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MAKING PEOPLE AWARE OF DEVIATIONS FROM STANDARDS IN HEALTH CARE

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MAKING PEOPLE AWARE OF DEVIATIONS FROM STANDARDS IN HEALTH CARE

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Abstract

In this paper we consider the role of standards as a means for interoperability among members of different communities. If we consider, in particular, the healthcare domain, there is an increasing number of efforts to develop explicit and formal representations of medical concepts so as to provide a common infrastructure for the reuse of clinical information and for the integration and the sharing of medical knowledge across the world. A critical issue arises when local customizations of standards are used as standards. If this occurs, standards are no more able to guarantee their supportive function to interoperability. To overcome this problem we propose a solution aiming at making members of different facilities aware of the changes occurred locally in a standard. At architectural level, we propose to build a layer that acts upon the interface of the application by which the articulation of activities across organizational boundaries is mediated (e.g., an handing over between different healthcare facilities). At application level, we provide practitioners with a common visual notation allowing them enrich the artifacts that mediate inter-articulation, by means of a reference to a standard, e.g. a schema of intervention. We claim that this increased awareness can support different people in aligning practices with standards and making standards effective means for coordination and interoperability. Furthermore, we report a case focusing on such a layer and visual notation by which to enrich the interface of the information system that mediates the handing over between an Emergency Service and a hospital emergency department.

Keywords: Standard, Healthcare, Classification Schemes, CSCW.

1 INTRODUCTION

In order to adopt a straightforward definition, a standard is just something that is established by an authority, a custom, or a general consent as a model or reference to classify things or articulate actions. The role played by standards in our society is manifold but the main functions are quite the same in every sector they are applied: to set a definite level of attainment (and the correct ways to achieve it) in order to promote quality and a feasible way to assess it; to promote interoperability among actors that can not share the same conventions (e.g., since they are members of different communities) so as to reduce transaction costs and attain greater efficiency. If we consider, in particular, the healthcare domain, there is an increasing number of efforts to develop explicit and formal representations of medical concepts so as to provide a common infrastructure for the reuse of clinical information and for the integration and the sharing of medical knowledge across the world (Dieng-Kuntz et al., 2006; Rector et al., 1998). Therefore, introducing, proposing (and sometimes even enforcing) standards aim to reach two main benefits: on the one hand, to control and govern processes to achieve effectiveness, increase efficiency or just allow better traceability and accountability; on the other hand, to achieve interoperability at various level, either between machines or human actors: e.g., to guarantee better coordination when all processes relating the care of a patient that involve more than one caring facility (e.g., two wards of the same hospital, two facilities distributed in the same region).

In this paper, we focus on the second aspect regarding the use of standards: i.e., how they mediate the articulation work between different groups of practitioners, or even heterogeneous communities of practices, that are involved in the same goal of caring a person, possibly with incommensurate perspectives and incongruent strategies (Schmidt et al., 1992). This aspect is nowadays getting more and more critical: in fact, under the drive of more efficient resource management and the necessity of relevant cost cuts, healthcare tends to be more often outsourced to a number of smaller and specialized facilities that constitute a highly distributed and relatively loosely-coupled net of “competence systems” (Olesen et al., 2001). These current trends in healthcare — the so called “Distributed Care Systems” (Pritchard et al., 1995) — make interoperability among different facilities a central issue. Consequently, also the use of standards as a support to achieve this interoperability must be seriously taken into account. In fact, although a standard should always assure the interoperability between the multiple trajectories (Strauss et al., 1985) involved at different levels of care, sometimes it happens that standards are locally customized in order to be completely and actually included in the practices of a certain setting¹. This customization is related to a *tension* between the

¹In order to distinguish between regular “standards” and “standards that are locally customized” by practitioners for their daily work, in the following of the paper we refer to the former case as *standards* and to the latter case as *local standards*.

