Association for Information Systems
AIS Electronic Library (AISeL)

ECIS 2009 Proceedings

European Conference on Information Systems (ECIS)

2009

The role of strategy in the evolution and innovation of information systems: A simulation experiment

Christoph Tribowski
Humboldt-Universitat zu Berlin, christoph.tribowski@wiwi.hu-berlin.de

Karsten Spin
Computertechnik & Consulting, karstenspin@osr-computertechnik.de

Oliver Guenther
Humboldt University, guenther@wiwi.hu-berlin.de

Olaf Sielemann
Computertechnik & Consulting, olafsielemann@osr-computertechnik.de

STORING DATA ON RFID TAGS: A STANDARDS-BASED APPROACH

Tribowski, Christoph, Humboldt-Universität zu Berlin, Spandauer Str. 1, 10178 Berlin, Germany, christoph.tribowski@wiwi.hu-berlin.de

Spin, Karsten, OSR Computertechnik & Consulting, Heidenfeldstr. 12, 10249 Berlin, Germany, KarstenSpin@osr-computertechnik.de

Günther, Oliver, Humboldt-Universität zu Berlin, Spandauer Str. 1, 10178 Berlin, Germany, guenther@wiwi.hu-berlin.de

Sielemann, Olaf, OSR Computertechnik & Consulting, Am Querfeld 11, 33689 Bielefeld, Germany, OlafSielemann@osr-computertechnik.de

Abstract

The potential of Radio Frequency Identification (RFID) for increasing supply chain efficiency has been repeatedly stressed by practitioners and researchers alike. The cross-company usage of RFID applications can only work if the collaborating companies agree on the syntax and semantic used. EPCglobal, an international industry consortium, has specified a stack of specifications that enable a standardized identifier to be stored on the RFID tag and all object related data to be kept on the network. Such a standardized concept does not yet exist to store object related data on RFID tags. To minimize the coordination effort as well as the emerging interoperability or integration problems and, therefore, also guarantee wide-spread adoption of the data-on-tag approach, it is advisable to build on existing standards for the storage of data on RFID tags. In this paper, we recommend applying the ISO 13584 standard for parts libraries (PLIB). We conceptualize how to use ISO 13584 to store data on RFID tags and use a case study on a kitchen furniture manufacturer, which uses RFID tagged components in a cross-company application with its suppliers, to develop a scenario for the storage of data on RFID tags.

Keywords: RFID, Data-on-Tag, Standardization, ISO 13584, PLIB.

1 INTRODUCTION

The potential of Radio Frequency Identification (RFID) for increasing supply chain efficiency has been repeatedly stressed by practitioners and researchers alike (Niederman et al. 2007). The most widely spread practice of using RFID tags on components, products and logistical units as they move through the supply chain follows the GS1 EPCglobal approach (EPCglobal 2007) of storing only an identifier on the tag and all related data in the supply chain participants' information systems (either using the official EPC or a company specific ID). The main advantages of this approach are the facts that RFID tags are relatively cheap if they only have to store an identifier and do not need memory for user generated content; that it is easy to standardize the identifier, e.g. on the basis of the European Article Number (EAN), which is uniquely assigned by GS1; and that there is no need to encrypt a simple identifier because the access to the data on the network is restricted.

On the other hand, there are several factors that support storing data on the tag (Günther et al. 2008, pp. 143-144). The first factor addresses the need for fast data access – when the IT infrastructure must meet real-time requirements and bottlenecks happen during back-end queries. For such cases, data on tags may help ensure quick access to the required information. The second factor concerns the dependency of the business process, including production, on the back-end system. Storing relevant data on the tag can help production to be kept up without being connected to the back-end system – at least temporarily. The third factor refers to the reliability of the back-end system: storing data on the tag facilitates decentralization and helps avoid single points of failure. This can be relevant if the existing IT infrastructure is not optimized for reliability, e.g. if no redundant system is in place.

The advantages described for both approaches for data storage serve as the disadvantages for the other concept at the same time. But especially because of the differences, Diekmann et al. (2007) claim that these methods are not antithetic but complementary and should be integrated into a consolidated approach; this guarantees that the relevant data is always accessible. In their work, two case studies that employ a combined data-on-network and data-on-tag approach were presented.

When extending RFID applications to inter-organizational processes, the standardization of data formats and data content becomes crucial (Hasselbring 2000). For the data-on-network approach, researchers and companies respectively founded the Auto-ID Center and EPCglobal consortium and have developed the Electronic Product Code (EPC) to uniquely identify physical products (Brock 2001). The data format specification includes a 96-bit code with a fixed, 8-bit header. The standardization of data content is achieved by relying on existing standards (e.g. the Serial Shipping Container Code). The most famous usage of this EPC combines the European Article Number (EAN) with a serial number for each object.

