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TECHNOLOGY and ORGANIZATION: Strategic Intersections and Asymptotes

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ABSTRACT

Although it is commonly assumed or hoped that information systems can be aligned or matched with organizational needs, notions of match, alignment and fit are poorly defined. Nor is the hoped for alignment apparently happening. We argue that it is not in general possible to state an organizational need and then proceed to match it with a suitable technical arrangement. We see needs and technology as co-emergent, and mediated through possibilities. Needs do influence technological development, but those developments, from the very beginning; open up new possibilities, which in turn begin to be re-articulated as needs. Further, technological developments are not purely needs driven, but may open up new organizational horizons, and so begin to generate needs autonomously. We illustrate our argument with a case study of the introduction of new biometric technology into a police department

INTRODUCTION

The idea that computer-based information systems ought somehow to 'fit' their organizational context, or match organizational needs, meets with general accord as evidently desirable. In evolutionary models of information systems growth in organizations, such as Nolan's (Nolan 1979), a 'mature' stage of evolution is envisaged in which IT/IS strategy becomes aligned with or integrated into corporate strategy, and IS developments and investments become prioritized in accordance with their relevance to key business objectives. This desirable endpoint seems however never to be reached, nor is there any indication of it coming nearer. Is this because of some temporary turbulence in the technology or in organizational economies? Is it rather a deeper problem, caused by the restless and intertwining dynamisms of technological change and organizational change, which will always prevent any final alignment, but nevertheless allow approximations to it? Or is there a mistake in the notion that organization and technology can be matched or fitted together in the first place?

We incline in this paper most closely to the latter view, on the grounds that the idea of what would constitute a match never stands still, but itself evolves as organizations move into new areas of activity and new uses of technology. This is not to declare that attempts to establish requirements, needs, or priorities before embarking on a project of technological change are futile; such attempts are generally essential to provide structure to a programme of work and grounds for commitment of resources. But it is to say that the matching of information systems to organizational needs can never be achieved in any final sense, not principally because needs are always plural, contentious and shifting - though they are - but more fundamentally because the impacts of technological change can never be fully appreciated except through use of the new systems, and out of that very use new avenues of possibility will open and new desires emerge.

This paper is divided into two main sections. The first provides some conceptual analysis of ideas of match or fit between information systems and their organizational contexts. It starts from a useful analysis and review by Iivari, and picks up from him the call for an approach to the subject that is more processual than structural.

Scarbrough and Corbett's model of the technology process and Friedman's model of computer systems evolution are then used together to lay the groundwork for an argument that organizational and technological change are complex, continuous, interacting processes, occurring at all levels and in all areas of organizations. They cannot be effectively driven from one point, and therefore any match that can be achieved between an information system and its organizational context will be partial and temporary (but may still be worthwhile).

The ideas developed in this analysis will then be applied in the second section to a case study, where we discuss the implementation of a system for fingerprint identification (AFIS - Automated Fingerprint Identification System) in the fingerprint unit of a police department. The 'organizational need' in this case is at first glance straightforward and unremarkable - to continue fingerprint identification work, if possible with gains in efficiency and hit rate; but the new technology turns out to open up organizational possibilities. Our analysis shows how its impact was more revolutionary than consolidating, highlighting the danger of assuming the existence of a point in time when organizational needs and information systems will align or fit.

TECHNOLOGY, NEEDS, AND POSSIBILITIES

In his analysis of the concept of the organizational fit of information systems, Iivari points out that it has been used in IS research in an imprecise, 'pre-theoretical' manner (Iivari 1992). He sees the notion of fit as fundamental to contingency theories of information systems, and uses it as a general structural concept, to be distinguished from notions of user-system fit prevalent in the area of human-computer interaction and drawn from a psychological tradition (as used for instance by (Mumford 1995, p35) in her treatment of job satisfaction 'fits' in the ETHICS methodology). Iivari regards the high-level concept of fit as still viable, despite a meta-theoretical attack on contingency theory in general and the concept of fit in particular from Weill and Olson.

