

A DESIGN METHOD FOR PARTS PICKING ZONES IN A MANUFACTURING ENVIRONMENT

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ABSTRACT

This paper describes a method for the design of an order picking system in a manufacturing environment. Unlike order picking systems in warehouses, there is almost no literature available concerning order picking systems in a manufacturing environment. We start by defining the needed input parameters, followed by a parts classification method. This leads to the calculation of order specifications (order lines, volume, weight,...). The needed throughput, available floor space and associated costs then define the most appropriate order picking system under the given circumstances.

INTRODUCTION

Order picking is the process of retrieving products from a predesignated storage medium for multiple customers (Choe and Sharp, 1991). Each customer order is characterized by a number of order lines and the amount needed per order line. The customers, in a manufacturing environment, are the different workstations across the factory floor. The design of an order picking area requires attention, as the order picking process is considered to be the most labour-intensive and costly activity (de Koster et al., 2007; Ten Hompel and Schmidt, 2005). Unfortunately there is little literature to be found concerning the overall design procedure of an order picking area. The literature that has been written focuses almost always on distribution warehouses (Baker et al., 2009; de Koster et al., 2007; Goetschalckx et al., 2001; Gu et al., 2007; Van Den Berg et al, 1999) and not on manufacturing environments and their specific needs. In manufacturing, there is a move to smaller lot-sizes, point-of-use delivery, order and product customisation, and cycle time reductions (de Koster et al., 2007). To allow this change, parts picking supermarkets are currently seen as the answer. In this paper we will present a method for the design of an order picking system in a manufacturing environment.

LITERATURE REVIEW

According to Dallari et al. (2008) most order picking systems are designed on the basis of insights, experience and, sometimes, on a detailed simulation. Most of the literature considers a specific order picking system in which they try to optimise some order picking policies like storage assignment, routing, batching and zoning. Yoon and Sharp (1996) were the first to consider the interdependent relationships among different functional areas in an order picking system.

According to Yoon and Sharp (1996) the general structure of an OPS consists of eight functional areas:

- receiving area
- pallet reserve area
- case pick area
- item pick area
- sorting area A and B
- unitizing area
- shipping area

Although the model presented by Yoon and Sharp is constructed for distribution warehouses, several of its characteristics can be implemented in manufacturing systems. The OPS design procedure developed by Yoon and Sharp is subdivided in three main phases:

- input stage
- selection stage
- evaluation stage

Dallari et al. (2008) added a fourth phase (detail stage) and made some adjustments in the previous stages but the principles remain the same.

There has been a lot of literature on order picking methods and operational policies. Figure 1 (de Koster et al., 2007) gives an overview of the different order-picking methods and distinguishes between order-picking methods executed by humans or by machines. In manufacturing environments the more limited scope (volume, number of parts etc.) as well as the more stringent cost controls make the automated methods rather the exception. Many of the parts-to-picker systems became the exception as well and it is an open question whether this has any factual base. This is an inspiring issue for this research.

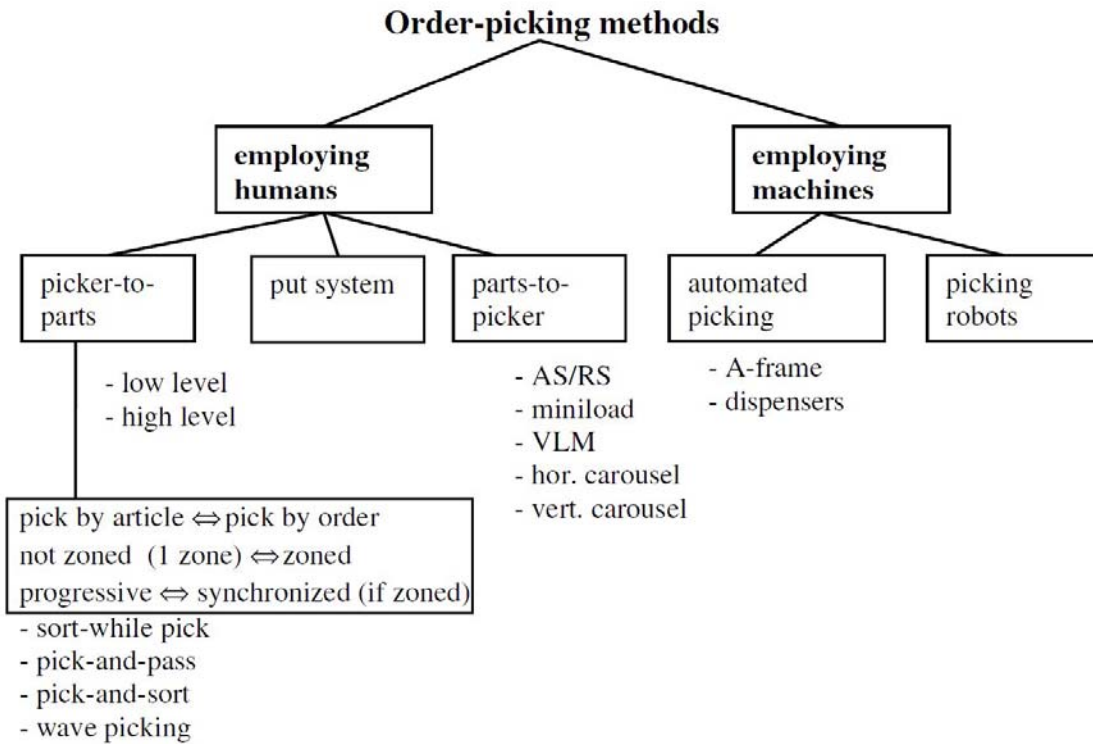


Figure 1: Classification of order-picking methods (de Koster et al., 2005)

