

# High-Resolution Management

A new approach to management is emerging hand-in-hand with new tools such as RFID, GPS and digital technologies: high-resolution management. What effects will such technologies have on the art of managing?

## Executive Summary

In this article, Prof. Brian Subirana et al. explains why new breakthrough technologies are sharpening managers' focus on the supply chain. Just as advances in digital photography can enable a zoologist to discover and document a new species, tools such as RFID and GPS can help managers gain a more detailed view of their companies' operations. This dramatically improved perspective will have an important impact on how managers make decisions. With access to more accurate information, management will be able to move freely from macro to micro levels and will be able to measure, plan and act accordingly. Furthermore, the scale at which businesses operate will be "lowered" and businesses will start to see greater fragmentation of their markets, products, points of distribution and supply chains.



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Imagine you are about to make a major breakthrough in zoology. You believe that there exists somewhere a flying mammal previously thought to be nonexistent. While on a hike one day, you take a picture of a stunning landscape. In the top left corner, without knowing it, you've captured an image of the very mammal bird you are seeking. Back at home, after further inspection, you realize that you may have inadvertently captured proof of your theory. You excitedly download the photo to your PC. You are convinced that after cropping the photo you will be propelled to worldwide scientific acclaim. You enlarge the photo in Adobe Photoshop and attempt to crop the image of the bird. There is one problem. The resolution of the photo is simply too low. When you enlarge the area where the bird is flying, all you see are blurry pixels. Your dreams of reaching scientific stardom quickly dissipate.

Now, imagine you are in a warehouse. Switch your mind to thousands of goods moving from the shipping dock to the inventory area and back out again. Imagine taking a still photo of the situation with the same camera. Do you have the same problem? Are you unable to make out the details of what is really going on? Do you know with 100 percent accuracy what products are in the warehouse? How precise are receiving, storing, shipping and checking?

What you have momentarily and hypothetically just witnessed is a problem that plagues all types of businesses. How many times has someone in your company uttered, "We don't have that level of accuracy in the information, so we have to make aggregated estimates"? Under the current paradigm, it is sometimes impossible to drill down and understand what is happening at a highly detailed level. But, imagine if you had access to that detail? Imagine if you could pinpoint at any time and at any location exactly the product in question? You are not alone. In a Harvard Business School study of a major U.S. retailer, 65 percent of all inventory records were found to be inaccurate.

Welcome to high-resolution management. And, we are not talking about simply going out and buying a new camera with higher resolution capabilities. In fact, still cameras will not help. Instead, there are a number of different technologies and sensors such as Radio Frequency Identification (RFID) tags, Geographic Positioning Systems (GPS) and digital video cameras that allow you to access real-time details specifying the location, the frequency and the content of a single product. We contend that these technologies will change drastically how management makes decisions. Why? Because with access to the finest granularities of information, management will be able to move freely from macro to micro levels and will be able to measure, plan and act accordingly. Furthermore, we also purport that the scale at which businesses operate will be "lowered" and businesses will start to see greater fragmentation of their markets, products, points of distribution and supply chains.

## Measurement and the Evolution of Management Manufacturing Practices

To understand high-resolution management, let us momentarily step back into history. We might start with craft production in the 1890s in the automotive industry. If one