The cross-company usage of data on RFID tags can also only work if the collaborating companies agree upon the syntax and semantic used. Standardization initiatives have taken the first steps in this direction. The German Association of the Automotive Industry (VDA) published a recommendation about the usage of RFID for container management in the automotive supply chain (VDA 2008). The syntax in the user memory is specified by the alternation of data field identifier and value. The semantic of the data fields (IDs, description, data type, etc.) are described in a table in the recommendation, e.g. vehicle identification, maximum quantity of parts, purchase order number, etc. A similar approach for tracking tyres individually has been proposed by the Automotive Industry Action Group (AIAG). In this recommendation, the auto-industry-specific data such as the global location number that identifies the facility where the tyre is made; the tyre cure date and the country of origin should be stored in the user memory (RFID Journal 2005).

Both recommendations to store data on RFID tags will minimize the coordination effort as well as the emerging interoperability or integration problems for all companies in the automotive industry that want to introduce these kinds of applications. However, many different, possibly competing standards for numerous applications within and across industries are not desirable; therefore, to guarantee the wide-spread adoption of the data-on-tag approach, it is advisable to build on existing standards for the storage of data on RFID tags.

In this paper, we recommend applying the part libraries (PLIB) standard ISO 13584. This standard has been widely discussed as a reference model for developing product classification systems and standardized property lists (Leukel et al. 2006b). Major industry consortia have incorporated this standard into their specifications for B2B data exchange (e.g. BMEcat 2005), product classification systems (e.g. eCl@ss, UNSPSC) and property dictionaries (e.g. DINsml). Implementing the PLIB concept for the storage of data on RFID tags promises to avoid heterogeneity and maximize interoperability in cross-company RFID applications.

In Section 2, we conceptualize the usage of ISO 13584 for storing data on RFID tags. A case study of a German kitchen furniture manufacturer is applied in Section 3 to develop a scenario for the storage of data on RFID tags. The company took part in a joint research project on using RFID tagged components in a cross-company application with its suppliers. Finally, Section 4 concludes the paper.

2 PROPERTY-BASED CONCEPT OF ISO 13584

For our purpose, Part 42 of ISO 13584 (ISO 1998), which describes its conceptual model, is of primary interest. ISO 13584 was originally developed to describe technical product data, i.e. functional and physical characteristics, on the basis of unambiguous, semantically well-defined, globally unique properties. Its usage for commercial product data has been proven as well (Leukel et al. 2006a). To describe how the conceptual model of ISO 13584 has to be implemented, the definition and usage of properties have to be distinguished.

2.1 Definition of ISO 13584-compliant properties

The goal of defining ISO 13584-compliant properties is to make them available and accessible in standardized online dictionaries. For instance, the German Institute for Standardization (DIN) Properties Dictionary (http://www.dinsml.net) is based on ISO 13584. That means that each property:

- is identified with a global unique identifier;
- is described with a set of mandatory and optional attributes (e.g. description, unit, data type), which are specified in the ISO 13584's information model;
- is assigned to a set of references to product classes which define context the properties can be used;
- was defined following a standardized process.

The number of properties in the dictionary is continuously growing. Any company can submit new properties to the standardization procedure to be included in the dictionary. The read access to the online dictionary is free of charge, but companies that want to use it without restriction have to purchase a license. This license includes the passing of the properties used to other companies that are involved in their business process (e.g. suppliers and customers). When describing products on the basis of properties, it can happen that the property values are dependent on each other. For instance, if a liquid is described with the property "volume", it depends on the temperature of the liquid. The property "temperature" is called the *condition* in this context. To solve this issue, ISO 13584 defines tree different types of properties: non-dependent properties, dependent properties and conditions.

2.2 Usage of ISO 13584-compliant properties for the storage of data on RFID tags

RFID technology in supply chain management can be used to track components, finished products or logistical units (e.g. containers, pallets, cases). These objects have certain characteristics which might be stored on their respective RFID tag. Following ISO 13584, all data have to be expressed in form of property-value pairs. This information has to be very precise, e.g. concerning meaning of the property or unit of the value, but to minimize the amount of data storage needed on tags, only the ID of the standardized property (which includes this precise information) and the value should be stored.