DESCRIPTION OF THE DESIGN METHOD

The main goal of our method is to design an order picking system for a manufacturing environment. In our method we will only consider the design of the case/item pick area. Automated picking (picking by employing machines) will not be considered as it has little use in a manufacturing system: automated picking is mostly used for regular shaped boxes with high volumes (f.e. pharmaceutical

industry). In a manufacturing environment all parts need to be unpacked to allow assembly and thus handled in their net irregular shape. By using the method one can render the performance of the existing order-picking systems that employ humans.

In figure 2, a flowchart is given of the different steps in the method. In the following paragraphs this will be explained more clearly. The whole method has been implemented in Excel.

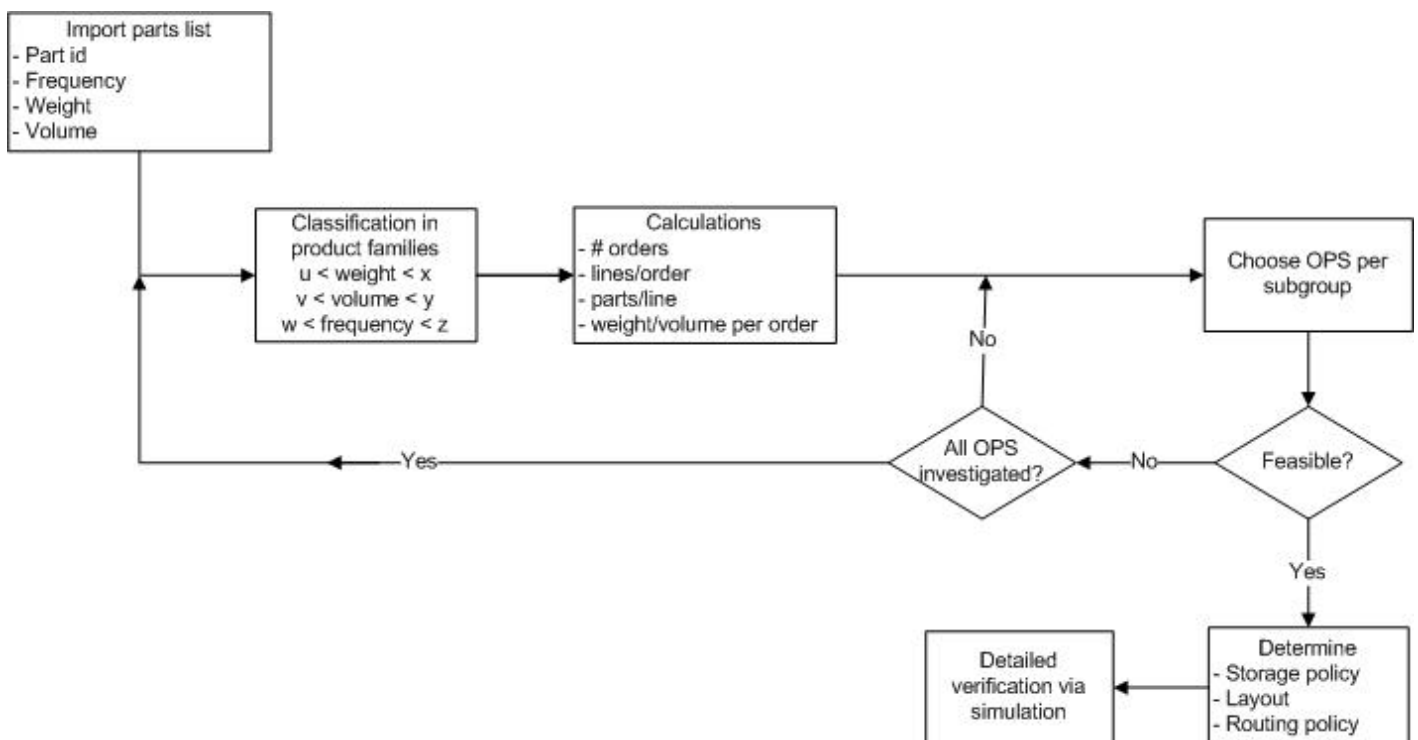


Figure 2: Flowchart of the OPS design method

Step 1: Input

The first step is to import a parts list. The following product parameters need to be known:

- Part-id
- Frequency
- Parts per product
- Weight
- Volume

A part-id is needed to identify unique Stock Keeping Unit's (SKU's) throughout the design procedure. With frequency we mean the percentage of finished products that contain this specific part. Parts per product is the amount of a specific part that is needed for the assembly of one product. The weight and volume of each individual part is needed to group parts in homogeneous product families. This classification can be extended with additional attributes (safety requirements, bulky parts indicators etc.) that enhance the classification process.