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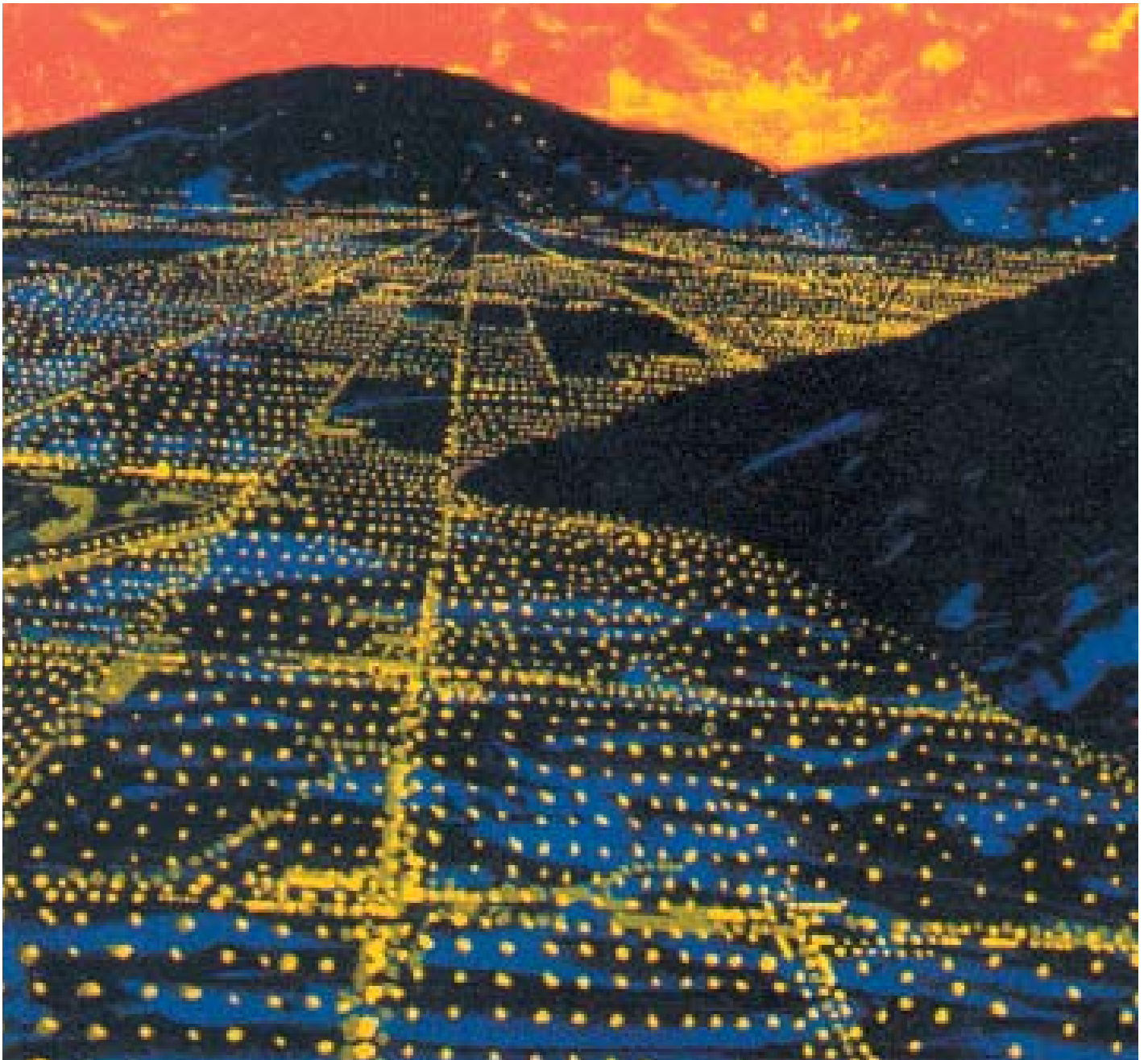
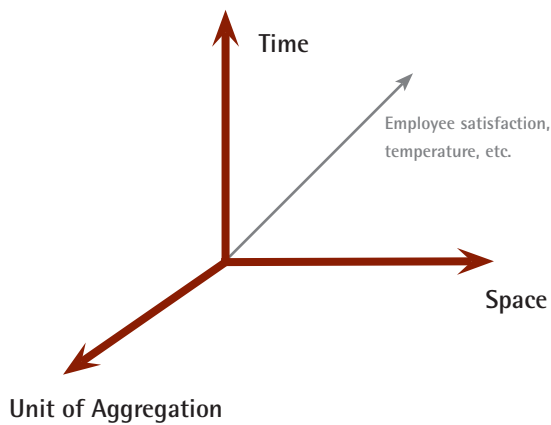


Figure 1

## Dimensions of High-Resolution Management



had the means in the late 1890s, it was possible to commission a custom built car from one of a handful of manufacturers. During this time, workshops engaged in custom automobile manufacturing had several resounding characteristics. First, custom automobile manufacturers had highly skilled workforces where, over a number of years, workers progressed from apprentices to talented craftspeople picking up the skills and techniques enabling them to perform a wide range of tasks. Second, the workshops contracted a number of different machine shops to make parts and components. Third, all shops used general purpose machining tools in production. Fourth, workshops made fewer than 1,000 cars per year, of which 50 or fewer were built to the same design and specifications.

