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Seamless Integration: Standardisation across Multiple Local Settings

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Abstract. The pressure towards tighter or "seamless" integration of health information systems is a recurring issue with both practical and analytical relevance. It taps into a discourse in the IS literature in general and organisation and management science in particular. Unfortunately, the prevailing perception of integration in the IS literature is as a predominantly technical issue. The CSCW literature, however, is attentive to the socio-technical aspects of integration. Building on this – but supplemented with recent elaborations in science studies – we aim at exploring the unintended consequences of information systems integration. A user-led perspective implies emphasising the tailoring to local needs based on in-depth studies of the micro practices. We argue, however, that the condition for such an approach is radically undermined by politically motivated, regional changes towards integration with implicated standardisation. Enforcing order in the form of standards across multiple local settings, seemingly a prerequisite for tight integration, simultaneously produces disorder or additional work in other locations for other users. Empirically, our study is based on a large, ongoing integration effort at the University hospital of Northern Norway, specifically studying work practices and perceptions across multiple laboratories.

Key words: integration, standardisation, unintended consequences, work practices

1. Introduction

The health care sector is under strong and growing pressure to collaborate and coordinate more efficiently across geographical, institutional, disciplinary and professional boundaries. Given the huge and escalating health expenditures – doubled in Norway from 1990 till 1998 to a staggering 73.5 billion NOK, a yearly growth adjusted for inflation averaging 4.4% per year – the expectations towards collaborative use of ICT are tall and rising. Reiterating prevailing thinking in organisation and management science (Davenport, 1998), health policy initiatives in the Western world emphasise strongly the importance of dismantling "vertical" boundaries in favour of "horizontal" processes of work and sharing of knowledge (SHD, 2001, 2004). The notions of "continuity of care", "shared care" or "integrated care" are different yet ultimately similar expressions for this increased awareness of providing health care services across boundaries of time, place and discipline (Pritchard and Hughes, 1995).

In the context of health care, the notion of "integration" has a deeply ambiguous meaning. It marks the political and ideological commitment towards integrated care, i.e. service integration as experienced by individual patients. On the other hand, it is simultaneously used in the much narrower sense of the technical integration of relevant clinical information systems. The tension between these two connotations gets deepened by the changing political economy resulting from the ongoing turbulent business environment with aggressive strategies of mergers and acquisitions among vendors and structural changes in the ICT health care markets by focus on tenders.

A principal aim of our paper is to contribute to the development of a socio-technical understanding of integration in health care. More specifically, we discuss manifesations and implications of the implicated forms and levels of standardisation that are necessary for integration to be possible. Integration presupposes what Timmermans and Berg (2003) denote compatibility standards, i.e. negotiated agreements about what and how to share and exchange information *across multiple local settings* and systems. Dependability qua effectiveness, reliability and trust of healthcare technologies hinges increasingly on tighter integration. Dependability thus becomes a *systemic* quality of complex and dynamically shifting configurations of applications, systems and modules, implying that an essential element is how dependability achieved in one local setting *directly implicates* the conditions for dependability in another locality.

There is, especially within the field of computer-supported cooperative work (CSCW), a rich stream of analytic and empirical research that analyse the socio-technical aspects of the design-use gap. This identifies and demonstrates discrepancies, work-arounds and glitches in the way information systems are used relative to initial intentions (Berg and Timmermans, 2000; Ellingsen and Monteiro, 2003). This body of literature, typically informed by ethnographically underpinned descriptions of a local work practice, has convincingly demonstrated the value of appreciating situated micro-practices. Dramatically less attention, however, has been devoted to how this *scales up* (Schmidt and Bannon, 1992), i.e. how integrated, collaborative information systems cutting across multiple local settings inevitably have to rely on a certain level of standardisation. It is neither practically nor analytically feasible to fine-tune design to all local settings. The thrust of our analysis, then, is to discuss analytical and operational trade-offs embedded in such efforts.

Drawing heavily on recent conceptualisations from science studies of standardisation and dependability of large-scale (integrated) technologies (Law, 2003; Perrow, 1984; Timmermans and Berg, 2003), we critically analyse how tight or "seamless" integration unfold over time. Our motivation is not merely to point out or demonstrate how actual use falls short of initial visions – which should not surprise many – but to problematise

the ambition in the first place. The line of our inquiry is to explore the evidence for and implications of acknowledging a certain level of non-integration (i.e. fragmentation) as an *intrinsic, not accidental*, aspect of the integration of any reasonably comprehensive collection of information systems.

Empirically, we trace the implementation process during January 2004–May 2005 at the University hospital in Northern Norway (UNN) where an existing electronic patient record (EPR) system (by a large vendor we dub GlobSys with a system we dub RecSys) was replaced with another (from a national vendor we dub HealthSys). The (lack of) integration between the EPR and other applications was an influential element in the whole replacement process. We zoom in to specifically analyse how the ambition and outcomes of integration played out for the case of laboratory work practices. Achieving seamless integration, which was the clear intention at UNN, thus involved integration of all the different laboratory systems, thus evolving crucially around the granularity of standardisation. We have selected the Clinical Chemistry and Microbiology laboratories to highlight differences in local work practices.

Section 2 of our paper outlines how the issue of integration and the implicated level of standardisation has been conceptualised, starting from a technical point of view but moving on to more socially informed accounts. In Section 3 we describe and discuss methodological considerations before presenting the case narrative in Section 4. Our analysis in Section 5 zooms in on the specific issue of integration of the laboratory systems, but in such a way that the more general aspects of integration are highlighted. We analyse unintended consequences from the integration of laboratory systems by discussing (i) the implied uniformity and (ii) the granularity of standardisation in integration efforts. Section 6 concludes by discussing implication that follow from our perspective on integration.

