

Factory-in-a-box – Demonstrating the next generation manufacturing provider

Mats Jackson¹, Magnus Wiktorsson² and Monica Bellgran³

^{1,2} Mälardalen University, Sweden

³ Haldex AB, Sweden

Abstract

Meeting customer demands require manufacturing systems with a high degree of flexibility, low-cost/low-volume manufacturing skills, as well as short delivery times. On top of these challenges, there is a gigantic need within industry for technologies and strategies that will reduce CO2 emissions globally. In this challenging environment there is a need to identify and develop new and improved manufacturing capabilities within the manufacturing industry. The Factory-in-a-Box concept consists of standardized production modules that are e.g. installed in a container and transported by truck or by train. The concept has been developed, exemplified and realized in five industrial demonstrators developed by researchers together with competitive manufacturing companies in Sweden such as ABB Robotics, Bombardier and Pharmadule. The objective of this paper is to discuss the possibility of realizing a Product Service System (PSS) using the results from the Factory-in-a-Box project

Keywords:

Manufacturing System; Product Service System; Flexibility; Speed; Mobility

1 INTRODUCTION

Globalization makes competition within a manufacturing industry more difficult to sustain, and it is recognized that low cost and high quality is not enough to guarantee a firm's competitive position in the market place. To successfully develop and implement the next generation of products and services, industry must be successful in generating new product ideas as well as having the ability to quickly realize these into successful products and competitive production systems.

It is well accepted that the mass-production paradigm based on high-volumes has been replaced by a more flexible and responsive approach [1]. Meeting customer demands requires a high degree of flexibility, as well as abilities to reconfigure operations to suit new demands [2]. Thus, the uncertainty in markets and rapid introduction of new products has created a growing need for flexible, reconfigurable, and responsive manufacturing systems. On top of these challenges, there is a gigantic need within the manufacturing industry for technology and strategies that will reduce CO2 emissions globally.

One possible solution to the above scenario can be the concept of product service system (PSS). PSS can be described as "a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models" [3]. A PSS concept is based upon a shift from the traditional production of a product or service towards the delivery of a 'function' to the customer that might, in practice, mean the provision of combinations of products and services that are capable of "jointly fulfilling users needs" [4]. The consequences of this are a range of changes relating to the management of products throughout their life-cycle in an effort to minimize environmental impacts and to identify

alternative profitable revenue streams. It is obvious that service activities need to cover the whole product life-cycle; affecting product, manufacturing, and customer use. In conclusion, a competitive service solution for local manufacturing is a manufacturing provider that can deliver e.g. a complete manufacturing offer including installation, ramp-up, maintenance, management and reuse.

In January 2005, the Swedish Foundation for Strategic Research started a research project called "Factory-in-a-Box". The Factory-in-a-Box concept has the key characteristic of a modular production unit that is flexible, mobile and quick to ramp-up. The Factory-in-a-Box concept has been developed, exemplified and realized in five industrial demonstrators developed by researchers together with competitive manufacturing companies in Sweden, such as ABB Robotics, Bombardier and Pharmadule. The objective of this paper is to discuss the possibility of realizing a Product Service System (PSS) using the results from the Factory-in-a-Box project.

2 METHOD

Research presented in this paper was carried out as one part of the recently finalized Swedish research project called Factory-in-a-Box. This paper is based on a literature review, a series of interviews, as well as case studies that have been used to collect data from the development of the demonstrators in the Factory-in-a-Box project.

In general, case study method is the preferred strategy when 'how' or 'why' questions are being posed, when the investigator has little control over events, or when the focus is on a contemporary phenomenon within some real-life context [5], which is relevant for this work.

Case studies are often criticized for lack of statistical reliability and validity. Furthermore, it is argued that it is not possible to test hypotheses. To overcome this dilemma, it is increasingly important to select a representative case and to validate the result continuously, and not simply at the end of the study. It is also important to describe the actual case carefully and only to draw conclusions that are valid exclusively for similar systems.