Iivari identifies three main interpretations of the concept of fit in contingency theory, a *selection* approach (which has been dominant), an *interaction* approach, and a *systems approach.* In the first of these, the fit of information systems to organizational context is deemed to be achieved by selection - either managerial or natural selection. Interaction approaches interpret fit as being achieved when specific IS are judged to support specific organizational activities sufficiently well to meet stated performance or conformance criteria. A systems interpretation sees fit in terms of the degree of consistency obtained between the set of IS on the one side and multiple prevailing contingencies on the other. He wants to see some unification of the research traditions behind these approaches, and more development of the interaction and (especially) systems approaches. He also wants to build links between three areas of research - research into information systems as such, into IS impacts, and into IS adoption - emphasizing the need for longitudinal studies and for empirical investigation of actual impacts and adoption processes. Iivari's move towards research into process (rather than structure) is interesting, although it may jeopardize the primacy of the notion of fit if it becomes a goal for a process (since the goal may shift as the process unfolds).

Scarbrough and Corbett offer a processual model of technological innovation in organizations, which treads a middle way between technological determinism and managerial determinism (Scarbrough and Corbett 1992). They propose a cyclical/reciprocal model of the technology process (see p 9), in which the three phases of the technology process - invention, exchange, and use - influence one another reciprocally (i.e., invention can be triggered from exchange, and exchange from use). One round of innovation sets off the next (use stimulates further invention). Social and technical structures, skills and knowledge, all flow (and are all fluid) within the cycle. Scarbrough and Corbett go on to argue that organizations can also be beneficially seen as processes rather than structures, and further that, in an organization, organizing and technological processes shape and reflect one another.

The Scarbrough and Corbett model provides a base for understanding change and innovation in an organization as a complex, continuous, plural, and multi-level process: invention can occur anywhere, and can be procedural as well as technical; social forms will emerge in the course of the development and use of some new artefact, method, or system; and new knowledge, skill, and expertise will accumulate in the areas of innovation. Invention will not spring out of a vacuum, but emerge out of consideration of possibilities in particular contexts, where these contexts have themselves been shaped by previous inventions, developments, and uses.

Scarbrough and Corbett acknowledge (pp 101-102) that technological change is often more acceptable to a workforce than changes in work organization or working practices. The

reasons are complex, but have to do with the perception of technological change as progressive, concrete, familiar, and representing confidence in the future, contrasted with a view of organizational change as destabilizing. Despite its increasingly pervasive impact on organizational and social life, information technology is apparently regarded as unthreatening, still 'just a tool'. The implication of this point for the present argument is that whereas debate about organizational change is liable to be conservative, cautious and perhaps closed, technological change will be more readily accepted and introduced. Far from producing any matching of information systems to organizational need, this will tend to produce a current of technological change always running ahead of the articulation of needs.

Friedman's model of computer systems development (Friedman and Cornford 1989) is also processual, and at once more general and more specific than Scarbrough and Corbett's. It is more specific in concentrating particularly on computer/information systems evolution, and more general in being pitched at the level of whole sectors of economies rather than at the level of organizations. Friedman tries to unify three different strands of explanation of computer systems growth - organizational stages approaches (like Nolan's), technological explanations (hardware/software generations), and labour process approaches (tracing the evolution of forms of work with computers). His key unifying motif is that of *constraint*: the evolution of computer systems is driven forward by the mobilization of resources to overcome constraining factors which presently limit further development of computer systems. He shows a general progression through successive phases in which first hardware constraints, then software constraints, and subsequently user relations and interorganizational constraints come to the forefront as primary problem areas. Resources and effort are concentrated on solving or ameliorating the immediate difficulties, and once some progress has been made, this problem area begins to subside and a new one, formerly less urgent, comes to the fore.

Friedman's account adds linear momentum to the cyclical model of Scarbrough and Corbett (creating a helical or spiralling movement overall), and shows more precisely how technological progress, work organization, and management action, while remaining partly autonomous one from another, interweave to address pressing problems and open up new possibilities. The same general forces and initiatives are at work in all organizations, and produce similar and communicable results (accelerating the overall change process), but never identical ones.

These processual analyses can be used to explode the entrenched but by now outmoded pyramidal model of organizations, which sees management as layered into strategic, tactical, and operational levels, and significant decisions and innovations as always issuing from the strategic apex and cascading down. This model is inadequate, and can explain neither the richness nor the potential of organizations. It is mistaken in assuming an upward gradient of complexity from base to apex and in using that both to justify status and power differentials and to expect comprehensive and coherent strategy formulation at the top. In reality, complexity and the skill and expertise needed to deal with it are found at every level. Strategy is needed everywhere. If strategy formulation is the preserve of the organizational apex, and denied or unrecognized elsewhere, the organization will most likely have no strategy, since that which passes for it, issued from the top as edict or mission, will be untranslatable at operational levels.

