Evaluation of Bucket brigades

- A next generation order picking strategy

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November 2007
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Order picking is one of the key elements of a warehouse and often more than half of the operating costs of a warehouse can be attributed to order picking. Bucket brigades constitutes a tool by which the order picking operations can be improved in many situations. In principle it is simple, yet it is very powerful. Testing Bucket brigades is easy and requires zero investment. This article explores the use of Bucket brigades in practice and covers when the method is useful, how it should be implemented and what the effects of using Bucket brigades are. Being relatively new and being based on research that has proven its triad of simplicity, efficiency and self-balance, Bucket brigades truly is a next generation order picking strategy.

This article is based on our master's thesis with the same title, conducted in the fall of 2007. The thesis was made in collaboration with Consafe Logistics.

Background

Bucket brigades is a way of organizing work so that the distribution of work in a system becomes self balancing. In its general form Bucket brigades are used for progressive assembly and order picking is one of its applications. Being self-adjusting a Bucket brigade system is free from or has minimized the occurrences of blocking and starvation. Similarly to the ideas of Eliyahu M. Goldratt[1], Bucket brigades realize the difference of individuals and use this to increase the total productivity of a system.

Method

The study was conducted through multiple case studies and a simulation. Descriptions of Bucket brigade implementations in USA were studied and visits including interviews were held at seven Nordic warehouses. A simulation model was created to evaluate the performance of Bucket brigades in a special situation called *pickomat cluster*. A *pickomat cluster* is a region of a warehouse with several pickomats[2] that require more than one fulltime worker to be handled. In the simulation the performance of Bucket brigade order picking was compared to zoned order picking in the environment of a pickomat cluster.

Description of Bucket brigades

In a Bucket brigade all work follows a certain circuit while being processed. Each worker processes his piece of work along the circuit moving towards the end. When the last picker in the system has finished a piece of work by reaching the end he walks back to the previous worker and takes over his piece of work. This worker in turn walks back to his predecessor to take over his work and so on. A series of handovers will propagate from the end of the circuit to the beginning of the circuit. When a worker takes over the first worker's work the first worker will go to the start of the circuit and start up a new piece of work. The workers in the circuit are sorted by their working pace so that each worker has a faster worker ahead of him. Consequently, the slowest worker will be positioned in the beginning of the circuit and the fastest will be positioned in the end of the circuit.

Bucket brigades in relation to other order picking methods

The following description and figures will explain how Bucket brigades relate to other order picking methods. The first part of picking an order is how to get an article from a storage location – retrieval. The second part is how to get all the articles of one order together – assembly. Bucket brigades is basically the same as zoned order picking with progressive assembly, but without static zone

[1] Goldratt & Cox (1992), *The Goal: A process of ongoing improvement.*

[2] Pickomats are automatic storage machines. Because of the time it takes a machine to retrieve an article, workers usually handle several machines simultaneously.

borders. If the conditions are right all order picking methods but wave picking can be replaced by Bucket brigades. Regarding wave picking, Bucket brigades would not retain the picking in parallel property. The same would also apply for picking with downstream sortation if it is designed to operate in parallel. Figure 1 below displays the retrieval methods used in order picking. Figure 2 displays the options available concerning order assembly and it includes an illustration of where Bucket brigades fit in and which other methods can be changed to Bucket brigade order picking.

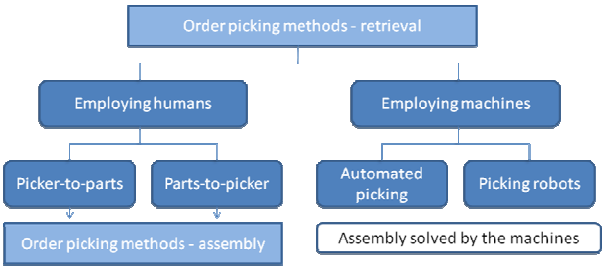

Figure 1: Order picking methods - retrieval

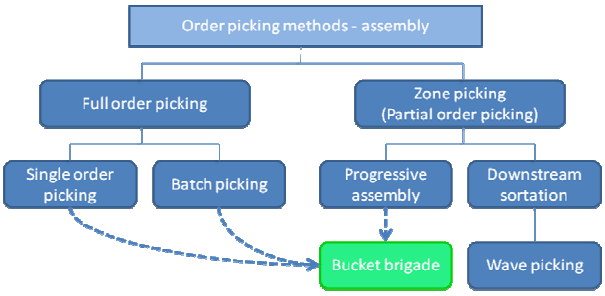

Figure 2: Order picking methods - assembly

The implementation of Bucket brigades at a Swedish warehouse

The concept of Bucket brigades proved promising enough that one of the warehouses that were visited during the study completed a trial of using Bucket brigades. The warehouse manager was very positive of the result and said that the new method worked “exceptionally well” for his warehouse. As of two months after the trial, they are using Bucket brigades permanently and have no thoughts of going back to their previously used order picking method. Productivity has increased and the employees prefer to work with Bucket brigade rather their previous way of working when individual workers picked all the articles of an order by themselves. Their experience of changing order picking method to Bucket brigades was that it was easy and worked well from the beginning.