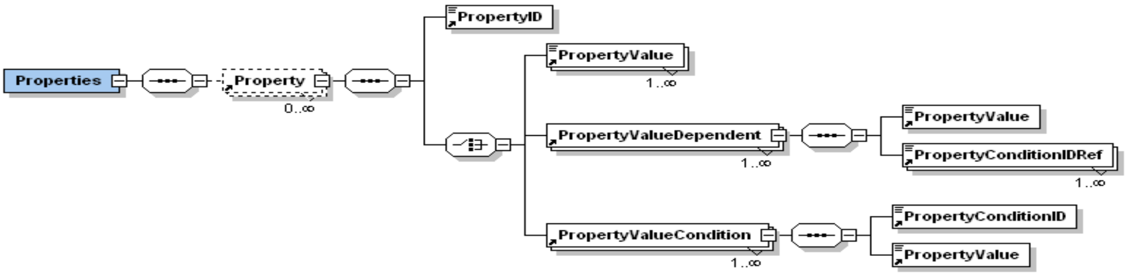

Figure 1. Logical model for property usage in XML Schema format

When storing these property-value pairs on tags, the syntax and semantic layers have to be distinguished. Semantically, all three different types of properties have to be supported; therefore, it is not enough to provide only the property id and value for a property: for a dependent property, the reference to the value of the condition has also to be given. One option for this usage of property-value pairs is described in Figure 1, which uses a graphical representation of an XML Schema. The reference to the value of the condition is called "PropertyConditionIDRef" in this model.

To illustrate the usage of the three different types of properties, the example in Figure 2 shows the independent property "colour" and the dependent property "optical density", which is dependent on the condition "optical glass type". The representation format follows the model in Figure 1.

Although we have used an XML format based on the developed XML Schema to describe the semantics of using property-based product descriptions, it is not necessary to utilize this format as the syntax. The main disadvantage appears when comparing the payload of this short example with the XML element names etc. – which make up 91% of the characters and symbols – which are not essential for the content.

2.3 Benefits of using ISO 13584

Standards in general contribute to the harmonization of interfaces between heterogeneous systems and, for this reason, increase interoperability. This may result in decreasing coordination efforts and wider usage. In the context of storing data on RFID tags, besides the technical interoperability, data interoperability is of great importance. Typical problems include the following:

- data could be misinterpreted because the information is not understandable;
- different data models could describe the same information;
- and different information could have the same description in individual data models.

For the mapping between different data models, a high coordination effort is needed to overcome these problems, if it is at all possible.

From another point of view, competing standards do not solve this issue if companies do not know which standard they should choose. In information systems literature this is known as the *standardization problem* (Westarp et al. 2000). The different standardization efforts introduced in Section 1 for the usage of RFID in the automotive industry highlight this problem.

The property based concept of ISO 13584 addresses both problems. First, the standardized properties are precisely defined according to the ISO 13584 data model, which includes language independent verbal definitions as well as additional information regarding units, data types, etc. This results in easier data exchange via standardized interfaces, higher data quality, and a reduction of data redundancy (Pohn 2006). Second, using ISO 13584 implies following a bottom-up approach because with properties small pieces of information are standardized and so can be applied to very different circumstances. Other standardization initiatives (e.g. AIAG and VDA) can create their own standards based on these standardized properties. In this way, ISO 13584 is not competing with other initiatives and, even more importantly, with the EPCglobal approach.

```
<?xml version=”1.0” encoding="UTF-8"?>
<Properties xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
		<Property>
				<!--Colour-->
				<PropertyID> DIN-AAB245-002 </PropertyID>
				<PropertyValue>blue</PropertyValue>
		</Property>
		<Property>
				<!--Optical Glass Type-->
				<PropertyID>DIN-AAA179-002</PropertyID>
				<PropertyValueCondition>
						<PropertyConditionID>ID1</PropertyConditionID>
						<PropertyValue>BK7</PropertyValue>
				</PropertyValueCondition>
		</Property>
		<Property>
				<!--Optical Glass Type -->
				<PropertyID> DIN-AAA179-002</PropertyID>
				<PropertyValueCondition>
						<PropertyConditionID>ID2</PropertyConditionID>
						<PropertyValue>PYREX</PropertyValue>
				</PropertyValueCondition>
		</Property>
		<Property>
				<!--Optical Density-->
				<PropertyID>DIN-AAB097-002</PropertyID>
				<PropertyValueDependent>
						<PropertyValue>2.51</PropertyValue>
						<PropertyConditionIDRef>ID1</PropertyConditionIDRef>
				</PropertyValueDependent>
		</Property>
		<Property>
				<!--Optical Density -->
				<PropertyID>DIN-AAB097-002</PropertyID>
				<PropertyValueDependent>
						<PropertyValue>2.23</PropertyValue>
						<PropertyConditionIDRef>ID2</PropertyConditionIDRef>
				</PropertyValueDependent>
		</Property>
</Properties>
```

Figure 2. Example for the usage of different types of properties

2.4 Extraction of ISO 13584-compliant Properties

If a company chooses to use ISO 13584-compliant properties for a certain use case, the properties usually do not have to be developed from scratch. The existing data sources in the companies' information systems about the object under investigation have to be taken into consideration. Data models provide a useful basis for the identification of properties because the attributes describing an entity in an ER diagram or a class in a UML class diagram can often be transferred into a property, while associations between entities or classes refer to the type of property (dependent, independent, etc.). A methodology for extracting properties from an XML Schema has already been developed by Leukel et al. (2006a).