universality achieved by the use of standards and the *locality* which is due to the constraints posed by the current work situations (Timmermans et al., 1997). Such a tension has a deep impact on the choices related to the adoption of the standards and their local customization. A critical issue arises when, in at least one of the facilities involved in the care of the same patient (as well as in any cooperative work setting), local standards are used as standards. In fact, on one hand, it is assumed by all practitioners that a standard is used *as it is*; on the other hand, sometimes standards are *necessarily* changed in a local domain to be of any use or value. When standards are used for the sake of interoperability between different facilities, members of a single facility are supposed to interpret the standard in its “standard” acceptance, irrespectively of whether some changes have occurred or not. To overcome these problems, we propose to provide practitioners of different facilities with a twofold support working at two different conceptual levels: *at architectural level*, we propose to build a layer that acts upon the interface of the application by which the articulation of activities across organizational boundaries is mediated (e.g., an handing over between different healthcare facilities) in order to promote mutual awareness of deviations from standards and of their local customization. *At application level*, we provide practitioners with a common visual notation that lets them enrich the artifacts that, by means of a reference to a standard (e.g. a schema of intervention), mediate inter-articulation. This notation is intended to be used to annotate these artifacts with symbols that describe the nature of the changes occurred, and their severity.

In this paper we report a case focusing on such a layer and visual notation by which to enrich the interface of the information system that mediates the handing over between an Emergency Service and a hospital emergency department. This layer has a twofold function: i) It can be seen as a programming interface by which the annotating practitioners of the Emergency Service can endow the electronic interface with affordances that can dynamically convey to hospital staff event-based graphical cues promoting awareness on the deviations occurred with respect to the standard schema. ii) In case of no computational support, it can be seen as a layer of positively redundant (F. Cabitza et al., 2005) information that the annotating practitioners attach to the regular interface in order to add a meta-information that calls for further inquiry by the accepting practitioners of the emergency department.

This solution hence aims at making members of different facilities more aware of the changes occurred locally in adopting a standard or, better yet, more aware of the distance (or deviation) between a standard and its local versions at work. We claim that this mutual awareness can facilitate different people in the process of aligning the local standards with the widely-accepted standards in order to achieve the interoperability that is needed to coordinate the activities concerning the care of the same patient.

Hence, our support is intended to promote the awareness of deviations from standards in order to, on the one hand, promote the alignment between local standards and standards so that the

function of interoperability entailed by the use of any standards is guaranteed; on the other hand, to make standards (either local or not) present-at-hand (Winograd et al., 1987) when breakdowns (i.e., any unexpected complication) occur and hence to cope with them more properly, effectively and efficiently.

2 BREAKDOWNS WITH STANDARDS

As quite obvious, standards can assure interoperability between heterogeneous parties that get involved across the same trajectories of caring (Strauss et al., 1985) only because they literally “stand hard”, i.e., they are *non-modifiable* once they are officially issued and adopted. Notwithstanding, since some party interest is necessarily inscribed into classification schemes and since standards are also used to control and bound activities (Bowker et al., 1999), it may happen that they are locally customized in order to better fit users’ needs and domain requirements. As customization aims to make standards more embedded in practices and hence more transparent in their daily use, a critical issue arises when local standards are used as if they were generally agreed standards in the interaction with external facilities and when from “ready-at-hand” can unexpectedly become “present-at-hand” (Winograd et al., 1987), i.e., when some breakdown on use of standards occurs. In fact, on the one hand, it is assumed that a standard is used *as it is*; on the other hand, sometimes standards are *necessarily* changed in a local domain to be of any use. When standards are used for sake of interoperability between different facilities, members of one facility are supposed to interpret the standard in its “standard” acceptance, disregarding that some changes could have occurred.

