

Ambient Intelligence in Product Life-cycle Management

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Abstract

To fulfil the increasing demands today the short innovation time and the high quality of production itself is not enough in production of goods, but all phases of a product (from idea to recycling) should be managed by advanced tools and means. Nowadays the competition among companies, joined to the environmental protection rules, is so compelling that they should not only be on the top of technology in the area, but also run their business according to life-long models. The emphasis on the product post-sale life is common for these models. The most popular model is Product Life-cycle Management, for manufacturing companies, or Service Engineering (SE), for service-oriented companies, and, for both, common paradigms are in *maintenance*, with conformance-to-use certification. The paper introduces some basic research results achieved in the application of Ambient Intelligence, and suggests considering maintenance as a cross section of the two business paradigms. The importance of SE is specially underlined in this work.

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1. Introduction

It is not hard to understand and accept that in the recent highly competitive global economy the companies should produce high quality products and/or services at lower costs in shorter time (see Vernadat, 1996). This demand forced a number of manufacturing/service industries to apply new strategies for product design, manufacturing and management. For the last decade, the information technology sector went through very fast and impressive development. This advancement made it possible to implement new supply chains, delivering *products-services*, supported by co-operating organisations. This type of changes opened horizons to enable new business paradigms, such as Product Life-cycle Management (PLM) or Service Engineering (SE), embedding high-intensity infor-

mation flow, with enhanced transparency of the material resources decay and with increased intangible value added. These paradigms make it possible for networked companies to be more competitive in a novel business area, improving after-sale services, products maintenance and recycling. In some cases, to excel in service and maintenance area is the critical means for a company to be winner on the market. Indeed, the full acknowledgement of the technical conformance of a product at the *point-of-use* is a basic request to comply with eco-consistency incumbents, and the reliable recording of the lifecycle falls-off becomes standard duty to certify the item sustainability achievements.

2. New market rules, new ways of production and management

Production/manufacturing world is moving fast from an economy of scale to an economy of scope, under the global economy for customers' satisfaction (see Vernadat, 1996; Michellini and Kovacs, 2004). Under that conditions, for

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most companies around the world, surviving in business means to satisfy three challenges, as follows:

1. to meet customer requirements;
2. to reduce the time-to-market of their products; and
3. to manufacture products at lower environmental impact.

These changes in industry have been reflected on human society, too. Following (Michelini and Kovacs, 2004), the earlier affluent society needs to be turned into a more conservative thrifty society, as the world, we are living in, cannot deal with ceaselessly consuming raw materials.

Of course, as well known (see Vernadat, 1996), the goal in the industrial economies is value creation by marketing products. Nowadays, in several different businesses the created value consists of many components and the weight of the value related with tangible product turns to be but a fraction of the whole delivery. In the thrifty society, frugality and recycling play a relevant role; the traded artefacts are replaced by products-services, supported by extended enterprises (see Michelini and Kovacs, 2004). In this type of manufacturing organisations the value is added by the supplier on the lifelong steps of the provision, aiming at new business paradigm types. This type of business organisation has been acknowledged, and the so-called PLM tools are example achievements.

PLM makes possible the manufacturing set-ups complying with the thrifty society demands, due to the transparent recognition and control on resources decay and environment burden. The earlier challenges for companies add or extend over new ones. If formerly meeting customer satisfaction meant to develop product with high performance and quality, nowadays companies need, moreover, to supply lifelong services and maintenance procedures, including dismissal and recycling incumbents.

The above-discussed issues led to new rules on the market:

Rule 1. It is not enough to produce the required product, but the most important is to produce after-sales services, which satisfy or, in some cases, predict, as well, the customer requirements, complying with the enacted environment protection rules.

Rule 2. Reducing the time-to-market period of the product means the reduction of the time-to-market period of the services, supplied as integral part of the delivery, with due concern on the technological sustainability of the traded goods.

Rule 3. Not only goods should be developed to satisfy demands of low cost and eco-consistent quality, but accompanying services shall, as well, satisfy these demands, further providing full visibility of the impacts on the human natural surroundings.

The farther our community will turn from the affluent to the thrifty society, the more relevance will be given to the products-related services in the companies' competition. In other words, if in the affluent society, competition between companies producing *product-service* deliveries made emphasis on "product", in the future, in the thrifty society, the competition will make emphasis on the "service" part of the delivery. Naturally it does not mean that the role of the product component could totally be replaced.

Still, the role of the second part of the product-service supply is getting more and more relevant, and companies could build-up their businesses in the area of providing accompanying services for products manufactured by another company. The context, thereafter, has recently led to the appearance of a new scientific field, the SE purposely developed to expand the (mainly) intangible provisions for enhanced use of conventional goods.

2.1. A new paradigm: PLM

The PLM concept appeared in the second part of the 1990s. This concept provides a platform to share product-related knowledge across an extended enterprise, from product design and creation, through dissemination and after sales services, up to product dismissal and recycling. Following Garetti (2004), PLM is defined as "*a new integrated business model that, using ICT technologies, implements an integrated cooperative and collaborative management of product related data, along the entire product lifecycle, dismissal included*".

Fig. 1 represents a simplified, but still characteristic view of PLM and SE together. The left-hand side of the figure shows a graphical interpretation of the PLM concept. As one can see, the PLM joins three main chains of the extended/virtual enterprise: Engineering-, Operation- and Support Activities Chain. Any chain may consist of some/several sub-processes. For example, Engineering Chain contains three sub-processes: Product Design, Process Planning and Factory Planning.

It is possible to highlight several reasons, which led to build a PLM. From the manufacturer viewpoint, product innovative upgrading, customer-driven quality, operation excellence, etc., require enhanced visibility on actual lifecycle data. From the external market viewpoints, items responsibility at the point of service, product complexity, shrinkage in the duty life, dismissal incumbents, etc., push toward higher transparency of supply chain and environmental issues.

The implementation of the PLM concept is impossible without proper ICT tools. Ameri and Dutta in their work (Ameri and Dutta) summarise the impacts which PLM gives to ICT solutions applied in manufacturing. Let us enumerate some of them:

- It makes a closer connection between, one side, engineering and manufacturing and, on the other side, finance and marketing, assessing the criticality of the design steps for the after-sale services.

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