MIS Quarterly

RESEARCH ARTICLE

RE-REPRESENTATION AS WORK DESIGN IN OUTSOURCING: A SEMIOTIC VIEW[1]

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Outsourcing work relies on the supplier's interpretation of the work delegated by the client. Existing streams of outsourcing literature tend to assume that the supplier should use the same convention as the client to make sense of the work package. In this research, we use a semiotic lens to challenge this assumption by viewing such sensemaking as a process of decoding symbolic representations. This complementary view involves innovative use of digital technology for re-representing the outsourced work through new conventions. We studied a Chinese business process outsourcing supplier in-depth to learn how such re-representation is achieved through the creation of special-purpose languages. Our research contributes to the Information Systems (IS) outsourcing literature by providing a semiotic view on the design of outsourcing work supported by digital technologies. Three re-representation practices (i.e., dissociating the signifiers, signifying through new conventions, and embedding new conventions in the digital infrastructure) constitute the core of this view. The results are highly significant for outsourcing theory and practice, not least since they suggest that the use of semiotics and visuals for re-representation may enable suppliers to reformulate outsourcing work and the expertise needed to deliver services.

Keywords: Outsourcing, work design, representation, digital infrastructure, semiotics, case study

[1]Michael Barrett was the accepting senior editor for this paper. Anne-Francoise Rutkowski served as the associate editor.

The authors have contributed equally to the paper.

The appendices for this paper are located in the "Online Supplements" section of the *MIS Quarterly*'s website (http://www.misq.org).

Introduction

Delegating work from the client firm to the supplier is at the heart of IS outsourcing.[2] The quality of the delivered work relies on the supplier delivery personnel's interpretation of the work package (e.g., Barrett and Oborn 2010). Using a semiotic lens (Mingers and Willcocks 2014, 2017), we understand the specifications and requirements documents in a work package as symbolic representations (Peirce 1932).[3] To be meaningful for the supplier delivery personnel, such representations need to be decoded through conventions, that is, the agreement to use the same rules in the communication between the client and the supplier (see Crystal 2003). However, decoding through conventions is one of the most challenging problems in IS outsourcing.

Prior literature on the design of IS outsourcing work offers three approaches to facilitate decoding of symbolic representations in work packages. One stream of literature views outsourcing design work as a knowledge *transfer* activity in which the client firm passes on skills needed for the supplier to use its conventions to interpret the meaning of work packages (e.g., Blumenberg et al. 2009; Chua and Pan 2008; Rottman 2008; Zimmermann and Ravishankar 2014). Another stream of research focuses on the *decomposition* of the total work package into smaller work packages, or chunks, allocated to multiple suppliers (or geographically dispersed teams of the same supplier). Each supplier team decodes the meaning of its chunk of the work package, yet assumes the conventions of the client (e.g., Aron et al. 2005; Kotlarsky et al. 2007; Mirani 2007; Srikanth and Puranam 2011; Susarla et al. 2010). Finally, an increasingly popular stream of research suggests that the supplier and the client firm engage in knowledge *translation* processes. The content of the original work package is manipulated to expose implicit and contextual aspects of the client's conventions in ways that make sense for the supplier's delivery personnel (e.g., Kotlarsky et al. 2014; Leonardi and Bailey 2008; Vlaar et al. 2008). Despite the diversity of the three approaches to outsourcing work design, they share the assumption that suppliers should adopt the same conventions as the client for decoding the meaning of the work package as it is delegated by the client to the supplier.

Drawing on an in-depth case study (Gerring 2007) at Lifewood, a Chinese business process outsourcing (BPO) supplier, we use semiotics (Mingers and Willcocks 2014, 2017) to propose a new approach that challenges the shared convention assumption in prior literature. Our complementary view builds on the use of digital technology for deliberately re-representing[4] the work package by creating a new set of conventions to decode its meaning. At Lifewood, we observed how work designers developed a special-purpose language supported by digital infrastructure for facilitating the supplier delivery personnel's provision of the service. First of all, this observation recognizes a distinction between the supplier work design team (i.e., the organizational unit that liaises with the client, plans and designs the work, and trains the delivery personnel) and the supplier delivery personnel (i.e., the organizational unit that performs the services designed by the work design team). Second, we define a special-purpose language as a vocabulary containing words or signs with specific meaning, and rules that describe the internal structure of the language (Crystal 2003). At Lifewood, this new language embodied a new set of conventions for decoding work packages in outsourcing.

Our new semiotic view on IS outsourcing, called re-representation, makes a significant theoretical contribution to the IS outsourcing literature. Complementing the shared convention assumption in prior literature (see e.g., Kotlarsky et al. 2014; Srikanth and Puranam 2011; Zimmermann and Ravishankar 2014), our research explains how IS outsourcing can be accomplished by developing a special-purpose language, mediated through three re-representation practices: dissociating the signifiers, signifying through new conventions, and embedding new conventions in the digital infrastructure. In semiotic terms, this process involves changing the meaning, or the signified, of the work package, and therefore also the conventions used to decode the symbolic representations of the work package, the signifier. In this sense, our research also demonstrates and discusses the use of semiotics as an increasingly recognized theoretical perspective in information systems (see Mingers and Willcocks 2014).

This insight comes with significant practical implications. In particular, we show that linguistic conventions could be replaced by another set of conventions under certain condi-

[2]We refer to IS outsourcing as contracting one or more information technology-enabled business process to an external service provider.

[3]Using Peirce's (1932) categorization, signs can be distinguished as symbolic, iconic, or indexical subjects to the relationships between the signifier and the signified. *Iconic* representations contain visual images of what they intend to signify (e.g., pictures, sketches, portraits) and draw on the close resemblance to what they connote; *symbolic* representations are meaningful for those who understand their cultural, social or professional conventions; *indexical* representations are signs that point to something, independently of interpretation (Bailey et al. 2012; Peirce 1932).

[4]In our use of the term *representation*, we follow Bailey et al. (2012): "By representation, we mean what semioticians call a sign: something that stands for something else within the bounds of a particular speech community, culture, or community of practice" (p. 1486).

tions. Rather than leaving the meaning of the signified untouched as current practice tends to do, our perspective explains how changing the meaning of the work package allows suppliers to reformulate the need for linguistic skills, and, as a result, adopt different perceptions of expertise requirements for accomplishing the service delivery. This means that suppliers of outsourcing services can tap into a wider pool of delivery resources. Consider that language skills are widely recognized as one of the major factors influencing outsourcing decisions (e.g., Carmel and Tjia 2005; Levina and Vaast 2008). In the document outsourcing market,[5] estimated to be worth U.S. $35 billion by 2020, lingual skills are typically considered to be the main factor behind decisions regarding outsourcing location. Lack of language skills is often given as a reason to nearshore (regionally) (Carmel and Abbott 2007) rather than to offshore to far-flung destinations such as China where proficiency in, for example, German and Dutch is not available.

The remainder of the paper is organized as follows. First, we develop a semiotic lens to review the IS outsourcing literature with a specific focus on how it addresses the design of outsourced work. After the methods section, we offer our findings from our embedded case study where Lifewood's work design team analyzed the original work package, developed supporting materials, and digital infrastructure for transcription services. We then derive and outline three re-representation practices and discuss how work design teams can change the conventional signifier–signified relationship through these practices and develop a new special-purpose language. Finally, the paper outlines implications for theory and practice, discusses the limitations of our study, and presents suggestions for future research on this important topic.

A Semiotic View on IS Outsourcing

Semiotics investigates how meaning is generated and interpreted through signs and symbols (Mingers and Willcocks 2014). The Peirceian[6] approach to semiotics views a sign in terms of a semiotic triangle (Figure 1): signifier, signified, and referent. A *signifier*[7] connotes the *signified*, and stands for the *referent*. The signifier can be a word, an image, a number, a sound, or a smell. The signified, which is something with a material, or immaterial, presence, expresses the meaning of the signifier (Bailey et al. 2012; Mingers and Willcocks 2014). To be meaningful in practice, the signifier needs to make sense to the community of actors using it for doing their work (see Nicolini 2012). Such sense is created through conventions.

Peirce's work further details the relationship between the signifier and the signified in terms of three types of representations: iconic, indices, and symbolic. *Iconic representations* contain visual images of what they intend to signify (e.g., pictures, sketches, portraits) and signify because of the close resemblance to what they connote. *Indices representations* express physical and existential relationships between the signifier and the signified, as well as co-occurrence with what they signify. Well-known examples are smoke that signifies fire (Bailey et al. 2012) and thermometers as an index of temperature (Mingers and Willcocks 2014). *Symbolic representations* signify through conventions. In this regard, the link between signifier and signified is arbitrary (Bailey et al. 2012; Peirce 1932). For example, language or mathematical notations are based on symbols requiring relevant conventions to decode them.

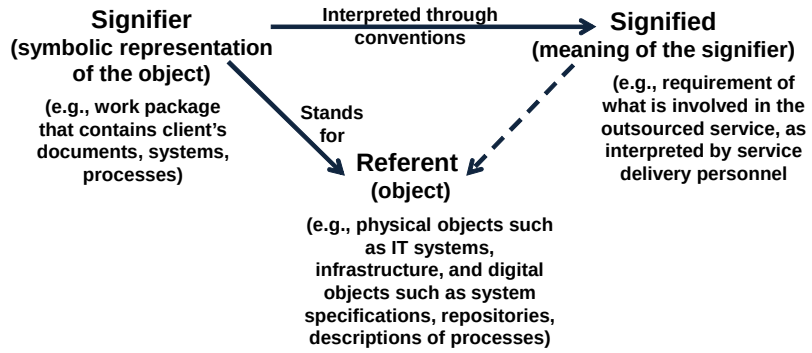
In the outsourcing context, we view the entire work package as a signifier that connotes requirements of the outsourcing task and its business context (that is, the signified).[8] The referent (Peirce 1932) of the outsourced work package can typically consist of IT systems, infrastructure, system specifications, business process requirements, and work contents (see Figure 1). As the content of a work package is language-based, it requires a particular set of conventions to decode its meaning related to the outsourced task. For example, call center operators decode the client's instructions how to deliver services using lingual and cultural conventions. Similarly, programmers employed by a supplier decode the client's technical documentation using a relevant programming language and other professional conventions. Consequently, the relationship between the signifier (work package) and what it signifies (the business service) is symbolic in nature. The conventions with which to understand the symbolic represen-

[5]http://www.futuremarketinsights.com/reports/document-outsourcing-services-market; last visited December 27, 2016.

[6]Scholars distinguish between Saussurian (de Saussure 1916/2003) and Peirceian (Peirce 1932) semiotics (also known as structural semiotics and social semiotics (Mingers 2014)). De Saussure views a sign as a dyadic relationship between two elements: the signifier and the signified. Peirce adds a third element—the object—thus forming a triadic relation between the elements of the sign (for a detailed discussion of the two approaches, and why the Peirceian approach may be considered more suitable for IS research, see Mingers 2014; Mingers and Willcocks 2014).

[7]Also referred to as *representation* (e.g., Bailey et al. 2012).