The example that we give below to illustrate this risk refers to the pragmatic side of standards, i.e., to the actions and activities that are implied and affected by the use of standard ways to conceive lines of action (protocols) and their classifications. Protocols in medicine can be seen as “standards which intervene in the different trajectories of patients” and that redirect their courses (Timmermans et al., 1997). On the other hand, we can see classification schemes as “artifacts” that can be used to coordinate actors’ cooperative activities (Simone et al., 2000) since they do not only organize information according to the actors’ perspectives but also “steer” their actions on this information. In this twofold nature there lies the risk of breakdowns: local standards may become a source of misunderstandings or, in a worst case, a source of errors that can seriously affect the health of a patient.

Mr. Smith is a pedestrian that, while walking in the street, experiences a heart attack. Few minutes after that some passers-by had called the emergency service, Mr. Smith is assisted by an ambulance rescue service. In this case, as in many other similar cases, the ambulance staff is going to save him applying a well-known and international resuscitation protocol: the Cardio-Pulmonary Resuscitation protocol (CPR). The CPR is a three-step protocol whose

main components are “securing an open airway”, “artificial ventilation”, and “closest-chest cardiac massage”. In the considered case, the physician in charge of the ambulance staff experiences some difficulties during her resuscitative effort and consequently decides to administer to Mr. Smith some Magnesium Sulphate. Although administering this drug is not encompassed by any standard protocol, the drug can be given as a last resort according to the very situated case. As a consequence, the staff of the emergency department to which Mr. Smith will have been admitted after the rescue could be not aware of this drug administration unless that deviation will be well clearly reported.

At the patient hand-off occurring at the triage department of the admitting hospital, this kind of information is usually conveyed by ad-hoc and situated means (usually face-to-face communication) and hence such situations could represent a potential risk for the health of any Mr. Smith involved in similar cases: if something goes wrong in the patient hand-off and the information about the additional administering is lost or not properly conveyed, serious Adverse Drug Reaction due to overdose or mismatch can happen, even as a consequence of strict compliance to some standard care protocols that ambulance practitioners could even completely ignore. To overcome these problems, we propose a solution aiming at making members of different facilities more aware of the changes occurred locally in adopting a standard or, better yet, more aware of the *distance* (or *deviation*) between a standard and its local and situated application. We claim that this awareness is able to facilitate different people in the process of aligning the local standards with the widely-accepted standards in order to achieve the interoperability that is needed to coordinate the interrelated activities concerning the care of the same patient. Our specific proposal is part of a wider conceptual framework described in Cabitza et al. (Cabitza et al., 2006). Torres aims at supporting people belonging to different groups to articulate their activities. To ground Torres in a particular domain, we aim at understanding the interactions occurring when the patients’ care crosses the borders of a healthcare facility and to computationally support them so to convey the local knowledge needed both to guarantee the continuity of care and to promote the articulation of the related activities. While in (Cabitza et al., 2006) the role of articulation work was emphasized, in this paper the emphasis is put on the role of standards.

3 REMINDING DEVIATIONS

In the CSCW debate upon the role of *formal constructs* such as protocols, plans and classification schemes in supporting coordination, Suchman pointed out that such formal constructs do not prescribe all the behaviors of actors in advance, but instead they are used as resources for situated actions (Suchman, 1987); the critical refinement of the concepts discussed by Suchman, proposed by Schmidt, distinguishes between two different roles that formal constructs can play: *maps* and *scripts* (Schmidt, 1997). As clearly pointed out by Berg and colleagues (Timmermans et al., 1997), the required compliance with the script embedded

in a standard protocol is continually eroded by the tendency (and often necessity) to make it rather a map by which to cope with the exigencies of the specific patient case (her illness trajectory). On the other hand, actors tend to continually minimize deviations of the contingent caring trajectories from those mapped within standard protocols since their intervention will be judged according to those maps and also because those maps are conceived to help practitioners in monitoring, evaluating and shaping illness trajectories towards recovery. The author call this continue process of re-alignment “repair” and detects one important form of repair in *reminding*. Our main claim, then, is that practitioners do have the competencies and the skills to properly cope with contingencies and with the tension between coded prescriptions (*universality*) and extemporaneous but effective solutions (situated *locality*) but that just for this intrinsic ability to make caring trajectories seamless they must be supported in again making these seams visible wherever these trajectories must unfold across heterogeneous settings and different communities of practice. The point is that they can be supported by helping them reminding how far they are from agreed standards, how necessary is that these deviations are made present-at-hand to all interacting actors and that actors are made aware of the need to manage the (possible) breakdowns and repair them in any hand-off.

