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Emerging Information System Applications in Brick-and-Mortar Supermarkets: A Case Study of Content Provision Devices and RFID-Based Implementations

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Abstract

This case study covers the Metro Group's Future Store, an example of emerging information systems applications in brick-and-mortar supermarkets and the retailing supply chain. We illustrate the main functionalities of various content provision devices fed from structured and unstructured data sources as they provide content to the shoppers at their convenience. Further, we outline the two relevant infrastructure innovations in the shop and along the supply chain - the content bus connecting all output devices and all input sources and RFID technology which is implemented both on palettes and cases and on individual items. The paper then analyzes major achievements and results of offering those applications to the customers before pointing to the management challenges still to be solved. The paper ends with a brief summary and some lessons learnt.

Keywords*:* Content Integration, RFID, Value Chain, Retailing, Point of Sale *(*POS*)*

1.   Introduction

"In the future, the use of innovative technologies will be one of the crucial competitive factors in our industry. With the Future Store Initiative, Metro Group will push the modernization of retailing on a worldwide level."

<div align="right">

Dr. H.-J. Koerber, Metro Group Chairman & CEO,
NRF Retail Conference, NYC, Jan. 2004

</div>

Today's retail industry faces a new reality: Grocery shopping has become more individualized and more comfortable. Consumers enjoy more choices and have more information upon which to base their buying decisions. They have become sophisticated customers who have gained a clear understanding of value, generated from vast information resources. Delivering this value is an enormous challenge for retailers.

One major concept is to use innovative information systems which have entered the retailing scene over the past decade. But consumers did not ask for barcode scanners, RFID tags, touch-screen kiosks, liquid-crystal displays, or any other specific technology. Instead, they demand more accurate price information, more complete and current product information, assistance in finding specific items, less out-of-stocks, and a faster checkout.

This requires content integration using information systems with innovative infrastructure technologies at the Point of Sale (POS) and along the supply chain which so far has been neither been feasible nor affordable: Content sources along the value chain and all established and innovative content provision devices in the store are to be connected and exploited.

Infrastructure needs to be set up; processes need to be adapted accordingly, seamlessly, in real-time, and without bothering consumers with technical constraints.

Hence, the research aim of this case study is to investigate implementation issues and business potential of combining state-of-the art content integration devices and innovative RFID-based technology under real-life conditions in a brick-and-mortar supermarket and along the retailing supply chain.

2.   Research Methodology

Investigating opportunities of content integration at the POS focuses on how such services and devices are to be set up and linked. With regard to the focus on 'how' (Yin 2002) and the required depth of investigation, a case study was chosen as the most appropriate research design, with interviews and document analysis for data collection (Benbazat et al. 1987). The case study covers the so far one and only provider of a variety of content integration systems at the POS in a brick-and-mortar supermarket. In-depth interviews were conducted with key persons at the case company, and other Future Store Initiative partner companies (e.g., IBM, SAP, Procter & Gamble) between February and October 2004. Further data was collected through document analysis (e.g., www.future-store.org, various meeting minutes, etc).

3.   Case Setting: Metro Group's Future Store

3.1   Concept and Launch

In Spring 2002, a small team within Metro Group - with $bn 73.3 sales in 2004 the third largest retailer worldwide[1] - saw the opportunity to strengthen Metro Group's position as a global driver in retailing. Their goal was to deeply exploit the potential of information systems in retailing and to set new standards for customer satisfaction combined with increased profitability along the value chain.

