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The Struggle for District-Based Health Information Systems in South Africa

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This article describes the initial period (1994–2001) of an ongoing action research project to develop health information systems to support district management in South Africa. The reconstruction of the health sector in postapartheid South Africa striving for equity in health service delivery and building of a decentralized structure based on health districts. In terms of information systems (IS) development, this reform process translates into standardization of health data in ways that inscribe the goals of the new South Africa by enhancing local control and integration of information handling. We describe our approach to action research and use concepts from actor-network and structuration theories in analyzing the case material. In the detailed description and analysis of the process of IS development provided, we focus on the need to balance standardization and local flexibility (localization); standardization is thus seen as bottom-up alignment of an array of heterogeneous actors. Building on a social system model of information systems, we conceptualize the IS design strategy developed and used as the cultivation of processes whereby these actors are translating and aligning their interests. We develop a modular hierarchy of global and local datasets as a framework within which the tensions between standardization and localization may be understood and addressed. Finally, we discuss the possible relevance of the results of the research in other countries.

Keywords South Africa, health information systems, decentralization, empowerment, action research, standardization, information systems development

The work presented here is based on research carried out in the Health Information System Program (HISP)¹

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in South Africa since the advent of democracy in 1994. As a legacy of apartheid, the new South Africa inherited one of the least equitable health care systems in the world; 60% of the resources were (and are) used by the private sector, serving only about 20% of the population. In order to rectify the wrongs of the past, the new government launched the Reconstruction and Development Program (RDP) (ANC, 1994a) with a title that clearly expresses its intent: the reconstruction and development of communities that suffered under apartheid. The restructuring of the health sector, as laid out by the RDP and the National Health Plan (ANC, 1994b), is based on a decentralized system of health districts. Development of a new national health information system to support the restructuring of the health sector is part of this plan. The politics of apartheid were deeply inscribed into the “old” health information systems; the process to change the system has been complicated and intimately linked to the wider political, social and health sector changes in South Africa. In its first pilot phase (1996–1998), HISP aimed at developing district health information systems to support the emerging decentralized administrative structures in three pilot districts in Cape Town. In February 1999, based on achievements of the pilot phase, the Department of Health in South Africa adopted the strategies, processes, and software developed in the pilot districts as the national standard. These are currently being rolled out to all districts (second phase, 1999–2001).

The legacy of apartheid has made standardization of health data a major element in the process of changing the health information systems in South Africa. The politics of apartheid—segregation, centralism, and exclusion of “black” South Africans—have all been deeply inscribed into all the bits and pieces of the information systems in which standards for data collection are basic elements. During apartheid (1948–1993), the health services were

extremely fragmented according to race, type of service, and the system of "homelands." Until May 1994, there were 14 departments of health at the central level: the "general" Department of National Health and Population Development, 3 specific "white," "Asian," and "colored" administrations, and 10 for "blacks," "homelands," and "self-governing states." As one consequence of this fragmentation, there were no comprehensive national standards for data collection, and each province used different data sets, definitions, and standards. Furthermore, apartheid was characterized by extreme inequity in health services provision and health status between populations and racial groups. Equity in health services provision and health status has therefore been a major political target in postapartheid South Africa. The important issue in this case is that striving for equity between geographical areas and racial groups will require a system of national standards to measure and monitor the extent to which this policy is being achieved and to pinpoint areas where more resources and efforts are needed.

Another reason why standardization is important is of a more general character and is linked to the tension between local and global scale development of information systems. Starting in three pilot districts in Cape Town in 1996, the aim of HISP was to identify information needs and to engage the community of end users and local management structures in the process of developing new health information systems. The process was soon faced with a major obstacle: Local-scale development relies on development at the global scale, as all information systems are tied up in a complex web of social and technical interaction (Kling & Scacchi, 1982). It is difficult to create and nearly impossible to *maintain* isolated "democratic islands" of localized information systems. Local health units are part of, and dependent on, the larger health system and will therefore need to interact with the higher level health system by way of standards for data collection. As a consequence, information system design for local empowerment in the health sector needs to address standardization a central issue. This problem may be analyzed in terms of the tension between *standardization* and *flexibility* for *localization* (Hanseth et al., 1996). While standards are foundational for coordinating activities across time and space (Bowker & Star, 1994), flexibility is necessary for grounding these activities locally, that is, for successful localization.

This article describes and discusses the process whereby HISP developed from a local, bottom-up, grass-roots movement to become an "official" national standard in South Africa. We focus on two areas of research that have been central in the HISP case:

1. The process toward developing standards for primary health care data, and how this process is interrelated with
2. The design and development of a district based health information system using a participatory prototyping strategy.

Furthermore, we address the issues related to action research as it has been carried out in HISP, within the framework of interpretative research (Walsham, 1995). Action research was introduced in the 1940s as a way of generating knowledge about a social system while at the same time attempting to change it (Elden & Chisholm, 1993). Our approach to action research and information systems design was initially influenced by a number of union-based action research projects in Scandinavia in the 1970s and 1980s. The focus in the earlier participatory design projects was on empowering workers who were affected by or threatened by new technology, by exploring ways in which their influence over technological solutions could be ensured (Sandberg, 1979; Bjercknes et al., 1987). The later projects shifted toward producing technological alternatives by involving workers in cooperative design at the workplace (Greenbaum & Kyng, 1991). Adaptation of information systems to the local context, empowerment through practical learning, and the creation of local ownership through participative processes are central issues in the Scandinavian projects, which, despite the differences in context, offer important lessons for Third World IS design (Braa et al., 1995). It is important to note that the original key members of the HISP team have background as social/political activists in the antiapartheid struggle and other social movements, and that we have always explicitly and implicitly seen ourselves as political actors in a larger development process.

This article is organized as follows. The second section gives an account of general theoretical concepts applied in the research: actor-network theory, standardization, and structuration. The third section presents the research approach of action research in IS/IT development. The fourth section presents the HISP case, providing background and historical reconstruction, examples of information handling at local levels, the standardization process, and the process of prototyping. The fifth section discusses the standardization process and IS design as cultivation of organizational change. The final section provides a summary and conclusions.

THEORETICAL CONSIDERATIONS

Actor-Network Theory

In describing the story of HISP, we find it useful to follow the main actors, both human and nonhuman, that are driving the process. In doing this we use some terms and general perspective from actor-network theory. Here society is regarded as a sociotechnical web where technical objects participate in building heterogeneous networks that bring

together *actors* (nodes) of all types, whether human or non-human (Latour, 1987; Callon, 1991). In the case of HISP, key actors range from people, documents, the establishing of facts, and key events, to software, courses, workshops, and standards. According to Latour, *translation* occurs as actors enroll allies in the actor network and *align* their interests in a continuous process of renegotiation where

claims become well-established facts and prototypes are turned into routinely used pieces of equipment. Since the claim is believed by more than one person, the product bought by more than one customer, the argument incorporated in one more article or textbook, the black box encapsulated in one more engine, they spread in time and space. (Latour, 1987, p. 132)

Latour developed important aspects of actor-network theory through a number of historical case studies where the processes leading to inventions and scientific discoveries were seen as processes of creating and mobilizing actors in actor networks (Latour, 1987). This approach may help in describing and analyzing bottom-up processes where the outcome is far from given at the outset but is determined by the negotiations between actors and the alliances formed. By focusing on the various actors and the creation of alliances, important driving forces behind aligning actors may be identified, such as in the process of standardization. An example from the HISP case is how the software developed to capture and process a “data set” in a pilot site rapidly becomes a crucial actor in aligning a range of actors to accept and promote Essential Data Sets, thus providing the real-world basis for a national Health Data Dictionary. Years of workshops and committee work had not been able to produce similar results on the ground.