2. Conceptualising integration socio-technically

Given that existing work routines in health care more often than not are supported by and embedded in one of the many special-purpose applications (in the context of hospitals, e.g. laboratory systems, radiology information systems, patient administrative systems and order entry), the impetus for *organisational* integration translates very much into an issue of *technical* information systems integration. In the words of one of the proponents from managerial science, ''to put it bluntly, if a company's systems are fragmented, its business is fragmented'' (Davenport, 1998, p. 122). Similarly, for the health care sector Lenz and Kuhn (2001, p. 100) point out that ''it's amazing that today's large scale hospitals rarely have a truly integrated hospital

information system'' and Boochever (2004, p. 16) even more explicitly that ''system integration would provide the platform for improved workflow, patient throughput and patient safety, as well as decreased cost''.

Despite the widespread recognition that implementation of new information systems, in health care and elsewhere, amounts to socio-technical processes of negotiations (Berg, 1998), the specific issue of *integration* seems to lag behind insofar as it still gets conceptualised predominantly as a technical issue. There is accordingly a rich repertoire of proposed technical mechanisms for achieving tight or ''seamless'' integration (Grimson et al., 2000; Xu et al., 2000) but few socio-technical analysises of integration (but see Ellingsen and Monteiro, 2003; Hartswood et al., 2003; Winthereik and Vikkelsø, 2005).

To situate the attempts to conceptualise integration of information systems in healthcare as a socio-techical problem, it is necessary to first outline the way it traditionally gets portrayed as a technical issue (Kuhn and Giuse, 2001; Mykkänen et al., 2003; Xu et al., 2000).

Integration in hospitals is expected to automate the medical processes, such as patient admission, transfer and discharge, ordering of laboratory and radiological examinations or medication, and automatic or on demand (solicited or unsolicited) receipt of results (Tsiknakis et al., 2002). Basically, this includes the four principal classes of hospital-based systems, the EPRs, the laboratory systems, the radiology systems (RIS/PACS) and the patient administrative systems (PAS).

An integrated solution is supposed to give the physicians easy access to data from multiple information sources (Friedman, 2001; Tsiknakis et al., 2002; Winsten and McMahan, 2000), thus providing a complete picture of the patient's/client's medical history. The multiple information sources are accessed seamlessly from a single point of end-user interaction (Boochever, 2004). This avoids that the physician must perform redundant activities (corresponding to what Cabitza et al., 2005 denote redundancy of effort), such as specifying the patient identifying information over and over again (Ginneken, 2002).

Despite the high aspiration of an integrated solution (Ellingsen and Monteiro, 2003; Hartswood et al., 2003), Berg (1998, p. 294) fairly accurately characterises the situation when he maintains that ''fully integrated [EPRs] ...is hard to find''. One reason is that many software products have been built and acquired from heterogeneous sources during a long period of time, and the systems have differences in implementation technologies and architectures (Mykkänen, 2003).

Accordingly, there are many different strategies and approaches to integration (Hasselbring, 2000). These many be seen as an expression of the enormous challenges and difficulties with integration. The integration mechanisms – all technical – include federated database systems,

world-wide-web (Grimson et al., 1998) ERP-systems (Grimson et al., 2000), components (Clayton et al., 2003, p. 2) and internet portals. Common models and architectures are also suggested (Bernstein et al., 2005).

For sure, the CSCW literature contains numerous contribution that analytically as well as empirically spell out the social, political and organisational aspects of informations systems in working order (Heath et al., 2002; Schmidt, 2002; Tjora, 2004; Winthereik and Vikkelsø, 2005). The misconception of equating the (social) integration of work and services with the technical issue of information systems integration is also acknowledged, i.e. the mistake of "associat[ing] the current state of service fragmentation with the lack of information integration" (Hartswood et al., 2003, p. 241).

There is, however, a noteworthy distinction in approaches to integration. On the one hand, lacking integration presently prevailing may be acknowledged, but the *ambition* of integration remains. E.g. Hartswood et al. (2003, p. 242, emphasis added) suggest that the problem is largely due to the implementation process (i.e. insufficient user involvement):

> "Our final point is *not that greater healthcare service integration is an impossible goal*, nor that technologies like the EMR [EPR] are irrelevant to its achievement. Rather, it is that these technologies will only deliver their potential benefits *if the processes followed* in their design, development and deployement are orientated to providing sufficient opportunities for *user-led evolution*"

That design – also of integrated systems – could be adequately fitted to local work practices, typically through a combination of ethnographically inspired methods and user participation, is a dominant position within CSCW (Heath et al., 2002). For all its merits, the blind spot of this position is that it does little or nothing to address the issue of scaling up to serve integration across *multiple* local settings (Timmermans and Berg, 2003). This implicates a level of standardisation, as extensive local adaption does not scale, resulting in constraints stemming from one local setting spilling over to the next. In short, a local setting is no longer local, but dependent on design decisions in other settings.

Ordering efforts are (i.e. standardisation) is elaborated more within science and technology studies (Berg and Timmermans, 2000; Latour, 1999; Law, 2003; Law and Singleton, 2005). Here it is exactly the aim or ambition of tight or seamless integration that is challenged: what if the lack of success with integration in hospitals is neither accidental nor transient, what if efforts of producing order always simultaneously produces the opposite? As Berg and Timmermans (2000, p. 45) point out "[T]he two orders [referred to, i.e. two alternative clinical treatments] we have described *produce the very disorder they attempt to eradicate*". The key insight is that by imposing a certain order (level of standardisation) in one local setting, for one group of

users, this simultaneously and inherently produces disorder in other locations, for other users. Law (2003, p. 11) makes a similar point, but pushes further by underscoring the ultimately dysfunctional nature of preserving the ambition of full integration with the implied completeness and perfection. In Law's analysis, despite the fact that, in principle, one by one, instances of disorder are amendable, taken together unintended consequences multiply and expand as their mutual interaction cannot be deduced from the constitutive elements. This is perfectly compatible with implication portrayed in complexity theoretical perspectives on organisational dynamics. As Perrow (1984, p. 4) explains, ''This has to do with the way failures can interact and the way the system is tied together''. Or as Law (2003, p. 11) puts it:

> ''There are always many imperfections. And to make perfection in one place (assuming such a thing was possible) would be to risk much greater imperfection in other locations...The argument is that entropy is chronic''

Our analysis, then, is strongly inspired by, and in part based on, this perspective on integration as an endemic element stemming from the dependencies across multiple local settings.