The Scarbrough and Corbett and Friedman models allow us to see that any hope of an effective strategy for technological change in organizations will only come from sharing of

knowledge (and of power) across levels and areas in an organization (and across organizational boundaries). Since this sharing can never be complete or final, every strategy will be provisional. For the same reasons, any matching of information systems to their organizational context can only ever be partial and temporary (but is still worth striving for): the dreamed-of perfect match is indefinitely postponed.

To work at all, 'matching' must be a continuous constructive process, conducted plurally, rather than seen as the achievement of what Scarbrough and Corbett (1992) call closure or the arrival at a fixed point in time (Paul 1994). This means participative development at the application level, at the departmental level, and at the organization-wide level (for both internal and external integration). All developments need multi-level involvement, to spread knowledge and retain coherence. Development projects must be extended in both directions to encompass the phases of invention and use. There will never be enough time or energy to accomplish this completely. It can nevertheless be effective and successful within its limits - which may make all the difference between organizational success and failure.

CASE STUDY

This research was initiated by an invitation from a Chief of Detectives to study the emerging impacts on work practice and expertise of the introduction of a new information system to assist fingerprint identification: the need for a study into impacts was thus perceived within the police department itself. The software is AFIS (Automated Fingerprint Identification System). The AFIS specification was prepared centrally by the government and put out to tender. The contract included not only delivery of the software but establishment and operation of a national fingerprint database and identification system. The specification was very tight on delivery times and fingerprint matching capabilities. The software was supplied a company specializing in a range of engineering application areas.

The case follows the chronological sequence of events and is preceded by a brief explanation of the evolution of fingerprint work to date in order to provide a context for the case analysis and discussion that follow in later sections.

FINGERPRINT WORK

The need for and purpose of fingerprint identification work are scarcely questioned. Other biometric identification techniques, especially DNA matching, are increasingly important, but the absence of a substantial national database currently limits its ability to identify an unknown offender. Fingerprint identification work has been around for a long time (see Cherrill 1954), its methods and practices have matured, and its effectiveness is universally recognized. It is securely underpinned by anatomical theory, and identifications made by fingerprint technicians are almost never challenged in the courts. There is no significant new organizational need visible here, only a need to continue the work, maintain standards, and if possible improve efficiency and identification rates.

The basic task in fingerprint identification work is to identify a fingerprint obtained at a crime scene (a latent 'mark') as belonging to a particular individual, on the basis of a comparison with prints obtained from that individual (usually a set of ten - a 'tenprint'). Since a person's fingerprints are unique and persist throughout life, if a mark can be matched to a person's

fingerprints that will provide conclusive evidence that that person left that mark. The method of matching is precise, and to become expert at it requires long training. Fingerprint technicians acquire expert status when they reach a level of performance in which they make no false identifications and miss no or very few true identifications. The basic method involves visual matching of two fingerprints, using the naked eye, a magnifying glass, a magnifying screen called a comparator, or a computer display screen. The expert looks for specific characteristics in the skin ridges on the fingertips, particularly for ridge endings and for ridge bifurcations. A number of patterns commonly recur in fingerprints, such as loops, arches, whorls, and pockets, and these usually feature a central area (a 'core') and a peripheral area, where ridges diverge to flow round the pattern (a 'delta'). Experts use these patterns, and cores and deltas, in initial orientation and classification of prints, prior to detailed comparison. To establish a match between two fingerprints, the expert needs to find the same characteristics occurring in both prints, in the same sequence and spacing (i.e., same number of intervening ridges between one characteristic and the next). According to the current standards operating in this country, finding a matching sequence of characteristics in two prints is sufficient to judge them identical.

This is painstaking work, but fairly straightforward if we already have two prints we want to compare. If we have a mark but no suspect, how can we begin to look for a match among the thousands of sets of prints we may have filed in the local region, or the millions in the national fingerprint collection? Two chief methods have been used in the past to narrow down the searching process: one has been to keep 'bundles' of prints belonging to criminals active locally, and search them first; the other has been to classify prints on the basis of the primary pattern (loop, whorl, etc), store the fingerprint collection in classification order, and restrict a search on a mark to those prints falling in the same class. A comprehensive classification scheme called the Henry System was used for a century. Until the mid 1990s the Henry scheme was used to search a local mark against the national fingerprint collection. However, coding prints using the Henry classification is a time-consuming business, and fell into disuse in the mid-1990s, at which time local fingerprint collections were rearranged from Henry classification order into alphabetic order, thus becoming unsuitable for 'cold' searches (i.e., where no suspect is known).