Actor-network theory represents a particularly useful perspective on information infrastructure and standardization processes by virtue of its orientation towards improvisation and alignment (Monteiro, 2000). Actor-network theory

is heterogeneous, meaning that there is an open ended array of ‘things’ that need to be aligned, including work routines, incentive structures, training, information systems modules, and organisational roles. . . . Alignment, according to ANT, is not the result of any top-down plan or decision. It is the achievement of a process of bottom-up mobilisation of “things.” (Monteiro, 2000, p. 72)

The process of developing the health information infrastructure in South Africa is, similarly, characterized as a bottom-up alignment of heterogeneous actors.

Actor-network theory is being used by several IS researchers, though for slightly different purposes. Walsham and Sahay (2000) used actor-network theory to follow the process of network building in a longitudinal study of a GIS project in India. Monteiro and Hanseth (1995), on the other hand, argued that actor-network theory allows

for a detailed description of the concrete and that it fits well with the technical realities of networked information technology.

Inscription is another concept from actor-network theory that we are using. The term covers the way designers’ scripts and worldviews are inscribed into the object as a *scenario for action*, as well as more implicit translations being negotiated in the context of use (Akrich, 1992). Standards and standardization, key issues in the HISP case, thus represent direct means to express and to perform inscriptions.

Standardization—and Cultivation

In this subsection we present findings from research on standardization processes, which form the point of departure for analyzing standardization in the HISP case. In a study of transnational corporate infrastructures, Hanseth and K. Braa (2000) concluded that the idea of a universal standard is an illusion because:

information infrastructures are not a closed world defined by a closed standard. They should be seen rather as open networks—that is, as networks that are linked to other networks, which are again linked to other networks, and so on, indefinitely. (p. 125)

Standardization is thus seen as a forever-ongoing process involving a number of more or less overlapping and interlinked “networks,” which resemble the various levels, health structures and scopes of health data in the HISP case.

In a study of the Internet Standardization process, Hanseth et al. (1996), argued that standards and flexibility (localization) are interdependent and both necessary for changes to occur. Given a modular development, which they argued is a prerequisite for flexibility, standards will guard the interfaces to the module, allowing for innovation and changes (i.e., flexibility) to take place inside the module, thus allowing for later changes in the standards.

Bowker and Star (1994) have studied the history of the International Classification of Diseases (ICD), which is a list of standardized diagnoses organized in a strict hierarchy. Problems facing such a universal standard are linked to differences in the way diseases are understood, practices in handling them, and the way information is collected, coded, and verified.

There is a permanent tension between attempts at universal standardisation of lists, and the local circumstances of those using them; . . . this tension should not, and cannot, be resolved by imposed standardisation, because the problem is recursive. (p. 190).

Timmermans and Berg (1997) have studied standardization of medical protocols, that is, procedures for medical

treatment and action. They found that there is no *universality*. Universality should rather be seen as a distributed activity of localization. They argued that

Universality is always “local universality.” The achievement of local universality depends on how standards manage the tension involved in transforming work practices, while simultaneously being grounded in local practices. (p. 273)

Furthermore, they argued that there are always multiple universalities, some of which may be in conflict.

To summarize, based on two sets of arguments, to strive toward universal standards is seen as a futile project:

- The process of change: The world is constantly changing, as are the interfaces between the networks representing sets of standards.
- The problem of representation: There is no one universal way to use, understand and appropriate “standards.” Localization leads to multiple universalities.

In describing the process of developing new standards for health care data in South Africa, we use the term *cultivation* (Dahlbom & Janlert, 1996) to denote the design strategy followed in the HISP process. By cultivation, we mean a slow, incremental, bottom-up process of aligning actors by enabling translation of their interests and gradually transforming social structures and information infrastructures where the resources already available form the base. The precise outcome of the design process is not given, but is negotiated within a broader set of goals. This design strategy is characterized, on one hand, by *improvisations* and *bricolage* (Lévy-Strauss, 1966), using what is at hand to make do, and on the other hand, by a strong emphasis on flexible negotiation keeping design options open, for example, by *delaying decisions* that will lock future choices. Cultivation as a design strategy is directly linked to conceptualization of information systems as social systems. The cultivation of new standards—*standardization*—is then about transforming and changing the behavior and routines of a social system, which again may be understood within a framework of routines and institutionalization.

Routines and Institutionalization

Institutionalization of information systems and standards has been a key issue in the HISP case. On the one hand, the focus has been on how the existing centralized information systems and standards present obstacles to change, and on the other hand, on how new decentralized information systems may institutionalize new work practices. The health information systems in South Africa, and elsewhere, comprise thousands of health workers engaged in routine collecting, registering, collating, and reporting of data in a

large number of standardized formats. In a later section we provide examples of ways that health workers attribute institutional trust to these routine reporting systems, and see them as means to confirm social contracts. Consequently, when new “improved” standards for reporting were introduced, the health workers tended to resist these changes. We use Giddens’s structuration theory as a framework for understanding how routinisation of information handling is linked to institutionalization and resistance, and respectively to opportunities for change. Structuration theory emphasizes the unintended consequences of action as a mechanism of reproduction of institutionalized practices:

Repetitive activities, located in one context of time and space, have regularised consequences, unintended by those who engage in those activities, in more or less “distant” time-space contexts. (Giddens, 1984, p. 14).

The intended purposes of standards and routine health information systems are to provide information for decision-making, surveillance, and statistics. To some extent, unintended consequences of the information system are the creation of processes of repetition and routinization of social activities, which are important in forming and maintaining the health institutions. The duality of social processes, as both containing process and structure, both action and conditions for action, is captured in Giddens’s notion of structuration (Giddens, 1984, p. 25): “the structural properties of social systems are both medium and outcome of the practices they recursively organise... Structure is not to be equated with constraint but is always both constraining and enabling.”

The hundreds of health workers daily engaged in routines of collecting, collating, and reporting data represent the means, while the structures thus constituted represent the outcome, within which actions take place. It thus follows that, while at the same time social action is constrained by structures (resistance to change), these structures enable social action which may (or in fact *will*) eventually change those structures (opportunity for change). In terms of standardization, the duality of structure is captured, for example, by the notion of interdependence between standards (stability) and flexibility (change) (Hanseth et al., 1996).