After short rounds of internal discussion, Metro Group took action in the summer of 2002: Together with several world-class partners including Intel, IBM, Cisco, Fujitsu Siemens, NCR, Philips, SAP, Microsoft, PiroNet, Coca-Cola, Gillette, Johnson & Johnson, Kraft Foods, Nestlé, and Procter & Gamble, they initiated the Metro Group Future Store Initiative (FSI). From the beginning, the Future Store Initiative's aim has been to offer an integrated platform for real-life technical and process-related developments and innovations in 'bricks-and-mortar' supermarkets. The Future Store Initiative kick-off meeting in August 2002 brought up numerous ideas for the front-end, the application layer, and the back-end of a newly designed IT landscape in today's retailing (see Figure 1). It demanded the integration of structured data, e.g., pricing information, and unstructured data such as pictures in retail-

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1   The operating business of Metro Group is divided into six sales divisions which act independently in the market with their individual brands and specific sales concepts: (1) 'Metro/Makro Cash & Carry', the world's market leader in self-service wholesaling, (2) 'Real hypermarkets', (3) 'Extra supermarkets', (4) 'Media Markt' and 'Saturn', the leading consumer electronics centers in Europe, (5) 'Praktiker' home improvement and DIY centers, and (6) the department stores of 'Galeria Kaufhof'. So-called cross-divisional service companies provide services to all sales divisions right across the group, like procurement, logistics, IT, advertising, financing, insurance, catering, and real estate. Overall, Metro Group realizes about half of its turnover with food retailing and employs about 250,000 staff in 30 countries.

related information systems. The goal was to make almost all information sources available to customers during shopping. Thus, the idea for the first Future Store Initiative project, the Future Store (see below), was born.
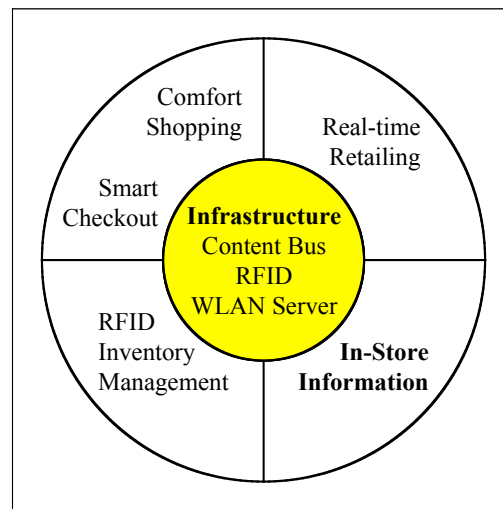

Figure 1: Future Store - Conceptual Project Structure, after Metro Group (2004)

With opening the Future Store in April 2003 in Rheinberg (Germany), Metro Group turned a former 'bricks-and-mortar' supermarket into something special, a supermarket with integrated new content provision devices, Radio Frequency Identification (RFID) technology, and accompanying process innovations - thus making the Future Store a real-life test-bed for the future of retailing.

3.2   Content Provision Devices

Innovative content provision devices, designed to make shopping faster and easier, include Personal Shopping Assistants (PSAs), Intelligent Scales, and Self-Checkout Systems. Also, Information Terminals, Electronic Advertising Displays, and Electronic Price Labels offer newly oriented communication. Further, Future Store's employees are given Personal Digital Assistants (PDAs), allowing them to support customers in their shopping processes.

Personal Shopping Assistants (PSAs) are attached to the shopping cart. They show for instance (1) an electronic shopping list, which can be managed by the customer, (2) an overview of goods with prices already scanned for buying, (3) a proposed shopping list based on their previous 'favorites', and (4) sales offers and advertisements which change in the course of the tour through the store depending on the location of the PSA in the store. If customers scan all articles by barcode, they can directly pay as the data is transmitted from the PSA server to the POS system upon request (see 'Checkout via PSA' below). *Customer Cards*, attached to a PSA, enable repeat visitors to participate in the 'Payback Loyalty Program'.

The *Intelligent Scale* for fruit and vegetables is equipped with a special camera and identification software. Customers only put the product on the scale. Based on surface structure, size, color and thermal image, the scale automatically recognizes the goods via optical identification, weighs them, and prints out the label indicating the price. There is no

need any longer for customers to memorize product numbers; they only confirm the right product identification.