This produced a problem, since the likelihood of an identification being made on a mark where there is no suspect, unless it could be matched in one of the 'bundles', was remote. This was the main difficulty that produced a need for an information system to support cold searching of marks against a tenprint collection. Some computer systems in use before the introduction of AFIS such as AFR (Automatic Fingerprint Recognition) systems were of some use in this regard, but required restriction of the search at the outset, and produced an unranked set of candidate matches, so requiring considerable subsequent comparison work which often did not produce an identification.

Many such AFR systems had been abandoned before the introduction of AFIS technologies, not principally because of their poor performance but because reallocation of district boundaries and codes made necessary to re-engineer them so substantially that was not worth undertaking when a new technology (AFIS) was known to be about to be available for piloting. AFIS thus appeared on the horizon at a timely moment: it was not so much that AFIS was the answer to a precise new organizational need, but that AFIS became available and looked promising at the moment when another system, which had been meeting the need for cold searching - though not very well - became possible to abandon for organizational reasons.

AFIS

AFIS consists of a central system; fingerprint unit front-end systems; an integrated communications system connecting the central system to the unit systems; training systems; and a test and development system. AFIS utilizes a secure national network to carry data between the central site and the police departments.

AFIS technologies move towards the government ideal of integrated or 'joined up' criminal justice. Success stories already abound: for instance, "…in January 2000, police stopped a driver for not wearing a seat belt and took him into custody when they suspected him of providing false details. A national AFIS search confirmed his true identity within 10 minutes and further checks revealed that the man had been wanted in connection with a $11million commercial robbery since 1996"(Leith 2000).

AFIS is one of the biggest image storage systems and hold hundreds of millions of images and million scenes of crime (latent) marks. Its search speed is one million fingerprint comparisons per second. AFIS architectures are designed to provide a foundation for future growth and technology insertion. State of the art AFR technology, improved workflow capabilities and access to an electronic office environment greatly increases the time that a fingerprint technician has to view and verify identifications. Modular and scalable central and unit system designs meet increased workload demand and increases in database sizes.

The impressive technical design and performance has made AFIS a great success, reflecting credit on those responsible for its procurement and its developers. Since September 2000, searches of the national fingerprint database have been taking less than 20 minutes on average, well under the contractual target of 1 hour. Participants in the research agreed that the success of the design phases of AFIS was largely due to the high level of involvement of fingerprint technicians. As a result, AFIS has an impressive technical design. The human-computer interface is particularly popular. The success of the design and pilot phases also led to AFIS being seen as a self-contained, ready to run system owned by the fingerprint technicians.

The following sections make some observations about this research in the light of the conceptual analysis of match or fit between information systems and their organizational contexts set out in the first part of the paper. The commentary on the early phases of the research is substantial since it is here that the relationships between technological progress, work organization and management action were articulated and the exploration of their interweaving began. Our observations are cumulative and arise partly from reflection on the research project and partly from reflection on the similarity between the issues raised in this case and those reported in other organizational settings

PILOT OPERATIONS

A small number of police departments were selected to pilot AFIS. The first step was to install the AFIS software and hardware locally and undertake 'back record conversion': this involved scanning in fingerprint images from existing records (previously held both on hard copy and on an earlier computer system). The next step – the pilot phase proper - linked the

local system to the national system, enabling the AFIS Mark Case Management (MCM) capability to access to the full national database. The majority of the police departments did not pilot AFIS.

During pilot operations, our brief was to gauge the impact of AFIS on working practices and organization in the fingerprint unit. In terms of Iivari's characterization of research areas, this was research into IS impacts. It quickly became clear that the study would be more valuable if it could be extended through the pilot and into the operational period (i.e., became a longitudinal study). Less obviously, as the political ramifications of the introduction of AFIS dawned on us or were revealed to us, we found it necessary to extend our investigation outwards (and upwards) into the broader IS context and into the IS adoption process.