These elements characterized the automotive industry until 1908 when **Ford** developed the Model T with two primary objectives: the car was designed to allow for repeatability in production and the car could be easily driven and operated by anyone, cutting out the previous need for a chauffeur or mechanic. To describe this new approach, Ford coined the term “mass production.” Mass production outlined a complete and consistent methodology for interchanging and assembling parts of the car. In the same wave as Ford came the principles of scientific management developed in 1911 by Frederick W. Taylor. Taylor proposed that the principal objective of management should be the maximum prosperity for both the employer and employee. Taylor also pervaded the idea that science and consistency should be dominant in how the organization viewed production, worker training and worker coordination.

By the mid-1950s, Ford’s and Taylor’s ideas were widespread throughout several industries and were commonplace in the U.S. and Europe. However, at the **Toyota Motor Company** in Japan a new approach was brewing - lean production. Along with the efforts of Eiji Toyoda and Taiichi Ohno from **Toyota** was the U.S. management theorist and consultant, W. Edwards Deming, all of whom promoted fundamental changes in a manufacturer’s operations and orientation. Lean production purveyed four essential principles: teamwork, communication, efficient use of resources (including the elimination of waste) and perhaps most importantly, continuous improvement. A group of industry experts offered this definition: “[a lean production plant] transfers the maximum number of tasks and responsibilities to those workers actually adding

value to the car on the line, and it has in place a system for detecting defects, which quickly traces every problem, once discovered, to its ultimate cause.”

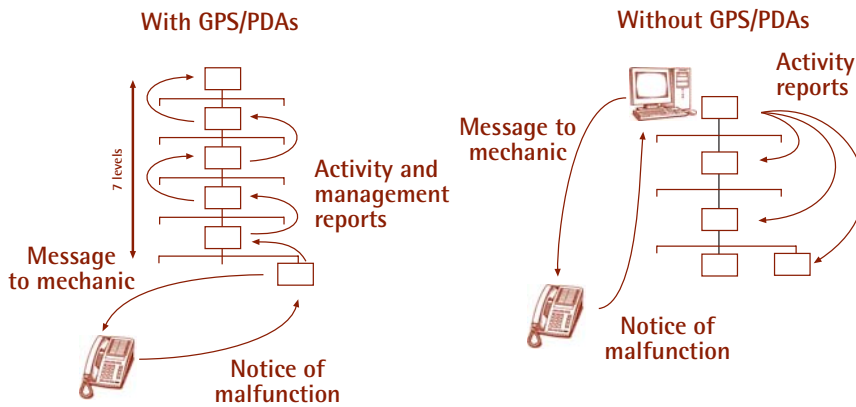
What was the result of lean production in Japan? Lean manufacturing proved what had been considered previously impossible: the improvement of quality and the lowering of costs at the same time. Japanese cars, once perceived as cheap, low-quality and ill-respected items, became affordable, high-quality engineering marvels. As a result, Japanese companies realized explosive growth. For example, **Toyota’s** net value added per employee increased from \$26,039 in 1960 to \$73,897 in 1983 while **Ford’s** only inched up from \$31,272 to \$37,235 during the same period.

Apart from the impressive results and the continuing rise of Japanese automakers (**Toyota** became the largest auto manufacturer ahead of **General Motors** in early 2006), what can we take away by looking at the evolution of the automotive industry? All successful changes introduced in Japan were based on some form of measurement including time and motion studies, continuous improvement and other concepts first developed in the U.S. Ford and Taylor introduced time-and-motion to facilitate the move from craft to mass production. Deming, Ohno and several others introduced the idea of statistical measurement along a standard distribution curve. Deming introduced the concept of the Measure-Plan-Act loop as shown below. A system that is being measured can maintain world-class standards, and, in fact, push the boundaries of these standards as a competitive advantage. Without measurement, it is easy to slip behind in the “arms race” called quality.