To illustrate our proposal, which is intended to be general enough for different typologies of standards (e.g., classification schemes, protocols), let us consider the example of the ambulance rescue service that is supposed to assist a person experiencing a heart attack. As already claimed in previous sections, we identified that problems may raise when the ambulance staff deviates from the standard resuscitation protocol and these changes are made evident to the emergency department staff only by means of situated and ad-hoc means of communication, usually face-to-face. Hence, our support is aimed to promote the awareness of deviations from standards (in this case the resuscitation protocol) in order to promote the alignment between local standards and standards so that the function of interoperability entailed by the use of any standards is guaranteed.

In Schmidt(Schmidt, 1997) it is pointed out that such standards — as any formal construct regulating routine coordinative activities — are not immaterial but are rather inscribed in common artifacts people use during their work. In the hospital domain, as we previously observed in (F. Cabitza et al., 2005), such artifacts are usually paper-based and more or less structured forms which play the twofold function of both accumulation and coordination (Berg, 1999); in other words, artifacts are used by practitioners to store the data concerning the patient as the care proceeds and, in so doing, they also get a trace of the interventions done so to be supported in the coordination of the related care activities. In the scenario depicted in the previous section, moreover, such artifacts, as reification of formal constructs that are part of a wider infrastructure, also act as boundary objects (Bowker et al., 1999) to let members of different communities coordinate their actions in the care of the same patient. The structure (i.e., fields, check-boxes) and content of a form (i.e., the values associated to the

corresponding information structure) refer either implicitly or explicitly to multiple standards. On the other hand, also *deviations* from standards are usually materialized in the forms, although usually only embedded within the content and not made evident in its structure. To make such deviations evident and make standard be *repaired* through reminding, we first identified two different levels of possible deviations:

- Δ_1 : deviations between a standard and the related local standard (see the dashed arrows in Figure 1). This kind of deviation can be detected by observing the information structure of the form materializing the local standard. In our example this refers to the resuscitation protocol (local standard) materialized in the checklist of the form used by ambulance staff to trace interventions accomplished for accountability's sake.
- Δ_2 : unforeseen deviations from local standards occurring mirrored by the information content of the form (see the dotted arrows in Figure 1). This is the case when the ambulance staff decide to administer to Mr. Smith the magnesium sulphate as a last resort. This is a change in a instance of the local standard: the specific instance concerning the care of a specific patient (e.g., Mr. Smith).

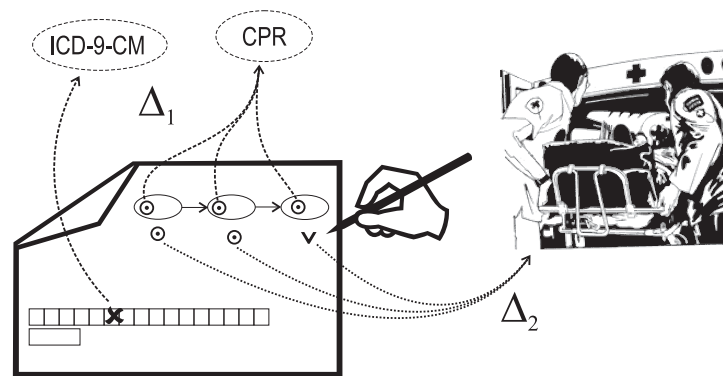


Figure 1. The ambulance rescue service example. In the paper-based form the protocol is materialized; Δ_1 is the variation between the CPR protocol and the local resuscitation protocol; Δ_2 is the variation between the local resuscitation protocol and an instance of it applied to Mr. Smith.

