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CHALLENGES AND RISKS OF RFID ADOPTION IN MANUFACTURING AND LOGISTICS

Vladimír MODRÁK, Peter KNUTH

FACULTY OF MANUFACTURING TECHNOLOGIES,
TECHNICAL UNIVERSITY OF KOŠICE, SLOVAKIA

ABSTRACT
RFID (Radio Frequency Identification) technology is at the present time fairly popular, since it opens new opportunities in the field of automated identification. RFID has also opened the door to a new era in logistics management or supply chain management (SCM) respectively and to optimization of manufacturing processes. Comparing to the bar code identification technologies, RFID technology has several advantages for managing and collecting object's data or tracking goods that move through the supply chain (SC).
The purpose of this article is to highlight selected areas of this technology that may be critical for further RFID development and applications. In the paper are also discussed differences between RFID and barcode technologies, especially in terms of their use in logistics management. Further, selected applications of RFID technology in Manufacturing are described. Finally, pertinent expectations of future development of this still progressive technology are outlined.
Keywords
RFID (Radio Frequency Identification) technology, logistics management

1. COMPARISON OF SECURITY AND RELIABILITY BETWEEN THE RFID AND BARCODE TECHNOLOGY

In recent time considerable attention is given to security of RFID technology. To corroborate it by facts the following events can be mentioned. In January 2005 students at John Hopkins University broke encryption of SpeedPass electronic payment and RFID Point of Sale (POS) system. In February 2006 Adi Shamir reported, that he could monitor power levels in RFID tag which can be used to compromise Secure Hashing Algorithm 1 (SHA-1) used in some RFID tags (Thornton, 2006). However, it is not the reason for a resignation, as a level of risks depends in generally, but also in the specific area, on preventive actions. The example supporting this statement offers the situation in privacy protection. In contrast to barcode technology, RFID technology has greater implications on individuals' privacy, because RFID tags used in personal identification cards can be read from an abundant distance without that person's knowledge or consent. This led to creation of groups like FoeBud or CASPIAN that are against this technology, because they fear, that they could be tracked by tags. In meantime blockers for passport RFID tags in a form of passport jackets containing physical barrier and other countermeasures as unique identifier numbers, encryption, and mutual authentification were

developed to ensure greater security. On the other hand the more sophisticated protections bring more opportunities for potential failures.

Barcode technology stores data in the widths and spacing of printed parallel lines, or in patterns of dots or concentric circles. The brief comparison of RFID and barcode technology (Table 1) shows main differences and advantages of RFID over barcode technology. As we can see, barcode technology mostly suffers from the fact, that it is optical technology. It means that dirt, dust or other optical barriers between reader and barcode, or inside the barcode reader, makes barcodes less reliable or unreadable. Vertical damaged barcodes and barcodes under extreme atmospheric conditions are not readable at all too. Even though, 2-D barcodes are able to recover its full information, even when partial damage occurs. On the other hand barcodes in compare with RFID tags can be entered manually. The most noticeable differences between RFID and barcode are ability of RFID technology to read large amounts of tags at ones (anti-collision system) without line-of-sight and ability to assign unique identification code not only to type of product, but also to each product. This wasn't possible with barcode technology because of barcode capacity in compare with EPC code. Furthermore RFID tags can be writeable according to tag type and can provide automatic identification of large data volumes in logistics without any additional labor.