3. Method

3.1. THE RESEARCH CONTEXT

The case study has been conducted at the University Hospital of North Norway (UNN) during January 2004 – May 2005. UNN has approximately 5000 employees, including 450 physicians and 1000 nurses. The hospital has 600 beds of which 450 are somatic and 150 psychiatric. Together with 10 smaller hospitals in North Norway, UNN is administrated by the regional health enterprise Health Region North. Health Region North is responsible for a regional health policy in the northern region, a sound economy and coordination of activities among the 11 hospitals. The health enterprise has also identified information technology as a strategic area, especially related to standardised and common systems across the hospitals in the region.

In addition to the clinical departments, UNN has 7 laboratories: Clinical Chemistry, Microbiology, Pathology, Clinical pharmacology, Immunology, blood bank and Medical genetics. Together, these laboratories conduct approximately 3 million analyses a year. Clinical Chemistry is the absolutely largest of the laboratories (using number of analyses as a measure), conducting nearly 2 million analyses a year. In Norway, there is normally a connected Clinical Chemistry laboratory for each of the country's 85 hospitals. The Microbiology laboratory at UNN is one out of 20 microbiology

laboratories in Norway and conducts about 436.000 analyses a year. This is only ¼ of the number of analyses conducted at the Clinical Chemistry laboratory.

3.2. THE RESEARCH APPROACH

The study adheres to an interpretive research approach (Klein and Myers, 1999; Walsham, 1993). Data gathering conducted by the first author consists of: participant observations (work settings and project meetings), interviews, document analysis, and informal discussions.

Access to UNN was gained through the first author's affiliation to the hospital's IT department. Through this position, he also had the formal responsibility of evaluating the HealthSys introduction project, although the boundaries between formal evaluation and a research focus were blurred. The role as a formal evaluator legitimised access to all the project meetings, user-training and access to the project's steering group.

The first author has participated in 60 project meetings in the HealthSys project during 2004. The project members participating in these meetings were IT-consultants, physicians, secretaries, bioengineers and nurses. Their number varied from 5 to 16. In line with Eisenhardt's (1989, p. 539) emphasis that "one key to useful field notes is to write down whatever impressions occur", notes were taken during these observations and subsequently transcribed. Questions and analytical points were added ex post and discussed extensively with the second author.

The first author had an office in the IT department allowing him to participate in informal discussions; lunch breaks etc. facilitating awareness towards emerging situations and issues. In total 50 notes are based on such informal talks with HealthSys project members, managers, users and HealthSys employees.

In addition to the actual project meetings, he was especially interested in how HealthSys influenced the work situations for physicians since the project group recognised them as an important user group for the success of the project. The first author therefore conducted 12 in-depth semi- and unstructured interviews whereof 8 with physicians, 2 with nurses and 2 with HealthSys project members. In this sense, we are aware that we risk privileging the physicians at the expense of other stakeholders, e.g. secretaries (Frost and Stablein, 1992, p. 283; Van Maanen, 1988, pp. 4–5).

He has also had access to approximately 500 emails sent to or sent within the HealthSys project and also had access to the HealthSys project document archive consisting of several hundreds documents.

The analysis of the data is based on a hermeneutic approach where a complex whole is understood "from preconceptions about the meanings of its

parts and their interrelationships'' (Klein and Myers, 1999, p. 71). This implies that the different sources of field data are all taken into consideration in the interpretation process. The method included relatively detailed case write-ups for the sites involved (see for instance Eisenhardt (1989)) followed by an examination of the data for potential analytical themes. Emerging patterns from the data (Schultze, 2000) were attempted categorised to themes in order to make good overviews based on the perspectives chosen. This process was repeated, also involving new theoretical insight.

The results of the study have been presented for the management at UNN as a part of the formal evaluation process. A similar presentation was also given for the management at St. Olav hospital, a large university hospital in a different region of Norway. In addition, the results were presented for the major informants, the IT department at UNN. The feedback from these sessions was that it was ''fair'', an indication of authenticity as Golden-Biddle and Locke (1993, p. 599) underscore: ''the text conveys that the researchers grasped and understood the members' world as much as possible according to the members' constructions of it''. Finally, earlier versions of this paper have been presented at an international research workshop in order to develop interpretations with others outside the field as a strategy for enhancing reliability (Schultze, 2000).

4. Case: Integrated system at University Hospital Northern Norway

4.1. BACKGROUND AND MOTIVATION

The University Hospital of Northern Norway (UNN) participated for almost 8 years in the national and longstanding Medakis project (1996–2003). This project started out as an ambitious, collaborative project between the five Norwegian university hospitals and the vendor GlobSys with considerable financial and political backing from the health authorities. The overall goal was to develop a common, all-encompassing EPR for these hospitals, covering the needs of all the different health professions in different hospital departments (Ellingsen and Monteiro, 2003). Despite falling significantly short of these expectations, the GlobSys' RecSys EPR has been in operational, increasingly wide-spread, use in the five university hospitals for several years.

The key role of EPRs in Norwegian health care is reiterated regularly in health policy programmes (SHD, 2001, 2004). This, however, has not been sufficient to coordinate an integrated and uniform health care. A sweeping health reform in 2002 shifted the ownership of the Norwegian hospitals from the counties over to the Government in an attempt to curb expenditures and poor exploitation of existing resources. The former five health regions were

replaced by five regional health enterprises with substantial autonomy, each comprising one of the former university hospitals and several local hospitals.

Increasingly, the users at UNN (especially the physicians), were dissatisfied with the GlobSys' RecSys EPR portfolio. In daily work, they depended on having access to X-ray-descriptions, laboratory results and the EPR. A lack of mutual integration especially between the EPR and the existing laboratory systems made this situation difficult as a physician phrased it:

> ''I don't have the laboratory results; I don't have the x-ray-description. Instead I have three different logon-codes that I have to use on three different systems [GlobSys' RecSys, Laboratory and RIS] and I have to leave and enter the different systems in turn''

4.2. HEALTHSYS – THE INSTRUMENT FOR A SEAMLESS INTEGRATED SOLUTION

This situation made it relatively easy for Health Region North to break out of the long-term collaborative effort in December 2003. UNN was the only hospital in the northern health region running GlobSys' RecSys EPR, and Health Region North decided to replace this with what the 10 other (smaller) hospitals in the region had, namely systems from the vendor HealthSys (see Figure 1).