The fingerprint unit we studied comprised a section of some 25 fingerprint technicians and clerical support staff located in a single large office within the Forensic Investigations Division at police headquarters. The division also included photographic and chemical laboratories. Crime Scene Investigators (CSIs) - who visit crime scenes and obtain forensic evidence, including fingerprints - were not located at HQ, but at bases distributed around the district.

From the point of view of information systems strategy, the arrival of AFIS was a non-event. Since it is merely a matter of recomputerizing an existing application, there were no strategic implications. What is more, the software arrived on its own hardware platform, was perceived to be well engineered and supported by the system supplier, and came free (the government funded the pilot schemes). There were no resource implications for the police department's IT staff, who had next to no involvement in the installation or initial operation of AFIS. Strategically, even operationally, AFIS was invisible outside the fingerprint unit at this time. In terms of the overall IS architecture for the police department, AFIS, however highly engineered and powerful it might be, looked like a minor piece of end-user computing, peripheral to its main IT provision.

The back record conversion (BRC) phase of AFIS worked well: the records included in the local database were well chosen, and an impressive hit rate was rapidly achieved. Because of the demise of the previous system, AFIS immediately became, for these fingerprint technicians, the front line search system. Because the AFIS interface is well designed to support the general flow of fingerprint identification work, the users adapted to it quite easily. Because the matching algorithm worked well and fast (on the small local database, at least), and produces a ranked list of candidate matches for a mark, AFIS was welcomed as the kind of software they had always wanted. A band of enthusiasts formed, who found they could use the BRC system not only to load on their old tenprint forms, but also to match marks against them and achieve hits that had escaped them before. The pilot police department gained a reputation with the system suppliers as leaders in the practical exploitation of AFIS. Though their success was partly due to their having to 'jump ship' to the new system because their old system had collapsed, they appeared as innovators. Without any serious change to working practices, the fingerprint unit gained performance improvements and kudos.

From the point of view of the fingerprint technicians, AFIS did not change the way they work, merely given them the search engine that the previous computer system and the earlier Henry classification mechanism could not provide. Fingerprint technicians, experts, managers and software suppliers all insist that *identification* of a mark is achieved not by the software (despite its name), but by the expert (fingerprint officer). All the software does is

search for possible matches and present them for consideration. To make the identification, the technician or expert follows the same procedure as before, looking for coincident sequences of characteristics in two fingerprints under comparison. The fact that the experts are not privy to the details of the AFIS search, matching, or scoring algorithms did not concern them. The main threat to the fingerprint experts' position is seen by them not to come from usurpation by the software of their role in identification, but from their own improved productivity using AFIS, which may lead management to contemplate reductions in the number of fingerprint experts and technicians required (an example of organizational change being perceived as more threatening than technological change).

Fingerprint expertise is in fact shifting. The need for mastery of the Henry classification system is disappearing, even though experts still declare it to be useful background knowledge. The capacity of AFIS to search across a whole database, the need to search against specific fingerprint patterns has also reduced, even though the ability to recognize loops, whorls, and the other patterns is still felt useful for describing and discussing fingerprints. Skilled AFIS users emerged, able to use image enhancement techniques and feature selection strategies to encode marks in such a way as to gain maximum benefit from the AFIS matching algorithm. Skills emerging at this level of detail can only come out of practice. They cannot have been designed into the software in order to meet declared organizational needs. They are produced rather by users experimenting with the limitations and possibilities of the system they are learning to work with.

The next phase of AFIS, after back record conversion, included the extension of mark-to-print searching from the local database to the national database. This full mark case management (MCM) capacity also included new capabilities described in the system documentation but that had neither been prepared for nor much discussed. These capabilities included workflow management and office automation. We anticipated at the time that, if used, these features would significantly change the organization and flow of work within the fingerprint teams. They could produce closer association between scenes of crime and fingerprint work through more integrated processing of marks, and could increase connections between diagnostic and clerical work. How this would turn out could not be predicted in advance, but emerged during implementation and use, as we report in the later sections of this paper.

The implications for work organization seemed on the face of it considerably more far-reaching in operational AFIS than they were in the BRC phase. Yet it is impossible to say where the organizational need driving this information system development came from. Most of the additional functions came as surprises to local management. The system supplier did not push them, but merely took the line that it is making them available. Central government seems to be the most likely source of these 'requirements', and yet they also appeared to paint them as opportunities or possibilities rather than clear directions. We realized that, whatever the strategy or intention might have been, pressure for real organizational change would build with the following phase of AFIS, when the fairly limited functionality and familiar interface of BRC was replaced by the much more comprehensive and integrated package for managing information and workflow and connecting the Unit more closely to crime scene work and into a general national criminal records system.