Once the required properties are determined, the corresponding properties in the property dictionary have to be found. Three cases could appear in general: first, a corresponding property in the dictionary exists and the semantic of the usage is the same. In this case, the property ID from the dictionary and the values from the existing instances can be used without further processing. Second, a corresponding property in the dictionary exists, but its property definition differs in usage, e.g. about data type or measurement unit. Here, the property ID from the dictionary can be used if the instances can be transformed into the required semantic. Finally, the company could require properties that have not been defined in the dictionary yet. This is highly dependent on the type of object, e.g. some industries are more actively working together with the dictionary operator. In this case, the new property should be created in the dictionary. As already mentioned in Section 3.1, this creation has to follow a certain standardization process that has several phases (initiation, evaluation, etc.), which takes 25 weeks at most.

3 CASE STUDY OF A GERMAN KITCHEN MANUFACTURER

Wellmann GmbH & Co. KG (Wellmann) based in Enger, Germany, is a kitchen manufacturing specialist. Founded in 1953 by Gustav Wellmann, the company was taken over by Alno AG in 2003. In its supply chain, Wellmann's position is that of the Original Equipment Manufacturer (OEM). The structure of its suppliers is very heterogeneous and varies from small factories to industrial producers and logistic service providers. The kitchens produced are offered by several retailers – mostly under their own brand names. The business goal of Wellmann is to provide high quality, complete kitchens on schedule for competitive prices, despite numerous variants and a high share of individual and special parts.

This case study covers all processes, including procurement and production, that are relevant for introducing RFID at Wellmann. This introduction is currently being analyzed in a joint research project by the company and two universities and is being partly financed by the German Federal Ministry of Economics and Technology. The implementation of RFID in Wellmann's logistical and production processes is done in several successive steps. In the initial steps, only parts with the most critical logistical importance (Strassner 2005), i.e. parts of high value, are tagged with RFID transponders. These are kitchen cupboard fronts that are custom ordered; produced by an external supplier; and delivered just-in-time for assembly at Wellmann.

3.1 Scenario description

The production of cupboards with fronts follows a structured process that consists of ordering parts, picking parts, drilling fronts, assembling components and assembling whole cupboards. The process starts with a customer who plans his or her kitchen at a retailer which in turn creates a custom order for Wellmann. As soon as the route planning for the custom orders is finished, the orders for the externally sourced parts are automatically placed by Wellmann's Enterprise Resource Planning (ERP) system once a day to all affected suppliers. Each position in the electronic order is always associated to its corresponding position in the custom order. In this case study, we focus on fronts, which can either consist of wood or glass. Glass fronts are either framed in wood on all four sides or only have wood on the top and bottom. The combination of individual dimensions, different types of handles and other characteristics makes the production of cupboards with fronts vary greatly.

Parts are moved through the factory in special containers, which are identified with a unique twelve digit Transport Group number (TG number). Within this container, the parts are identified with a twelve digit Transport position number (TG position number). Additionally, each part is identified with a twelve digit Transport order number (TA number). All numbers are newly assigned before each production step. To control all production steps, the numbers of all objects are stored in Wellmann's ERP software. The data model for identification numbers is depicted in Figure 3.

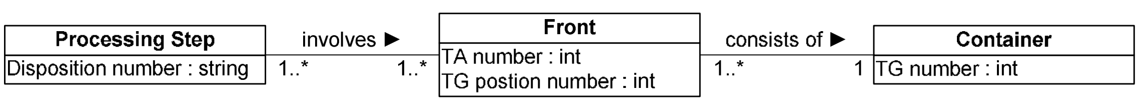

Figure 3. UML model describing the identification scheme

The supplier produces the fronts ordered and supplies them just-in-time when the assembly of the kitchen is scheduled. The delivery of the fronts is scheduled for two working days before the cupboards are sent to the customers. The supplier prints a delivery note, which contains only the TG number and the supplier's delivery note number as a bar code. Additionally, all parts are listed with their corresponding TG position numbers, TA numbers and characteristics (e.g. dimensions and colour). On an attached negative delivery note, all parts from the order that could not be delivered are listed in the same way. Besides these delivery notes, each front has a label attached that contains the TA number for its first processing step as a bar code and the description of its characteristics as well as its production and delivery date.