HealthSys is one out of three vendors on the Norwegian hospital-based EPR market and enjoys a 30% market share (Lærum et al., 2001). The HealthSys EPR module comes integrated with a Radiology module, Laboratory module, PAS module and a Psychiatry module. Historically, HealthSys customers have been smaller hospitals in Norway. However, recently HealthSys tries to get foothold in markets associated with the large hospitals, thus aiming to respond to the challenges related to regionalisation of the Norwegian healthcare.

To change this was argued to be ''obvious''. In the words of top IT management in Health Region North, ''There are 11 hospitals in this region and 10 running HealthSys's portfolio of health based information systems.

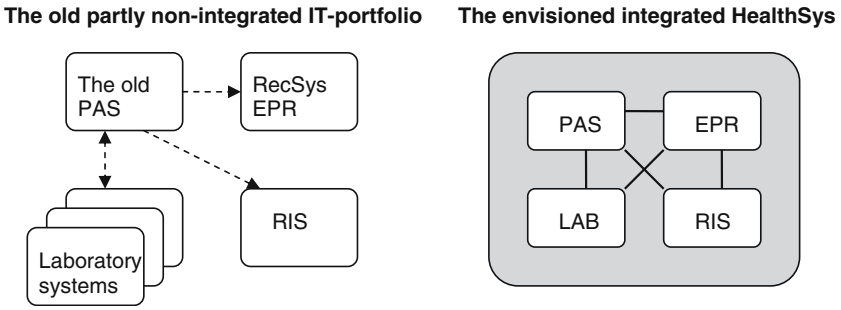

Figure 1. The old and the envisioned IT-portfolio.

Therefore it is obvious that UNN should do likewise''. This decision was perfectly aligned with Health Region North's strategy of streamliness and standardised systems in the region. HealthSys could presumably offer a complete package including (RIS, PAS, EPR, Laboratory-system and psychiatry). HealthSys promotes their IS-modules as a complete and integrated solution:

> ''The HealthSys solution is based on a common architecture, integrated modules and a common logon-procedure across the different modules.''

The HealthSys modules resided in the same database, implying that some registers in the database are shared between the modules. Thus, Health Region North clearly regarded the HealthSys system as a major instrument for an integrated and seamless solution:

> ''The basic thought for us in Health Region North is that clinicians should have only one interface to relate to. By implementing HealthSys's IS portfolio, one gets very easily away with the integration challenges'' (IT-leader, Health Region North)

Moreover, the laboratory module in HealthSys is one module, meaning that all of the laboratories using HealthSys system reside in the same database with no borders between them. Implementing common HealthSys laboratory systems would also come close to the visions of Health Region North of reorganising the laboratory services in the northern region where tighter coordination and collaboration between the laboratories were an explicit goal.

Health Region North supported the project of replacing GlobSys' RecSys EPR with HealthSys with 10 MNOK (about 1.2 MEUR). By June 2004, the PAS and the EPR module were implemented. By the end of 2004, the laboratory module was implemented. Before introducing the HealthSys's laboratory module , the laboratories at UNN had numerous laboratory systems. The Clinical Chemistry, Immunology and Clinical Pharmacology were running the same system (although different instances) systems on a Tandem platform from a Scandianvian based vendor. In contrast, the Microbiology laboratory was running a completely different system. Implementing and using the HealthSys laboratory module was considered crucial for a common and completely integrated solution.

4.3. THE WORK PRACTICES IN THE LABORATORIES

Clinical Chemistry laboratory is associated with relatively simple analyses, which enables the requesting physician (in the clinic) to clearly state what kind of analysis she wants to be performed. The result is typically positive/negative or a numeric value, providing relatively clear meaning to the physician. The clear-cut character of the analytical process has enabled modern

clinical chemistry laboratories to implement a high degree of automation in the analytic process (Bishop et al., 2005, p. 125). Most of the analyses at Clinical Chemistry laboratory are conducted automatically through analyses machines, processed in a few hours and mostly conducted by bioengineers. Only in case of doubts, physicians have to verify results. The high number of simple analyses makes it particularly useful to organise the computer-based user interfaces as working lists. See Figure 2.

Dealing with microbiology samples is a completely different matter than making clear-cut orders to the Laboratory of Clinical Chemistry. For instance, the Microbiology laboratory requires that the physician who makes a requisition provides information about *clinical information, material and location*. This information must be provided by the physicians requesting the analysis. What's more, often it is not obvious to the ordering physician what kind of analyses that needs to be conducted, she rather presents a problem

> ''For us, the point is to a large degree that the clinicians present a problem and very many of them don't know what we do. They may ask: 'Hepatitt?', and then there are arrays of different analyses that must be done in order to both be cost-effective as well as covering relevant possibilities. If we find something, then we have to explore that possibility further with supplementary analyses and things like that (...) half of the virology tests we order ourselves based on the problem (...) sometimes the problem is even

