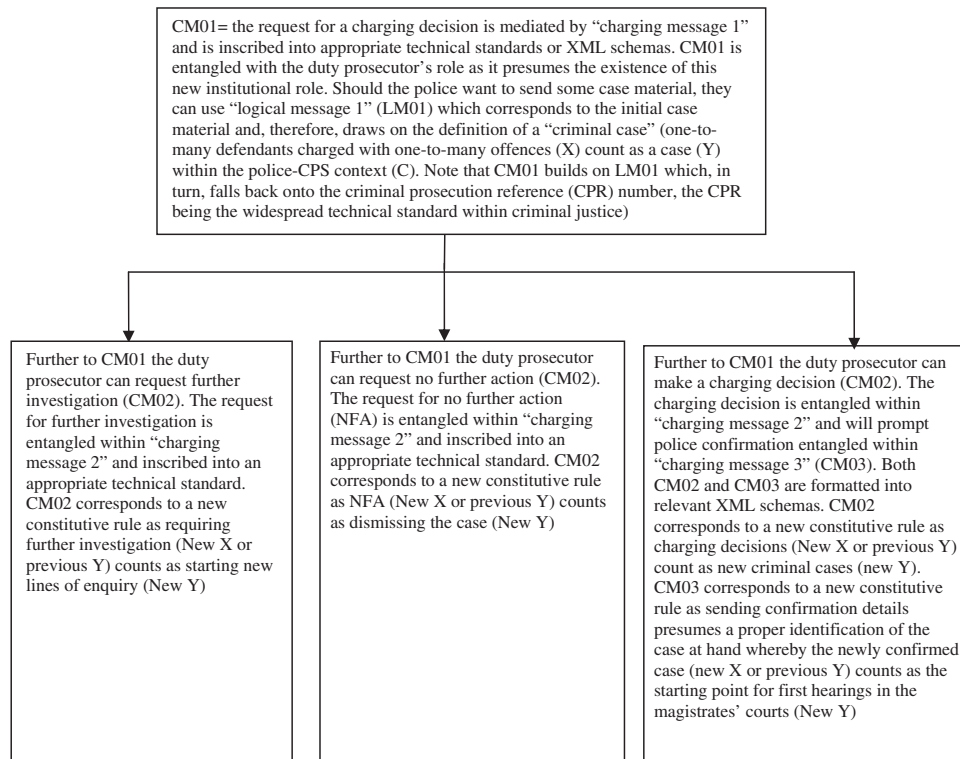
CM01= the request for a charging decision is mediated by "charging message 1" and is inscribed into appropriate technical standards or XML schemas. CM01 is entangled with the duty prosecutor's role as it presumes the existence of this new institutional role. Should the police want to send some case material, they can use "logical message 1" (LM01) which corresponds to the initial case material and, therefore, draws on the definition of a "criminal case" (one-to-many defendants charged with one-to-many offences (X) count as a case (Y) within the police-CPS context (C). Note that CM01 builds on LM01 which, in turn, falls back onto the criminal prosecution reference (CPR) number, the CPR being the widespread technical standard within criminal justice)

Further to CM01 the duty prosecutor can request further investigation (CM02). The request for further investigation is entangled within "charging message 2" and inscribed into an appropriate technical standard. CM02 corresponds to a new constitutive rule as requiring further investigation (New X or previous Y) counts as starting new lines of enquiry (New Y)

Further to CM01 the duty prosecutor can request no further action (CM02). The request for no further action (NFA) is entangled within "charging message 2" and inscribed into an appropriate technical standard. CM02 corresponds to a new constitutive rule as NFA (New X or previous Y) counts as dismissing the case (New Y)

Further to CM01 the duty prosecutor can make a charging decision (CM02). The charging decision is entangled within "charging message 2" and will prompt police confirmation entangled within "charging message 3" (CM03). Both CM02 and CM03 are formatted into relevant XML schemas. CM02 corresponds to a new constitutive rule as charging decisions (New X or previous Y) count as new criminal cases (new Y). CM03 corresponds to a new constitutive rule as sending confirmation details presumes a proper identification of the case at hand whereby the newly confirmed case (new X or previous Y) counts as the starting point for first hearings in the magistrates' courts (New Y)

Figure 4 The iterative structure of techno-institutional entanglements.

techno-institutional entanglements where technological and social/institutional aspects are conflated during the design process on the basis of generic, first-order data standards (i.e. CM01) and more fine-grained, specific data standards (i.e. CM02 and CM03).