Table 1: Comparison of barcode and RFID

System	Barcode	RFID
Data transmission	Optical	Electromagnetic
Memory/Data Size	Up to 100 bytes	Up to 128 kbytes
Tag Writeable	No	Possible
Position of Scan/Reader	Line-of-sight	Non line-of-sight possible
Read Range	Up to several meters (line-of sight)	Centimeters to meters (system dependent)
Access Security	Low	High
Environmental Susceptibility	Dirt	Low
Anti-collision	Not possible	Possible
Price	less than $0.01	$0.10 to $1.00

Source: Radio Frequency Identification (RFID), Accenture, 16.11.2001

Improving visibility in manufacturing and logistics gives "management programs better visibility into the supply chain, which enables identification of bottlenecks, targeted recalls, and new forms of market research" (Karygiannis, 2007). "Both active and passive RFID tags have significant potential to provide low-cost, short-range, identification for many consumer goods and can help to identify objects" (Finkenzeller, 2003). Perspective profits of RFID implementation in manufacturing and logistics are stocking management improvements, labor cost reduction, counterfeit and fraud reduction, stock shrinkage reduction, improved efficiency and return goods facilitation (improved customer satisfaction). RFID technology can be used in several levels in supply chain management and logistics (see Table 2).

Table 2: Levels of RFID in Supply Chain and logistics application

Level	**Use**	**Application**
Item	Consumer units	Products and individual items
Case or Carton	Traded units	Boxes (packaging) product carriers
Pallet	Distribution units	Pallets / Trucks

Source: d'Hont, Susy 2003 p. 13

In manufacturing and logistics conditions applications, first-pass read accuracy is essential in order to achieve high efficiency and reliability. As mentioned above, damaged barcodes have to be scanned at least two times, or have to be manually read. Read and write features together with anti-collision algorithm of RFID technology eliminate the need of multiple scans. These days reliability of RFID technology is already solved by knowing RFID physics (Schlosser, 2004). Besides this, there is still no universal solution or standard for implementing RFID technology into logistics, manufacturing or supply chain management.

Data security of RFID technology depends on the class and generation of RFID tags. RFID tags are more difficult to replicate, their electronics is more complex than barcodes and barcodes electronics. RFID systems are often used for asset tracking, personal access and security control applications. This covers the field of counterfeit protection, computer system and access control, building or facility access control, branded goods replication prevention, value asset tracking, identification card management, baggage handling and stolen item recovery. United States Department of Defense is one of the leaders in the field of RFID technology use and develops applications of this technology from items tracking to food, clothing, personnel and armaments tracking. Creating “smart borders” is another application of improving home security together with increasing the security of international shipping containers.

The biggest concerns about RFID technology are privacy protection, because RFID has potential of weakening personnel’s privacy. If this technology is used improperly it can track and monitor individuals with help of tagged goods after leaving the store. Consumer privacy is then endangered, purchasing anonymity is reduced or eliminated and civil liberties are threatened. RFID attacks can be in general classified into denial of service or relay attacks, sniffing, tracking and spoofing. Techniques like trusted RFID readers or access control mechanism that are located either on a tag like hash locks (Weis, 2004) pseudonyms (Juels, 2004) or off the tag are used in order to prevent unauthorized threats and attacks. Off the tag RFID access control mechanisms are RFID Guardian (Rieback, 2006c), RFID Enhancer Proxy (Juels, 2005), The Blocker Tag (Juels, 2003) and FoeBud Data Privatizer. The easiest way still remains deactivating RFID tag permanently through “frying”, “clipping”(Karjoth, 2005) or “killing”, or temporarily using sleep/wake modes (Spiekerman, 2004) or Faraday cage. In the field of cryptography new low-power algorithms like stream ciphers (Finkenzeller, 2003), block ciphers (Feldhofer, 2004), lightweight protocols for authentication (Vajda, 2003) and public key cryptographic primitives have been created.

2. APPLICATION OF RFID IN MANUFACTURING

RFID technology can be profitably used also in manufacturing mainly because it can provide wireless automatic large amount data collection and it can handle temperatures up to 200°C. Other very useful property is that tags can store additional information about products which can be stored also in a database. Connection possibilities of this technology with other sensors open way to measure climate factors like temperature, humidity or even vibrations. These information can be later used to score transportation or production process and automatically target damaged goods. The examples RFID applications in manufacturing are shown on Figure 1, Figure 2 and Figure 3.