On the point of the connection to the CSI bases, it is interesting to note that a local PC system for tracking CSI jobs was initiated after agreement had been reached to take AFIS. This had only been partially implemented at the time of our initial research: we were told that it would

not be completed. It was clear that if the mark case management capabilities described in the AFIS documentation had been understood, the partially implemented system might not have been developed at all, but perhaps a front end designed for AFIS instead. During the pilot operations phase, this was not organizationally feasible because no one was publicizing the additional capabilities of AFIS, and no one in the headquarters criminal investigation division or in the IT department was in a position to include AFIS in an IT strategy. As it turns out, with the tracking incomplete and the earlier AFR system abandoned, AFIS is being introduced into a disconnected IS environment where paper flows and registers were being used to track data and events.

CASE MANAGEMENT

The AFIS architecture described above required its physical location in the fingerprint units. This tended to reinforce the perception of fingerprint work as unique and mysterious. It also reinforced the sense of ownership of AFIS: during pilot operations, the system quickly became embedded in the crime scene processes. The resounding success of AFIS integration into crime scene identification, the traditional core activity of fingerprint units, had a downside: the high level of direct support for the fingerprint community tended to marginalize other workers, such as crime scene investigators, criminal records clerks, and detectives, all of whom are involved in the two wider 'business' processes that fingerprints support – verifying the identity of arrested persons (supported by AFIS Ten Print Management – TPM) and identifying offenders from the (latent) finger marks left at crime scenes (supported by AFIS Mark Case Management – MCM). During development and pilot operations, the description of AFIS as 'just a fingerprint tool' became a touchstone used by fingerprint workers to show that they were comfortable with the system and did not feel threatened by it: unfortunately, in the early stages of implementation, it also reinforced the myth that the impacts of this powerful new system would be limited to the fingerprint community.

AFIS was fundamentally different from any AFR system previously developed or used. AFIS provides a 'front-end' to the criminal names database: the sophisticated AFR functionality and physical location of the hardware in the fingerprint units tended to mask the significance of this technical integration until the early phases of implementation. Despite the widespread understanding of crime detection and police work more generally, fingerprint work is still regarded even by many inside the police as a 'black art'. The mystery surrounding the contribution of the fingerprint community to the wider crime detection and identity verification processes reduced management awareness of the significance of many of the issues that arose from the use of AFIS as a common medium to support these two distinct 'business' processes.

Analysis of this second phase highlighted fewer obstacles and occasions where expectations diverge than had been experienced during pilot operations. The explanation for this seems to lie in the emergence of new relationships and networks within the fingerprint unit as AFIS became assimilated into the management of crime scene (mark) cases. Where expectations of the participants' did diverge, it tended to arise from the interpretation of documents such as the functional specification, updates for police chiefs; memoranda of understanding (MOU) and guides to operational procedures . Although such guides were working documents, subject to continuous and collaborative review and updating by fingerprint unit staff, it is interesting to note that these printed (and therefore 'fixed') documents provided the locus for

discussion of non-alignment of AFIS and local organizational needs as well as the evidence that contractual obligations had been fulfilled.

In contrast to the ossification surrounding the documents, the pace of change to the process and organization of fingerprint work increased. The support of AFIS MCM for mark-to-mark and print-to-mark searching, as well as mark-to-print searching – the primary means of undertaking crime scene work - highlight the inadequacy of the perception of AFIS as "just a fingerprint tool". Analysis of the transition from pilot to full MCM operations shows how increasing awareness and exploitation of AFIS functionality encouraged the emergence of new ways of working, for instance through the establishment of links between scenes of crime even before a suspect had been identified. The possibility of identifying a suspect responsible for a series of crimes prompted this use of AFIS: the technology enabled fingerprint evidence to be used pro-actively and speculatively in ways that previously would not have been possible, or at least realistic in resource terms.

Since crime scene mark processing had historically been a local responsibility and therefore the primary function of local fingerprint units, the (latent) mark case functions offered by AFIS were quickly and readily integrated into this established field of expertise. Although the implications of AFIS for the ten print process were equally well documented as those affecting the scenes of crime process, our research showed that awareness of them was lower and their significance was not as quickly appreciated.