When the fronts are received at Wellmann, the receiver first scans the TG number on the delivery note or the TA number off of a label attached to one of the fronts. With either of these possibilities, the list of ordered parts is received from the ERP system and displayed. To check the completeness of the delivered parts, the receiver can scan the barcodes (TA number) of each front label and compare the lists. Additionally, the receiver could enter the TG position numbers or the TA number of the parts that have not been delivered into the system. The receiving process is finalized by storing the delivery note number in the ERP system. This triggers a rescheduling of the downstream activities, where the undelivered fronts are removed from further processing steps.

For further processing, the fronts have to be buffered directly in front of the next work station. In this case, the fronts are drilled at a CNC (Computer Numerical Control) jig boring machine. Each bore program is retrieved from a central server over the network and always relates to one special front. This program determines the bore template as well as the depth of the drill holes and the components that have to be assembled (e.g. hinges and cushion for the doors). During the production of one batch, which consists of several front containers, changes with the bore program might occur. For this reason, the boring machine is loaded with programs once a new container arrives; therefore, the TG number barcode of the container is scanned from the picking list that was created for this work step. The operational sequence of the boring programs depends on the position of the fronts in the container; therefore, the picking process of fronts into the container has to be done very accurately. If there is one front missing, the bore program for this front has to be removed manually. The operator, who equips the machine with fronts, removes the missing front by selecting the position on the display of the CNC machine. Because the machine works automatically after the operator has equipped the machine with the custom fronts from a container, mistakes have a great effect on the overall process if they are destroyed. In such a case, a complete delivery of the kitchen to the customer at the scheduled time is not possible any more.

After this processing step, a new picking list is printed. This contains the next processing step, the container ID (TG number) and lists the fronts in this container (TG position and TA numbers). After each processing step, this data is retrieved from the ERP system. Additionally, the completion of the processing step is recorded. This acknowledgment is necessary because the production order has to follow the planned and scheduled production process. After the acknowledgement in the ERP system, the next processing step is unlocked.

For the transport to the following processing step, the fronts are put into a new container, which depends on the type of cupboard and the new TG position numbers that are assigned for their following processing step. At the final working station, the fronts are assembled with their bodies that have the same TG position number. The bodies are delivered on an assembly line. For a smooth process, the sequence of the fronts plays an important role again, to avoid the downtime of the assembly line. Cupboards whose fronts have not been delivered have to be set aside. The bodies are buffered until the fronts are produced and provided.

3.2 RFID Process Benefits

In contrast to barcode technology, RFID offers the possibility to simultaneously identify several objects without contact, without line of sight and without human interaction. For these reasons, two general effects are achieved: first, manual effort can be decreased (e.g. faster receiving and shipping processes); and second, costs incurred due to errors (e.g. at the boring machine) can be reduced.

The general potential from using RFID at Wellmann can be achieved with the data-on-network approach; however, in the production environment where components are tagged and not consumer products, the usage of the EPC is not suitable. Instead, the TA number, which is assigned by Wellmann and pushed to the supplier, is stored as a unique identifier. All manual process steps described in the scenario above are positively affected by the introduction of RFID: the registration of fronts at the receiving business step, the manual deletion of missing fronts at the boring machine as well as the control of the fronts' sequence. An automatic matching of front and bore program ID helps reduce costs incurred by errors (the higher price for emergency orders for fronts, etc.) and reduce the risk that a kitchen can not be completely delivered to the customer.

Additional to the benefits that can be reached with the data-on-network approach, there are advantages to Wellmann by storing data on the RFID tag. First, the data related to the processing step can be accessed without connection to the network. Second, the bore programs for the boring machine including the specific parameters and characteristics of the fronts can be stored on the transponder. These bore programs can be accessed directly before a front is processed. Furthermore, the completion of the processing step, the retrieval of the following steps and the printing of this plan can be omitted when all necessary data are stored on the RFID tag. The processing progress can be stored on the tags as well as a trigger to release it for the following processing step. In case of a failure or breakdown of Wellmann's local network, the production is not affected.

For Wellmann's supplier in this case study, the introduction of RFID in cooperation with Wellmann offers benefits, too. Certainly, the supplier also benefits from the reduction of manual effort (e.g. the shipping process and creation of delivery notes). Additionally, the conflict potential in the transferring of title and risk can be reduced.