In order for the members of the facility receiving the patient to properly care the patient, it is necessary to make its members aware of these changes, or better yet, aware of the necessity to address these deviations with who has to undertake them. If motivations and rationales are given and become object of fast discussion, the least outcome is that practitioners can discuss the case more aware of actions undertaken and of their implications. In our solution, we propose to extend the Torres conceptual framework to support the users in identifying and establishing in an explicit way the two levels of the above described deviations: i.e. deviations of local standards from standards (Δ_1) and deviations of instances of local standards from local standards (Δ_2). To reach this aim we provide users with a meta-model which encompasses a set of specific relationships allowing to express explicitly the two levels of Δ s. Given that standards are necessarily explicit by definition, since they are used as a reference

by people to guarantee interoperability and control², and given that local standards and instances of local standards can be represented in Torres terminology as local formal representations³, we want to focus on how the two levels of Δ s can be represented by means of a set of specific relationships provided by the Torres meta-model.

These relationships, which also take their inspiration from the conceptual modeling field (Batini et al., 1993) relate, on the one hand, *excerpts* of a local standard to selected parts of the reference standard (excerpts); on the other hand, they relate excerpts of an instance of a local standard to excerpts of the related local standard. With excerpt we consider a subset of concepts and relationships, in the simpler case a single concept, of either a local formal representation or a standard. Among the possible relationships, we identified the following ones: *is-adoption*, *is-refinement*, *is-abstraction*, and *is-changed*. *Is-adoption* is the relationship which in the Δ_1 case ties an excerpt of a local standard with an excerpt of the related standard and in the Δ_2 case ties an excerpt of an instance of a local standard with an excerpt of the related local standard. Hence this relationship expresses that either standards or local standards are adopted “as they are”. *Is-refinement* and *is-abstraction* are dual relationships linking excerpts: *is-refinement* relates an excerpt with an excerpt where the latter is described at an increased level of details; conversely, *is-abstraction* relates an excerpt with another excerpt where the latter is described at an increased level of abstraction. *Is-changed* relates an excerpt with another excerpt where the former excerpt is slightly changed with respect to a latter excerpt in a way that can not be considered neither a refinement, nor an abstraction. This relation is especially useful when it relates to protocols. In fact a local formal representation could indicate a sequence of actions to be performed which is not the same (in order or in the actions themselves) with respect to the standard. More specifically we identified some specializations of the *is-changed* relationship: *is-modified*, *is-skipped*, *is-added*. *Is-modified* relates an action (in the Δ_1 case represented in a local standard excerpt and in the Δ_2 case represented in an instance of a local standard excerpt) which is changed with respect to the corresponding standard (Δ_1 case) or in the corresponding local standard (Δ_2 case). *Is-skipped* refers to an action which is represented in a standard (Δ_1 case) or in a local

²In whatever format standards are represented, users can always make a reference to them, e.g., by indicating the name of the standard and the code identifying a category like for the ICD-9-CM classification of injuries and procedures (ICD-9-CM, 1994).

³In Torres a local formal representation is any clear, explicit and as formal as possible representation of what about a local facility (in terms of work and practices) has to be perceived from the outside world. For the definition of local formal representations, we propose users (i.e., the healthcare practitioners at various extent) to adopt a loose semantics formalism which provides basic building blocks for representing domain concepts, and relationships connecting them. This way users can describe in an approximate but yet simple way both local standards as materialized in the information structure of a form and possible instances of local standards as materialized in the information content of the form.