Example on Figure 1 shows RFID implementation in centralized system which consists of following RFID system components:

- central computer – computer that processes all object, material and identification
- information flow and controls object and material flow
- databank – contains information about processes and materials
- reader – device which reads information from tags

Decentralized systems are possible only when writeable tags and readers/ writers are used. In that case, process information is stored in tags attached to objects which are controlling production. The need of databank is redundant and central computer is just monitoring whole process.

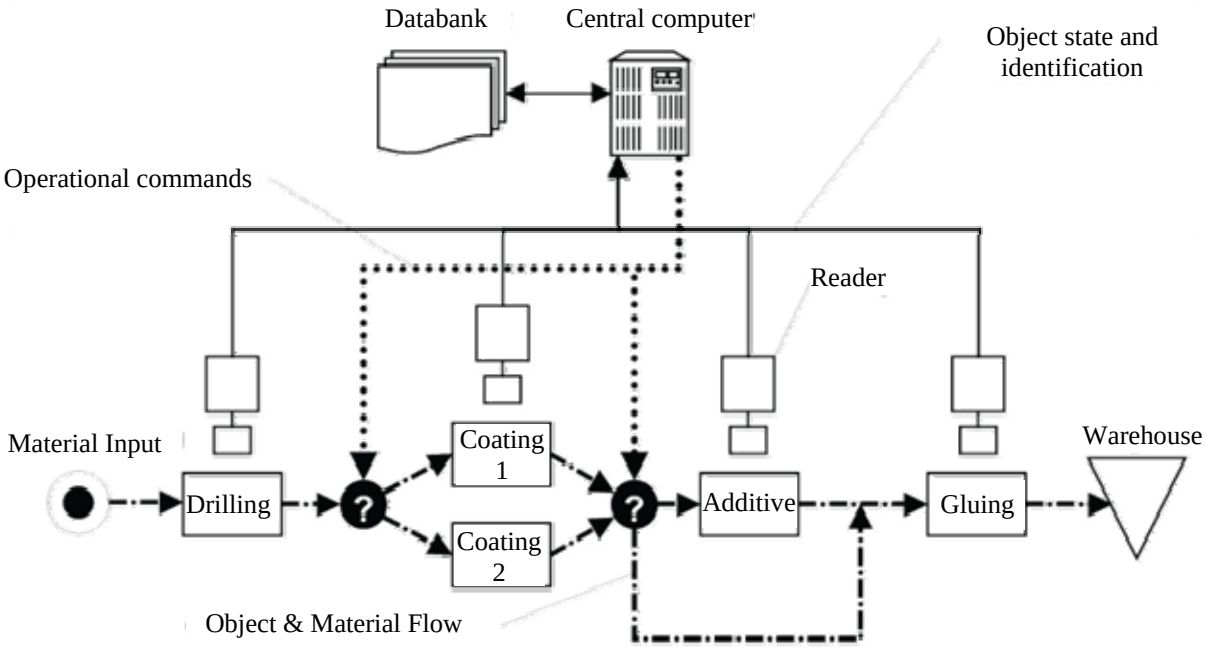

Figure 1. Centralized object and material flow model (Adopted from Finkenzeller, 2006)