Wellmann wants to establish a standardized approach for storing data on RFID tags instead of developing a separate solution with every business partner. Although the prototype described in this case study encompasses only the business relationship to the front supplier, it is Wellmann's intended target to expand the RFID solution to other suppliers, logistic service providers and retailers. Those, in turn, work together with other manufacturers and will benefit from a standardized approach as well. Searching for a prospective solution not exclusively for this use case, Wellmann chose to store the data on RFID tags in the form of ISO 13584-compliant properties.

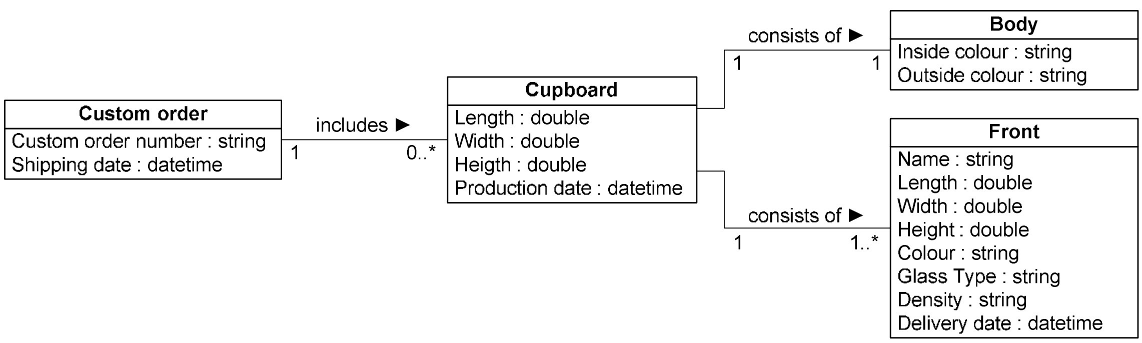

Figure 4. UML diagram showing the objects' characteristics

3.3 Extraction of ISO 13584-compliant properties

The effects of the RFID introduction described in the scenario above affect the existing processes only. In this case study, RFID does not act as an enabler for new processes with a transformational effect (Straube et al. 2007); that is why all relevant data that should be stored on RFID tags are implicitly contained in the current business processes and should be extracted from them instead of being newly created. To define the properties compliant to the ISO 13584 specification, at least the name of the property, the type of the property and the data type have to be extracted. Further information, such as IDs and units, can be manually added later. The needed information can be found in the information model of Wellmann's ERP system.

The processing steps of the fronts, which are the objects of investigation in this case study, are receiving, producing and assembling. The identifiers related to the fronts as well to the containers the fronts are transported in have already been described in Figure 3. Considering this information model, the RFID tag is put on the fronts, which means that the TA number and TG position number can be extracted as properties (compare Table 1). Because of the association of the class fronts to exactly one container, the TG number can be added as a property as well. Attention has to be paid to the "one or more" association to the processing steps. This indicates that all three properties are not unambiguous, but depend on the ID of the disposition number of the processing step. For this reason, the disposition number builds the condition for the tree dependent properties.

Further characteristics of fronts and their related objects are depicted in Figure 4. In this information model, coming from the class front, all other classes are connected with an association multiplicity of exactly one. That is why no dependent properties have to be created because of multiplicities in the class diagram. Other dependencies (e.g. glass type and density) have to be manually detected. The attributes of the class front can be extracted as independent properties along with their corresponding data types. The attributes of the related classes can be extracted as well, but if the names of the attributes are not unambiguous for the front, the class name has to be added to the property (e.g. cupboard length). The extracted characteristics are shown in Table 1.

The properties of the bore program for the fronts can be extracted from Wellmann's manufacturing execution system. In general, there exist two options: first, the whole bore program could be stored as one property that has the data type BLOB (binary large object). Second, the properties for the bore program can be extracted from the bore program. The bore program is encoded in PrimeFact's XNC format (Smeerdijk 2006). The subset of this XML Schema, which is used by Wellmann, is depicted in Figure 5. The ISO 13584-compliant properties are extracted with the methodology proposed in Leukel et al. (2006a) and added to Table 1 (where the attribute SubProgram is renamed to bore program ID).