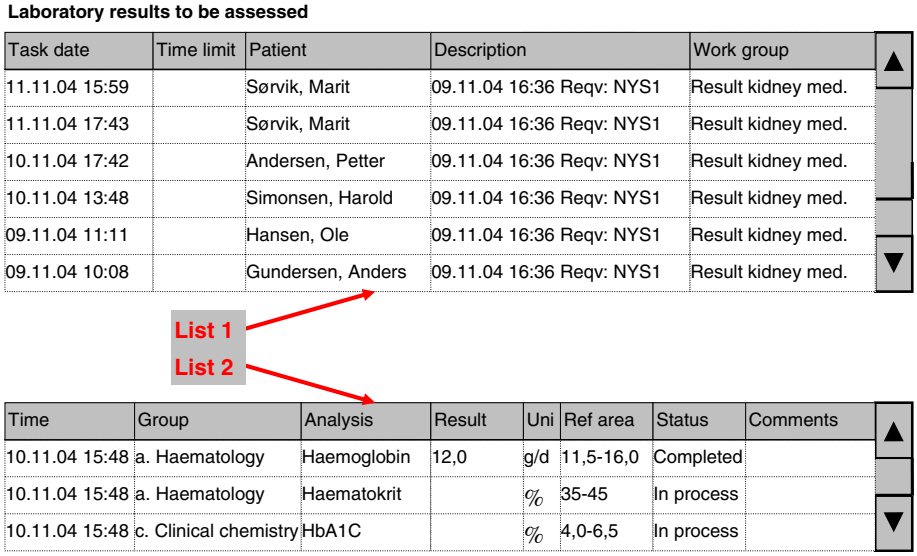

Figure 2. The work list for the users in the clinic. Arrow 'List 1' points to the list containing patients having new laboratory results. Arrow 'List 2' points to the list containing the results for a patient highlighted/selected in list 1.

> wider, for instance if the clinician writes: 'diarrhoea after journey abroad', we have to think on parasite examinations, virus infections or the array bacteriological infections. This means that our role vis-à-vis the clinicians are completely different [than Clinical Chemistry]. In our field, much of the assessment [of the problem] is our responsibility'' (Chief physician, Microbiology)

This difference in laboratory practices between the Clinical Chemistry and Microbiology is also expressed in the way result is communicated. The results from Microbiology may require thorough explanation to the physicians who request the tests:

> The results from our laboratory are very often unintelligible for the clinician. There are many test properties, very complex biology and so forth. Therefore, we provide an interpretation and guidance with regard to how the information should be understood and how it should be used (...) For instance, often we got the result: 'the HIV test is not negative'. It is not clearly positive either. This may express that this is not HIV really, but it may also express that it is very early in the infectious phase, that is, the biological traces are not explicit yet. It is a communication aspect here, a lot of what we do is to communicate uncertainty'' (Chief physician, Microbiology laboratory)

4.4. INCREASED PRESSURE FOR STANDARDISED AND UNIFORM SYSTEMS

Although the practices in the laboratories are different (as illustrated above), the pressures of health care reform and managed care have caused increasing interest in improving productivity of streamlining the analytical process and the information flow in the laboratories modelled after Clinical Chemistry. As many other hospitals nationally and internationally, also UNN participates in a project aiming at establishing an automated ''front-end'' where every sample is registered, controlled and dispatched into an analytical process in integrated laboratory sub-systems.

The vision of a streamlined information flow in the laboratories is also at the core of Health Region North's ambition of creating a close collaboration among the laboratories in the health region, both organisationally and technically. Organisationally, this implies to share functions, such as a common automated front-end to the laboratories and the inclusion of similar laboratory functions in common organisational units, such as Blood bank North, Clinical Chemistry North and Microbiology North. Technically, this implies to establish common health information systems in general and laboratory systems in particular across the hospitals in the region.

Accordingly, when introducing the integrated HealthSys system, the laboratories were expected to replace their systems with the common HealthSys laboratory module in order to comply to ensure tight integration with the rest of HealthSys modules. For the Clinical Chemistry, Immunology and Clinical Pharmacology laboratories, this was an unquestionable argument, thus being in line with Health Region North's ambition of shared functions and systems in the health region. The pressure for integration – implying a corresponding pressure for standardisation in the sense of uniformity – was (as we have elaborate on above) embedded in the strategic intentions of Health Region North:

> "For (...) blood bank, pathology and Microbiology we want the same systems and preferably in the same database for each specialised discipline in the whole region" (Director, Health Region North).

To promote the regionalisation of the health-based information systems, a regional IT department (Health Region North ICT), was created in January 2006. The former IT departments in each of the hospitals were decoupled from the hospitals, merged into this common regional IT department consisting of 126 employees. Health Region North ICT is organised directly been under Health Region North control and administration. Key intentions with this establishment were:

> "To contribute to an efficient ICT management through regionalisation (...) it is estimated a minimum profit on 5–10% in (...) approximately 2–3 years" (Ernst and Young, 2005).

And typically "standardisation of applications" (ibid: 21) was one of the means to achieve this.

The HealthSys laboratory module was up and running for the Clinical Chemistry, Immunology and Clinical Pharmacology laboratories in November 2004. However, the Microbiology laboratory refused to implement the HealthSys laboratory module even if the vendor promised to put in considerable resources into improving the laboratory module. Despite having a really outdated, existing system, the Microbiology laboratory argued that their work routines differed so much from the others (see Section 5.2 further below) that a common use was impossible. In our analysis we aim to explain why and explore how the implicated level of standardisation granularity shapes the integration efforts.

5. Analysis: Unintended consequences of integration of laboratory systems

Having outlined the case narrative from the University of North Norway effort spanning approximately a year, we want to target our attention more specifically at the issue of integration. The challenge of integration of

laboratory systems provides a confined yet instructive instance of the more general problem.

The overall theme of our analysis addresses the unintended, organisational consequences of tight integration with the HealthSys system. Despite the undisputed attractiveness of visions about the orderliness – with expected repercussions for efficiency and quality – embodied by tightly integrated systems, we unpack a rich and unfolding socio-technical dynamics. Our analysis is structured around two aspects:

- An apparent prerequisite for integration is the elimination of unwarranted variation in laboratory systems, i.e. to uniformly impose one, common laboratory module. We analyse the way this intended order produces highly unintentional, negative outcomes in other location. Order/*disorder gets relocated*, not eliminated.
- Integration and the implicated standardisation is not a binary concept but an issue of degree: the key issue is the *granularity* of standardisation across the Microbiology and Clinical Chemistry laboratories.