How were these processes tracked and measured? Ford and Taylor started with a stopwatch and notepad. Deming, Ohno, and others added other tools such as statistical tracking charts, which made it possible to use sampling principles and draw statistically sound conclusions. A spate of new terms such as *kaizen* (constant process analysis), *kan-ban* (pull production based on the needs of the final consumer) and *poka yoke* (mistake-proofing) began to permeate throughout management ranks as measurement-based approaches in the quest of increasing quality and lowering price. The increasing processing power of computers spawned myriad tracking tools. One example was the development of Material Requi-

Figure 2

## Improved Service Through High-Resolution Management: The Otis Elevator Company



Prior to the use of GPS and PDAs, the maintenance structure was very decentralized and costly. The company had seven levels of information for responding to emergency calls.

Otis Elevator Company simplified this system by intelligently combining GPS technologies in the vehicles of its mechanics with direct connections to each of the elevators installed and maintained by the company. This was achieved through the introduction of devices that permit communication by GPS or SMS messages. The new system has simplified the overall maintenance structure and service of the organization. The company now knows where its mechanics are at all times, as well as the condition of each elevator.

1. Single center for receiving calls
2. Detection by owners of problem
3. Planning of organization
4. Benchmarking among repairmen and offices

rements Planning (MRP) systems aimed at tracking all of the raw materials making up a particular product. Today, Statistical Process Control (SPC) is a staple in modern manufacturing and process engineering. For example, when wafers for microprocessors are manufactured in a silicon fab, hundreds of parameters are measured and analyzed in real-time, and adjustments made to ensure high quality and yields.

As of 2006, we have a number of tools at our disposal including access to newer tracking tools such as RFID, GPS and digital video cameras. We propose that the adoption of these tools will be instrumental in leading the evolution from lean manufacturing to the next generation in management: high-resolution management. Does it sound like we are advocating a robotized world where the machine is controlling the human? No, that is not the case. High-resolution management is a natural evolution that is based on prior principles of measurement, root cause identification, real-time control and run-to-run improvement. Just like its ancestors - craft, mass and lean production - high-resolution management is bound to have a profound effect on every aspect of an organization.

You might ask, "Why change now?" You may think that all parts of your organization are functioning perfectly, but as history will tell us, what is a competitive advantage now may not be in the future. Smug self-satisfaction about one's current advantage might hurt in the medium or long term, for such advantages are often fleeting. To further incite the need for change, think of the world-renowned golf champion, Tiger Woods. Woods may be the very manifestation of "continuous improvement," repeatedly changing his golf swing even while he was at the top of his game. You may be able to already think of areas in need of improvement. For instance, how is your supply chain these days?

### High-Resolution Management in the Supply Chain: The RFID Example

One recent study estimates that on a worldwide basis, retailers experience an average stock-out rate of 8.3 percent. Approximately 55 percent of out-of-stock items take over 24 hours to replenish. These factors translate to a sales loss of 4 percent. Furthermore, there is typically a 1 to 3 percent error rate on shipments to the store and 10 to 15 percent of vendor shipments are disputed by the retailer.

Where stock-out problems do not reign, the problem of overstock is prevalent - the average consumer packaged-goods company has 11 weeks of inventory in their distribution center. Retailers have an average of seven weeks of inventor. Inventory overstocking ties up cash and limits a firm's ability to turn inventory into cash inflow. Add to these time-sensitive management issues items like seasonal goods, and product expiry in fresh foods and pharmaceutical items, and inventory management becomes a critical problem.

Aside from inventory challenges, manufacturers are also struggling with the security of the supply chain in the form of shrinkage, counterfeit products and diversion to other markets. A recent study of consumer goods manufacturers found that shrinkage represented over 2 to 3 percent of sales. It is estimated that if shrinkage were cut in half, retailer profits could be 30 percent higher. Furthermore, over 50 percent of shrinkage is attributed to employee and vendor fraud. The remaining is accounted for through damages and theft. How long would it take for theft to disappear if one could focus in on the thief with microscopic precision?