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">
  <xsd:element name="Component"><xsd:complexType><xsd:sequence>
        […]
        <xsd:element name="Operations">
          <xsd:complexType>
            <xsd:sequence>
              <xsd:element name="OperationCall" maxOccurs="unbounded">
                <xsd:complexType>
                  <xsd:sequence>
                    <xsd:element name="Position">
                      <xsd:complexType>
                        <xsd:attribute name="X" type="xsd:double"/>
                        <xsd:attribute name="Y" type="xsd:double"/>
                        <xsd:attribute name="Z" type="xsd:double"/>
                      </xsd:complexType>
                    </xsd:element>
                    […]
                  </xsd:sequence>
                  <xsd:attribute name="SubProgram" type="xsd:string"/>
                </xsd:complexType>
              </xsd:element>
            </xsd:sequence>
          </xsd:complexType>
        </xsd:element>
  </xsd:sequence></xsd:complexType></xsd:element>
</xsd:schema>
```

Figure 5. XML Schema for bore programs based on PrimeFact's XNC format

Ser. No.	Preferred Property Name	Example of Value	Unit	Property Data Type	Type of Property	Dependent on Ser. No.	Possible Identification in DINsml
1	Name	Front		String	Non-dependent		DIN-AAA054-002
2	Length	0.625	m	Double	Non-dependent		DIN-AAA357-002
3	Width	0.02	m	Double	Non-dependent		
4	Height	0.2	m	Double	Non-dependent		DIN-AAB517-003
5	Colour	Blue		String	Non-dependent		DIN-AAB245-002
6	Glass Type	BK7		String	Condition		DIN-AAA179-002
7	Optical Density	2.51	D	Double	Dependent	6	DIN-AAB097-002
8	Delivery Date	2008-11-24 08:24:19		Datetime	Non-dependent		
9	Custom order number	VD234		String	Non-dependent		
	[…] Figure 4						
10	Disposition number	34K13Z3		String	Condition		
11	TA number	1234003		Integer	Dependent	10	
12	TG number	1234		Integer	Dependent	10	
13	TG position number	003		Integer	Dependent	10	
14	Bore Program ID	98735123		Integer	Condition		
15	X-axis Value	482.5	mm	Double	Dependent	14	
16	Y-axis Value	563.0	mm	Double	Dependent	14	
17	Bore Depth	5.9	mm	Double	Dependent	14	DIN-AAA080-002
18	Bore Diameter	8.0	mm	Double	Dependent	14	DIN-AAA788-002
19	Bore Program	AD8976BE7620AB		BLOB	Non-dependent		

Table 1. Extracted ISO 13584-compliant properties

3.4 Prototypical Implementation

To realize the RFID project at Wellmann, special requirements and challenges have to be considered. First, only one type of RFID tag has to be used for applications in logistics and production. A combined approach of the data-on-tag and data-on-network concepts has to be applied. Second, passive RFID tags are preferred over active ones because of the price differences. For the data-on-network approach, RFID tags according to EPC Gen 2 (ISO/IEC 18000-6) in the UHF frequency range have succeeded in the market and should also be used at Wellmann for this reason.

Nevertheless, most RFID tags that comply with these specifications are only produced with the 96 bit memory for the EPC. For the reasonable usage of the data-on-tag approach at least 1024 bits of additional memory is necessary. The additional cost of this type of RFID tag is currently about 20 Eurocents. Individual companies have to decide for their own RFID business cases whether such a solution is economically reasonable or not. In the case of Wellmann, between 20,000 and 30,000 fronts, which are the subject of investigation in this case study, have to be tagged each year (253 working days). The extra costs of 5000 Euro per year at Wellmann can be justified by the reduction of costs incurred due to errors at the boring machine. Assuming that only 25% of the ca. 5 cupboards per day (1265 per year) that are mis-bored can be saved from errors, which saves about 20 Euro per cupboard for recycling, material and extra logistics, the annual savings add up to 6325 Euro. The qualitative benefits, such as the reduced dependency on the backend system and the number of additional satisfied customers, can be added, but it is not so easy to evaluate them monetarily. In this costs consideration, only the extra costs and savings of using a combined data-on-tag and data-on-network approach were considered, not general RFID benefits and the costs for implementation, maintenance and training.

To prepare for the introduction of RFID at Wellmann, technical tests in the laboratory were first conducted with RFID tags with 512 bits of extra memory. Later on, RFID tags with 1024 bits were chosen because of the needed memory as already stated above. For this prototypical implementation, a proprietary syntactical format – following the VDA recommendation (VDA 2008) with a separator – was chosen to store the data on tags. Since the ISO 13584 standard, which is recommended in this paper, only covers the semantics layer, further research on the syntactical layer is necessary.

4 CONCLUSIONS AND OUTLOOK