RESEARCH APPROACH

The authors have been deeply and directly involved in strategic planning, daily implementation, political brokering, software prototyping, institutional development, and training at all levels. The research approaches we use fall within the framework of action research. Action research has been typified as a way to build theory, knowledge, and practical action by engagement with the world in the context of practice itself (see, e.g., Whyte, 1991; Vigden &

Braa, 1997). The Scandinavian union-based IS research projects brought critical, political, and empowerment perspectives into action research (Bansler, 1989; Ehn & Kyng, 1987). Building on “web models” (Kling & Scacchi, 1982), we apply a social systems model to information systems: Information systems are part of their social context of use, and vice versa. Information system design therefore needs to be part of wider processes of social and organizational change. We engage in action research as a way to involve the wider social system in the design and development of information systems. Contemporary forms of action research, rather than being “value neutral,” seek to bring about changes that have positive social value:

An action researcher has some vision of how societies or organisations could be improved and uses the research process to help bring this desired future state into existence. . . . In addition, the new varieties of action research . . . aim at increasing the system’s self development capacity. (Elden & Chisholm, 1993, p. 127)

Action research, as we apply it, falls within a broader class of interpretative IS research, which has increased in importance in recent years (Walsham, 1995). Interpretative research aims at understanding social meanings rather than knowing facts and helps IS researchers to understand information systems in social contexts. Klein and Myers (2000) suggested a set of seven principles for evaluating and conducting such research.

The third principle of interaction between the researchers and the subjects requires critical reflection on how research data were socially constructed through the interaction between the researcher and the participants. Participation between researchers and the “subjects” in terms of shared goals and purposeful social coconstruction of facts is a stronger element in action research than what is generally the case in interpretative research. In HISP, data collection and interpretation have gone through cycles from presenting an analysis of a situation to implementing changes with users, health workers, or managers, then evaluating the analysis or change intervention in collaboration with those involved. We use actor-network theory as a tool to enforce critical reflection on our own role as actors. For example, we clearly state the scenarios and meaning we wanted to inscribe in the software (discussed later).

The fifth principle of dialogical reasoning requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research and the actual findings. The feedback cycles and participation inherent in action research generally focus on identifying such contradictions in order to solve them in an ongoing dialectic process. The longitudinal prototyping of software and standards for data collection carried out within HISP has, more specifically, aimed at confrontations between the preconceptions of the research and the reality on the ground.

An example relating to these two principles is the position taken by key HISP team members (including one of the authors) on the issue of essential data elements related to immunization. HISP was instrumental in developing a composite data element that later became a national standard called “Immunized fully under 1 year—new,” in our pilot districts in the Western Cape. Until recently, HISP team members advocated this data element as the only immunization data element necessary; all other data elements collected were regarded as “useless” and could be discarded. It is now clear that the introduction of this element was fraught with problems in almost all provinces. Health facility staff usually do not easily understand how it is defined: There are no established routines for identifying infants as “fully immunized” nor for tallying and counting their number. For these reasons, the data collected may generate immunization coverage rates of 150–750%. Fortunately, the National Immunization Program managers did not buy the arguments put forward by HISP and some of its partners, and insisted on collecting a limited set of data elements for specific vaccinations. This limited data set has been necessary not only to provide indicators for key government programs and targets, but also made it possible to identify all the facilities where staff do not understand the data element “Immunized fully under 1 year—new” and, furthermore, to adjust the values of this element in the short term. This example shows how a push for standardization failed because problems regarding use and institutionalization were not considered. The example also shows how feedback and implementation in action research may bring distortions to the surface and lead to further changes.

The sixth principle of multiple interpretations requires sensitivity to possible differences in interpretations among the participants. The research in HISP has been molded in negotiation with other actors holding multiple perspectives and interpretations on the research. As an example, the research strategy in HISP has been developed in contradiction to a number of high-profile projects based on different interpretations of the needs of the health services and what might be appropriate strategies. The major confrontation has been between HISP’s strategy of low cost and partly paper-based systems for collecting an essential standardized data set for primary health care, on the one hand, and implementation of comprehensive, high-cost electronic health record (EHR) systems on the other hand. The failure of some of these “competing” high-cost and high-tech projects made HISP’s relative success attractive to a number of other actors, which subsequently aligned their interests with HISP (see later discussion). In more general terms, transparency and confrontation between interpretations by the researchers and others may be enabled through feedback, implementation, and participation in action research.

The seventh principle of suspicion requires sensitivity to possible biases in the narratives collected from the informants (participants). In (participatory) action research and in the HISP case, the narratives are developed and constructed through dialogue between researchers and participants, rather than merely “collected.” The principle of suspicion therefore includes scrutinizing the researchers’ own narratives. One result of such reflective analysis was the understanding that the rapidly increasing momentum of HISP during the crucial ‘turning period’ 1998–1999 was due as much to the failure of “competing” projects as to the achievements of HISP itself. Important actors in the health field accepted HISP because of its *relative* success. HISP’s academic institutional base and its close relations and partnership with national and provincial stakeholders provided a reasonable balance —“one leg on the inside and one on the outside” of the health sector—that has been important in pursuing a research agenda.

THE HISP CASE: PRESENTATION AND DISCUSSION OF KEY ELEMENTS

We present the HISP case in four subsections: (1) a brief historical reconstruction, (2) information handling at local levels, (3) the standardization process, and (4) the software development process.

The HISP Case: A Brief Reconstruction

As part of South Africa’s Reconstruction and Development Program after 1994 election, strategic management teams were established to develop plans for the reconstruc-

tion of the health sector in all provinces. In early 1995 the subcommittee of the Strategic Management Team on Health Information Systems in the Western Cape Province proposed a pilot project to develop district health and management information systems. This was based on research carried out in Atlantis and Mitchell’s Plain, two “colored” townships created by apartheid through forced removal in the 1970s (Braa et al., 1997). The proposal received funding from the Norwegian Agency for Development Co-operation (NORAD) for a 2- to 3-year pilot project (Figure 1).

Pilot Phase, 1996–1998: Prototyping and Implementation in One Province

1996. Based at the two Cape Town universities, HISP was established in three health districts in and around Cape Town with one full-time district facilitator in each district and a project coordinator. University staff, activists from the health sector and nongovernmental organizations (NGOs), and two Norwegian researchers (the authors) comprise the HISP team. The initial focus was on identifying information needs and supporting interim district management teams. These efforts transformed into two main areas of research and implementation: (a) development of Essential Data Sets and standards for primary health care data, and (b) development of a District Health Information Software application supporting the implementation and use of such data sets.