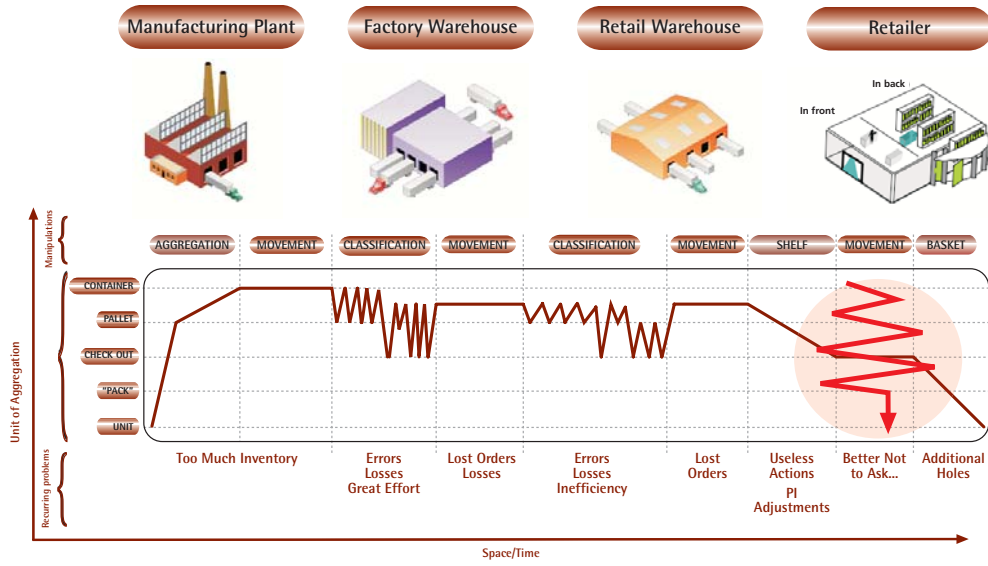
Counterfeiting also causes havoc. It has been estimated that counterfeit products account for 10 percent of the \$500 billion global pharmaceutical industry. Shrinkage, counterfeiting, and diversion damage the relationship between the suppliers, employees, transit companies, retailers and consumers. We might conclude that if the supply chain were a patient, it would need to be rushed immediately to the intensive care unit.

Let us dig deeper into the supply chain by taking a look at the movement of goods throughout the entire process. After a product is made in a manufacturing facility, it moves to the manufacturer's distribution centre. It is then shipped to the retailer's distribution center before being delivered to the retailer. Within these four locations, the product is "packetized" at different aggregation levels (single product, pack or sleeve, case, pallet, and container) in either uniform configurations (such as full pallets) or in mixed configurations (such as mixed pallets).

Let's go through the process in detail using the example of disposable razors. During production, the output is a single razor. It then is grouped into either a four-pack, eight-pack or 12-pack. Each type of pack is placed into a case, which are then grouped and transferred to pallets. The pallets are then grouped and

Figure 3

## The Supply Chain Produces Errors in Information on Stock



The supply chain is fragile. The different movements of products, between the manufacturing plant and the end client, typically include many errors.

At each stage of the chain, goods are manipulated. This generates errors in information regarding levels of stock in warehouses, and thus, in the information systems designated to control goods from the point of manufacturing to the hands of the retailer and the client.

Introducing technologies such as RFID contributes toward better management of stock in each of the links along the chain and reduces the number of errors that are produced in terms of damaged goods, inventory errors and warehouse organization.

transferred to a single container. Once the container is moved to the manufacturer's distribution center, it is depacketized from a container into a pallet and sometimes a case before being shipped out to the retailer's distribution center in the form of a pallet. At the retailer's distribution center, it moves up or down between a pallet and a case, as products are mixed to meet the needs of an individual store. In the retailer storeroom, the razors may be packetized, depacketized, moved, stored, and accessed continually. Are you confused? Imagine being the person responsible for tracking an individual razor throughout the process!