A company that considers the introduction of RFID technology has to develop a business case and calculate the related costs and benefits. The business case determines which of the following three scenarios to pursue: (i) the RFID tag stores the identifier only and all object-related data is stored externally (typically a networked databases); (ii) all object-related data is stored on the RFID tag; or (iii) one uses a hybrid approach using both paradigms for different applications. Due to various reasons, for the company described in the case study the hybrid approach is appropriate.

If companies want to use RFID technology in a cross-company application, standards have to be considered. For the data-on-network approach, the EPCglobal standards provide an appropriate solution. A standard for the data-on-tag concept had been missing.

In this paper, we recommended using ISO 13584 for the standardized storage of data on RFID tags. A standard in general contributes to the harmonization of interfaces between heterogeneous systems and, for this reason, increases interoperability, data quality and reduces data redundancy. The properties in our approach are precisely defined according to the ISO 13584 data model, which includes language independent verbal definitions as well as additional information regarding units, data types, etc.

We have shown that using ISO 13584 is a suitable approach for the data-on-tag concept by presenting a case study from Wellmann, a German kitchen manufacturer. Within this case study, we explained how the properties were extracted from the existing information models. For the processes under consideration, all necessary data could be transformed into independent, dependent and conditional properties. Thus, at least for this application ISO 13584 is appropriate.

The next steps for a successful implementation of ISO 13584 consist of standardizing those properties that have not yet been standardized in the DINsml property dictionary. Subsequently, and after gaining experience with RFID technology, the scope of the application will be expanded.

Although we used a single case study approach in a very specific industry, the goal of using ISO 13584 is that the approach can be used for all other industries and RFID applications. This is because using ISO 13584 implies following a bottom-up approach. With properties, small pieces of information are standardized and can be applied to different circumstances. In this case study, we applied them to the production of custom ordered kitchen cupboards. Other standardization initiatives (e.g. AIAG and VDA in the automotive industry) can create their own standards for certain applications (e.g. container management and theft prevention) based on these or other standardized properties.

References

Brock, D. L. (2001). The Electronic Product Code (EPC) – A Naming Scheme for Physical Objects. Auto-ID Center White Paper.

Diekmann, T., Melski, A. and Schumann, M. (2007). Data-on-Network vs. Data-on-Tag: Managing Data in Complex RFID Environments. In Proceedings of the 40th Hawaii International Conference on System Sciences (HICSS 2007). Hawaii, USA.

EPCglobal (2007). The EPCglobal Architecture Framework. Final Version 1.2. http://www.epcglobalinc.org/standards/architecture/

Günther, O.; Kletti, W. and Kubach, U. (2008). RFID in Manufacturing. Springer, Berlin, Germany.

Hasselbring, W. (2000). Information System Integration. Communications of the ACM, 43(6), 32-38.

ISO (1998). ISO/IS 13584-42 Parts Library: Description Methodology: Methodology for structuring parts families, Geneva, Switzerland.

Leukel, J.; Hepp, M.; Schmitz, V. and Tribowski, C. (2006a). Ontologizing B2B Message Specifications: Experiences from Adopting the PLIB Ontology for Commercial Product Data. In Proceedings of the IEEE International Conference on e-Business Engineering (ICEBE 2006). Shanghai, China, October 24-26, pp. 146-153.

Leukel, J.; Schmitz, V. and Hepp, M. (2006b). A Critical Assessment of ISO 13584 Adoption by B2B Data Exchange Specifications. In: Proceedings of the 13th ISPE International Conference on Concurrent Engineering (CE 2006). Antibes, France, pp. 362-370.

Niederman, F.; Mathieu, R. G.; Morley, R. and Kwon, I. (2007). Examining RFID Applications in Supply Chain Management. Communications of the ACM, 50 (7), 92-101.

RFID Journal (2005). Auto Industry RFID Data Standard Proposed, News Article, http://www.rfidjournal.com/article/view/2043/1

Pohn, R. (2006). DIN Online Dictionary www.DINsml.net. In: Proceedings of the 3rd International Conference on Terminology, Standardisation and Technology Transfer (TSTT 2006), Beijing, China, August 25-26.

Smeerdijk, W. J. (2006). XNC White Paper, Version 1.1. http://www.primefact.nl/xnc/XNCWP11.pdf

Strassner, M. (2005). RFID im Supply Chain Management. Deutscher Universitäts-Verlag, Wiesbaden, Germany.

Straube, F., Vogeler, S. and Bensel, P. (2007). RFID-based Supply Chain Event Management. In Proceedings of the 1st Annual RFID Eurasia, Istanbul, Turkey, pp. 1-5.

VDA (2008). VDA 5501. RFID in the Container Management of the Supply Chain. Recommendation of the Verband der Automobilindustrie e. V., Version 1.1, Frankfurt, Germany.

Westarp, F. v.; Weitzel, T.; Buxmann, P. and König, W. (2000). The Standardization Problem in Networks - A General Framework. In: Jakobs, K. (eds.): Standards and Standardization: A Global Perspective, Idea Publishing Group, pp. 168-185.