1997. After about 9 months of intensive negotiations driven by local managers in collaboration with the HISP team, the first essential data set is implemented in all local government health facilities in the Cape Metropole (including HISP pilot districts), and later in the whole of

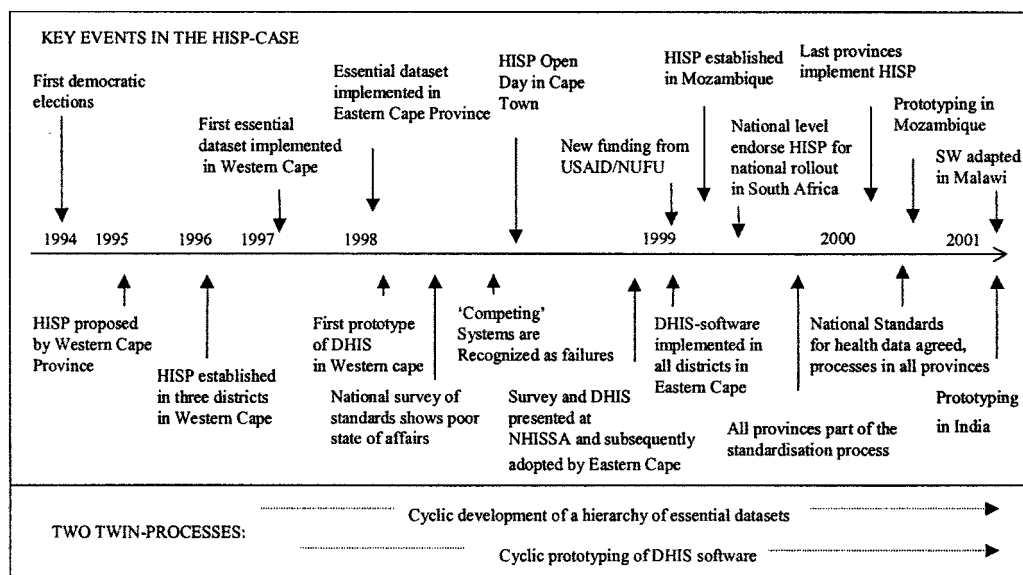


FIG. 1. A chronology of important events in the HISP case.

Western Cape. This process feeds into and interacts with a similar process in the neighboring Eastern Cape Province.

1998. The first version of the District Health Information Software (DHIS) is implemented and used to capture and analyze monthly data at district, regional, and provincial levels in Western Cape. This is the start of the period of active prototyping and user interaction, which continues at the time of writing.

The failure of two other software and IT projects becomes an important event in the further development of HISP. In the Eastern Cape Province a unified monthly report is implemented as from January 1998, in all primary health care centers. First, a software application developed to capture and analyze this data had significant limitations and was replaced by the DHIS software. Second, a large high technology primary health care information project based on scanning of individual tick-sheets from all patients' health services encounters in the Free State Province, with a large provincial budget and much attention, ran into problems and was abandoned. The failure of the Free State project, compared with the relative success of HISP, increased HISP's credibility considerably. Despite this, NORAD decided not to continue the funding and most people believed activities would not continue beyond the pilot phase.

An Open Day conference in October 1998, seen as a wrap-up of the HISP pilot phase, became a manifestation of the achievements and popularity of HISP at both grass-roots and provincial levels in the Western Cape Province. Representatives from national level were impressed and invited HISP to present at their meeting in Durban 2 weeks later. That meeting had a profound effect on two processes: First, the presentation of the national survey of health information systems and essential data sets triggered a process toward a new national Essential Data Set, formally adopted in early 1999. Second, representatives from the Eastern Cape decided to switch to using the DHIS software. Eastern Cape data for 1998 were "cleaned" and imported into a DHIS data file, the software was implemented in all districts in Eastern Cape, and initial training was held during November–December. The Norwegian University Council (NUFU) decided to fund HISP for the period 1999–2001.

Phase 2, 1999–2001: National Rollout of Software, Training, and Standardization

1999. After official endorsement as a national standard in early 1999, pilot projects were started in several provinces: KwaZulu-Natal, Mpumalanga, Northern Cape, and the North West Province. HISP was established in Mozambique as a collaborative effort between Universidade Eduardo Mondlane and the Ministry of Health.

2000. Business plans for the HISP rollout in South Africa were developed in each province, and the last three provinces began implementation during the first or second

quarters. EQUITY/USAID funded the national rollout for 2000–2001, allowing HISP to hire another five full-time trainers and purchase more programmer time. Parts of the DHIS user interface were translated into Portuguese and activities started in pilot districts in Mozambique.

2001. The HISP rollout continued in all provinces and districts in South Africa, with data input coverage for the financial year (April 2000 to March 2001) reaching 95%—the highest known for any routine health information system in South Africa. The DHIS software was adopted by Malawi and piloting began in several other developing countries. In terms of funding, however, the situation in 2001 was similar to 1998: Despite generally being perceived as a success, no funding was secured for the following year. This illustrates a basic ambivalence in the HISP process: HISP has never been fully accepted by official structures, but never fully dismissed neither. Being a bottom-up, grass-roots movement, this is probably inevitable and indicates both the strength and the weakness of a movement like HISP: *independence* and *vulnerability*.

Information Infrastructure as Institutional Glue

Already in 1925 Marcel Mauss showed how social interaction and rituals, as the interchanging of gifts, "tied up," confirmed, and committed social relationships and constituted and reproduced social institutions (Mauss, 1954). In somewhat similar ways, the interchange of data and reporting systems acts as "institutional glue" and seems to constitute and reproduce the social relationships and *contracts* and the social fabric within the health services. When drawing up the information flows of the systems, the institutional structure of the health sector is also being identified. The mapping of the health information systems is thus a reflection of the hierarchical structures in the health sector down to the individual health worker.

Figure 2 shows the data flows and thereby the administrative structures in Mitchell's Plain district as inherited from apartheid. Note that all flows are going one-way *out* of the district, with no *local* administration and/or coordination of data collection or information processing. Mitchell's Plain was classified as a "colored" township under apartheid and was thus administered "from a distance," as were all other "nonwhite" areas in apartheid South Africa. The data flows thus represented the centralized command structure of the apartheid state. Nearly all of the excessive number of data elements collected related to workload, or as one Cape Town City Council official put it, "We want to control that the health workers do their job."

Another key perspective on these data flows is that they reinforce existing social contracts between health workers and their "masters." Workers view data collected as a tool for "showing the bosses what we do" at the same time as

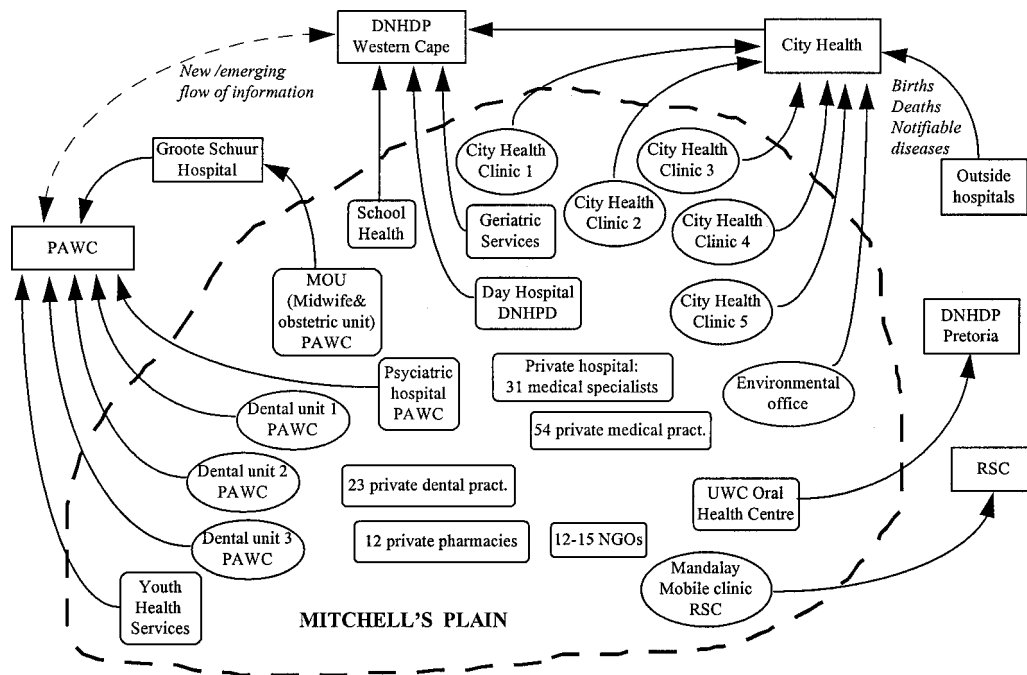


FIG. 2. The flow of information in Mitchell's Plain health district in 1994. Abbreviations: DNHDP, Department of National Health and Population Development (preelection name); PAWC, Provincial Administration Western Cape; RSC, Regional Service Council; NGO, nongovernmental organization; UWC, University of Western Cape; City Health, Cape Town City Council Department of Health.

they continuously complain about excessive demands for data being punishment from up high.