5.1. ONE SIZE FITS ALL: REDISTRIBUTED DISORDER

This ''one size fits all'' approach to standardisation of laboratory systems, seemingly a prerequisite for tight integration, implied that the common HealthSys module contained all the variations and options. As outlined in Section 2, order in one place implies a corresponding disorder in another place as Berg and Timmermans (2000, pp. 36–37) state:

> ''[T]hese orders do not emerge out of (and thereby replace) a preexisting disorder. Rather, with the production of an order, a corresponding disorder comes into being...The order and its disorder, we argue, are engaged in a spiralling relationship – they need and embody each other''

Results at one laboratory were now accessible to all users, not only the ones ordering the tests. Historically, the amount of people having access to sensitive laboratory results has been kept to a minimum level. E.g. in the HealthSys EPR module, the users in the clinic had limited access to HIV/AIDS results. However, using the same, HealthSys laboratory module implicated that results from the different laboratories were visible across the departmental borders:

> ''In the HealthSys laboratory module, you can see the results across the laboratories. For instance, the results of HIV tests are presented in plain text including the name of the person who is tested'' (Bioengineer, Clinical Chemistry)

In addition to increased access to sensitive information, the users in the laboratories argued that collecting everything in the same laboratory milieu threatened to drown them in irrelevant information.

> ''It is simply a lot more data to look at and now the problem is that you see so much of samples, analyses and results. It is difficult to have overview and easier to make mistakes'' (Bioengineer, Clinical Chemistry laboratory)

Moreover, all the analyses codes where collected together in one list:

> ''The HealthSys system has both strengths and weaknesses by being so integrated with the other laboratories ... but for us it is not helpful .... Just consider that you have to scroll the listbox [the list of analyses codes]. This also means that there are too many available options for the physician ordering a test''

Furthermore, the increase in the information presented to the users made it more problematic to achieve a core activity in all knowledge intensive work, namely to sort important information from the less important. The users in the clinical departments complained about being swamped in irrelevant details:

> ''Mixing everything together in a big chunk on the working lists has caused a problem for several departments because they want Microbiology results separated from the mass produced blood results'' (project member)

The seriousness of this became evident when several departments claimed that these results should only be signed by authorised physicians:

> ''For the Department of Gastro surgery, the pathology results are the big thing. Only three or four physicians at this department are allowed to sign these results. Those results are very, very important'' (project member)

However, the open access in HealthSys for both secretaries and physicians made it possible for everybody to sign these results as ''anybody can sign laboratory results. It should be a physician, but it can as well be a secretary'' (project member).

Unfortunately, the HealthSys laboratory screen presenting the results for a patient, in practice, prioritised results from the Clinical Chemistry on behalf of results from Microbiology as these (e.g. blood results) covered most of the screen. The less frequent Microbiology result was more hidden, causing a lack of overview (see Figure 3).

In order to read this textually relatively extensive result from the Microbiology laboratory, the user had to use the slide bars on the right hand side of the text. It was not possible to blow up the text to read the whole lot. Not surprisingly, this caused frustration among the physicians:

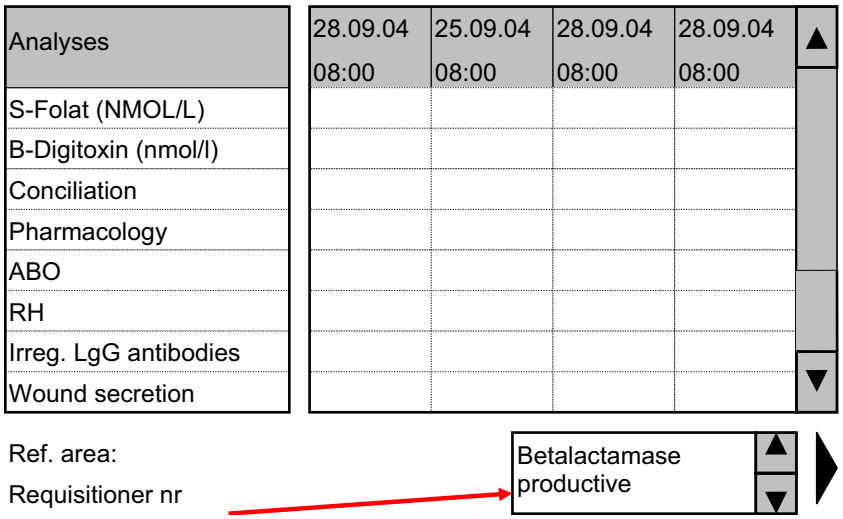

Figure 3. The laboratory result screen for the clinicians. A small part of the Microbiological result appears inside the textbox indicated by the arrow.

> The text field is almost not readable ... just look [struggling to scroll down to find them]. The content is almost completely drowned! ... I cannot use this ...I have to print it out [on paper] in order to read it'' (physician, Department of Geriatric).

The point is that integration (one system) was promoted at the expense of usefulness for the users in both the clinic and in the laboratories. The different user groups had to relate to more information than they really needed in order to make the HealthSys system work. To sum up, imposing order by standardised laboratory systems does, as Berg and Timmermans (2000) predict, redistribute rather than eliminate (perceived) disorder.

5.2. GRANULARITY OF STANDARDISATION

To highlight the issue of degree or granularity of standardisation, we describe in more detail where, how and why the work practices at the two laboratories deviate. At stake here is the extent and implication of the ''otherness'' of Microbiology (Berg and Timmermans, 2000; Law, 2003; Law and Singleton, 2005). Representatives from Microbiology argued that, their work was different from Clinical Chemistry as it was more geared towards interpretations and context-awareness and less about ''merely'' providing positive and negative results. The problem, from the point of Microbiology, was that the

HealthSys laboratory module was based on the work of Clinical Chemistry thus making Microbiology invisible (''othered'').

Given the many Clinical Chemistry laboratories in Norway and their high production it should not come as any surprise that:

> ''The problem is that every vendor making laboratory systems, starts out where the production is most intensive and that means Clinical Chemistry, but the problem is that Clinical Chemistry has an incredible simple data structure'' (Physician, Microbiology laboratory)

The HealthSys vendor suggested the work list way of doing things (as at Clinical Chemistry) to the Microbiology laboratory, but the users turned it down and said they used work lists to a very little degree. Dealing with microbiology samples is a completely different matter than making clear-cut orders to the Laboratory of Clinical Chemistry. The process inside the laboratory is much more complex involving collecting information from various information sources, thus generating highly contextual information. In the HealthSys's laboratory module, this information was either missing (for example registers for non-human samples, material, location and antibiotics) or dispersed throughout the system:

> ''In the HealthSys module, generally, the information that we need is very much dispersed in different screens and folders. This requires a lot of clicks orientation and manoeuvres to group things together, such as which bowl, which colony [cultivating] and where the result comes from as traceability is extremely important'' (Physician, Microbiology laboratory).