[8]In this paper, we use semiotics at two levels. On a high level, the work package as a whole can be seen as a *signifier*, and the meaning of this package for the supplier firm is what it *signified*. Then there is a more granular and detailed level, which we use in the later analysis, where each original (source) document included in the work package is the *signifier*, with its meaning for the supplier's delivery personnel as the *signified*.



Dotted arrows to the referent element of the semiotic triangle because for signifiers without material presence the referent does not exist.

Figure 1. Outsourced Work Package (Based on Peirceian Semiotic Triangle View)

tation of the work package need to be acquired by the supplier, either from the client firm, or by learning through experience when applying its own conventions. In what follows, we review the main approaches to work design in outsourcing with a specific focus on the conventions used by the supplier.

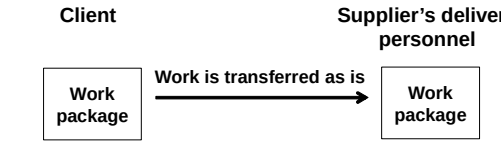
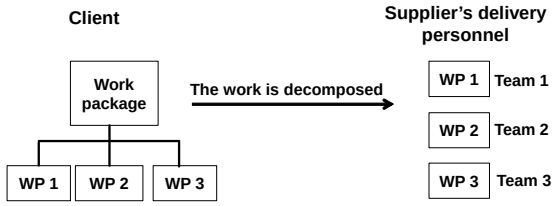
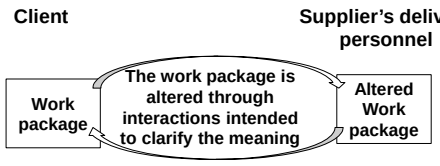
Work Design in Outsourcing: A Semiotic View

The act of delegating a task from a client firm to a supplier has been at the center of numerous IS outsourcing studies (Dibbern et al. 2004; Lacity et al. 2016). In terms of semiotics, the literature has been concerned with the supplier's problem of decoding the work package, or signifier, through conventions, and different ways to design the outsourcing work to facilitate such decoding. The first stream of literature (e.g., Chua and Pan 2008; Oshri et al. 2008; Rottman 2008; Zimmermann and Ravishankar 2014) views the design of outsourced work as a *knowledge transfer* activity where decoding skills are transferred from the client firm to the supplier. The rationale of knowledge transfer is to help the supplier's delivery personnel to acquire explicit and implicit knowledge related to the outsourced task. For example, Chua and Pan (2008) describe classroom-based knowledge transfer sessions between offshore and onsite teams. In a similar vein, Oshri et al. (2008) observe multiple channels (face-to-face and technology-mediated) through which offshore teams acquire knowledge by being exposed to the client's ways of delivering the service. From a semiotics viewpoint, the knowledge transfer sessions aim at making the supplier teams' acquiring conventions to be used as they make sense of work packages. In addition, the supplier retains the signifier's relationship with what it signifies. For example, supplier personnel delivering inbound call-center services study the way the client firm used to perform this task, paying attention to cultural nuances such as holding an informal chat about the weather and will attempt to apply similar conventions when delivering the service.

Another stream of literature (e.g., Aron et al. 2005; Carmel 1999; Kotlarsky et al. 2007; Mirani 2007; Srikanth and Puranam 2011; Susarla et al. 2010) underlines the advantage of *decomposing* the work package, or signifier, into smaller units of work based on expertise requirements. Smaller units of work are then allocated to different supplier teams, or suppliers, based on expertise match. As such, each work package involves signifiers designed for specialist teams that possess specific domain or technical knowledge required to accomplish the task. From a semiotics viewpoint, this approach to the design of outsourcing work involves the manipulation of the signifier. However, at the same time, it maintains the signifier's relationship with what it signifies, as well as the conventions used to decode it. For instance, Aron et al. (2005) examine decomposition with the intention of limiting the supplier's ability to gain strategic knowledge about the client's customer base. They describe how a bank purposely created smaller units of signifiers and distributed them among three suppliers. The suppliers were then capable of completing each chunk of work, using similar conventions as the client, while not being aware of the aggregated purpose of the various parts (Garud et al. 2003). Upon completion, the suppliers delivered the various smaller output units to be integrated by the client. As such, the delivery of the entire service, the signified, is retained intact by the supplier personnel, although the signifier is manipulated through decomposition.

Finally, a third stream of research views work design in outsourcing as a question of knowledge *translation* (e.g., Kot-

Table 1. Research Streams

Research Streams	Focus	Illustration (from Semiotics Perspective)	Example References
Transfer	Transfer knowledge needed for decoding work package	Signifier and referent (schematic):  Signified: unchanged	Blumenberg et al. (2009) Chua and Pan (2008) Oshri et al. (2008) Rottman (2008) Zimmermann and Ravishankar (2014)
Decomposition	Divide the work package into smaller units to decrease scope of decoding to smaller work packages	Signifier and referent (schematic):  Signified: unchanged but broken into smaller pieces	Aron et al. (2005) Carmel (1999) Kotlarsky et al. (2007) Mirani (2007) Srikanth and Puranam (2011) Susarla et al. (2010)
Translation	Recognize syntactic and semantic differences between clients and suppliers to be able to decode work package	Signifier and referent (schematic):  Signified: unchanged	Leonardi and Bailey (2008) Kotlarsky et al. (2014) Vlaar et al. (2008)

larsky et al. 2014; Leonardi and Bailey 2008; Vlaar et al. 2008). It emphasizes how syntactic and semantic differences between the clients and suppliers must be handled as a translation process. The delivery team needs to understand the novel conditions and learn about sources of different assumptions embodied in the original signifier (see Carlile 2002; Kellogg et al. 2006; Levina and Vaast 2005; Oborn and Dawson 2010). For example, Vlaar et al. (2008) discuss how onsite and offshore supplier teams engage in reciprocal sensemaking activities in order to advance their understanding of a client's requirements and business context. In a similar vein, Kotlarsky et al. (2014) describe how a supplier manipulated information provided by the client about offshored applications by codifying selected pieces of information that were seen to be sufficient to coordinate problem-solving when needed. Likewise, Leonardi and Bailey (2008) show that onsite and offshore teams may need to enact specific work practices aiming to make knowledge explicit in documents created onsite for an offshore team. Such knowledge manipulation (Kotlarsky et al. 2014), or alterations to the knowledge transfer process (Leonardi and Bailey 2008), results in changes to the signifier (e.g., the content of the work package) as it moves from a client to an offshore team. For instance, in the study reported by Kotlarsky et al. (2014), the supplier recreated the client's shared knowledge using its own templates to ensure that the offshore team would understand them. However, such changes in the way the signifier is documented neither affect the relationship between the original signifier and the signified, nor the conventions used to decode the symbolic representation of the work package (see Kotlarsky et al. 2014; Leonardi and Bailey 2008; Vlaar et al. 2008). In these cases, the translation of knowledge involves recreating the source through the use of a "common lexicon" (Carlile 2004), which is familiar to offshore team members. Indeed, this approach emphasizes the manipulation of the signifier in order to overcome knowledge differences between the groups without affecting the nature of the service delivered (the signified).

Table 1 depicts the three dominant views in the IS outsourcing literature, and illustrates how signifier, signified, and referent of an outsourced work package are perceived by these three streams.

The three streams of literature have at least two things in common. First, the relationship between the signifier and what it signifies has not altered despite some manipulation of the signifier. Second, uncovering a critical underpinning in these streams of literature (see Alvesson and Sandberg 2011), they assume that the supplier's intention is to retain the same conventions as the client, even in cases where the signifier is manipulated. Therefore, replacing a client's application specification documentation with the supplier's templates (that is, manipulating the signifier) does not change the notion of the delivered service, as the intention is to improve the supplier's delivery personnel's ability to make sense of the relationships between the manipulated signifier and the intended signified, while applying the client's conventions. For example, customer service operators in call centers are typically equipped with scripts, not only for diagnosing problems but also for how to relate to the customer (e.g., how to greet, what "small talk" questions to ask) (Sharp 2003). The instructions capture implicit conventions that reflect norms, behaviors, and common knowledge of the typical client, and represent them in explicit form. In situations where the supplier is not able to follow the client's conventions (e.g., in the case of cultural conventions associated with different attitudes to authority between onshore (United States) and offshore (Russia) developers reported by Levina and Vaast (2008)), such inconsistencies may cause difficulties for effective communication in the outsourcing context. Interestingly, Bailey et al. (2012) and Kallinikos (2011) demonstrate how the retention of the same convention in cases where digital representation of a physical entity (such as a production-line monitoring panel) has in fact challenged the worker's ability to confidently monitor and operate the physical entity.

However, the representational power of digital technology can also be used to construct new meaning to the signified (Mody 2014). One alternative to the traditional approaches is to use digital technology to support the transformation of the taken-for-granted relationship between the signifier and the signified. Such transformation would entail the creation of special-purpose languages; that is, a vocabulary that contains words or signs with specific meanings and rules that describe the internal structure of the language (Crystal 2003). We use the notion of re-representation to refer to the activity of developing and using a special-purpose language for transforming the signifier–signified relationship, and the conventions for decoding it. When used in the outsourcing setting, re-representation serves as a way to design work for the delivery personnel.

With this theoretical background in mind (see Table 2 for a summary of key constructs), we examine a case study where the design team of a Chinese supplier of BPO services designed the work for delivery personnel through the creation of (project-specific) special-purpose languages via three re-representation practices. In doing this, it transformed and recreated the relationship between the signifier and the signified, where new conventions (and ultimately new meaning, or the signified) were created for the delivery personnel to be used for accomplishing the outsourced work. In what follows, we carefully unpack the re-representation practices used, with the intention of deriving significant implications for the IS outsourcing literature.

Research Methods

Our in-depth case study research at Lifewood, a Chinese provider of business process outsourcing solutions, examined how its design team organized the delivery of outsourced transcription services. Lifewood offered a powerful venue for theory generation in being "prototypical or paradigmatic of some phenomena of interest" (Gerring 2007, p. 101) where "its extreme value on an independent or dependent variable of interest" allowed us to theorize an emerging phenomenon. We carefully analyzed two embedded cases: genealogy and aircraft maintenance work.[9]

When visiting the service delivery facility of Lifewood in Wuxi in December 2011, we already recognized it as a potentially insightful setting for studying an alternative form of outsourcing work design. We observed how young Chinese, high-school-educated personnel in the delivery team at Lifewood were able to transcribe effectively[10] more than 100-year-old, handwritten records, as well as handwritten aircraft maintenance work orders from modern and reliability-oriented airports. As we learned more about how Lifewood organized the outsourcing work, we realized that it did not resemble what is known from the prior literature. We, therefore, designed a study at Lifewood that included two waves of data collection (September 2012 and September 2013) at Lifewood's biggest delivery center in Dongguan, China. Table 3 (with references to the appendices) provides a detailed account of the data collection.

In both waves of data collection, our interviews focused on Lifewood's design team. The team included top managers with significant knowledge of the client domain,[11] and staff

[9]Because of space limitations, we provide a detailed description and analysis of the genealogy case in the main body of the paper. The aircraft maintenance subcase is described and analyzed in Appendix B.