3 THE FACTORY-IN-A-BOX CONCEPT

The Factory-in-a-Box concept consists of standardized production modules that could be installed in e.g. a container and transported by e.g. truck or train. The modules can then rapidly be combined into production systems that can be reconfigured for a new product and/or scaled to handle new volumes. Production capacity may be provided as a mobile and flexible resource that rapidly can be tailored to fit the needs of a company, at a specific point of time. The emphasis on mobility in the Factory-in-a-Box concept is important in Sweden, where geographic limitations are a reality.

Three examples of customer segments for the Factory-in-a-Box are:

- Company A has a new product design, but without production capacity. The options for the company are to invest in new production capacity or to outsource production. If the company chooses to outsource, chances are that production will be placed abroad and that the company may lose control of their product. Using the Factory-in-a-Box concept, company A may instead lease a production system for the time needed and then return the system to the supplier providing the production modules.
- Company B has a peak in their production, which exceeds their capacity to produce. The company may need to outsource production or make large investments. Using the Factory-in-a-Box concept, company B may lease production capacity as an alternative to outsourcing.
- Company C is a large enterprise, which wants to have full control of the manufacturing of a sub-system, provided by a supplier. Company C can help a supplier by providing a Factory-in-a-Box module to improve quality or handle variation in production volume.

A Factory-in-a-Box could be placed close to product development or customers within the distribution chain. A likely scenario is that the Factory-in-a-Box can be rented or leased from production specialists, i.e. a type of functional sales of production capacity.

The concept of mobile capacity is not new in principle. There are examples of mobile hospitals and welfare centers see e.g. Vårdmobilen (in Swedish), mobile amusement parks, mobile libraries see e.g. Bokbussen (in Swedish), mobile sawmills see e.g. Urban Forest Ecosystem Institute, and mobile gear for musical concerts. However, there are no examples found of adding the mobility factor to a manufacturing system within the engineering industry. Adding mobility to a modular manufacturing system adds another dimension to the concept, and opens up new possibilities.

The Factory-in-a-Box concept thus offers a new application of previously used ideas.

There are a number of technical requirements for the Factory-in-a-Box concept in order to realize the key features of mobility, flexibility, and speed. Examples of these requirements are:

- The modules should be easy to transport to the production site as well as easy to move at the site, e.g. having both external and internal mobility.
- Ability to dynamically adapt the degree of automation and flexibility to human interaction.
- Reconfigurability in order to meet changing demands and automatic/semi-automatic configuration of modules and system are prerequisites for scalability when changing production volumes and for fast ramp up of the production.

The use of standardized production modules provides autonomy and reusability. A Factory-in-a-Box installed at a company should be integrated with the company's existing technical production capacity and its present workforce. The intention is to balance automation and manual labour in the Factory-in-a-Box modules. Thus, each configuration will include e.g. automation requirements, operator staff requirements, configuration simulation modules, and case-based experience/knowledge databases.

4 THE FACTORY IN A BOX DEMONSTRATORS

The goal of the Factory-in-a-Box project has been to build five completely operative demonstrators – 5 Factory-in-a-Box production cells – developed in close cooperation between different academia's and industrial partners. The demonstrators have made it possible to exemplify, realize and visualize the Factory-in-a-Box concept; they are practical examples of the usability of the concept in industrial application. All demonstrators are practical solution for a particular function(s) and provide a real business case for the concept. The five different demonstrators are described in the following chapter;.

4.1 Factory-In-A-Box 1 – Automatic assembly with focus on flexibility

A first example of a Factory-in-a-Box module has been developed and demonstrated within ABB Robotics production system – an automatic production module to assemble robot components. The overall goal of this pilot demonstrator was to develop an automatic production module, which assembles robot controller cabinets, meeting the overall Factory-in-a-Box requirements of flexibility, speed, and mobility. The demonstrator has been developed in parallel with an ongoing product development project of a new robot controller at ABB Robotics: "IRC5".

The vision of this demonstrator has been a production system that can be assembled and configured according to the specific needs and that can be delivered to any location. Factory-in-a-Box module #1 has explored this vision and tried to make this a reality. The focus of this demonstrator has been to investigate the following requirements that were specified in the original project plan;