As an example, in the Day Hospital in Mitchell's Plain, the manager wanted to replace the data collection forms used in the wards with simple tally sheets (see Figure 3). While the old form included patient folder numbers and other scribbling not used afterward, the new tally sheet was intentionally including only what was useful. The two forms represented roughly the same amount of work carried out in the injection room on a particular day in 1995 and 1996, respectively. The old form has 59 entries, whereas the new form has 66. The health workers initially refused to use the tally sheet because they felt that an anonymous check mark did not reflect the amount of work it represented. The reporting system was thus seen as a way to legitimate their work. The old form contains text and figures representing *real* patients. Furthermore, it looks much "busier" than the check sheet, and it gives a certain personal touch in relation to each activity performed. The old form thus represents a "personalization" of work, a particular health worker dealing with particular patients. This is not seen as being represented by a check-mark in the new "anonymous" form. In other words, the *unintended consequences* of the data reporting system, to confirm and reinforce social contracts and existing power structures, are as important as the *intended purposes* of the system, to report on activities in the injection room. All

data items and standards addressed within the HISP case have similar origins of being embedded in daily reporting routines and work practices.

The Standardization Process

The aim of the standardization process has been to (1) develop national and provincial essential data sets, and at the same time (2) encourage the districts to develop their own additional essential data sets. Each data set would include the elements in the data set for the level above. All these data set should preferably also include the essential data elements needed for vertically organized programs. The appendix shows the standard Primary Health Care data sets for South Africa 2001, containing 46 data elements. In the discussion that follows, we present a few examples to illustrate increasing levels of sophistication of the standardization process: First, standards for primary health care data need to ensure compatibility and enable comparison across areas; second, they should be feasible to collect; and third, they should be useful.

Compatible and Comparable Health Data. The national survey carried out by HISP-related researchers in the middle of 1998 showed clearly that the provinces were using a multitude of cutoff ages when collecting data on teenage pregnancies. Cutoff ages of 15–17 years were generally used when the designers put major emphasis on

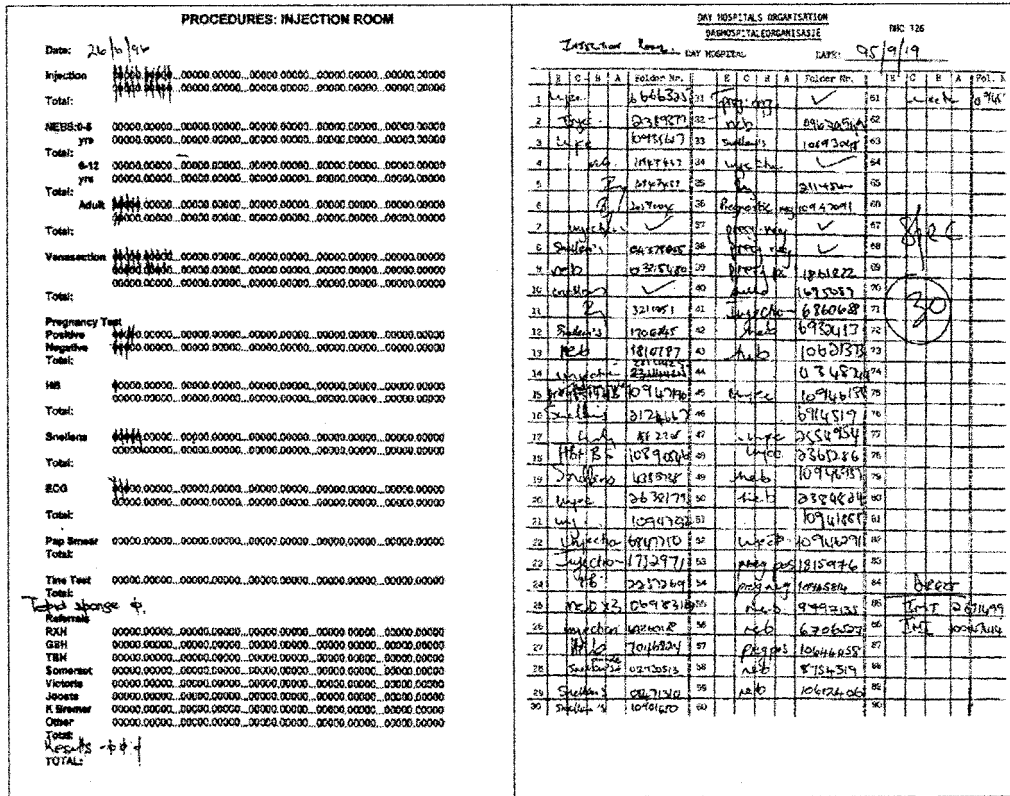


FIG. 3. Comparison of the new tally sheet in the injection room on the left with the old reporting form on the right, reporting 66 and 59 “events,” respectively. Note the columns marked E, C, B, and A in the old form, for European, Colored, Black, and Asian. These columns are not in use anymore, and the space is used for marking the categories of the events reported.

medical issues (risk pregnancies), whereas cutoff ages of 17–20 years were used when the designers put major emphasis on social aspects or the need to reduce population growth.² The compromise cutoff age of 18 years has now been implemented nearly everywhere.³

Feasible Data Collection. Data standards requiring diagnosis, such as ICD, represent a major problem in primary health care. For instance, the control of sexually transmissible infections (STIs) has high priority. The problem is that South Africa does not have the laboratory infrastructure to test all such cases, and patients with STI-like symptoms are treated using a syndromic approach. It is estimated that only 50% of those treated have actually been infected through sex. Collecting for two indicators, both “Case treated as STI—new” and “Male urethral discharge—new,” has in most cases solved the dilemma. Male urethral discharge is almost exclusively an STI, and this can then be used as a proxy to roughly estimate the level of STIs, which is then used to monitor the effect of public health campaigns to prevent HIV/AIDS. The relationship between the two indicators is also analyzed as a proxy to assess gender biases in each facility’s service

delivery. These two data elements were both invented in the HISP pilot districts in the Western Cape, and tested there and in the Eastern Cape before finally becoming national standards in 2001.