[10]The accuracy levels required by Lifewood's customers were between 95% and 99%, depending on the specific service.

[11]The roles included VP of Operations, Production Director, HR Director, IT Director, Compliance Director (~ 10 people in Lifewood).

Table 2. Key Constructs

Construct	Definition
Design team	The organizational unit that liaises with the client, plans and designs the work, as well as trains the delivery personnel.
Delivery personnel	The organizational unit that performs the services designed by the design team.
Signifier (equivalent to representation)	A visual sign that denotes or connotes the signified, which is something with a material, or immaterial, presence. Within the scope of this paper, the signifier manifests at two levels: (1) the outsourcing work package including documentation such as system specifications and business process requirements; and (2) each document included in the work package.
Signified	The meaning attributed to something with a material, or immaterial, presence. Within the scope of this paper, it is (1) the meaning attached to the work package, including understanding how the delivered services fit into the business context of the client; and on the more granular level, and (2) the meaning attached to a specific document included in the work package.
Referent	The object to which the signifier refers or what the signifier stands for. For signifiers without material presence the referent does not exist. Within the scope of this paper referent is the (1) collection of physical documents, and (2) digital image of each individual document.
Iconic representation	A visual image of what it intends to signify (e.g., pictures, sketches, portraits) and signifies because of the close resemblance to what it connotes (Bailey et al. 2012; Peirce 1932).
Symbolic representation	A symbol that is only meaningful for those who understand its professional, social or cultural convention because of the arbitrary link between the signifier and the signified (Bailey et al. 2012; Peirce 1932).
Special-purpose language	A vocabulary containing words or signs with specific meaning and rules that describe the internal structure of the language (Crystal 2003).
Convention	The agreement to use the same rules in order to communicate (Crystal 2003).
Re-representation	The development and use of a special-purpose language to accomplish a transformation of a signifier–signified relationship captured in the original representation, as well as the conventions for decoding it.

with process and design expertise[12] (~ 40 people in total in Lifewood). The design team was involved in various tasks such as project planning and analysis of work content, as well as the design of workflow, digital resources, work instructions, and training materials. Key informants in this study whom we interviewed included representatives of this team (17 interviews and several observations during wave 1, and 16 interviews during wave 2). We also collected data about the delivery personnel—how they were trained, how they followed working instructions and used digital infrastructure in order to accomplish their tasks. These data were collected mainly through observations and with the help of an interpreter who translated our questions into Mandarin. Delivery personnel were mostly young high-school graduates (~ 2,000 delivery team members in Lifewood); they were native Mandarin speakers, without knowledge of English (or other foreign languages). Their character and pattern recognition skills were developed through their upbringing in China, in which studying a language is based on the gradual acquisition of characters over the years.[13]

All interviews, as well as most conversations[14] that took place (e.g., clarifications of observations of the delivery personnel's actions), were recorded and transcribed. In addition, the two authors, who conducted the field observations independently, wrote detailed field notes verbatim, seeking to document a complete picture of observed actions by delivery personnel as they used computer interface including display-enabled input-output, keyboard use, data field navigation, and consultation with their supervisors. We also collected images of the documents transcribed by Lifewood and made use of them as a primary data source in our analysis responding to a recent call

[12]This included staff from the following departments: IT (Data Management, Network, R&D); Training; Workflow and Simulation; Pricing, HR; Operations; Quality Assurance; and Project Management (~ 30 people in Lifewood).

[13]See the quote in the "Developing Supporting Materials" section illustrating this.

[14]The security level on the production floor meant there were a few conversations we were unable to record; instead, we took notes that were transcribed the same day.

Table 3. Data Collection

	Data Collection		
	Method and Informants/Sources	**Topics**	**Purpose**
Wave 1: Dongguan Delivery Center, September 2012	**Interviews** with key members of the design team (see Appendix A, Table A1, for a list of interviewees and their roles) **Observations** of a planning meeting for the genealogy project (see Appendix A, Table A2) **Observations** of delivery personnel: how members used instructions and digital infrastructure to accomplish their jobs (see Appendix A, Table A2 for details) in the aircraft maintenance and German registry projects **Document review**: workflow diagrams, data entry instructions for the delivery personnel, performance improvement targets, and productivity reports	Design of service delivery Service delivery monitoring, quality assurance and support Skills and expertise of the design team and delivery personnel Training Digital tools and their role in service design and delivery Staff motivation	From the work-design team's perspective, to understand: • Considerations and steps involved in the design of the service delivery process • When and how digital technologies contributed to the design and service delivery processes • How the client's requirements were translated and matched with the skills of the delivery personnel From the delivery personnel's perspective, to understand: • How digital technologies (more specifically, different elements of the digital environment) were used to transcribe handwritten documents • What steps were followed to accomplish their tasks • Character-recognition and pattern-recognition skills
	Data Collection		
	Method and informants/sources	**Topics**	**Purpose**
Wave 2: Dongguan Delivery Center, September 2013	**Interviews** with key members of the design team (see Appendix A, Table A3 for a list of interviewees and roles) **Observations** of delivery personnel: how members used work instructions and digital infrastructure to accomplish their tasks (see Appendix A, Table A4) **Document review**: screenshots, keying instructions, images of the source documents **Archival data** on workflow changes for aircraft maintenance service	How work is "represented" to the delivery personnel so that it matches their skills and cognitive abilities Use of IT (tools, infrastructure) How processes and tools were changed to improve performance over time The evolution and rationale of digital tools and dictionaries	To understand: • How work design and digital technologies were expected to guide the delivery personnel to accomplish their tasks • How performance could be improved • How digital technologies evolved/ changed over time, and the rationale of these changes

to apply visual data in IS research (Diaz et al. 2015). We examined the specific characteristics of the documents transcribed, including particular words in the documents and our interpretation of the text written in the images. We then compared field notes to identify any contradicting, corresponding, and complementary aspects. This comparison was imperative for generating questions to follow up with Lifewood personnel.

In line with most case studies, the data collection and data analysis were conducted in tandem. With a semiotic lens in mind and broadly using Mingers' (2014)[15] guidelines for conducting semiotic research in the IS discipline, our analysis of the genealogy and flight maintenance subcases at Lifewood

[15]Mingers (2014) is the earlier version of Mingers and Willcocks (2017).

can be described in three steps. First, we *appreciated the research situation* by using our semiotics research framework. This step involved using the Peirceian semiotic triangle view to create an initial understanding of the Lifewood research site and its main components and key questions. We discovered how the relationships between signifier and signified showed significant deviations from our initial assumptions derived from literature and outsourcing practice experience. In turn, this guided our data collection toward the work design team. Second, we then *analyzed the research material using semiotic concepts* to develop an enhanced understanding of the ways that the work design team re-represented the work packages in the genealogy and flight maintenance projects respectively. We investigated the semiotic nature of the work package, creation of support materials, and the digital infrastructure devised to support the delivery personnel's transcription work. Finally, we *assessed the validity and plausibility* of the potential explanatory mechanisms of the re-representation observed at Lifewood, including formulating three re-representation practices (disassociating the signifiers, signifying through new conventions, and embedding new conventions in the digital infrastructure) and analyzing the viability of the semiotic view in light of prior outsourcing literature.

Company and Case Background

Founded in 2004, Lifewood Data Technologies is a BPO business unit of Pactera, a large, NASDAQ-listed Chinese outsourcing supplier. Lifewood offers data-processing and indexing services for organizations in banking, aircraft maintenance, genealogy, medical-claims processing, and other industries. These services typically involve transcribing handwritten documents into digital templates linked to a dedicated client's database. By the end of 2013, Lifewood employed around 2300 people in China, Bangladesh, and Benin, and it had completed more than 4000 genealogy and historical projects covering marriage records, census, probates, and electoral records. These projects involved 40 languages and documents that in some cases dated back to the 19th century.

The Challenge: Enabling the Transcription of Handwritten Documents in Numerous Languages in China

As part of its low-cost operations, Lifewood relied on local recruits to transcribe handwritten documents in numerous languages. The target recruit was a Chinese high-school graduate from a rural area. By and large, most recruits were unable to read, write, or even recognize the alphabet of any other language than Mandarin. However, it was not deemed viable to teach new natural languages to delivery personnel because it would erode Lifewood's cost advantage. Lifewood, therefore, faced the challenge of devising a work design in outsourcing that would allow its delivery personnel to efficiently transcribe handwritten documents in numerous languages without having to enhance their linguistic skills.

In what follows, we describe in detail, in the context of genealogy,[16] how the design team addressed this challenge by developing a digitally enhanced special-purpose language that would enable the delivery personnel to accomplish the outsourced work.

Background: The German Registry Project

In late 2012, Lifewood was contracted to transcribe German records from the late 19th century. This genealogy[17] project, referred to as the German registry, included over 1,200,000 records of birth, marriage, and death certificates. The work package contained handwritten documents handed over to Lifewood as batches of images of several pages, which included a combination of the three types of certificates.[18] The project required Lifewood to transcribe information included in these historical, handwritten documents, and enter it into digital templates for building a database for the client. For example, in the case of marriage certificates, the typical certificate (see Figure 2) included details of the bride, the groom, their parents, as well as dates and locations for their birth and marriage. In total, 11 pieces of information (shown in red rectangles, and explained in blue call-outs) were entered into separate fields of the digital marriage template.

[16]In Appendix B we demonstrate how the work design team design outsourced work for a typical airline service, which aims to complement the following section which focuses on the typical genealogy project.

[17]*Genealogy* is concerned with tracing family history and origins. Lifewood's genealogy clients were typically contracting the company to digitize original handwritten historical records. Depending on the volume of documents, each genealogy project took between a few weeks and a few months. In this section, we use examples from one of the largest genealogy projects, the German registry project. The project involved 1,209,606 records that were digitized between April and September 2013.

[18]The documents were scans of images from original books in which births, marriages, and deaths were recorded by hand in temporal order. The images received from the client therefore contained multiple consecutive records to be transcribed. It is important to note that, for the German registry (as well as all other genealogy projects), images of pages from churches included multiple records, each of which had to be transcribed as a separate entry in the client's genealogy database.