The grouping and de-grouping of the product coupled with the multiple sorting and transferring points leaves plenty of opportunity for inventory gluts and errors, shrinkage, miss-shippments, wasted efforts and a whole host of other inefficiencies. Imagine, if at the beginning of the process, a four-pack is coded as an eight-pack. This error would cascade throughout the rest of the process. The error may in fact be amplified through the chain and accumulate with other errors. The costly manual perpetual inventory exercises are illustrative of the extent of this plague. The human resource power required to scan each barcode of each pack at every checkpoint in the process is too costly and cumbersome. In short, the current approach is manual and is lacking the sufficient resolution to cut down on errors and inefficiencies.

So, is there a cure to the ailing supply chain? We believe RFID offers a solution to combat most of the illnesses and, in the short term, four troublesome areas in supply chain management: shrinkage, out-of-stocks, inventory costs and handling costs. While RFID has been around since World War II, where it was used to provide intelligence on incoming aircraft, its use in supply chain applications emerged in the 1990s. RFID offers a replacement to the Unified Product Code (UPC). Relative to RFID, UPC is an *active* tag, meaning that it needs to be scanned by personnel before being identified. In contrast, RFID is a *passive* wireless sensor, which does not require any physical scanning to be identified. For example, when receiving goods in a UBC warehouse, workers often need to scan, count and retag them before storing or sending them out. A warehouse that employs RFID could potentially eliminate the entire process of receiving. As a recent study led by **Wal-Mart, P&G, Kimberly Clark, MIT** and **IESE** shows, significant gains can be achieved short-term through the use of Electronic Proof of Delivery (EPOD) at recei-

ving. Goods are moved into the warehouse and RFID readers immediately collect all of the tag information and load it directly into the warehouse information management system.

Recent research suggests that when you have greater resolution on tracking products throughout the supply chain with the use of RFID tags, the benefits are plentiful: no shrinkage, fewer out-of-stocks, less inventory, lower obsolescence, the elimination of counterfeit products and enhanced product promotion management.

### High-resolution Management to the N<sup>th</sup> Degree: The Fragmentation of your Business Model

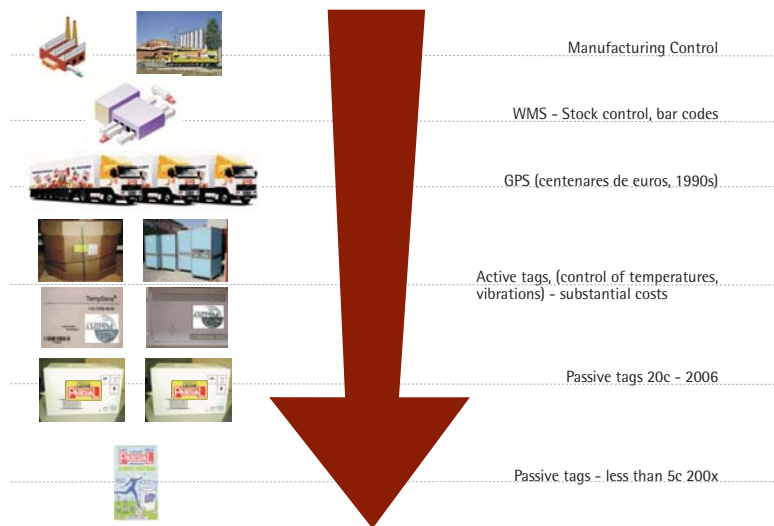
Through the RFID supply chain example, we have seen that RFID is analogous to a magnifying lens on your business. RFID is one of many technologies under the increasingly growing umbrella of high-resolution management. High-resolution management is an operating theory whereby managers frequently drill down to the nth degree and use the information for the very same objectives as lean manufacturing - increasing quality and lowering costs at the same time.