Useful Information. Emphasis is always placed on the usability of any data element in addressing the targets of the health services, meaning that a data element can be expressed as a relevant indicator and that these indicators are actually used. For instance, during the standardization process the data set for the Expanded Program on Immunization (EPI) was reduced from 44 to 13 elements, and EPI reporting was included in the national standard reporting system (whereas previously a separate EPI reporting system was maintained). One of these 13 elements, “Fully immunized under 1 year—new” is a local innovation developed in the HISP pilot districts and in the Eastern Cape, and can be used to calculate immunization coverage per geographical area. The problem of implementing this standard was outlined in some detail in the preceding section and shows how the development of standards for immunization involved trial and error, as well as innovation. As discussed earlier, the implementation of this

new data element has been problematic because its definition was unclear to health district staff and procedures and routines for its collection and use were poorly developed. However, the trial of this new element and the related discussions and negotiations resulted in the integration of the EPI in the standardization process, a significant revision of the immunization data set, and the inclusion of the revised data set in the national one. The “immunization actors” thus translated their interests into the national standardization network through a give-and-take negotiation, which resulted in a changed national data set and increased momentum to the standardization process.

Provincial Universalities. Since 2001, the national South African data set represents the common standard or “gateway” through which the provincial datasets in all nine provinces in South Africa are developed. The following example illustrates how local provincial “universalities” are developed within a national hierarchy of standards. In Mpumalanga province, representatives from provincial and district management and all health programs held a workshop where about 500 data items in the previous provincial data set were challenged “one by one.” They ended up with about 110 essential data elements, 46 items from the national standard dataset (see Appendix), and an additional 60 to 70 new and old items that were identified as being essential for the province. Given HIV/AIDS prevalence of about 20% in the adult population, a number of additional information issues were related to this problem. One such additional issue was an element for reporting the number of HIV/AIDS patients in each community who were following a medication regime to prevent a particular type of pneumonia widespread among HIV/AIDS patients. Since HIV/AIDS prevalence is estimated from a blood survey, this figure can be used to calculate an indicator measuring the quality of the preventative work among HIV/AIDS patients in each individual community in the province. If this local innovation proves to be useful, it is highly likely that other provinces will adopt the indicator and it may become a national standard.

Prototyping of Open Source Software

In this section the process of software development is described with a focus on two topics: (1) inscription of organizational change in the software, and (2) the process of participatory prototyping. Since 1997–1998 HISP has developed a free (open-source) database application based on Microsoft Office 97/2000. Office 97 was initially selected mainly because it was a standard among potential users already. Some components have since been developed using VB, Java, and HTML, and we are gradually shifting toward a platform-independent application suite that runs under Windows and Linux as well as on most

commonly used SQL-compliant data base management systems (e.g., Access, MySQL, PostgreSQL, Oracle, DB2, SQL Server).

Inscription of Organizational Changes in the Software. The software design process started out with a set of objectives and scenarios the design team wanted to inscribe in the software (following Akrich, 1992):

- Shift of control of information systems from central towards local levels, that is, toward more equal control between central and local levels.
- Local flexibility and user orientation—it should be easy to adapt the software to local conditions.
- Support for health sector reform towards decentralization and the development of health districts, that is, integrating the vertical flows at district level.
- Empowerment of local management, health workers, and communities.
- Horizontal flow of information and knowledge, based on the principle of free access to all anonymous, aggregated health data/information.

These objectives were translated into concrete inscriptions through key principles laid down during the development of the first prototype (December 1997 to March 1998):

1. The application must support the hierarchy of essential data sets (see annex), that is, allowing users to add, modify, or delete local data elements, indicators, and so forth.
2. The application should be designed in such a way as to support the drive toward decentralized capture, analysis, and use of data—in particular, support the push toward having the facility staff responsible for data collection also doing data capture, quality checking, initial processing, and output.
3. The application should be easy to use for new areas (provinces, districts), and should allow users to tailor the geographic scope of their data sets to their needs. This resulted in the use of a front-/back-end solution in Access, where the back-end data files cover different areas and the user can switch between them at will.
4. The application should as much as possible rely on the flexible and powerful analytical and display tools already available within Office 97 (e.g., Pivot Tables in Excel), even if this increased the learning curve.
5. The application should be free (open-source) software—both gratis and with free distribution and redistribution of the source code.

Participatory Prototyping. Software development was in 1998–1999 largely done by a small two-person team:

one system analyst/designer (one of the authors) functioning as both “team leader” and conduit for the participative interaction with users and the rest of the HISP team, and one very skilled and efficient Access (VBA) programmer from a local private company hired on an hourly basis. During 2000–2001 additional programmers from the same company took part in the software development.

The first prototype, a software module aimed at capturing and analyzing routine monthly data (“the MD module”) was released for pilot testing in the HISP pilot districts in March 1998, and went through a series of very rapid prototype cycles during the next 4 to 6 months. New “builds” were sometimes released on a weekly or even daily basis.

The informal mechanisms for reporting bugs and requesting new functionality—all tightly integrated with user support—proved popular and encouraged users to provide feedback to the development team. This combined with the rapid deployment of new or corrected versions astounded many users, who previously had experienced many drawn-out tender processes, fully prespecified development projects that often ended in frustrating delays or fiascoes. Requests for new functionality and/or new modules had to be filtered or moderated by the HISP development team depending on the number of users making a request and team capacity, but all relevant requests were logged and prioritized if they could not be implemented rapidly.

The development process has gone through several phases, emphasizing performance and progress over any established prototyping model. Prototyping as described in the literature (e.g., Bhudde et al., 1991) is usually quite formal and structured, with well-established user groups, channels of communication, and conflict resolution. Within the institutional framework in which HISP operates, consisting of a variety of hierarchical levels and organizational and political structures, such user participation would be impossible or inefficient. *Formal* user groups would easily become battlegrounds due to the current large-scale transformation of South Africa’s administrative structure.

The methodology used is thus more informal and to a significant degree based on *improvisation*, whereby any interested or innovative user, regardless of his or her place in the hierarchy, had full access to the development team (a meritocratic approach). This access is either direct or indirect via the other DHIS trainers/facilitators—users have been encouraged to use whatever channels they preferred. Access is not regulated in any way, but the development team normally has to guide users to a significant degree in understanding their own requests and how they can be implemented in practice. Such guided user participation is obviously time-consuming and only possible with a limited number of users.

DISCUSSION: STANDARDIZATION AND IS DESIGN

In this section we discuss some implications of the HISP case on the two main topics of the article: 1) standardization and 2) information systems development.

Standardization, Flexibility, and Local Universalities

Hierarchy of Local Universalities. Here we use the concepts of local universalities (Timmermans & Berg, 1997) and modular development (Hanseth et al., 1996) to develop and discuss a framework within which the tensions between standardization and localization may be understood and handled. In the area of health data, the lower levels of the health services will generally need more detailed data—that is, larger data sets or longer “lists,”—in order to support their day-to-day work than will the higher levels, in order to support their coordination and overall management. For example, while the health facility needs a register of local tuberculosis patients to ensure proper treatment of each individual patient, the district will only need, say, the number and percentage of patients fully cured or treatment defaulters, in their overall management of the tuberculosis program and the coordination of work and learning between health facilities.