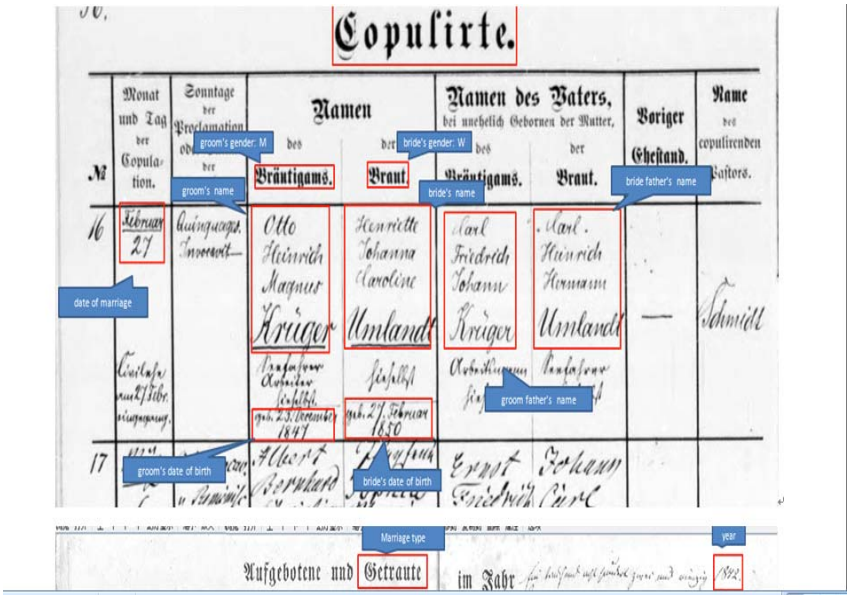


Figure 2. Marriage Record Example

Because the documents were nearly 150 years old, the quality of the original documents was generally poor, and some parts of the images had faded away. Since many individuals, each representing a particular establishment (e.g., a church), were involved in recording the events, multiple ideographic templates for capturing the birth-, death-, or marriage-related information had been used over the years.

Findings: Work Design for the German Registry Project

Analyzing the Work Package

At an early stage of the German registry project, the work design team, comprised of experts from Operations Management, Quality Assurance, IT, Data Management and Network, R&D, and HR, had already become involved in studying sample images received from the client. This involvement was important for Lifewood's understanding of the scope and complexity of the project. It helped Lifewood to estimate the time and effort required to accomplish the outsourced project. First, the design team examined the client's requirements, including background and historical information about the documents, record types, fields to transcribe for each record type, missing information, accuracy level,[19] and technical format of the genealogy database that the client intended to build. One senior manager noted that, if necessary, the client was contacted to seek clarification:

> *We sometimes have data elements that are unexpected, because it* [the data] *is historical or someone wants to keep it. So when we come across anything unexpected, typically somebody like Kathy* [Assistant Operation Manager] *or whoever is in charge of the project would talk to the customer.*

The design team also examined whether the image quality could be improved using in-house digital tools. Last but not least, they looked into related transcribing projects accomplished in the past, in order to identify whether any supporting materials designed for previous projects could possibly be reused for the German registry.

Once the complete work package of the German registry was received, the attention shifted to devise the detailed work design needed to enable efficient transcription by the delivery personnel. In doing this, the design team was mainly concerned with the quality of the handwriting and the general format of the record. Consider the German genealogy image (Figure 3) as an example of a typical image, in which strings of text are fading away or annotated. In addition, it has more than one death record, each to be transcribed as a separate entry in the database.

[19]The accuracy was required to be above 95%, but could be as high as 99%.

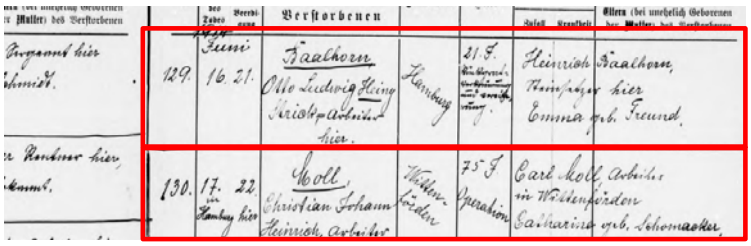


Figure 3. Image with Two Death Records from the German Registry Project

The design team examined these images in order to classify and group records included in the work package according to their nature (e.g., baptism, confirmation, marriage, or death) and geographical region (e.g., specific parish). As the design team grouped different records, including the example record, they went back and forth between the client specifications and the various types of records to make notes about which fields needed to be transcribed for each record type. It also took note of the similarities between records that could be taken into account when developing supporting materials and digital templates for the project. At this stage, existing supporting materials from related past projects were also assessed for their suitability to be used for the newly arrived work package.

Creating Supporting Materials

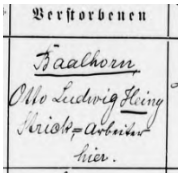
Supporting materials served as a basis for providing guidance to delivery personnel (hereafter referred to as operators) regarding how to identify relevant pieces of information in each record: how to find and recognize what was relevant, and what belonged to which field of the digital template, from all that was included in the given record. Guided by the client's requirements, the focus of the design team was on identifying structures, or patterns, in each group of records with the intention to embed them in rules and instructions for operators to follow. The design team also paid attention to deviations from the typical record structures to create additional instructions. For example, one senior manager described how such deviations from a typical record structure posed a challenge for operators:

> *It is confusing for operators that sometimes the given name is one word, and sometimes two, and it is not the rule that there are always two. Because a lot of given names were two words, one operator put a second word into the given name and then typed the middle word and then, after reading the name, basically realized that part of what he put as the given name belonged to the surname.*

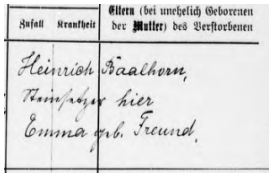
Consider the example image in Figure 3 again. Each of the two records has multiple fields populated with a string of text that contains either letters or numbers. The client requirements instructed Lifewood to transcribe all text from these records, breaking them into pieces of information that belonged to specific fields of the digital template. For example, while recorded in a single box of the handwritten record, the name of the deceased (Figure 4a) was digitized into two fields: given name and surname. Similarly, the name of the living relative (Figure 4b) was also required to be broken into the given name and surname. However, a close examination of the record shows that some text with the name of the relative in fact crosses over two boxes of the handwritten record.

Since operators approached text strings as pictorial images, Figure 4b highlights a typical problem of decoding. A repeated concern was whether the first line of the image should be decoded as two separate strings of text, or as one piece of information about a relative that starts in one box and crosses over to another box. In response to such concerns, the design team developed keying instructions (KI), intended to help operators to locate the string of characters associated with information to be entered in each field according to the client's requirements. The KI offered (in Mandarin) location guidance about where in the image of the record to look for text to be entered into each specific field of the digital template (e.g., "look right-hand side, second row") and what cues to look for (e.g., "characters that appear after numbers") (see Figure 5).

The design team also examined variations in handwriting styles to develop supporting documentation of key visual images. These included (1) pictorial representation of the most commonly expected handwriting style of individual letters and commonly used combinations of letters, linked to the equivalent letter key on the keyboard (as shown in Figure 6); and (2) variations in writing of the same letter(s) or names



a. Name of the deceased



b. Name of the relative

Figure 4. Text String to be Digitized into Multiple Fields (Examples from Record 1 in Figure 3)

Figure 5. Keying Instructions Example

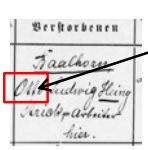
Figure 6. Handwritten Characters and Frequent Combinations for the German Registry Project

(see variation in writing "Otto" and a letter "a" in Figure 7[20]). Furthermore, special "hot keys" were created and linked with specific (frequent) combinations of letters and high-frequency words. These documents were used to train operators to recognize and make a connection between the images of the handwritten letters/words and the keyboard key that the operator would need to strike. The rationale for this approach was explained by a member of the design team:

> *In Chinese culture, studying is more about memorizing.… So I think almost all Chinese already have the mindset to memorize such things.…They* [the operators] *don't want to know what's that language or…what it means in English, they just type it.*

Each operator had KIs, high frequency words, and a list of hot keys on their desk, or attached to the wall of their cubical,

[20]Example "a" in Figure 7 shows how the given name "Otto" in our sample death record is different from another instance of the same name, which was included in the supporting materials to represent the typical pattern for recognizing "Otto."



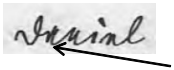
Given name "Otto" in the example (record 1)

Name "Otto" as included in supporting documents for recognition of German names

a. Example of variation in pattern of writing of the name "Otto"

Anna

Andreas



Daniel

b. Variation in the character "a" across German names (extract from detailed name recognition materials)

Figure 7. Examples of Variations in Images of Characters and Patterns in Commonly Used Names

when transcribing the records. Some of these supporting materials were used to train operators to recognize visual representations (i.e., images) of letters, and visual patterns of names (strings of text) in the handwritten records (e.g., materials shown in Figures 6 and 7). Other supporting materials (such as the keying instructions) were used to help operators keep track of the structure of records, the rules of locating relevant text in the record, and relevant fields in the digital templates. These KIs, first introduced to the operators during training, were used throughout the project as the main transcribing guide for operators to follow.

Developing Digital Infrastructure

The design team put significant efforts into the development of the digital infrastructure for the German registry project. For instance, all documents included in the work package were scanned to become digital representations of the physical records. In-house digital tools were used to improve the quality of fading images. As the IT Director explained:

> *We have a group of people who focus on enhancing the images. Because we want to have good quality files, but a smaller size, they know how to make the file high standard.… They do research on images: how to build the image faster, to zoom in for operators, to show the operators how to open up the image in a more effective way.*

Further, a set of digital tools were developed and integrated into the bespoke transcribing technological platform, known as LiFT. Figure 8 shows how operators viewed the digital representation of the example death record (shown earlier in Figure 3) on their computer screen via the LiFT interface.

The digital infrastructure of the genealogy project included templates comprising fields for each piece of information that the client required to be transcribed (as depicted in Figure 8). Each field in the digital template was associated with a specific piece of information from the record. For example, the first field in the top entry (Figure 8) shows that the record above is a death certificate followed by information about the death date of the person (1914, June 16). While the date of death was typically straightforward to recognize, the name of the deceased required rules that described the structure of the record. First, when examining the relevant box where the name of the deceased was written (the field is shown in Figure 4a), it is unclear from the string of characters what part of the text is the surname and what part is the given name. For the untrained eye, there are seven strings of text in this box. However, with the use of the newly developed rules (e.g., KI) about the physical location of text strings and their related digital field in the LiFT system, operators could more easily appreciate which string of characters was the given name or the surname. For example, an explicit rule in the KI explained that the underlined text is the surname, followed by the given name, which can be either one or two strings of text. In addition, the design team designed a rule that only alphabet characters were accepted into these fields (name and surname). This rule was embedded in the LiFT system, rejecting any numerical entries as mistakes.