For *Checkout via PSA*, customers scan their articles via a barcode during the shopping process and, at checkout, release the 'Pay & Go' process. Further, two *Self-Checkout* machines are equipped with touch screens, scanners and payment terminals. Customers can draw each article across a 360 degree scanner with a barcode reader so that the goods are registered. Subsequently, they put the products in a shopping bag which is weighed automatically. The weight is compared to the weight of the scanned goods. In case of discrepancies, employees at the information desk are alerted automatically. Payment is either made cash or by bank or credit card.

Information Terminals are computer terminals for customers in the sales room. They offer some PSA functionalities. In addition, they provide comprehensive information about selected products (meat, wine, baby care, fruit and vegetables, hair coloration and multimedia products) - covering production, ingredients, sales prices, and the respective location in the store. They also present an overview of alternative or equivalent products. Recommendations for recipes impart additional benefit.

Electronic Advertising Displays, complementing classic advertising, are controlled centrally via the WLAN to show images and video animations in the direct vicinity of products when customers identifying themselves via their PSAs come closer. Advertising messages can be changed within seconds to reflect individual shopping preferences and product tastes, enhancing marketing possibilities with the use of advanced information systems and data availability (Hoffmann 2003).

Electronic Shelf Labels display prices at the sales shelves and are updated via WLAN. They are directly connected to the price administration system and the checkout system. About 37,000 electronic shelf labels with liquid-crystal displays in four different sizes are in use in the Future Store, each equipped with a compact battery, a little radio receiver and a tiny receiving antenna. Prices are updated centrally, i.e., prices shown at the shelf are at all times identical with the prices to be paid at the checkout as both systems are fed from the same data source.

3.3 Infrastructure Innovations

Stand-alone devices would neither offer consistent and valuable content information, nor would they provide process advantages for retailers. With various structured data sources (e.g., checkout system and merchandize management system), unstructured input data (e.g., picture and product databases of producers or marketing departments), and data outlets (e.g., PSAs, Intelligent Scales, Electronic Shelf Labels) in place, an innovative content integration infrastructure needs to link all devices and sources. Beyond WLAN, fixed Ethernet, and barcode / EDI infrastructures, the latter being increasingly intertwined with RFID technology, the *Content Bus* (see Figure 2) serves as a technical content integration platform, offering real-time data integration in the Future Store.
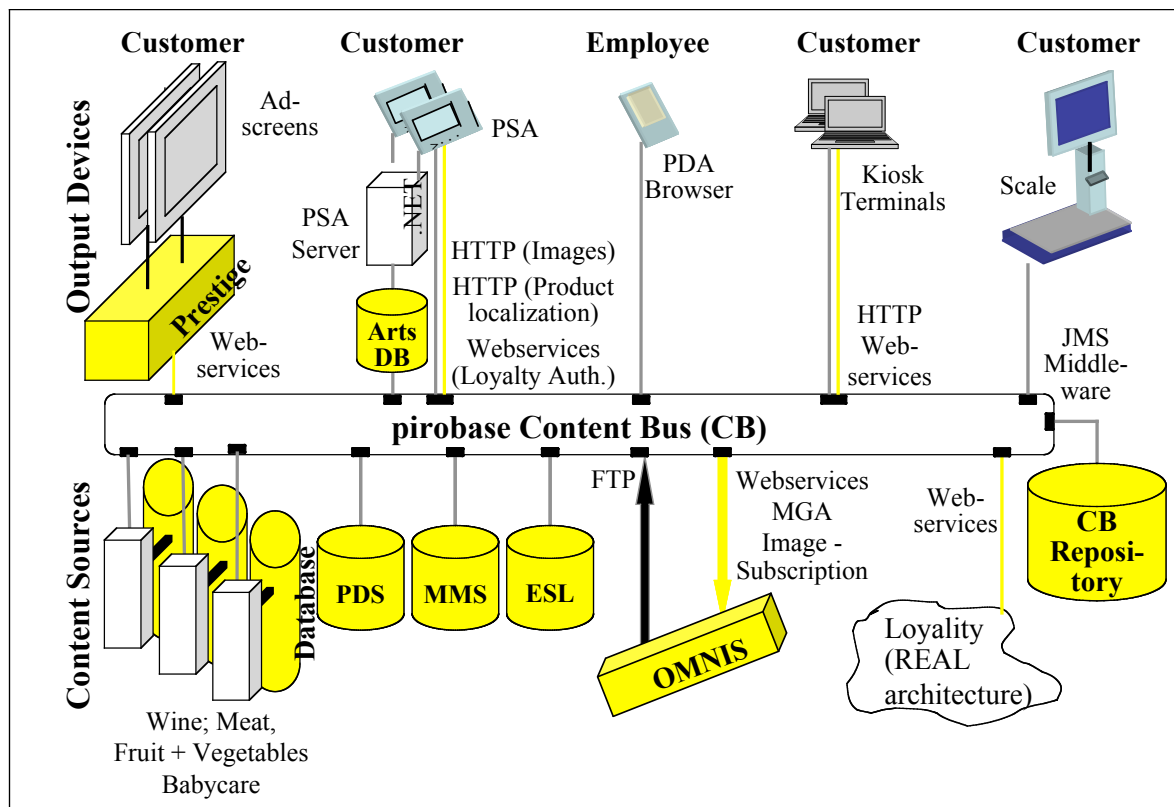
Figure 2:   Content Bus (Source: Loebbecke 2004).