The fact that the lower levels of the health services need different—larger or extended—data sets or standards for health and management data than the higher levels represents a “softer” approach toward universality than in the case of medical procedures, discussed by Timmermans and Berg (1997). Each level may formally define their contextual (local) universality as an extension of the “global” one. We describe this system of health and management data standards as a *hierarchy of (local) universalities* (see Figure 4). A local health unit, a district, and a province are all examples of such universalities, which interact and communicate with the entire system through the standards of the level above, while at the same time maintaining their local data sets.

In the start of the standardization process, the provinces in South Africa all had strongly differing data sets compulsory for all health units within the province. A major issue in the process of standardization in South Africa has been through prototyping, negotiation, and tinkering to develop a national standard data set acceptable for all provinces and national health programs. All provinces have now incorporated these national standards into their provincial data sets. The example from Mpumalanga province showed how a provincial universality is being developed as an extension of the national standard data set, which is used for interaction with the “outside world.”

The principle of a hierarchy of standards has been important in lowering the tension between the various

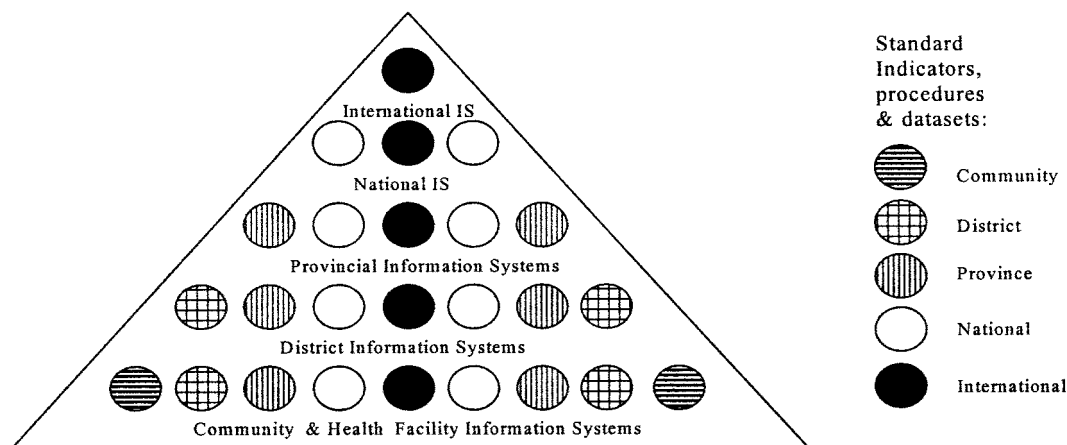


FIG. 4. Hierarchy of standards where each level has freedom to define its own standards as long as they align with the standards at the level above.

organizational units (e.g., provinces, health programs) in the standardization process. This is so because local freedom to define their own information needs is granted and the number of standardized data items, which are what the conflicts are about, are kept as low as possible. Within this framework, standards are seen as interfaces and gateways for communication between relatively independent actors (i.e. modules) across organizational structures and hierarchies. Star and Griesemer (1989) used the concept of boundary objects in a similar way to explain how communication between different communities of practices is enabled.

The Standardization Process: The Interdependency of Stability and Change. In the discussion here, we explore the relations between stability and change in the standardization of health data and discuss to what extent these elements are interdependent in a way comparable to the case of the Internet (Hanseth et al., 1996).

The case of sexually transmissible infections (STI) showed how local innovation solved the problem of monitoring the spread of STI—including HIV/AIDS—at the local level in a context where there are insufficient laboratory infrastructures to test and diagnose such cases. The rapid success of these new data elements was due to the fact that they were easily defined and understood, and their collection could be based on the existing routine practices. This innovation rapidly led to changes in standards in all provinces and was included in the national standards following a seemingly natural flow of progress. On the other hand, the case of immunization (discussed earlier) illustrates a somewhat more realistic development, where local innovations go through several stages before they are successfully implemented as national standards.

Standardization of health data, as argued here, requires “localization” and flexibility for local change quite simi-

lar to the case of the Internet. What about the other way around—do standards and stability enable localization and innovation? The answer is no, not in a technical way as in the case of the Internet, but indirectly there are similarities. The availability of an enabling environment within a framework of standards has been a prerequisite for innovation and localization in the modules.

Note that the network aspects—the need to communicate with other areas and levels—are as important in the case of health data as they are in the case of the Internet. In the early pilot phase, there was no framework of standards within which HISP could work. Localization on health data standards in the HISP pilot districts would therefore go on in isolation, as there was no “health data arena” for cooperation, diffusion, and interchange of ideas. When the first provincial data set (tested in the HISP pilot districts) was accepted in Western Cape in 1997, this situation changed. The HISP process, which focused on innovation and localization, was suddenly operating within a framework of standards and could much more easily network and cooperate with actors in all provinces. Best practices of collecting and analyzing essential health data could now be compared, and an *enabling environment within a framework of standards* was created.

To date, the HISP case has covered a period of innovations and rapid changes and revisions of standards. However, as the standards are maturing, the pace of the changes is slowing down and the situation is normalizing. Nevertheless, the standardization of health data in South Africa will go on as a continuous process of change because (1) innovation will continue through practice, (2) the health data standards are interlinked with a number of other data structures and networks causing a continuous pattern of change (new vertical programs will join the process), and (3) the context of health services is changing, for example, given the HIV/AIDS pandemic.

IS Design: Cultivation of Organizational Change

The design of the DHIS software *prescribed* decentralized capture, local analysis, and local use of data, which in general clashed with existing organizational structures. The first translation of a democratic ideal of end-user control into the software resulted in a focus on *data entry clerks*, usually working in a district or regional office and historically responsible for data capture. They are thus the end users of the software, but not of the information.

In the Eastern Cape Province the information handling at district level is divided between the data-entry clerk (low-level skill) and the information officer (higher level skill). During a training session, the following question quickly came from an information officer: "If the data entry clerk is validating the data, doing initial analysis, and printing reports, what am I supposed to do?" Whereas a data entry clerk responded: "Ha! We are empowered! But now we need training!" This contradiction between the way work *and* information management are *prescribed* by the software and the actual hierarchy and organization of work *and* information management is not yet solved. The data entry clerk may be the end user of the computer and software, but, according to the traditional assembly-line way in which the information handling is organized, he or she is not intended to be a user of the information.

This focus on the data entry clerk therefore turned out to have several disadvantages: First, data entry clerks are removed from the "coal face" and usually have little or no interest in the data and what they represent because the clerks are not users of the information. Second, district information officers, district managers, and facility supervisors felt to some extent excluded from the computer-based information system. Third, facility managers and staff continued to be predominantly data producers (on paper) with little meaningful feedback, since data entry clerks would tend to see data capture decentralized to the facility level as a threat to their own job security.