In a similar vein, rules specifying format (e.g., text or numerical) or range of possible entries (only certain years between which the documents included in the work package were recorded, only numbers between 1 and 31 for a "day" field, or only 12 possible names of a month for the "month" field) were defined for every field of the digital template. As the IT Director explained:

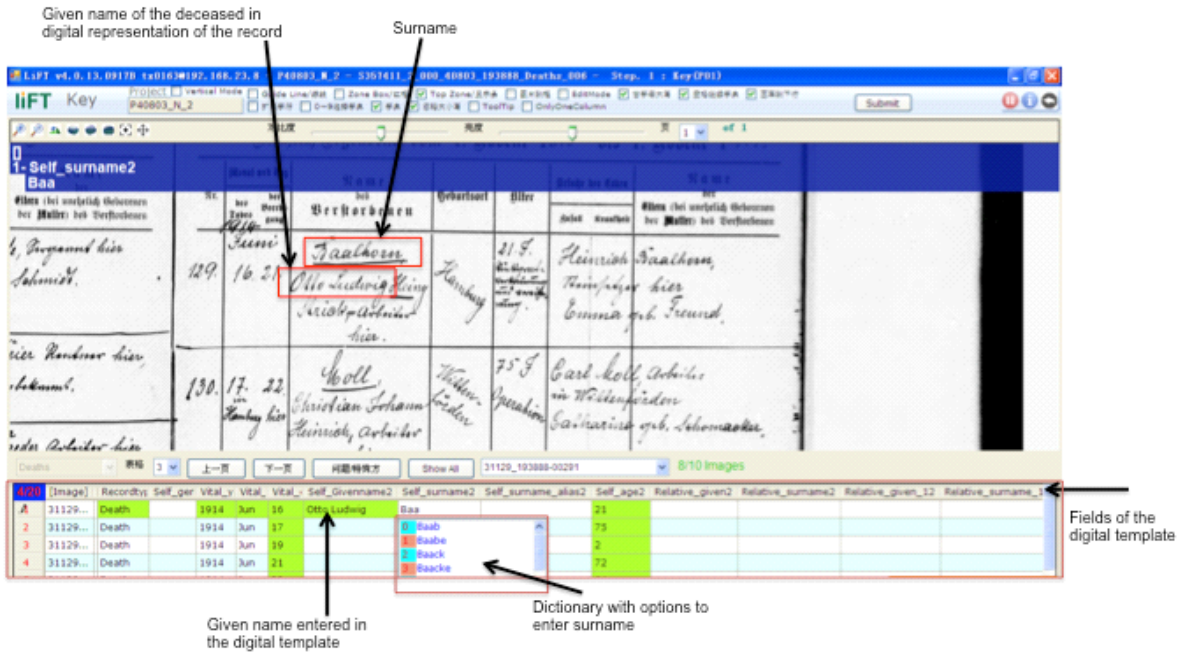


Figure 8. Example Image, Digital Template, and a Director as Shown Via LiFT Interface

> *Unstructured documents tend to be essays. What we do is be more focused on the dictionary, so we try to edit it and make it more business-grouped. Say the bride and bridegroom words came up. We are more alert and pay attention to our operators, and we try to put more structure into the dictionary—locations, different places, and narrow it down.*

A senior member of the design team explained the process of creating the structure of the template design:

> *Normally with a template design, yes, there is some kind of structure. So, before we do a template design, we need to provide the template designer with all the specifications, where is the location, and also what kind of rules we want, so everything has to be written down. Once we have done the specifications, others will check it over, and then it will be passed to the template designer. Then the QA team will check the template against specifications. That's the process of template design.*

The digital infrastructure also prespecified, through the use of the data dictionary[21] function, the likely entry for most of the fields. In Figure 8, the dictionary attached to the surname field is open, showing possible entries based on the combination of characters entered by the operator and the frequency that this surname was found in already digitized records (for the current or earlier completed project of a similar type). The design team studied historical archives to include the most popular German names (surnames and male/female given names) at the times when the records were created and these names were included in the digital data dictionary.

Another digital function built into the dictionary turned the entry in the digital field into red font (instead of "Baa" currently shown in black) if the surname (after the operator typed the rest of the surname) did not appear in the dictionary of possible surname entries. The red color was used to make the operator aware that it was the first time that this specific surname was entered, signaling that there might have been a mistake in the entry. In fact, we observed how one team member was reluctant to enter a name not included in the name-field dictionary. He tried several combinations of different characters until the text turned black (instead of red). Entries already included in the dictionary seemed to reassure him that the entry was likely to be correct. If, however, the operator left the new surname entry, this would flag the record for quality assurance checking. The quality assurance group would receive a notice to check the record. After checking the record, the record would either be corrected or approved

[21]The data dictionary of the German registry project contained over 100,000 words.

11-Apr-13	20-May-13	27-Jun-13
LiFT v4.0.13.0411D • Standard platform	LiFT v4.0.13.0520C • Change of function key Ctrl+D to auto duplicate	LiFT v4.0.13.0627A • Added hotkey to F6/F7 to skip unnecessary keying field • Added feature to allow operator adjust brightness of image • Added option on "Enter button" to move to left or right field

Figure 9. IT Changes Made to LiFT During German Registry Project

for addition to the surname dictionary. As one member of the design team explained:

> *Another thing might be whether we need to apply the marking scheme model.*[22] *We can apply a lot of business rules to the marking scheme, say if a bunch of names is not in the dictionary, so we highlight them in a different color.… and if one is not in the dictionary, we highlight it, so the operator just focuses on those things, which is how we correct.*

In addition to these features, the digital infrastructure was designed to automatically re-center an image of the digital record on the screen each time another field was transcribed. For example, the given and surname field in the digital record (Figure 8) would be at the center of the screen when the digital infrastructure expected the operator to transcribe this field. After these fields were entered, the image would move slightly to the left so that box with the relative's name (Figure 4b) would then be center.

These digitally enhancing features demonstrated the rules embedded in the digital infrastructure, designed to implicitly guide the operators through transcribing. More rules were added through changes to the LiFT infrastructure as the design team found ways to improve the system (as illustrated in Figure 9, which contains extracts from the German registry project data).

Last but not least, the digital infrastructure contained a digital workflow, a step-based scheme that sequenced activities and monitored the application of explicit and implicit rules, from the moment an image of a handwritten record was uploaded until it was transcribed into a digital template and brought to an end with the submission of the transcribed entry into the client's database, creating backup and reporting. As records were transcribed, the digital workflow monitored the level of accuracy of the transcribed records and, based on prespecified design rules, would flag some of the transcribed records to the Quality Assurance team for further examination, if there were numerous unsuccessful attempts to transcribe a field properly (e.g., difficulty in transcribing the surname). The digital workflow was typically modified over time as the design team became able to identify areas that could be completed in a more effective and/or efficient manner. The IT Director gave examples:

> [Example 1] *In the next version 1.1 we combined the two processes into one process. With the first version, our operators would wait ten seconds or more to jump to the next status. It's a waste of time. So we combined these two processes.*

> [Example 2] *You can see here in the first version the job number was OCR'd*[23] *and some job numbers were incorrect, so we needed our operators to verify the job number with the image name. That was removed. Now we just ask the operator directly to key in the job number*.

The second example illustrates how the design team replaced a verification activity with a keying activity. Such a change in the digital workflow suggests that the design team considered the keying set of rules, already established and practiced by operators, to yield more accurate results than attempting to establish verification rules.

Analysis

Across the main approaches to work design in the extant IS outsourcing literature including knowledge transfer (Blumen-

[22]It was explained to us that the marking scheme was used to mark exceptions to existing rules.

[23]Asking for further explanation on the use of the optical character recognition (OCR) tool, we were told: *"The OCR is supposed to help, but the quality of the OCR is only 80 to 90%."*

berg et al. 2009; Chua and Pan 2008; Rottman 2008; Zimmermann and Ravishankar 2014), decomposition (Aron et al. 2005; Kotlarsky et al. 2007; Mirani 2007; Srikanth and Puranam 2011; Susarla et al. 2010), and knowledge translation (Kotlarsky et al. 2014; Leonardi and Bailey 2008; Vlaar et al. 2008), there exists a common assumption that the client should use the same conventions such as the supplier when decoding work packages. Our semiotic view challenges this assumption and suggests an alternative approach to the design of outsourcing work. It puts the relationship between the signifier and the signified at the heart of such work design. In the Lifewood case, we noted how the work design team devoted significant efforts to set up a new special-purpose language (Crystal 2003) with supporting digital infrastructure for organizing the delivery of the German registry project (as the firm did for all projects; see also the flight maintenance example in Appendix B). In doing so, the design team manipulated both the signified and the relationships between the signified and the signifier. In what follows, we synthesize our findings of the Lifewood study into three re-representation practices, each vital in developing such a special-purpose language.

Three Re-representation Practices

Dissociating the Signifiers

Our data analysis shows a significant ability among work design team members to replace established relationships between characters (signifiers) and their blending into meaningful words (what the characters signify in the context of the document) with iconic representations. Indeed, single characters were represented as icons, possible to recognize despite large variations in the handwriting (see examples in Figures 6 and 7). As such, the character was dissociated from its word and the word's symbolic representation. We refer to this practice as *dissociating the signifiers*.

Working at the character level, the design team first captured handwritten characters from the records (individual characters and frequent combinations in, for instance, the old German alphabet) and depicted them as iconic representations of alphabet letters. This detached them from the traditional blending with other characters, forming meaningful words. As different individuals wrote the original documents, there was variation in pictorial images of the characters, or the way that characters were written. The design team, therefore, captured such variation in handwriting styles for each character as well as for patterns of characters, especially in popular names (see examples in Figures 6 and 7) and commonly used aircraft parts (see Figure B3 in Appendix B). One senior manager commented:

> *We paid attention to every single bit in the image, how the letters look like, how names are written and where they are in the image, and then worked out a way to rearrange all this information in a way that makes it workable for the operators.*

As the design team at Lifewood dissociated characters from their words, it transformed the symbolic meaning of the text included in the documents into iconic representations for the operators to use for digitizing records. While members of the design team were able to apply linguistic and professional conventions to decode the blending of alphabet characters into meaningful words, the outcome of this practice was in fact multiple iconic representations. Indeed, for the operators, the characters did not carry any other meaning apart from what was given by their visual recognition of the image. The operators relied on their ability to memorize characters rather than to interpret them in the context of the document.

Signifying Through New Conventions

The second re-representation practice, which we refer to as *signifying through new conventions*, involved replacing the linguistic-based conventions used to understand *what* was written in the original handwritten document with a new set of conventions. These conventions were used to communicate to the operators *where* to find the relevant information.

Our research shows that the work design team developed rules and instructions by referring to strings of characters (e.g., location of surname as a data field, see Figure 4 and Figure B2 in Appendix B). In doing this, the design team removed the original linguistic convention and recreated new conventions as a set of rules that equipped operators with the ability to recognize the location of strings of characters in the image that were relevant for their task. This recreation of new conventions at Lifewood involved two steps. First, for each type of record (e.g., birth, marriage and death), the images were analyzed to distinguish pieces of information that the client required to be transcribed as a separate data field (see Figure 1). Second, the image structure was captured as a key instructions document that aimed to communicate where to find the relevant information to be entered into each field of the digital template (see Figure 4). This orderly combination of interacting signifiers based on their position in the document created by the design team is known as a spatial syntagm[24] (de Saussure 1974). It allows for replacing the

[24]*Syntagm* is based on the idea that a word gets its meaning through its position in two orthogonal dimensions. The first dimension is the way it combines with other words in a sentence, or in this case its position on a page. The second is its relationship to other words that could have been used in its place. (We would like to thank the anonymous reviewer for helping us to clarify this.)

actual meaning of part of a document by reference to spatial position (i.e., combination of spatial positions of relevant words) and membership of a set of alternative terms (i.e., selection of possible entries for each field of the template, captured in the data dictionary). Related to how to locate relevant information on a record image, the intention behind creating the new meaning was to signify the link between each piece of information in the handwritten record with a specific field in the digital template to be completed.