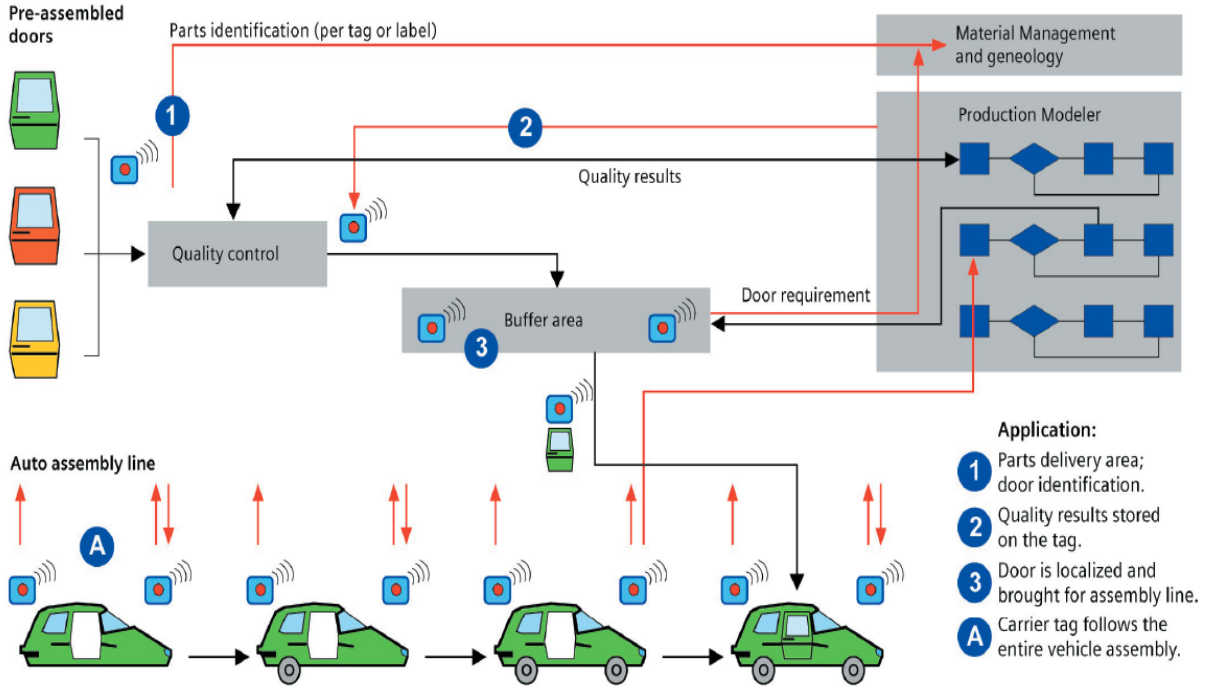

Figure 2. Example of RFID in car manufacturing (Adopted from euroRFID, 2007, p.18)

3. FUTURE AND RFID

RFID technology has a very good perspective in the future. This statement confirms heavy investments of big companies such as Wal-Mart, Metro, Proctor & Gamble, Target or Gillette. Progressive seems to be Mobile RFID technology that enables consumers to scan particular tag attached to an item using mobile phone in order to verify if product is genuine through manufacturer's EPCIS (Electronic Product Code Information Service) (see Konidala & Kim, 2006). In the future can RFID technology even fight against the crime and help police in form of investigative tools based on RFID technology. The European Union is thinking to implement RFID tags in Euro currency in order to enhance Euro security. But the fact is that due to privacy and ethical concerns, application of RFID will never reach its maximum economic potential. Even though, new research and inventions, ideas are coming into existence and fields of use (see Table 2).

Table 2: RFID Applications (Source: Wyld, 2005, p. 13)

Traditional RFID Applications							
Security/ access control	Electronic article surveillance	Asset/fleet management	Mass transit	Library access	Toll collection	Animal identification	
Emerging RFID Applications							
Warehouse manage-ment	Supply chain manage-ment	Reverse logistics	Shipment tracking	Asset tracking	Retail management	Document tracking	Anti-counter-feit
Advance access control	Mass transit - monthly and single trip	Airline baggage handling	Aircraft parts and tools	Healthcare applications	Regulatory compliance	Payments	

4. CONCLUSION

Challenges and risks issues of RFID technology are very important not only for the future development of RFID technology, but for all of us. It is obvious that RFID technology is not taken just with a great interest, but it is also facing rejection and concerns. Despite this, development of this technology will continue with the aim to reveal all potentials of RFID and not only in supply chain management. Over next years it is supposed that decreasing price of tags, return on investment and better knowledge of this technology will allow wider spread of RFID technology in other business and civic areas.

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