Metro Group also tests the first application of RFID technology world-wide under real-life conditions in the Future Store, including tests on item-level, e.g. RFID tags on cream cheese and razor blades. (For an introduction to RFID technology along the supply chain see Asif, Mandviwalla 2005; Angeles 2005). To increase feasibility and to split the cost along the value chain, tags are prepared by brand manufacturers (e.g., Kraft, P&G, Gillette) and then attached to the items by Metro Group in the Future Store.

Considering today's technical developments, one has to distinguish between RFID usage on palettes and cases on the one hand, and RFID on items on the other. RFID on palettes and cases mainly points to process innovations along the inter-company value chain. They are crucial and recently gained a lot of industry-wide attention, but do not necessarily relate directly to content integration solutions. RFID on item-level tagging, however, is still in its absolute infancy. Also tested in the Future Store, it provides insights into content integration potentials and enormous challenges.

Although even *RFID on palettes and cases* is still limited in the present Future Store environment, numerous manufacturing partners are involved at this early stage. Different classes of products and applications at the factory, warehouse, distribution center, stockroom, and shelf provide perhaps the most comprehensive look at how the use of RFID impacts the infrastructure, processes, and relationships in a retail deployment. Before goods reach the Future Store, in the context of product transport and warehouse dispatch, Metro Group Distribution Logistics fits RFID-tags to all product palettes and cases. The tags are electronically time-stamped and then entered into the central computer of the RFID goods flow tracking system. The tagged products and packages can thus be located and identified along the entire logistics chain, all the way to the Future Store sales floor. Goods ready to be shipped to the Future Store are taken from the central warehouse to the dispatch area. As they

pass through the exit gate, an RFID-transceiver reads the codes on the palettes and cases and passes this information on to the RFID good flow system. The goods then have the status 'on route to destination'. In the Future Store, RFID helps to control if the arriving goods match the order. When the trucks arrive at the Future Store, the palettes are once again identified by an RFID-reader handling as many as 35 tags per second. Subsequently, the goods are registered as being 'in the store warehouse'. The goods flow system exactly registers the goods in the warehouse. Each storage location has an RFID tag which is stored in the RFID goods flow system together with the RFID numbers of the palettes and cases stored at the particular location. In the Future Store sales room, RFID readers, located at the warehouse exit doors, identify every palette and case that goes into the store. The readers then send the relevant RFID codes to the RFID goods flow system, which identifies the products as 'transported into the store.' To avoid duplicate entries, RFID tags on empty palettes and cases are removed or de-activated. Afterwards empty containers are returned to the store.