The enactment of this re-representation practice leads to a set of new conventions of a visual nature (rather than being linguistic or professional conventions) and relies on a set of explicit rules on how to complete tasks based on visual cues.

Embedding New Conventions into Digital Infrastructure

We also learned how the design team designed and embedded structural elements and rules in the digital infrastructure to guide the decoding of the digitized records. We refer to this practice as *embedding new conventions into digital infrastructure*.

In the Lifewood case, we noted how showing text entered in a name field of a digital template in a red color was a rule that signaled to the operators that their attempted entry could be wrong.[25] Another set of rules was related to the predefined format of each field of the digital template to be numeric, date, or name. Such rules, embedded in the digital infrastructure, were explicit to the operators and learned via training and practice. Additional rules, implicit for operators, were related to the digital workflow that triggered processes such as quality assurance checking of specific entries, and the allocation of images of records to operators. The digital infrastructure also encompassed structural features such as data dictionaries that were linked to specific name-fields, which reduced the need to recognize each and every individual character and instead offered possible entries that could be recognized by comparing patterns of characters with possible names in the dictionary. As such, the structure and rules embedded in the digital infrastructure reinforced the new conventions related to the "signifying through new conventions" re-representation practice, serving as a digital layer of the special-purpose language. This practice also incorporated a number of new signifiers such as in-house tools and the LiFT user interface that were not part of the original work package. A senior member of the design team explained:

> *We use the LiFT platform to build in many rules that not only guide the operators but also do things at the back-end without them* [operators] *realizing this, based on the workflow we designed.*

Table 4 summarizes the properties of the three re-representation practices identified at Lifewood. It explains how each of these practices contributed to changing the original relationship between the signifier and what it signified; the contribution to the new special-purpose language; and the outcome of each practice. Collectively, the outcomes of these practices offer a new way to understand how tasks included in the outsourced work package could be accomplished by the operators.

Programming languages are an example of a formally constructed language that, in its essence, is closely related to the new special-purpose language developed in Lifewood through three re-representation practices. Similar to a programming language that uses sequences of text including words, numbers, and punctuation, as well as visual relationships between symbols to attach a meaning that, when known to a programmer, enable him/her to specify a program, Lifewood's new language was designed through syntagmatic analysis to enable the operators to accomplish the outsourced tasks. The "vocabulary" of this new language consisted of (1) characters associated with specific keys (i.e., new meaning was established through the relationship between a character and a key) and (2) common combinations of characters or high-frequency words linked to so-called hot keys. The "grammar" was captured in conventions through (3) keying instructions that contained rules explaining how to find in a document pieces of information that were relevant to the transcribing task, as well as (4) rules and guidelines that explained how different elements of the digital infrastructure (user-interface, templates, dictionaries and more) worked. These new conventions were then digitized and embedded within the digital infrastructure.

Discussion and Implications

From Representation to Re-Representation

Our research relates to earlier IS studies on representation in organizing work (Bailey et al. 2012: Kallinikos 2011). For instance, Kallinikos (2011) provides a detailed account of a fully computerized, remotely controlled, complex dairy production line in which workers are faced with the representation of the actual production line in the form of a set of bulbs and a print-out report. In this case, workers

[25] A set of associated signifiers that are members of the same defining category (e.g., given name), known in semiotics as paradigmatic relationships, was added by the design team.

Table 4. Re-representation Practices and Their Outcomes

Practice	Changes to the Conventional Signifier–Signified Relationship	Contributions to the Special-Purpose Language	Outcomes
1. Dissociating the signifiers	1. Characters (signifiers) with a linguistic meaning (original signified) treated as *iconic representations* as the design team replaced the need to understand the linguistic meaning of the character with the need to recognize the image variation of this character in different handwritten documents. => ***Symbolic representation*** *of each character in an alphabet (and common combinations of characters) has become an* ***iconic representation*** *(Figure 6). Variations of iconic representations of the same character/common patterns have been created (Figure 7)*. 2. Multiple handwritten images of the same character are associated with a specific key on the keyboard (Figure 6). Common combinations of characters and high frequency words are identified and associated with new keys ("hot keys"). Example record 1 (Figure 3): name of the deceased and the relative should be recognized as a sequence of images (pictorial representation) of characters.	Various visual images associated with each key are symbols that form the "alphabet" of the new language.	Variations of visual images of characters/ symbols.
2. Signifying through new conventions	Each piece of information (signifier) in a handwritten document has a linguistic or numerical meaning such as a name, place or date (original signified). Rules describe the logical structure of the document (see Figure 5) based on the location of pieces of information, i.e., where/how to find the sequence of characters/ numbers that should be entered into each field of the digital template. => ***New conventions are created*** *to explain where/how to find relevant information in the digitized image of the record. Using these new conventions, operators make sense of the image (i.e., extract relevant pieces of information) to fill into a digital template.* Example record 1: Keying Instructions explain how to find entry to each field of the digital template in the record. These instructions refer to specific boxes on the record (e.g., box with name of the deceased (Figure 4a), and boxes that contain name of the relative (Figure 4b)), and explain how to identify which part of the name in each box is a surname, and which is the given name, and how to deal with the string of information that is crossing two boxes (Figure 4b).	Rules and logic that describe the relative location of information, forming part of the "grammar" of the new language, constituting new conventions of the new language.	Rules and logic that describe relative position of fields in the document.
3. Embedding new conventions into digital infrastructure	Pieces of information associated with different fields are analyzed to identify rules that could be programmed and used to reduce the scope for potential mistakes when entering a sequence of keys in each field. These rules are incorporated into (1) digital data dictionary and (2) ergonomic ways of organizing images and fields on the screen. The digital infrastructure provides a digital working environment that has multiple new signifiers (e.g., in-house tools and user interface, color scheme) that were not part of the original work package. These signifiers are meaningful for operators who complete the transcribing task by following visual conventions. => ***New conventions are incorporated*** *into digital infrastructure. New digital signifiers are created and embedded into the infrastructure.* Example record 1: Digital representation of the record is embedded within LiFT infrastructure (Figure 8). In the digital template fields such as "Self-Givenname," "Self-Surname," "Relative-surname" (and other names) are restricted to letter characters, and fields with date of death and age are restricted to date and numeric entries (respectively). Data dictionaries with given names and surnames are linked to relevant fields.	Additional (visual) conventions of the new language are embedded in the digital infrastructure and serve as a digital layer of the "new language."	Digitally enhanced new conventions. Business rules and data dictionaries linked to specific fields of the digital template.

> failed to restore the confidence that referential reality is capable of providing to people accustomed to context-embedded work based not just on the reasoning and distancing capacity of the eye, but on sensory-motor manipulation of tangible things (Kallinikos 2011, p. 116).

Similarly, Bailey et al. (2012) examine the case of remote control as one type of virtuality, claiming that "operators use symbolic and iconic representations of objects and physical processes to monitor, manipulate, and alter the objects and processes from a distance" (p. 1500). In this regard, the digitization of a physical entity creates a representation (e.g., schematic plan of the production line) that *mediates* the worker's manipulation of the physical entity. The work design relying on such mediation is both enabled and restricted by the limitations of the digital representation of the physical entity. For example, Bailey et al. report that in a study conducted by Hirschhorn (1984) it was observed that

> working virtually with a complex, tightly coupled, technical system not only increases an operator's cognitive load, but also requires different forms of organizing precisely because complicated representational interfaces change the nature of an operator's work (p. 1488).

Our work complements this prior research on the role of representation in work design by examining other possible characteristics of the nature of work involved. Unlike the cases reported in Bailey et al. and Kallinikos, the outsourcing setting involves the transfer of information between two entities. Interestingly, our analysis shows that the transfer of the object (i.e., referent) across organizational boundaries demarcates two representation systems: one representation system of the transmitting party (client firm) and another one of the receiving party (relevant for the supplier delivery personnel), creating *a separation between two representation systems*. Rather than being caused by the digitization of the object, here the case of separation is instead a result of the retention of the same object while separating the transmitter (client firm) from the operators via the mediating role of the design team. Such separation creates an opportunity to *substitute* the original representation system with a different representation system via the introduction of a special-purpose language (Crystal 2003). Such substitution of one representation system with another is achieved through *re-representation* practices. Indeed, unlike in prior outsourcing literature where the representation system remains unchanged, or the digitization case (Kallinikos 2011) where the new digital representation system mediates the worker's manipulation of the object, our case shows a separation between representation systems. It thus requires re-representation of the original representation (signifier). Such a process establishes new links between the original signifier and the new signified.

Implications

Our research offers significant implications. First and foremost, it contributes to the IS outsourcing literature by providing a semiotic view on the design of outsourcing work. This view challenges the common assumption among existing streams of outsourcing literature—such as knowledge transfer (Chua and Pan 2008; Rottman 2008; Oshri et al. 2008), decomposition (Aron et al. 2005; Carmel 1999; Susarla et al. 2010; Kotlarsky et al. 2007), and knowledge translation (Kotlarsky et al. 2014; Leonardi and Bailey 2008; Vlaar et al. 2008)—that the supplier should use the same convention as the client to decode the meaning of the work package. Our re-representation perspective offers a new way of examining the use of digital technology for outsourcing purposes. It stresses that outsourcing work is predominately symbolic in nature, and provides a theoretical basis with which to understand how a series of re-representation practices enable a new take on the classic problem of interpreting the work delegated by the client in outsourcing. This is really important for expertise requirements in outsourcing, and calls for reevaluating the role of language skills in IS outsourcing. Traditionally, suppliers invest significantly in developing the expertise of their delivery personnel to match the client's domain knowledge (Levina and Vaast 2008; Oshri et al. 2007). In doing so, suppliers seek to reduce operational risk[26] by elevating the client's confidence in its ability to deliver high quality service. However, such elevation may be time-consuming and may result in an over-investment by the supplier. Rather than ramping up the expertise levels of the delivery personnel within the scope of the client's representation system, however, our research points out another direction. It suggests that suppliers may reformulate the expertise needed by re-representing the work package. Thus, re-representation as a form of work design offers suppliers the opportunity to reexamine the pool of expertise needed for the delivery of a service and disaggregate their expertise-base in view of the nature of the work-package representation. After all, a work package that conveys a symbolic representation decoded through professional and cultural conventions for one group of people, may be viewed as an iconic representation and thus decoded via a new set of rules for the other group. On the basis of our research, this observation suggests

[26]Operational risk is the risk that processes would not operate smoothly after being outsourced or offshored (Aron and Singh 2005).

that the skill of image recognition, rooted in visual analytics (Coopmans 2014),[27] should be considered as an alternative area of expertise. For example, some finance activities, such as expense reimbursement processing[28] (structured or unstructured), are prospective candidates for processing based on pattern recognition and new conventions rather than obtaining finance knowledge.