Cultivation as a design strategy is about facilitating a process whereby the actors are enabled to translate their interests into the transforming information network. In this case, the ongoing translation includes: (a) Upgrade and train the data entry clerks to become data officers (ensuring local data capture, data flow, and validation); (b) engage facility supervisors far more in validation and feedback; (c) involve the information officers more in health management; and (d) train and get district managers interested in using the DHIS for analysis and output. Translation means that these four groups all need to be enabled to see how developing the information network further may enable them to pursue their interests. The data entry clerks and information officers have incentives in that their jobs need to be "upgraded." However, this needs to occur within a context where the managers (a) become interested in analysis and

use of information and (b) see such an "upgrade," as benefiting their interests in this regard. Furthermore, the translations will depend on the alignment of the wider provincial information network, regarding information management and how decision-making power regarding budgets and management is decentralized within the province. Consequently, provincial management will also need to translate its interest and see how it can benefit from improved information management at local level. Cultivation of the translation process therefore needs to go on at several levels.

This example shows how behavior inscribed in the software clashed with the way work and information handling were organized between data entry clerks and information officers. This example represents only one of several areas within which the software enables practices that are clashing with current work organization, culture, and practices. The example from Eastern Cape illustrates two points:

1. When using a cultivation strategy with a focus on local translations, there is no clear-cut division between design decisions "inscribed" by the designers and later translations by the users. Rather, the design, implementation, and use tend to drift through a cycle of translations in a process not fully controlled by anybody.
2. The software and wider information system developed through such a cultivation process is not a passive reflection of the organizational structures. In the case of HISP, the opposite is in fact the situation: A "radical" software enabling "new" bottom-up work-practices emerges within the "old" top-down hierarchical bureaucratic structure and clashes with it.

The HISP strategy has been shown to be viable despite the clashes with the existing top-down organizational structures, because it is aligned with the official ANC public health policy of the "New South Africa" (ANC, 1994). The ANC Government's policy aims at a radical transformation of the organizational structures, culture, and practices within the health system. Thus, the HISP cultivation strategy could not easily have been formalized within the bureaucratic organizational structures. It had to occur partly outside of control by the bureaucracy and driven by activists representing the policies of the New South Africa.

The dialectics of social processes implied here, as both containing process and structures, illustrate the dualities of structures (Giddens, 1984). While in the HISP process the inscriptions, standards, information systems, and organizational structures inherited from apartheid present considerable obstacles to change, the apartheid legacy also provided the political and social context within which change was enabled. The processes of change described herein have thus been both constrained and enabled by the social structures within which they have unfolded, and

which they are ultimately changing, for example, by the inscription of new standards.

SUMMARY—SOME LESSONS FROM HISP

In this article we present a seemingly successful story where we ourselves have been actors. Have we been blinded by own success? Ultimately, there are only two ways of addressing this question: First is to apply the key element in action research itself, to feed our narratives and findings back to those who can assess them, ranging from those who have participated in the research to the wider research community. Second is to evaluate the de facto outcomes of the process: the availability of appropriate information for management, the actual use of this information, the sustainability of the processes and products, and their replication in other countries.

The HISP processes and software are now being adapted and further developed in countries as different as Mozambique, Malawi, and India. While the organizational structures, scale, and cultures differ greatly among these countries, there are important problems and concerns that they share. The vertical structure of health programs and their respective information systems make integration and control of information at local administrative levels difficult; vast amounts of data are collected and reported, but not used, at the lower levels of the health services. In order to address the latter problem, the need for developing computing resources at local administrative levels is being pursued in each of these countries. In the specific context of South Africa, HISP has addressed these common problems and concerns through bottom-up processes of standardization and IS development that emphasize local control of information and computing resources. An interesting question is therefore to what extent lessons and more tangible products from HISP may also be of use in these new contexts.

In the area of standardization, the particular social and historical background of South Africa and the breakdown of apartheid provided a particularly chaotic context of incompatible and “competing” standards that were defended by a variety of structures and organizations. Conversely, the situation in the other countries is more characterized by strong and stable national vertical health programs, which impose their standards and policies at the local levels of the health services. While in Mozambique the strong central control of these programs is born from needs caused by 20 years of civil war, seemingly similar central command structures in India are endemic to the particular bureaucratic structures of that country. Despite differences in contexts, we argue that the general findings regarding standardization of health data in South Africa are useful in the other countries.

In the area of bottom-up IS development, which we take to include the standardization process, we have generalized

the findings from South Africa as a multilevel cultivation approach. Cultivation includes the enrolment and alignment of multiple actors in the IS network by enabling the translation of their interests in the network. Cultivation is thus about negotiations and brokering between actors at multiple levels in the design and development of information systems and standards. Following this approach, diffusion of lessons and products (e.g., software) to new districts and provinces within South Africa has been to spread replicable processes (the similar) and to cultivate them in each new location (the specific and different, i.e., adaptation and appropriation). Within this framework of local adaptation, we believe lessons and more tangible results from HISP may be useful in other countries.

NOTES

1. HISP is a collaborative research and development program comprising the Universities of the Western Cape (South Africa), Eduardo Mondlane (Mozambique), Oslo (Norway), the Indian Institute of Management, Bangalore (India), and the Departments of Health in South Africa and Mozambique.
2. Pregnant girls have traditionally been expelled from schools (typically for a macho society, boys impregnating them are *not* expelled). Also, delaying having children is globally viewed as one of the most effective ways of both reducing population growth and ensuring healthier children.
3. The only “deviation” allowed is that users can split the “Deliveries to woman under 18 years” into subgroups if they want.

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APPENDIX

National standards for primary health care data in South Africa, 2001

National standard essential Dataset, South Africa, 2001	Child health:	Chronic care:
Attendance:	15. Diarrhoea under 5 years	30. Chronic care visit
1. PHC headcount under 5 years	16. Lower respiratory infection under 5	31. Diabetes mellitus visit
2. PHC headcount 5 years and older	17. Child under 5 years weighed	32. Hypertension visit
Maternity and neonatal service:	18. Not gaining weight under 5 years	33. Epilepsy visit
3. First antenatal visit before 20 weeks	19. Severe malnutrition under 5 years	Immunisation:
4. First antenatal visit 20 weeks or later	Curative care:	34. BCG at birth
5. Follow-up antenatal visit	20. DOTs visit—Facility	35. DTP-Hib 1st dose
6. Tet Tox 3rd/booster dose to pregnant	21. TB patient with 2–3 months sputa sent	36. DTP-Hib 2nd dose
7. Live birth	22. TB patient with 2–3 months sputa negative	37. DTP-Hib 3rd dose
8. Live birth under 2500 g	23. Case treated as STI	38. OPV 1st dose
9. Delivery to woman under 18 years	24. Male (penile) urethral discharge	39. OPV 2nd dose
Reproductive health:	25. STI contact slip issued	40. OPV 3rd dose
10. Oral pill cycle	26. STI contact treated	41. HepB 1st dose
11. Nuristerate injection	27. Referred to doctor	42. HepB 2nd dose
12. Depo-provera/Petogen injection	Mental health:	43. HepB 3rd dose
13. IUCD inserted	28. Mental health visit	44. Measles 1st dose 9 months
14. Condoms distributed	29. Psychiatric discharge patient seen	45. Measles 2nd dose 18 months
		46. Immunised fully under 1 year

Note. PHC, primary health care; DOT, direct observable treatment (tuberculosis); TB, tuberculosis; STI, sexually transmissible infections.