PRINT MANAGEMENT

The ten print process was radically changed by the introduction of AFIS. The most significant change was the devolution of responsibility for ten print verification to local units. Both the process and responsibility for its management changed.

Responsibility for the ten-print verification process was assumed by the pilot department at this point in the project: AFIS ten-print management (TPM) devolved responsibility to police departments. Many of those departments had no experience of this work whatsoever. Unlike the transition from pilot operations to full national MCM capability, where substantial change at the AFIS central site gave rise to little if any visible impact in the fingerprint unit at our pilot site, the transition to ten-print management involved little change centrally: the national database was still the resource used to support the verification process. However, the changes locally were substantial as a business process completely new to this organisation was introduced.

Our research into ten-print devolution (Beeson and Davis 2001; Davis 2002) highlights the technical integration of AFIS and other information systems – that is to say, the development of an interface - to support the ten-print verification process as the locus of substantial unanticipated change. The complexity of the issues and concerns arising from devolution of ten-print verification work were greater than expected. The main reason for this seems to arise from less intense involvement of local fingerprint staff. Ten print verification had been carried out centrally for many years: although aware of the nature of this work, staff at the study site had no involvement or experience of it.

The AFIS ten-print process succeeded practices that involved sending paper ten print forms for verification. Time to complete the verification process was measured in weeks. This

latency was known about and exploited by criminals. They would deliberately give false details when arrested, for instance using the driver's license of a friend with no previous record. When they appeared in court, the apparent absence of any previous record would lead to a light sentence for the crime. Only long after the court case would the falsification be realized, requiring the police to trace and re-arrest the offender. As well as being embarrassing and time consuming for the police, the latency in the verification process had a significant effect on the integrity of the criminal record database held. Anecdotal evidence suggests that 30-40% of the records held were false.

AFIS offered dramatic reductions in the time to complete the verification process: combined with digital finger print image capture technology, verification of an offender's identity within one minute became possible. This dramatic improvement in the speed of service delivery had a number of implications.

Experience elsewhere showed that AFIS provides the potential to change the sequence of events following arrest so as to exploit the improved process speed. As with other technological innovations, the criminal community responded more quickly than the criminal justice community. Police officers found that people brought into custody would say "…I see you have AFIS: I won't bother to give you a false name then…" Reduction in the incidence of false details reduced the need to cross reference aliases in the criminal record database and provides a means to 'clean up' the database.

Also significant is the need for legislative changes in order to exploit the process improvements provided by these technologies fully. To be most effective, the identity verification process needs to be initiated as early as possible, ideally on arrival at the police station or even on the street using a portable input device.

Most immediately significant from a managerial perspective were the implications of the devolved ten-print process for identity verification tasks carried out by workers outside the fingerprint unit. Although ten print verification is computationally less demanding than crime scene work, it is more complex organizationally. Identity verification involves the reconciliation of fingerprint image data about an arrest held on AFIS with the alphanumeric criminal record data. National databases are maintained through the efforts of a variety of departments. This variety adds another dimension to the complexity of change surrounding AFIS: the achievement of consensus about tasks and data prioritization becomes more difficult as the community involved with AFIS widens: the goal of alignment or fit becomes more elusive as new ways of exploiting AFIS are found and the community continues to expand.

SUMMARY

Our longitudinal study of the impacts of AFIS on the process and organization of fingerprint work has concentrated on the transition of the system through three important project phases: pilot operations, mark-case management and ten-print management. As we realized early in this research and pointed out early in the paper, it is important to remember that the increase to both software functionality and the range of people and departments affected by it are both cumulative. It is important, therefore, to consider this case in the broader context of fingerprint work and the criminal justice system in which that work takes place.

In what sense was there any matching of an information system to an organizational need going on here? The picture is not straightforward. If the department hoped for a perfect and unproblematic match between AFIS and its identification methods and work organization, it is likely that could only have been achieved by resisting change and denying potential. In the pilot operations phase, AFIS certainly did not improve the match between central and local IS at this site, or even between different local IS within police headquarters. A local strategy for AFIS gradually emerged from practical necessity inside the department and may escalate within the forensic investigation department.