Our study also contributes to the emerging literature on the use of semiotics in information systems. In view of recent guidelines (Mingers and Willcocks 2014, 2017) and special issue editorials (Aakhus et al. 2014), we offer an intermediate step between pioneering scholarship on semiotics and its wider adoption across specific IS research areas. Indeed, the adoption of a theoretical perspective new to the discipline requires empirical examples that demonstrate its relevance and ability to offer explanations beyond what is known in the literature. In this regard, our application of semiotics contributes to showcase the theoretical lens in the IS and management literature (see Bailey et al. 2012; Kallinikos 2011), and indeed allows this paper to develop an explanation new to the outsourcing literature. At the same time, it also advances our understanding of semiotics. While the proposition that a signifier can be manipulated is not new for students of semiotics (see Baudrillard 1981), the semiotics literature is silent with regard to understanding the implications of manipulating the signified. In this regard, our study offers new insights to semiotics in examining the consequences of manipulating the meaning (i.e., signified) of the signifier as the object is transferred from one entity to another. At the heart of this insight is the development of a special-purpose language (Crystal 2003) made of new vocabulary and grammar that articulate new conventions used to decode the signifier. Re-representation as an activity rooted in semiotics is universal and can be applied to other management contexts beyond outsourcing.

Third, our study also relates to the recent call to use images in IS research as a source of information in their own right (Diaz et al. 2015). Indeed, so far there has been very limited use of visual data in IS studies, despite the centrality of technology for supporting visualization in information systems (e.g., monitoring panels, screens, and workflow schemes) and the availability of images from social networking, video-sharing, and location-based web sites. Diaz et al. (2015) distinguish between naturalistic reality images (e.g., photographs that can be the input of subsequent analysis) and scientific reality images (e.g., tables that are the output of prior analysis). Of the two, there has been very little application of naturalistic reality images. Our study contributes to the development of naturalistic reality image research in which images from Lifewood served as primary data to be analyzed through the lens of semiotics. The collection of images from Lifewood was systematic, devised by a careful plan to obtain specific records that correspond with the theoretical basis of semiotics. Indeed, as these naturalistic reality images were analyzed, it became imperative to ensure that the analytical material contained in these images was analyzed in line with the fundamentals of semiotics, thus increasing the ability to communicate the idea of re-representation through the visual representation of the records. We believe that our study, as a naturalistic reality image study, offers the call for collecting visual data and move beyond merely verbal reporting and alphabetic writing (Diaz et al. 2015).

Furthermore, there are a number of practical implications. For outsourcing suppliers, we propose re-representation as a basis for designing the work of personnel engaged in delivering unstructured outsourcing tasks. As more suppliers go in this direction, it is important to note its significant implications for the set of skills needed in the delivery personnel, domain as well as linguistic skills. For example, it is plausible to think of delivery personnel at an offshore center delivering routine finance procedures, such as expense reimbursement processing, without any knowledge of finance or even of the language in which the receipts are written. Indeed, linguistic and professional conventions that would be required for performing this task can be replaced by a different set of conventions that would remove even the basic requirement of understanding the language.

Re-representing the outsourcing task with a special-purpose language challenges the idea that the availability of language is a key factor influencing location selection (e.g., Carmel and Tjia 2005; Levina and Vaast 2008). For example, Curacao and Aruba are considered as a first offshore choice by Dutch firms, while Morocco is a typical offshore choice for French-speaking Western countries. In a similar vein, lack of relevant linguistic skills is often put forward as a key factor to near-shore (regionally) (Carmel and Abbott 2007) rather than to offshore to far-flung destinations such as China where proficiency in English, French, German, and Scandinavian

[27]Coopmans elaborates: "Like image processing, visual analytics involves rendering of data in visual form. Such rendering, while software-supported, is not automatic: practitioners make judgements on how to do it. At the same time, visual analytics cultivates a neutral stance to what a visual display is supposed to show … visual analytics presupposes users' pattern recognition ability and makes this a central feature of the way it supports discovery" (pp. 39-40).

[28]Expense reimbursement processing is a task that requires a skilled person to locate and verify information in receipts and consequently enter the relevant information into a finance system in compliance with rules of financial reporting. Receipts can be structured or unstructured, printed or handwritten, high or poor quality.

languages is not available. Such language competency may become less critical in contexts where outsourced work could be redesigned to reduce the need for developers to understand clients' conventions.

Last but not least, it is important to note that one important ingredient in successfully utilizing a special-purpose language is to develop a set of digital tools that helps in substantiating the language and serving as a template for conducting the work. Future research could investigate other areas (such as accounting) of outsourcing where re-representation could be powerful, and also investigate the nature and properties of the digital tools set needed for doing it successfully.

Limitations and Future Research

Our findings are subject to limitations. We studied an extreme case, which is "paradigmatic of some phenomena of interest" (Gerring 2007, p. 101). In this regard, Lifewood is nonrepresentative but studied with the prospect of tracing something that is likely to become increasingly common in the future. In developing new theory, it is advantageous to study cases with high values of variables of key interest. Such theorization based on idealization inevitably points to what Tsoukas (1989) refers to as causal tendencies.

However, this also means that more research is needed into re-representation taking place in different settings, beyond outsourcing. One avenue is to study the role of design teams in different organizational arrangements through a semiotic lens. Design teams in transfer-based settings possess unique knowledge that enables the receiving party to mediate the relationship between the referent and its (re-)representation. Due to the unique settings of the outsourced service examined, Lifewood's design team recreated a symbolic representation decoded through a visual convention. Examining other design teams, outside the outsourcing context, may produce a variety of relationships between the signified and its representation.

Acknowledgments

We are deeply indebted to the senior editor, Michael Barrett, and the anonymous associate editor for their editorial guidance. The paper has benefitted from participant feedback at seminars at the Global Sourcing Workshop, Umeå University, and Renmin University. Thanks are also due to the anonymous reviewers for their useful comments. Special thanks to Jack Grieve and Stephanie Schnurr for useful advice on linguistics. Finally, we would like to thank Lifewood personnel for their time and willingness to participate in the study.

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MIS Quarterly

RESEARCH ARTICLE

RE-REPRESENTATION AS WORK DESIGN IN OUTSOURCING: A SEMIOTIC VIEW

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Appendix A

List of Interviewees and Observation Sources

Table A1. List of Interviewees: Lifewood, Visit in September 2012

No.	Name	Job Title
1	Ronald Cheung	Executive Vice-President of VanceInfo* CEO and Founder of Lifewood
2	Christina Hui	Vice-President
3	Roger S	Vice-President Of Operation
4	Billy Lee	Sales Account Manager
5	Eric Kang	Productivity Director
6	Wilson Chong	IT Director
7	Snow Gong	HR Director
8	Yuki Wang	Assistant BD Manager
9	Jason Luo	Admin & System Manager
10	Janie Jiang	Operation Manager
11	Kathy Fu	Assistant Operation Manager
12	Michael Zhang	Operation Supervisor
13	Victor Xu	Senior Network Operator
14	Whitman Yu	IE Supervisor
15	Jay Lin	BD Supervisor
16	Luna Huang	Assistant BD Supervisor
17	Dominic Cheung	Accounting Executive

*Before the second wave of data collection VanceInfo became part of Pactera.

Table A2. Observation Sources: Lifewood, Visit in September 2012		
No.	**Service/Project**	**Observants***
1	Airline	1 Supervisor and 9 delivery personnel
2	Genealogy (various)	4 QA Managers, 1 Supervisor, 1 Data Manager, 8 delivery personnel
3	New project planning (work package analysis) meeting (German registry)	Observations of a meeting that involved all members of the design team. Interviewees no. 1,5,6,7, and 10 (listed in Table A1) were present, and several more in different delivery centers of Lifewood participated via online video link

*Some of these observants were also interviewed with help of the interpreter.

A3. List of Interviewees: Lifewood, Visit in September 2013		
No.	**Name**	**Job Title**
1	Ronald Cheung	Executive Vice-President of BPO Unit, Pactera
2	Roger S	Vice-President of Operation
3	Whitman Yu	Workflow Manager
4	Todd Zhou	Project Manager for German registry
5	Wilson Chung	IT Director
6	Amy	German registry Supervisor
7	Rebecca Cao	Airline Supervisor
8	Laura Liang	Pricing Manager
9	Cathrine Pan	Airline Project Manager

A4. List of Operators Observed and Interviewed*: Lifewood, Visit in September 2013		
1	May	German Registry delivery personnel
2	Elva Lu	Airline delivery personnel
3	Frank Xiao	Airline delivery personnel
4	Sun Bian	Airline delivery personnel
5	Katy Ling	Airline delivery personnel
6	Purple Hao	Airline delivery personnel
7	Rubbie Ning	Airline delivery personnel

*All delivery personnel in Table A4 were interviewed with help of the interpreter.

Appendix B

Case Study: Design of Work for the Airline Service

In this appendix we aim to demonstrate how the work design team designed outsourced work for a typical airline service. We intend to complement the description that is provided in the body of the paper focusing on the genealogy project. Therefore, to avoid repetition, we only focus on aspects of the airline service that are specific for this real-time service. The airline work was considered as an ongoing service. New types of documents (e.g., for different airlines) could be added over time but the delivery of this service was based on real-time processing of incoming images.

Background of the Airline Service

Since July 2011, Lifewood has been providing transcription service for Cathay Pacific and other airlines (hereafter the airline service). This service involves transcribing handwritten aircraft maintenance documents such as forms and work orders (see Figure B1) that are filled out by engineers in the field, scanned, and sent as digital images[1] to Lifewood. A typical maintenance form contains, for example, information about the action taken to resolve an aircraft malfunction with specific information about the parts replaced, the part number, and the date and time of the repair. The Lifewood delivery personnel have to transcribe information included in these documents into a digital template, which is linked directly to the airline's enterprise system (e.g., each field marked in purple in Figure B1 had to be recorded). As a real-time service to the airline, this has to be completed within a short period of time (e.g., 30–40 minutes from the time the scanned image is received by Lifewood).

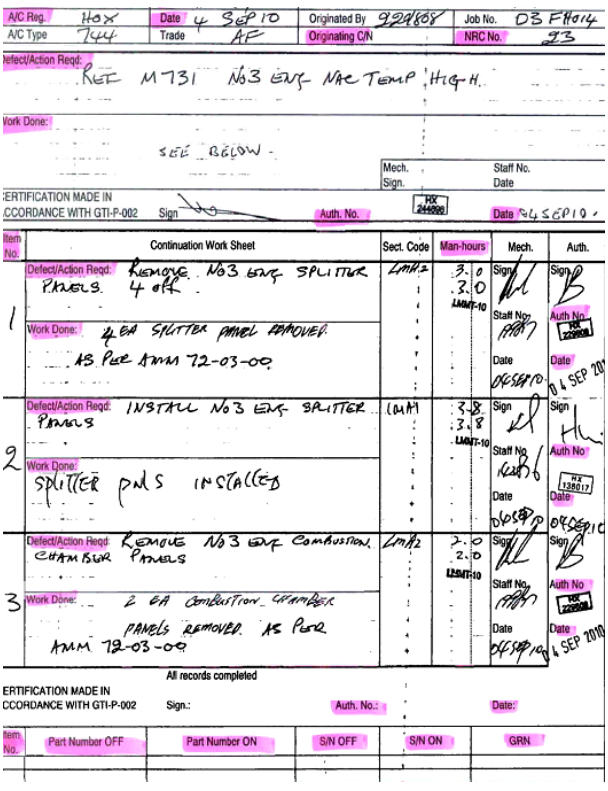


Figure B1. An Example Image from the Airline Service

[1]In contrast to the genealogy project where one image usually contained several records to be transcribed, in the real-time airline service (for Cathay Pacific) each image was associated with a single record—a work order or inspection report—which was often lengthy and complex (as shown in Figure B1).