standard (Δ_2 case) but which is skipped in the corresponding “more local” excerpt (a local standard in the Δ_1 case and an instance of a local standard in the Δ_2 case). Conversely, *Is-added* refers to an action which is not represented in either a standard (Δ_1 case) or a local standard (Δ_2 case) but which is referred in the corresponding “more local” excerpt (in the local standard or in the instance of the local standard, respectively). Always for what concerns the support provided by Torres, we first consider the problem of making deviations present-at-hand and leave the problem of computationally supporting discussion on those deviations at a further step of study. We then propose some additional conventional signs to make possible deviations from standards visible (and hence “afforded”) on the forms (e.g., in the ambulance case, so as to make aware staff of the emergency department of the Δ_2 variation occurred in the care of Mr. Smith). This could be possible by encouraging the ambulance staff to jot down on the form these signs to convey changes with respect to the standard protocol.

With reference to Figure 1, we depict a scenario in which the ambulance staff has been provided with a paper-based form where the officially adopted standards, i.e., the CPR protocol and the ICD-9-CM classification of injuries and procedures (ICD-9-CM, 1994), are represented in some graphical notation or with a limited set of checkboxes: the resuscitation protocol and the classification schema used by the ambulance staff is represented in the form; the latter gives graphical hints about the Δ_1 deviations according to some conventional signs inscribed within any macro-activity: in the considered scenario the \odot sign conveys the fact that the ambulance staff performs a macro-activity of the protocol in full compliance with the CPR standard.



Figure 2. The CPR form mock-up.

The same system of conventional signs can be used by the ambulance staff according to the specific situation by jotting these signs down just aside the form items to remind variations in the actual instance of the rescue intervention whenever these occur. In this case,

ambulance practitioners can make aware practitioners of the emergency department of all the Δ_2 variation occurred in the care of Mr. Smith and more specifically that something has changed in the adopted protocol since the ambulance staff administered to Mr. Smith the sulphate magnesium: here the \checkmark sign is used in correspondence with the last macro-activity to convey the fact that an action (the administering of sulphate magnesium) was added with respect to the activities encompassed by the protocol; instead the \ominus sign is used to convey the fact that the former two macro-activities of the CPR protocol were performed by the ambulance staff without any variation with respect to the standard.

These signs work as reminding notations to make practitioners aware of any level of deviation, with the only aim to enhance the effectiveness (and efficiency in terms of support for more concise narrative hand-offs) of coordination between the ambulance staff and the hospital triage.

4 FUTURE WORKS

Our ongoing research effort is toward the definition of a richer conceptual framework, Torres, aiming at supporting articulation work occurring across organization boundaries. In particular the focus of this paper is about how to support practitioners in making variations from standards, which are adopted with the precise aim to reach interoperability, more evident both in the process of accumulating information about a caring process and in the process of coordinating actors according to the accumulated data. The next steps of our research agenda encompass a deeper investigation of the hospital setting in order to detect various situations where standards are used and when and why they are locally changed, taking into account also the artifacts that support their crystallization and localization. On the basis of these deeper investigations, our research efforts are directed to enrich the Torres meta-model with a finer grained set of relationships to indicate and to better explicate how parts of local standards diverge from the related standards.

From the implementation point of view, our future work is intended to represent and convey by digital means (like palmtops or digital pens) the different levels of deviations occurred in the use of standards. In the ambulance domain, this issue concerns both finding proper ways to assist practitioners in emergency to signal breakdowns, as well as ways to properly afford them to all actors involved, so as to promote the awareness of changes and hence facilitate coordination among the actors involved. To this aim, we have designed a first mock-up (see Figure 2) as a proof of concept to experiment our notation on the digital form representing the CPR protocol. We are planning to undertake a set of mock-up sessions with some key emergency practitioners in order to assess how the graphical proposal meets the information and coordination needs. To experiment our proposal also at architectural level, we plan to build the layer promoting awareness information about deviations on top of the

digitalized counterpart of ambulance run sheets proposed in Chittaro et al (2007), in order to provide emergency practitioners with indications about any deviation from standard models of behavior and classification schemas related to ambulance run sheets.

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