Brand manufacturers also test *RFID on item-level* for selected products in the Future Store; they focus on different functionalities with 'their' item-level tags: Gillette experiments with tags on 'Mach 3 Turbo' razor blades for anti-theft protection; Procter & Gamble runs tests on innovative marketing concepts for 'Pantene' shampoo. Kraft Food, using the example of 'Philadelphia' cream cheese, wants to gain experience with the management of expiration dates and out-of-stock issues. The respective *Smart Shelves* are equipped with readers that inform Future Store staff when the shelves have to be replenished. Smart Shelves have bottom-integrated RFID readers and are linked with the central RFID goods flow control system. If an article is removed from or added to a shelf, the display detects the movement and updates the inventory in the system. Thus, the system registers automatically if goods are inaccurately deposited or missing, thereby preventing out-of-stock situations. Smart Shelves also automatically recognize when an expiration date has been exceeded and inform the staff accordingly.

Prior to an overall roll-out of RFID item-level tagging, three problem areas have to be solved: (1) technical problems depending on product material, e.g., tag reading is currently unreliable through metal or liquids, (2) the accompanying information / data management when data collection reaches a new order of magnitude, and (3) privacy issues (see also Juels et al. 2003). Nevertheless, selected applications in the end-consumers' turf, such as the intelligent fridge or the reactive laundry machine, can be pictured that could increase customer demand and thus create a 'pull-effect'.

4.   Case Analysis

4.1   Achievements and Measurable Results

The IT innovations in combination with new marketing concepts in the Future Store have contributed to a sales increase of about 23% (Metro Group 2005) compared to the preceding year (April 2003-April 2004)[2]. They entail a dual benefit for retailers, increased customer satisfaction and optimized work processes. *Customer satisfaction* measurably increases as content provision devices connected via the content bus and RFID together provide options for more individuality, more reliability, and more convenience for the shopper. Customer

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2   This sales increase compares to about 25% overall sales increase in Metro Group's Food retailing and to about 15% sales increase in Metro Group's food retailing in outlets of similar size.

surveys (BCG 2003; BCG 2004) illustrate positive attitude, user behavior and shopping loyalty with regard to the Future Store bouquet of innovations (see Fig. 3a-e).
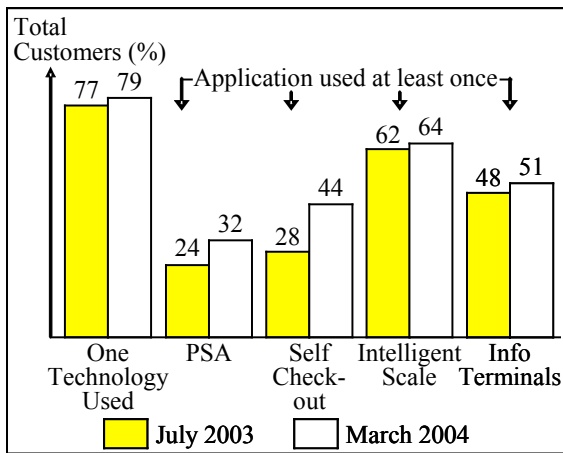

