Chapter 100
Embedded RFID Solutions: Challenges for Product Design and Development

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ABSTRACT

Full traceability of products is extremely difficult, although it has been sought after for as long as production, distribution and sales chains exist. Electronic traceability methods, such as RFID technology, have been proposed as a possible solution to this problem. In the specific case of RFID, the number of applications that promote innovative solutions in retail and other areas has been continuous growing. However, RFID tags are mostly placed externally on a surface of products or their packages. This is appropriate for logistics, but not for other applications, such as those involving user interaction. In those, not only is the placement of the RFID tag more complex, but it is also necessary that the tag is not visible or not directly accessible, to prevent accidental damage and intentional abuse. This certainly imposes challenges to manufacturing, but mainly creates new challenges to the development of new products and re-design of existing ones. This chapter presents some insights and what we consider to be the two main approaches to incorporating RFID technology into consumer products.

INTRODUCTION

RFID technology has attracted an increasing interest from companies and R&D institutions around the world in the past few years. Some of the application areas of this technology can be seen in the automotive, retail, logistic and health industries. The benefits can go from increased productivity and cost reduction, to more indirect factors– difficult to quantify – such as improved post-sales consumer service (Hodges & McFarlane, 2005). This technology is seen as a potential new phase

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in the development of the information society, in which the overall day-to-day objects will be inter-connected to other objects, data, etc. This will lead to a considerable impact in some value chains, resulting in a plethora of new applications (Gellersen, Schmidt & Beigl, 2000).

However, this trend represents a challenge that has limited the feasibility of applying RFID technology. The fragility of these electronic devices, associated to the great variety of products and the processes to which these are submitted through their life cycle, restrict the adoption of these technologies (Deavours, Ramakrishnan & Syed, 2005), Moreover, the development of solutions to incorporate an RFID tag in a product and/or packaging in molded components with the minimum impact on the manufacturing process still remains a difficult task (Hodges & McFarlane, 2005).

Despite recent evolutions in design and development processes, that cover the necessary modular product architecture (e.g., Grady, 1999; Ulrich & Eppinger, 2007), these present themselves as processes for new or re-designed products. None of these new processes have been optimized for the development of products that need to perform their function coupled with another product that already exists, being therefore conditioned by that existing product's form, size, and other physical and functional characteristics.

Thus, the challenges posed by introduction of RFID technology into consumer products can be divided into two types: those related to the manufacturing process (the ability to embed the RIFD tag into the product), but also those related to the required changes to the product form and possibly its architecture (where in the product should the RIFD tag be placed and how much does the product need to change to accommodate it). For the former, we can expect industrial processes to improve to meet the demands of the market. As RFID technology becomes more widely adopted, advanced processing technologies (such as non-conventional injection molding) will enable new solutions for embedding the tags into products during the manufacturing process. However, for the later, which is the focus of this work, it will clearly be necessary that appropriate design methodologies be identified and, if necessary, developed, for seamlessly adding RFID tags to products.

In this chapter, we discuss that to successfully incorporate RFID technology, the design and development of products will demand an effective analysis of existing products, following a modular product architecture philosophy, which will create a significantly different development process. We also discuss what those changes may imply in the overall process and which type of product architectures offers competitive advantages for such solutions.

RFID TECHNOLOGY OVERVIEW

RFID is a wireless tracking technology that allows a reader to activate a transponder on a radio frequency tag attached to, or embedded in, an item, allowing the reader to remotely read and/or write data to the RFID tag (Das, 2009). Essentially, an RFID system comprises an RFID tag, also called transponder, a reader, also called transceiver, and the supporting IT infrastructure. An RFID tag embodies a built-in antenna connected to an electronic microchip. These tags carry on a unique identifier that relates the tag with the precise tagged object, allowing unique product identification. A tag receives and retransmits signals on a set of predetermined frequencies, in other words, in response, a tag transmits a predetermined message to a predefined received signal.

RFID tags can be read-only or read-write. A read-only tag includes a programmed identification code, recorded at the time of manufacture or when the tag is allocated to an object. Once programmed, the data cannot be modified but may be read multiple times. Read-write tags can have their memory changed, or written many times; in