Fragmentation is not a new trend. Let us look at the example of clothing retailer **Zara**. **Zara** has been the darling of business press and academics worldwide for its ability to squash the traditional fashion goods lead-time from one year to just three weeks. How did it achieve such a reduction? Fragmentation. **Zara's** designers have a real-time feed of sales data detailing which Stock-Keeping Units (SKUs) are hot-sellers and which items are not working. The ability to access this performance on a SKU-by-SKU basis permits the company to test products in a few stores and make fast decisions. If sell data is weak, **Zara** can react immediately by cancelling an item. Likewise, if a store is selling out of an item, more products can be ordered and shipped directly to the store. As a result of this high-resolution approach, **Zara** is able to introduce 2,000 new items with new garments arriving weekly. Through these changes, **Zara's** parent company Inditex has grown quickly from over 500 stores in 1995 to 2,700 stores in 2006 and has increased profits during the same period.

In fact, the application of high-resolution goes far beyond high-street fashion retailers. Think of how GPS has changed the management of taxicabs. Using GPS, taxi drivers are able to pinpoint the shortest route and approximate time of arrival.

Figure 4

## Leche Pascual: The Evolution of Resolution



Companies first gained higher supply chain resolution through the application of bar codes, which facilitated better control in the factory and the warehouse. Next, resolution was improved through GPS technology, which enabled the tracking of vehicle routes and locations.

RFID technology prompted the next step. For example, the milk producer Pascual implemented a new system of monitoring products requiring a constant temperature of between 0 and 3 degrees through the use of "active" RFID tags, which are powered by batteries. The tags allow the company to check the temperature of 1,000 kg.-containers, which was previously impossible.

The company is strengthening its resolution by applying RFID tags to smaller units, such as boxes that contain 1-liter cartons of milk. The next step will be the application of RFID tags to individual products.

It also allows the dispatcher to immediately identify which taxis are closest to the next customer. This increases transparency, cuts down on inefficiencies and ultimately increases the utilization of each taxicab.

Highly fragmented business models are also the backbone of many information industries, such as the provision of real-time stock quotes and online advertising. Consider for a moment the complex and fragmented transactions that occur "behind the scenes" when you enter the website of your favorite newspaper to read the morning headlines. You may think it is a simple transaction between yourself and the newspaper's server, but your simple click triggers a transaction stream (reference) of tens (if not hundreds) of other transactions involving 40 different players such as online advertising firms, a multitude of potential brand advertisers, a predictive modelling company, a number of online retailers, and a digital notary. Just like a traditional physical product leaving a warehouse, your initial click is packetized and depacketized to provide each player with the appropriate level of detail. This information will be used to tell the advertiser, supplier, retailer and others which type of advertisement to show you as you read the online news.

While fragmentation in information industries might appear extreme, imagine if each and every product were equipped with enough information to become its own store. Think of purchasing a second-hand motorcycle from your neighbor. Imagine that the motorcycle in question had its own sophisticated tracking device. Upon buying it, the tracking device on the motorcycle would automatically download the market value from a website listing and notify your bank to transfer the funds to your neighbour's account. How close are we to such a world? Not that far away.

### The Future of High-Resolution Management

High-resolution management is the next evolutionary step after lean manufacturing. High-resolution management is based on vastly lowering the scale at which you analyze space, time, products and business models. As a result, we have already started to see how a few different sectors have started fragmenting their products and services all with the aim of improving quality and reducing cost. In the long-term, we can cast our imaginations forward and imagine a world without a supply chain, and in its place a packetized distribution network, where each product

contains all of the necessary information to essentially become its own store. As the resolution of each item increases, we will see greater randomization, more customization and increased frequency of delivery directly to the end consumer.

When we started this article, we asked you to imagine yourself as a zoologist pursuing the discovery of a new species of mammal. In the hypothetical picture you snapped, your eye was unable to see all of the details that comprised your digital image. And, that was only a still photo. Imagine trying to capture high-resolution to-the-nth detail in real-time? Emerging tools such as RFID tags, GPS and digital video cameras can help.

With increased resolution, come more options to drill down, eliminate inefficiencies and cut costs. With greater resolution, the key management skill will become cropping the unnecessary information and continuing to measure, plan and act. Who knows? You might just dramatically improve your supply chain performance. Perhaps you will drive a fragmentation revolution in your market of choice. Or, you could metaphorically make a discovery of a rare bird. At the end of the day, you need to choose what you want to do. High-resolution management is ready when you are. ■