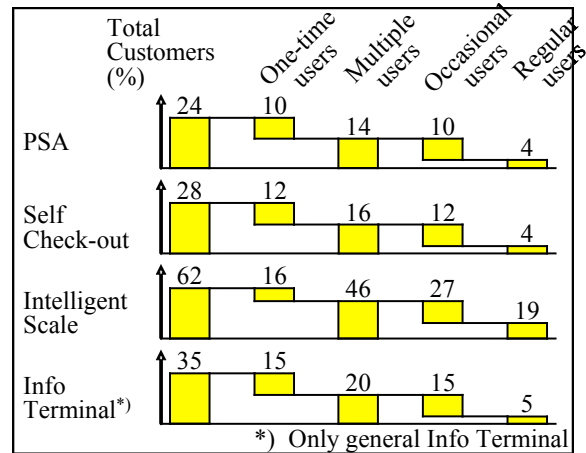Fig. 8a: Use of FSI Devices

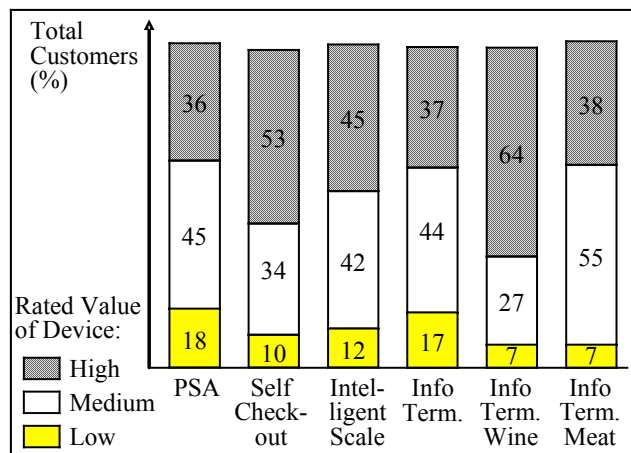Fig. 8b: Use Frequency of FSI Devices – July 2003

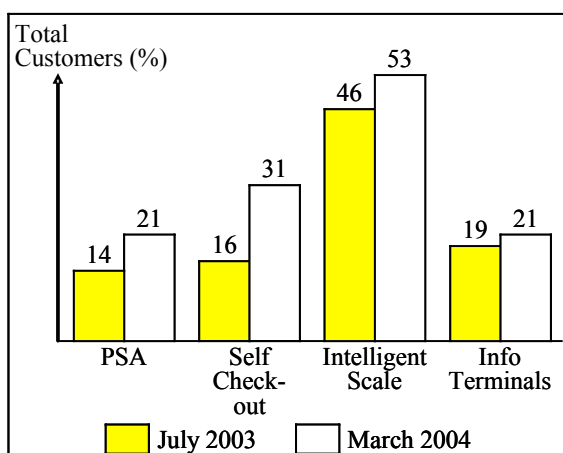Fig. 8c: Rated Value of FSI Devices – July 2003
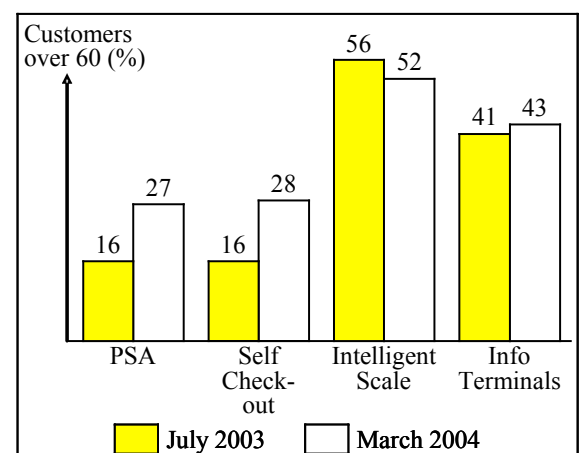
Fig. 8d: Regular Use of FSI Devices

Fig. 8e: Use of FSI Devices by Elderly Customers

Figures 3a-e: Future Store - Customer Survey - Selected Results (Source: Metro Group 2004; BCG 2003, BCG2004, own analysis).

The fast and convenient data transfer enabled by RFID supports retailers in accelerating their *work processes*. RFID, together with other IT systems, render retailing processes faster, more transparent and effective. For instance, out-of-stock has been reduced by 9-14% depending on product characteristics and about 11% less storage space is necessary saving warehousing and handling costs. Those advantages do not come for free; they have to be balanced against potential disadvantages. The most obvious ones to think of are additional expenses. Says Bernd Bueker, IBM (2004), "If we look at retailers and brand manufacturers, RFID advantages for retailers seem to outweigh the ones for brand manufacturers, simply because retailers still have more 'room for improvement' in the logistics chain than brands, which are already pretty much optimized along the supply chain".