Consequently, HealthSys's laboratory module was less useful for the physicians at the Microbiology laboratory. As the one of the HealthSys developers admitted in a project meeting with the Microbiology laboratory:

> ''I am 'programmed' completely different from the way you work. When I talk about work lists, then you won't even consider it''

> The physicians at the Microbiology laboratory use various information sources when analysing and interpreting a sample. They assess what the bioengineer has done, look at patient history, clinical findings and make the conclusion based on this information.

Today this information is registered on the work sheet (Figure 4), which is the reverse side of the paper-based requisition. What the physicians really wanted was an electronic version of this:

> ''In contrast to a work list, we want to see the referrals one and one with all the detailed information associated with it [the work sheet]. When it comes to the medical side, we need several components available in the work

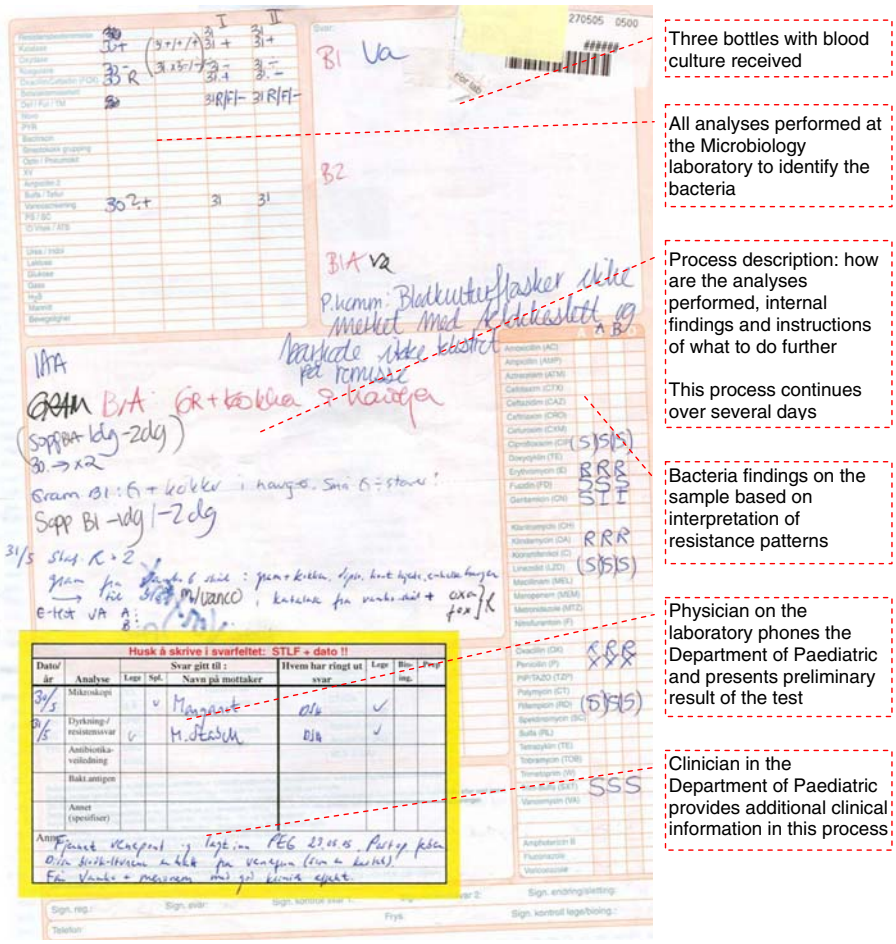

Figure 4. The paper-based worksheet showing the worksheet where there are positive findings on blood culture for one sample.

sheet: information that has come to the laboratory, what is ordered, clinical findings etc., information generated inside the laboratory: what we have done and found, and finally, our answer where we can see that we have provided a sensible result'' (Chief physician, Microbiology).

The Microbiology laboratory argued that the HealthSys laboratory module was designed to order simple blood samples (as from the Clinical Chemistry), but far from conforming to the needs of a complex microbiological work practice.

Figure 5 presents the laboratory ordering screen for the users in the clinical departments. Users will normally first, select the actual laboratory where a sample is to be tested, and second, select specific analyses from the left list box. Selected analyses appear in the right list box.

This interface requires that the physicians ordering tests have a clear picture of what kind of analyses he wants to be conducted as would be the normal case with Clinical Chemistry. Most of the results give result in form of positive/negative or a number. The Microbiology laboratory, however, needs additional information from the clinicians in order to narrow down the possible investigation strategies. Then *clinical information*) as well as *material* (articulation fluid, urine, plasma etc.) and *location* is extremely important. A major problem with this additional information is that:

> ''We don't get the necessary information. It happens time and again and we had to request this information from the clinician who sends the requisition'' (Physician, Microbiology laboratory)

Below is an extract of a project meeting where this point is underscored. The HealthSys vendor had been invited to the Laboratory of Microbiology in order to present the functionality of the laboratory module. The head physician of the laboratory starts out pointing out the difference between