In Figure 4, I am referring to logical messages in general and charging messages in particular as data standards to emphasise the fact that they mediate the electronic exchange of structured data between and among different systems. I conceive of them as means of inscribing and transmitting messages about social or institutional processes (i.e. carriers) while the associated XML schemas represent the (technical) format such messages assume. In other words, such messages may be conceived as cognitive bridges between the institutional and technical realm because they involve a re-arrangement of institutional practices through electronic and symbolic means (Lanzara, 2009b).

In paraphrasing Orlikowski & Scott (2008, p. 468), part of the problem in discussing this perspective derives from the fact that 'our language makes it difficult to express indissolubility. We are used to dividing, separating and distinguishing. Thus, even terms such as mutual constitution, entanglement, assemblage and relationality allude to separateness, even as we try to move beyond it'. In using the notion of entanglement, therefore, the attempt is to point to the indissoluble assemblage between technical and institutional standards where the distinction between the technical and the institutional domain is made only for analytical purposes to better appreciate how institutional practices are re-arranged into technical standards.

This paper shows how institutional facts are entangled with data standards through iterative sets of constitutive rules. Although recent accounts of information infrastructures have acknowledged the role of pre-existing social institutions in the development of large-scale information systems (Chae & Poole, 2005), they have failed to explain how social institutions map onto corresponding technical artefacts into a layered patchwork of inter-tangled components. Ultimately, the iterative nature of institutional facts accounts for the hierarchical structure of information infrastructures whereby standards established at one level can serve as the basis for standards at a higher level.

Conclusions

Admittedly, this paper has focused on a rather narrow set of institutional facts. Undoubtedly, in the development of information infrastructures, designers appropriate a broader array of institutional facts ranging from programming languages to context-specific norms that have not been investigated in the present study. To a degree, this oversight reflects the fact that the focus of this paper has been the analysis of those institutional facts that are shared not only by designers but users, public sector

officers and citizens alike that account for the emergence of information infrastructures.

The cognitive–cultural approach deployed in this paper is a fruitful way of investigating information infrastructures because it prompts scholars and practitioners alike to think of them as a grammar that underpins successful communication between and among disparate systems. If an information infrastructure may be conceived as a grammar, then it follows that this grammar encompasses both syntactic rules and principles of representation (Cf. The Oxford English Dictionary). Although the impact of programming languages and communication contexts has been thoroughly dissected in the literature (Star & Ruhleder, 1996; Chae & Poole, 2005), this paper argues that, besides pre-existing 'syntactic rules' corresponding, metaphorically speaking, to the rules informing programming languages and modes of communication, there are also principles of representation in action that relate syntax with social context. In the case study presented above, such principles of representation were labelled as constitutive rules to refer to the rules of representation whereby something (X) stands for objective knowledge (Y) in a specific socio-cultural context (C). This implies that besides the technical level of software, information infrastructures should first and foremost be conceived at the social level of institutions. Indeed, the very emergence of public sector information infrastructures occurs whenever designers draw on relevant institutional facts to share a specific feature of social reality and then inscribe it into technical standards. But what are the implications of this argument?

If technical and social (institutional) standards are mutually entangled, as it has been claimed throughout, the design of information infrastructures cannot take place in a vacuum but needs to take into consideration the institutional context where information infrastructures are cast. This not only entails designers who are proficient in the language of institutions such as, for example, members of the Compass Design Authority Team who are former crown prosecutors; it also implies policymakers who understand the language of technology as policymakers and politicians alike need to become cognisant of technology life cycles and plan accordingly. Thus, the growing entanglement between social (institutional) and technical standards is bound to create a situation whereby the life cycles of each is driven by the life cycle of the other so much so that we might witness instances of technology-enabled policymaking whereby the policy and process aspects of new legislation need to be more clearly and fully aligned with technology life cycles.

As well as entailing the parallel development of policymaking and technology life cycles, the notion of entanglement has a more probing implication in terms of design. Although Ciborra & Lanzara (1994) claim that design should be conceived as a context-making intervention, this paper argues that in its early stages the design of electronic communication systems in general

and information infrastructures in particular should be envisaged as a context-taking endeavour (Boland & Tensaki, 1995). Obviously, once designed information infrastructures create the very (formative) context where social and institutional practices unfold. Yet the very emergence of information infrastructures may be described as a context-taking activity whereby designers draw on shared and objectified knowledge to create common standards. Indeed in the case study depicted above, the change in the information infrastructure did not take place when the legislator enacted a new piece of legislation (i.e. the Criminal Justice Act 2003). The CJSE re-emerged as a new, bi-lateral information infrastructure when police officers and prosecutors alike perceived the duty prosecutor as a new institutional actor whom early charging decisions were granted. I submit that this change in perspective originated new institutional practices that accounted for the emergence of a new information infrastructure. It is my contention that drawing on such objectified facts not only entails the emergence of a common set of data standards whereby tacit knowledge is being externalised through such boundary objects as data dictionaries encompassing data structures, elements and items (the very stuff information infrastructures are made up of from a technical perspective). The establishment of a common grammar for communication and sense-making, broadly referred to as the conduit model of communication by Boland & Tensaki (1995), is a fundamental pre-requisite for successful coordination between and among disparate agencies and/or actors whose different practices and cosmologies would otherwise stymie joined-up collaboration.