4.2 Management Challenges

Foremost, in spite of technological achievements and customer benefits resulting from the innovative content offerings to Future Store customers and the RFID applications, privacy complaints have gained public attention and increasingly put pressure on what was meant to enhance customer convenience. As an intermediate result, the Future Store Initiative members stopped their RFID in customer cards and introduced a 'De-Activator' that customers can use to neutralize RFID coding before leaving the Future Store.

Technically integrating various new content provision devices combined with necessary, but partially unforeseen process changes has increased data (information) complexity to a degree that has been tough to handle (e.g., Schmitz et al. 2003). Making internal information available to customers implies, among other things, renaming most categories in the various databases (e.g., Stonebreaker, Hellerstein 2001). Providing externally available content on Electronic Advertising Displays requires the production of photos or even videos solely for this purpose following both data standards and content constraints.

Which other technologies should be tested? Since May 2004, the Future Store has tested so-called Everywhere Displays that turn any surface into a virtual, interactive touch-screen computer. The devices can project images onto walls, shelves, floors or any other surface and can be used for digital merchandising to show advertisements or other promotions when the customer is not directly interacting with it.

As soon as hardware and software for content integration come from different companies, the technical requirements turn into management issues (e.g., Pinker et al. 2002). Who owns the application, who owns the data, who owns the interfaces? What kind of incentives can be offered?

And last, but not least, taking the Future Store experience to the next level means deciding about further roll-out of content provision devices, of the content bus infrastructure, of RFID on palette and case level, and of RFID on item-level. How could and should this be organized? What will be the constraints?

5. Summary and Lessons Learnt

This case illustrates and analyzes the premier integrated real-world roll-out of several existing and new information technologies at and beyond the Point of Sale (POS) in the Future Store, a formerly traditional brick-and-mortar supermarket. Customers in the Future Store enjoy the new retailing world. The enormous investments by many members of the Future Store

Initiative have started paying off. Positive pressure from the stock market (share values increased by about 10% after the opening of the Future Store) has been translated into high and pushing expectations from investors (see also Subramani, Walden 2001).

With the Future Store, Metro Group has gained important experience in an integrated and consolidated manner in the fields of state-of-the-art content integration and early RFID implementations. The concentrated learning has been fruitful for all distribution channels in the Group. It has provided several opportunities to discuss and share information with suppliers, industry groups, and customers.

From a project management's point of view, so far four main lessons have been of the Future Store:

- Top-management support is crucial as content integration and infrastructure innovations are costly to develop and rarely render positive economic results in the short run (e.g., Chircu, Kauffmann 2000). The support is especially essential as information system innovations in the retail industry are not common. To build an innovative environment with time and opportunities to test new technologies and processes requires backing and encouragement from management of different disciplines, such as IT / systems development, marketing, sales, buying, communication, and logistics.

- Carefully applying innovative content integration has the potential for cost savings and improved customer satisfaction.

- In spite of all hurdles, is has been worth following up upon RFID. The increasing role RFID is playing in many business instances underlines the importance of real life tests and experience gains. As so often with new technologies, the devil lies in the unexpected details, such as tag reading through liquids and metals, standards along the supply chain, cost considerations.

- The integration of various new and innovative devices into existing work processes and the acceptance of customers make the judgment about their future use easier: 'Seeing is believing' - under this motto many Metro Group managers and responsible persons for the sales lines visited the Future Store and afterwards it was easier form them to make a decision for rolling-out the new technology in their respective arenas.

These insights summarize what the Metro Group's management involved in the project has communicated within the Group, as well as to Future Store Initiative partners, industry associations, and customers.

> "Even if individual innovations may not be 100% new in the Future Store, the number of novelties, the amount of data and information to be managed, and the integration complexity are truly new - and require a lot of work to be managed efficiently and effectively."
>
> Dr. G. Wolfram, Executive Project Manager, Metro Group Future Store Initiative, April 2004

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