Matching of information system to local organizational needs will continue to develop within the fingerprint department now that AFIS is fully operational. It may be a form of matching which merely underscores existing practices (i.e., additional functionality not used); or the additional functionality could be imposed by departmental managers, perhaps with adverse effects on expert commitment; or, as with the pilot phase, operational AFIS could be taken up creatively and the exploration of its possibilities used to stimulate debate about organizational evolution.

But there is currently still no strategic direction that includes AFIS visible outside SI. Because AFIS is so well packaged and supported, there has not been any substantial need for knowledge of it to grow outside the fingerprint and other departments involved in the ten-print verification process; confronted with ever more pressing priorities, the management hierarchy perhaps feel AFIS can be safely regarded as a purely local improvement, and responsibility for its evolution ceded to other agencies (such as any number of government agencies, the system supplier, or one of the various AFIS user groups). It may on the other hand be possible to achieve a degree of matching retrospectively. A local steering group could be established with multi-level membership to try to harmonize AFIS implementation and development with broader IS objectives. It would not be sensible to try to control the continued exploitation of AFIS entirely from a level above the forensic investigation department, since the deepest practical understanding of AFIS resides at the operational level. A multi-level group might be able to open up a constructive dialogue between experts in application areas and strategists from different points in the hierarchy.

CONCLUSIONS

We have tried to show in this paper that matching of information systems to organizational needs is not a simple matter, and is in fact infeasible in any final sense: there is no point in time at which organizational needs and information systems' capability will converge. Our analysis of the development, implementation and use of AFIS at the pilot site shows how alignment of information systems and organizational needs is repeatedly and indefinitely postponed.

Information systems, despite the claims of their developers, cannot fully integrate information provision in any organization. No matter how effective and reliable the technical integration of information systems, it will never offer a 'solution', merely a prompt for exploration of the increased functionality offered and the emergence of new information needs. For this reason, matching systems to needs is rather a matter of continuous achievement occurring in many areas of an organization concurrently. We have used processual models from Scarbrough and Corbett and Friedman to show the general complexity and momentum of organizational and technological change, and in particular to

show new needs always emerging out of the possibilities opened up by the use of existing systems and practices.

If information systems are to be matched to organizational needs at all, we argue, fuller consultation and participation across organizational areas and levels needs to be achieved, so that a plurality of views can be exchanged and multiple competences can be brought into contact. Strategy needs to become a distributed rather than a hierarchical organizational process, and development projects of all kinds need to be extended in both directions so that invention is not left merely to experts and managers and use purely to users. Wherever discontinuities between strategy and operation and between invention and use can be repaired, there will be a chance of local and temporary (but still useful) harmonization of needs and systems.

The force of Iivari's call for linked research into IS contexts, IS impacts, and IS adoption was brought home to us in reflecting on our own experience of our research so far into the AFIS implementation. That work has certainly led us from study of impact of one IS into the study of the broader IS context and of the IS adoption process. These reflections, including the writing of this paper, will influence the subsequent course of this research.

The AFIS investigation confirms our belief that the connection between an information system and organizational needs is tenuous and obscure. As Iivari suggests, investigation of real adoption processes and real responses to situations is more revealing than abstract analysis. We see in this case a development driven by complex combinations of circumstance and opportunity. The twists and turns are explicable, but not easily predictable. The process can be steered to some extent, but only by involvement in it. As suggested by our theoretical considerations, making the system work in context will be a process of accommodation of a plurality of interests as well as a convergence of skills and knowledge. This case shows that the AFIS implementation at the pilot site could not be (and has not been) designed in advance to match precisely articulated organizational needs, but people can work together with it to produce what turns out to be a mutually acceptable outcome. Such continuing participative development will, we anticipate, be manifest in the restructuring of fingerprint expertise as AFIS and other technologies are learned and adopted.

The case also highlights the dangers that arise from belief that alignment of organizational needs with information systems functionality can be achieved at some point in time. Many of the tensions between the fingerprint community and organizational managers observed during the implementation of AFIS arose due to the assumption that ‘implementation’ represented a point in time at which the technology ‘solution’ would fulfill the organization’s needs. Clearly, this is a naïve expectation. Our hope is that this case, and others, will alert organizational managers to the dangers that the mock Fixed Point Theorem highlights and will see information systems as presenting opportunities for change and innovation that require their creative and constructive input rather than acceptance as ‘solutions’.

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