Although qualitative research strives for analytical rather than statistical generalisations (Yin, 2003), the argument developed in this paper spans beyond criminal justice to encompass both universal service infrastructures and industry-wide interchange protocols (Cf. Hanseth & Lyytinen, 2006, p. 13). If one were to explore the design of the Internet, which according to Hanseth & Lyytinen (2006) is the archetype of a universal service infrastructure, he/she would acknowledge that the Internet originated because of the rapid emergence of widespread technical standards (i.e. TCP/IP protocols). The Internet, extranets and intranets, are all variants on exactly the same thing: a set of lowest common transmission and presentation protocols that designers drew upon because of the principle of 'good enough' (Evan & Wurster, 2000). In other words, a set of interconnected networks became the Internet when designers embodied the TCP/IP protocol as their *de facto* standard (Abbate, 2000, p. 205) on the basis of an agreed convention whereby there is no qualitative difference between transportation and content standards (Evans & Wurster, 2000, p. 33). More formally, in the language used in this paper, the TCP/IP protocol (X) counted as the standardised transmission medium (Y) but this standardised medium (new X or previous Y) counted as the basis for higher-level content/presentation standards (New Y)

in the context of developing interconnected information networks (C).

The argument developed in this paper entails a more insightful implication. So far scholars from across the board have urged us to consider the relationships between the material, the structural and the social (Chae & Poole, 2005; Volkoff et al., 2007; Orlikowski & Scott, 2008). It is in this vein, for example, that Chae & Poole (2005, pp. 23–24) have argued that 'human agents act through appropriating structural features of existing machines and disciplines, which in turn introduce material, disciplinary, and embedded human agency into the process'. By the same token, Volkoff et al. (2007) have drawn on Pentland & Feldman's (2005) work to explain the process of organisational change as a three-stage cycle in which the ostensive, performative and material aspects of organisational elements interact with each other. Similarly, Orlikowski & Scott (2008) have argued that contemporary organisational practices should be portrayed as multiple, emergent and dynamic socio-material configurations characterised by an inherent inseparability between the material and the social.

This paper questions these scholars' plea to study the material world because, in the digital domain, the flow of information is vastly unravelled from the flow of physical things (Evans & Wurster, 2000). When content is digitised, as it is happening with the dawn of the Internet era, the traditional link between the physical transmission medium and the message is broken as digital standards become the medium of transmission of higher-level content standards (Evans & Wurster, 2000). Some scholars have conveyed this concept in a more sophisticated fashion by labelling it as 'the computational rendition of reality' to refer to the increasing

digitisation and informatisation of tasks, operations and domains of activity, leading to the dissolvability and decomposability of human work in organisations, and, at the extreme, to the 'pulverization' of what we assume to be the material reality (Kallinikos, 2006). From the argument developed in this paper, one fruitful way to study the flow of information is to investigate the techno-institutional standards that underpin such a flow which, as it has been argued throughout, are deeply entangled with each other through iterative sets of constitutive rules embedded in designers' minds. Thus, to the extent that the law of requisite variety holds in the digital realm, these sets of constitutive rules work as cognitive building blocks that designers, developers and users alike draw upon to develop digital standards. Clearly the possible mismatch between institutional facts espoused within a software development context and the rules of law can and will trigger a host of clashes between legal and illegal practices whose solution will lay the foundation for a new digital culture. Ultimately, when 'brute facts' consist of digital standards rather than physical carriers, there are overwhelming implications because their dynamics are utterly different considering that digitised information items can be reproduced at virtually zero marginal costs, thus enabling gift-like exchanges that challenge conventional transactions embedded within markets and firms as we are witnessing with the licensing agreements in the open source software development context and the peer-to-peer model in the music industry. Thus, we might well be observing the rise of the institution of the 'gift' as a substitute for the institution of the contract in the digital economy. Little wonder that gift-like exchanges call for new types of transactions falling under the still uncharted network umbrella.

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