In our case study, situated in the automotive industry, some parts had to be handled differently because of safety regulations and sensitivity to damage.

Step 2: Classification

Due to the high amount and variety of parts, there are very different needs. There is a tremendous difference between how big parts are manipulated versus the handling of small parts. Also the weight plays an important role as parts with a certain weight cannot be handled without a hoist. Therefore we need product groups.

The classification structure implemented in the method makes it easy to group parts with common characteristics. Four classes have been introduced to classify the weight, ranging from heavy to light parts. Volume is also divided into four classes ranging from very big to small parts (nuts, bolts etc.). The ranges can be adjusted by the user and it is possible to add or remove classes. Frequency can be used to determine which parts are common, variant and rare. The limits must be set by the user. The user of the method can now select the range of parts one wants to investigate, taking into account the weight, volume and frequency.

In our case study, one of the weight cut-offs was set at 12kg, as this is a limit for manual handling. The volume restrictions were defined by the standard emballages the company was using (euro boxes, small boxes etc)

Step 3: Order specifications

Based on the classification made in step 2 and the order interval determined by the user, the following order characteristics per customer will be calculated:

- Maximum and average number of order lines/order
- Number of picks
- Volume per order
- Weight per order

A customer can be seen as a workstation or anything that orders parts for the assembly of a product.

In the automotive case study we defined a customer as a workstation in the same way they exist today at the assembly line. As an extension it is also possible to combine several workstation and treat them as one customer. In this way we can pick parts for several workstation at once.

Step 4: Choosing an Order Picking System (OPS)

There exist multiple order-picking systems. Picker-to-parts and parts-to-picker are the two major groups. The choice between a picker-to-parts or parts-to-picker OPS is very complex and depends on many factors. Major issues affecting the design of an order picking system are material properties, economic constraints, environmental constraints, system requirements, operating strategies and transaction data (Yoon and Sharp, 1996). The information obtained in step 3 and the product characteristics (weight, volume and frequency) will be used to identify a feasible OPS for each product family. If there is no feasible solution for a specific product family other options have to be considered (f.e. outsourcing in order to save space) or adjustments must be made in the classification step.

3.4.1 Picker-to-parts

We can distinguish between low- and high-level order picking. In high-level order picking high storage racks are employed. Parts are picked by using a lifting order-pick truck or crane. In low-level order-picking all parts are reachable from the floor level. For low level order picking several types of storage racks are reviewed:

- Shelve racks
- Shelve racks with floors
- Gravity racks
- Moveable racks

3.4.2 Parts-to-picker

For parts-to-picker order picking systems we consider the use of horizontal and vertical carousels, a vertical lift module (VLM) and an Automated Storage & Retrieval System (AS/RS).

R.D. Meller et al. (2006) developed a calculation tool for horizontal and vertical carousels and a VLM. In this method the same equipment parameters are used.

The information needed to calculate the results concerns capacity characteristics, operational characteristics, order info and costs. Table 1 gives an overview of the needed information for a horizontal carousel.

Table 1: Equipment parameters based on Meller (2006)

Horizontal Carousel	
# Shelves	2200
Shelves/bin	6
Shelf depth	0,6 m
Shelf width	0,6 m
Shelf height	0,45 m
Speed	30 m/min
Walking time btw units	2 sec
Start/Stop time	2 sec
Pick time	5 sec
Orders/batch	14
Lines/order	8
Items/line	5
Setup Time/batch	1 min
# Carousels/pod	4
# Pods (pickers)	1
Costs	
Price per carousel	€
Price per m ²	€

RESULTS

Based on the characteristics given by the suppliers of each order picking system, the following variables are calculated:

- throughput,
- required floor space
- associated costs

Based on these figures it is possible to determine for each product family what the most interesting order picking system is. This solution will be optimal only for the predefined product families. Several possible ranges of the classification parameters, resulting in different product families, will need to be investigated in order to achieve the overall optimal solution.

FUTURE RESEARCH

The method introduced in this paper is only a first step into the design of an order picking system in a manufacturing environment. The final goal of the research is to set up a classification diagram that can immediately tell you the optimal OPS for a certain range of parts. This range is defined by the weight, volume and frequency. In this way these diagrams can be of high value for the vast amount of companies that are currently designing their parts picking areas.

There is also research needed in the field of order picking systems and the parameters that influence the decisions.

After the selection of the order picking systems for all product families a next step can be implemented namely the analysis of what is the best storage and routing policy based on the chosen order picking systems and classifications. There is extensive literature on this subject.

As a next step in the method, an immersive 3D environment will be created, using standard building blocks in order to rapidly simulate and evaluate the designed order picking systems.

Validation of the method can be achieved by running the model with data from multiple manufacturing facilities and comparing their solutions with the calculated solution. By using these results we can further optimize the method.

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