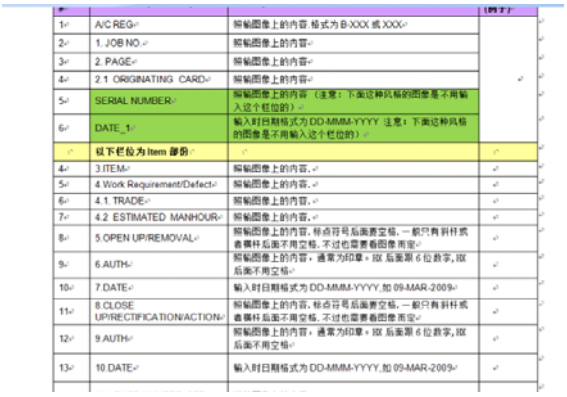
Design of Outsourced Work for the Airline Service

Analyzing the Work Package

Similar to the genealogy project, the design team examined the client's requirements, which included background about the documents and distinguished between different types of documents (e.g., maintenance records and work orders) for different types of aircraft. They examined the fields to transcribe for each document type, how to deal with missing information, accuracy level, and the technical format of the enterprise system where the information should be entered. When analyzing the airline's images, the design team was mainly concerned with the quality of the handwriting and the general format (i.e., structure) of the documents.

Creating Supporting Materials

Like the genealogy project, supporting materials were intended to guide delivery personnel regarding how to find and recognize what was relevant, and what belonged to which field of the digital template, from all that was included in the given document. The structure of each document type was captured into keying instructions (KI) that included explicit rules and instructions for operators to follow. The KI for the airline service explained (mainly in Mandarin) about where in the image of the document to look for text to be entered into each specific field of the digital template (see Figure B2).



1	A/C REG	照输图像上的内容 格式为 B-XXX 或 XXX	
2	1. JOB NO.	照输图像上的内容	
3	2. PAGE	照输图像上的内容	
4	2.1 ORIGINATING CARD	照输图像上的内容	
5	SERIAL NUMBER	照输图像上的内容（注意：下面这种风格的图像是不用输入这个栏位的）	
6	DATE_1	输入时日期格式为 DD-MMM-YYYY（注意：下面这种风格的图像是不用输入这个栏位的）	
	以下栏位为 Item 部份		
4	3.ITEM	照输图像上的内容。	
5	4.Work Requirement/Defect	照输图像上的内容。	
6	4.1. TRADE	照输图像上的内容。	
7	4.2 ESTIMATED MANHOUR	照输图像上的内容。	
8	5.OPEN UP/REMOVAL	照输图像上的内容，标点符号后面要空格，一般只有斜杆或者横杆后面不用空格，不过也需要看图像而定	
9	6.AUTH	照输图像上的内容，通常为印章，8X 后面跟 6 位数字，8X 后面不用空格	
10	7.DATE	输入时日期格式为 DD-MMM-YYYY,如 09-MAR-2009	
11	8.CLOSE UP/RECTIFICATION/ACTION	照输图像上的内容，标点符号后面要空格，一般只有斜杆或者横杆后面不用空格，不过也需要看图像而定	
12	9.AUTH	照输图像上的内容，通常为印章，8X 后面跟 6 位数字，8X 后面不用空格	
13	10.DATE	输入时日期格式为 DD-MMM-YYYY,如 09-MAR-2009	

Figure B2. Keying Instructions for the Airline Service

The design team also examined variations in handwriting styles and developed supporting documents capturing key visual images for operators to learn to recognize. They identified and captured repeated words (see Figure B3), which were included in the data dictionary training.

Figure B3. Examples of Frequently Used Words in the Airline Service

Developing Digital Infrastructure

Physical documents completed by airline engineers were scanned at the airport locations and thus arrived at Lifewood as digital representations of the physical records uploaded to the LiFT platform. Figure B4 shows how operators saw the digital representation of a typical document on their computer screen via LiFT interface. Similar to the German registry example included in Figure 8, Figure B4 shows the digital template and data dictionary linked to the field "RESTIFICATION." As Figure B4 shows, there is a long text string to be transcribed into this field of the digital template; the dictionary now shows possible entries for the third word ("deck") in the text.

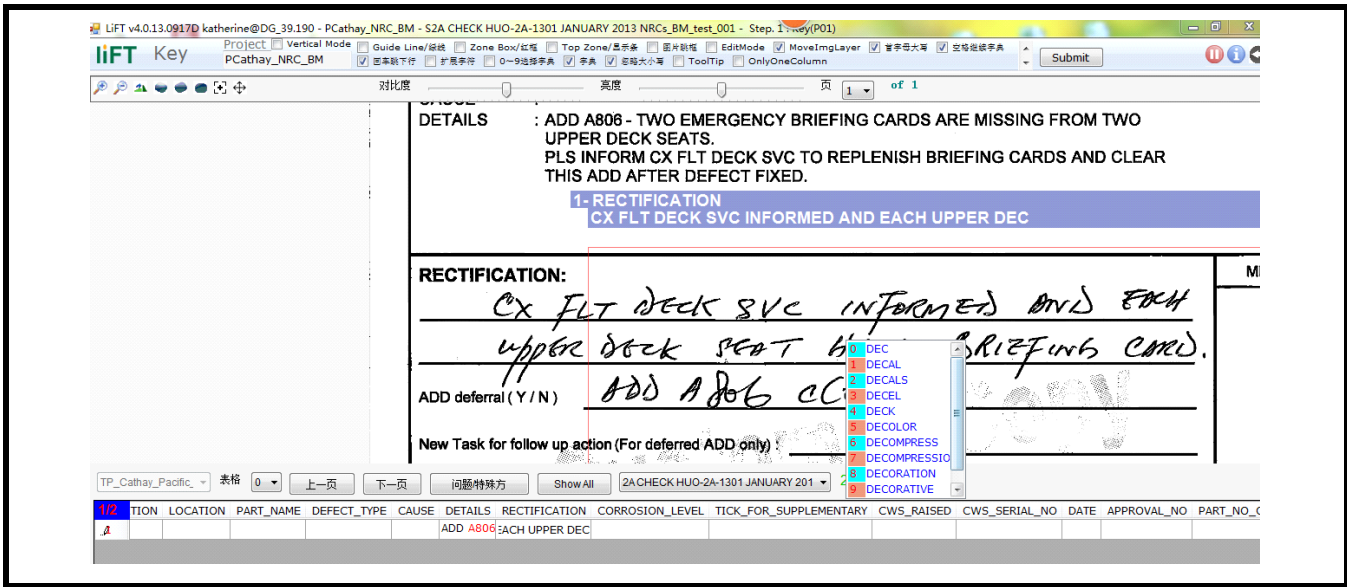


Figure B4. Digital Template and Dictionary in the Airline Service (Example)

The digital infrastructure also included a visual enhancement of certain features on the computer screen in order to improve the ergonomic experience for the operators (i.e., to maximize their productivity). For example, words offered by the data dictionary appeared with numbers and a color scheme (see Figure B4). The following quote and vignette[2] conveys the design philosophy behind the visual aspects of the data dictionary design:

> [For the airline service] *because the response time is very critical, so we must use the customer's system for that* [to enter data directly into the customer's database]. *But using that system was very slow, so we uploaded it to our system. The way they had designed the system was not very productive for our operators, so it was not very good. So our operators said, "OK, if it was designed this way, it's much better for us to key in without moving the head and the eyes and holding things up," so our team designed a system, a template, which is different from the customer's template.* (IT Director)

Vignette 1

A member of the design team explained that, in the dictionary, more popular words appeared higher on the list. In total, about six to eight words appeared on the list. The left column offered the index number of each dictionary word with a turquoise and red color scheme alternating between odd and even numbers. A selection of a word was made by typing the index number (for example, "5. Repair" required the delivery staff to type "5"). When we asked about the purpose of the color scheme (in addition to the numbering scheme), the design team member explained that the color scheme was so designed because it helped delivery personnel to quickly realize the number without having to carefully count or examine the number scheme. For example, the team member would know that typing "4" would enter the word "deck" by looking at the turquoise and red colors— three turquoise (0, 2, 4) and two red (1 and 3) means "4."

[2]This vignette is based on several data sources including our observations and interview data.

The functionality of the data dictionary was designed to assist the delivery personnel to recognize handwritten images faster and with greater accuracy. In particular, as illustrated in the vignette, words (e.g., airline parts) used more frequently in a specific field appeared higher in the dictionary window, matching first character(s) typed in the field, with real-time algorithms collecting frequency information and updating frequencies as team members transcribed documents. The dictionary algorithms also flagged any new entries to the QA team so that new entries could be reviewed by the QA team before being added to the dictionary.

In the same way as in the German registry project, words typed in a specific field of a digital template were red or black. If a typed entry did not appear in the dictionary associated with the specific field, then the color of the letters was red (see "A806" in red in one of the fields of Figure B4), while entries already in the dictionary were in black. The red color was intended to signal to delivery personnel that there might be a mistake in the way (s)he typed the text.

Additional ergonomic features included the re-centering of the digital document on the screen. The red rectangle in Figure B4 in the middle of the screen shows the text that is currently being transcribed (i.e., the word "deck" is centrally positioned on the screen).

A digital workflow designed for the airline service sequenced activities and monitored the application of explicit and implicit rules, from the moment the image of a handwritten record was uploaded until it was transcribed into a digital template and submitted into the airline's enterprise system, creating backup and reporting. Operators were often unaware of the rules that the digital workflow was based on. For example, in the airline service, the design team applied a design rule in which documents of a certain template were transcribed by a specific (sub-)group of operators. The digital workflow also applied rules concerning which images were sent to the QA team for quality assessment. The workflow was modified over time as the design team identified areas that could improve the service. Figure B5 summarizes the changes in the workflow for the airline service.

Item	Date	Author	Remark
1	2011.7.14	Whitman	Version 1.0 for NRC project workflow
2	2011.8.23	Whitman	Version 1.1 1) remove 7.0 2) change "9.0 import job number & key(Lifekey)" and "10.0 MK_1ST" to "8.0MK1st(key+MK1st)" 3)remove "19.0 check output data(check free text field(defect,rectification,open up/removal))"
3	2013.5.20	Whitman	Version 1.2 1.change the system from lifekey to lift 2.change "8.0 MK1st(key+MK1st)" to "7.0key(lift)" 3.combine the original process 9.0-12.0 to 8.0-10.0

Figure D5. Changes Made to the Workflow of the Airline Service