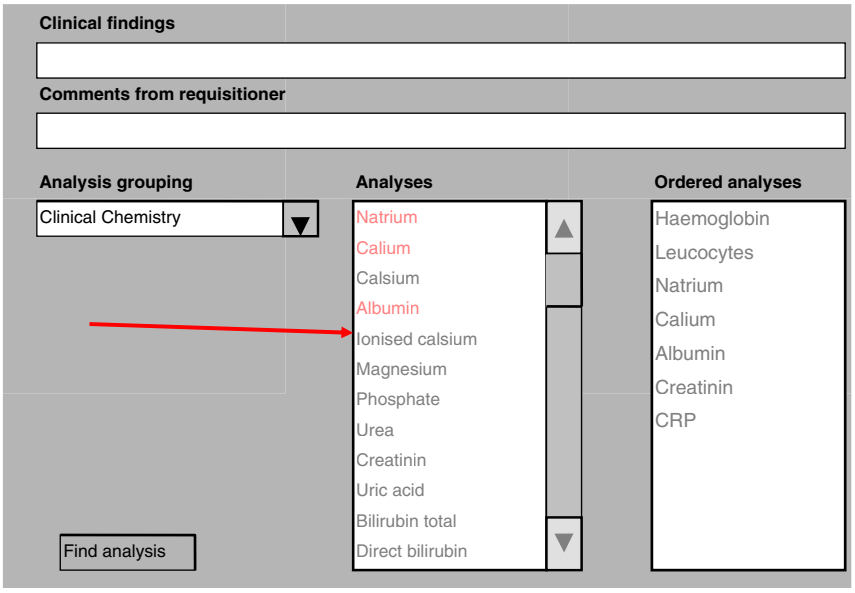

Figure 5. Screen in HealthSys where physicians in the clinic may order tests from the laboratories. The red arrow indicates the list of analyses which may be ordered from the laboratory.

Microbiology and clinical chemistry (a point he has made in several project meetings) for the HealthSys developer. After that, the extract illustrates the importance of *material* and *location*.

> Head physician, Microbiology: Analyses, material and location is the essence of the difference between Microbiology and Clinical Chemistry. The actual analysis has less relevance for us, but is 'king' at Clinical chemistry. In a sense, they start with the conclusion.
>
> Bioengineer (suggesting an alternative strategy when ordering tests): Maybe the ordering clinicians should register *material* as the first thing: if the material is registered first, it would be possible for the system to check options for available analyses (...) As it is today we often have to call the clinician to inquire about the material we have received.
>
> Secretary (following up): The point is if we know that the material is the left nail, then we know what to do, and then a package of analyses should be available
>
> HealthSys developer (a bit frustrated): It is a completely new world we enter here [at Tromsø] [he is used to a previous HealthSys installation in Bodø] ... It means turning the world upside down.
>
> Bioengineer: Well, it means getting the input control that we need.As was pointed out, the actual analysis is of less value for the Microbiology laboratory. What is important is to ensure that the ordering physicians provides all necessary information and through this tells us that he has understood what he has ordered, that is, a more specific input control.

This underscores not only the differences in work practices between Clinical Chemistry and Microbiology, but also how the different practices spill over, influencing each other in the overall effort for an integrated and standardised solution. In addition, the common HealthSys system prevents the local tailoring of the user-interface for the physicians in the clinic. Tailoring it according to Clinical Chemistry principles, such as simplicity, efficiency and clear-cut analyses, implies to ban the Microbiology laboratory's need for thorough input-control, problem-orientation and interpretation/explanation of the results. In the other way around, basing the user interface design on microbiology principles clearly complicates the work for the physician ordering results from Clinical Chemistry as she knows precisely what analysis to order, underscoring the need for speed and simplicity.

6. Conclusion

We have elaborated on the differences between two laboratory practices as one part of a large-scale reorganisation and integration project of the laboratories in the northern health region of Norway. From a user-led perspective, it seems obvious that the design of the systems fall significantly short of meeting the requirements and expectations at the Microbiology laboratory. In fact, many if not all of the illustrations we have used describe apparently amendable design. It could seem, thus, that our case is but another instance of poor design, of design inadequately tailored to the local needs of the Microbiology laboratories work practices.

The core of our argument, however, is that such a perspective fails to accommodate a vital aspect of the case, viz. the implications of the ambition of seamless integration and the necessity to approach the issue of dependability of systems from a different angle. Integration is embedded as an element in the broader political restructuring of (also) Norwegian health care into a stronger regionalisation. The principal motivation behind the establishment of the five regional health enterprises in 2001 was to exactly improve efficiency, coordinate activities and exploit existing resources on a regional level. As was stated in SHD (2001):

> ''The Ministry of Health and Social Affairs must be very clear in bundling IT with the governmental undertaking of the hospitals. This means that the Government as an owner promotes a desired technological development through the establishment of regulations, standards, funding arrangements and organisational incentives.''

The regionalisation of the health care sector has implied:

- Handing regional/national competition
- organisational flexibility and absorbing workload peaks
- Common bid for tender
- Common purchasing of equipment from external vendors
- Centralisation and standardisation of services
- Relatively free flow of health personnel between the hospitals

In this light, we have witnessed a large-scale health reorganisation effort, not only aiming at streamlining the laboratory functions in Health Region North, but rather reorganisation of the whole Norwegian specialist health services (that is the hospitals). In this regard the regional ambition of establishing integrated and common IT functions for Clinical Chemistry and Microbiology laboratories express a much larger agenda of establishing regional (and national) effectiveness. A key element here – and this is the link to our case – is that this includes the (attempted) centralisation and standardisation of selected services including laboratory services. In other words,

Health Region North knew perfectly well that there were differences in work practices across the different laboratories. But they seized this opportunity to enforce (more) standardised work practices to facilitate the centralisation of the laboratory service in the region. A similar type of centralisation and standardisation had already been implemented for the IT support in the region.

In sum, we have pointed at the complexities of integrating multiple local settings through a common system. The issue of integration of information systems has not been equally acknowledged as a socio-technical problem in the manner development and use of new applications has (Berg, 1998; Tjora, 2004). This is unfortunate as it declines to challenge a prevailing perception of integration as largely a technical issue (Grimson et al., 2000; Xu et al., 2000). And even more important, we have illustrated that a local setting is no long longer local, but is dependent on design in other settings. Involuntarily, this implies that truly user-led development is impossible to achieve in large-scale integration projects. Furthermore, this increases the possibilities for unintended consequences and disorders of which we have emphasised in our analysis. Given the fact that many integration efforts generally imply standardisation to practices and systems, we suggest that the disorder generated by integration efforts is *immanent*. When specific instances of this disorder are eliminated, new ones are simultaneously produced, possibly relocated.

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