Articles in the warehouse are small and densely stored, so the workers only walk short distances between picks. Picking is done to carts that are easy to hand over. The sorting of the workers based on their working pace was done by an experienced picker with a good view of the competence of the individual workers. The increase in productivity was confirmed by a productivity record being set closely after the implementation. In one hour there was 465 picks to one single cart in one hour, beating the old record of 380 picks for one person in one hour. It can be noted that while the old record was set by the fastest individual picker in the warehouse, the new record is accomplished by a joint team effort as all the workers on the line has picked to the record breaking cart.

Simulation results

A simulation model was used to determine the suitability of operating Bucket brigades in pickomat clusters. The simulation compared the performance of a zoned pickomat cluster to that of a Bucket brigade pickomat cluster. The results showed that it is possible to use Bucket brigades for order picking in pickomat clusters. Using Bucket brigades the performance of the pickomat cluster becomes more stable and predictable, the efficiency increases and the administration is simplified as the system becomes self-balancing. For the Bucket brigade to work well, the number of pickomats per worker must not be too low. With two machines or less per picker the zoned system performed better than the Bucket brigade in the simulations. As Bucket brigades rely on pickomats being handed over, there must be pickomats to hand over. However, situations with less than two machines per picker are very uncommon as workers in such situations would be utilized poorly regardless of order picking method. Figure 3 shows the efficiency of zoned order picking compared to Bucket brigade order picking in several situations. Range is a value used to configure the differences in speed between the pickers. With range 2 the fastest picker is twice as fast as the slowest. Whenever the bar is below 100% the Bucket brigade system is more efficient than the zoned system.

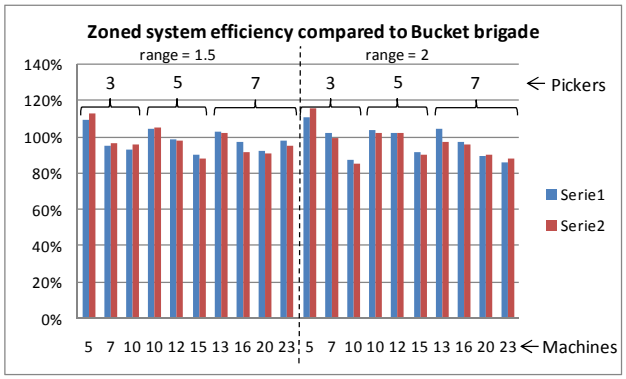

Figure 3: Comparison of Bucket brigade and zoned system performance

When Bucket brigades are useful

Bucket brigades offer certain benefits, as described below. To consider using Bucket brigades, one or several of these benefits must be valuable to the warehouse in question. For Bucket brigades to be successful it is crucial that handovers can be done quickly. It is also important that the majority of the workers' time is spent on picking items and not on transportation as implementing Bucket brigades often increases the distance traveled by the workers. An even picking frequency along the entire line is also desirable to avoid workers blocking each other. Whether a warehouse uses fixed or random storage locations do not influence the potential of Bucket brigades to any major extent. If Bucket brigades are to be used, a set circuit through the warehouse must be established that all batches follow when they are being picked.

Bucket brigades are not suitable if any form of truck is involved in the order picking. In situations with pick-to-belt it is very likely that Bucket brigades can be useful as blockings is a major problem in pick-to-belt due to workers not being able to pass each other. When picking is done to carts Bucket brigades can often be useful. In this case the success of Bucket brigades depends heavily on the picking frequency being relatively high in all parts of the warehouse so the workers follow the same circuit for each batch they pick. As indicated by the results of our simulation, some pickomat clusters can also benefit from using Bucket brigades.

Besides being useful in existing warehouses, considering Bucket brigades can be very fruitful while designing new warehouses. Bucket brigades might make new designs possible, such as designs that in theory are very effective but without Bucket brigades would suffer from massive congestions in practice. For example flow rack areas with high pick densities or fast pick areas.

How Bucket brigades should be used

Some of the most important factors in a successful implementation of Bucket brigades are to ensure quick handovers, to create an even distribution of picks along the picking circuit, to batch as many orders as possible and to considerately handle the issue of sorting the pickers according to their working pace. It is better to create one long coherent Bucket brigade instead of several sequential shorter lines. Furthermore it is good to use workers with high differences in working pace in the Bucket brigades line and if huge batches exist, smaller batches should be allowed to pass the huge batches. If there are a lot of orders with picks only in a limited part of the picking circuit it can be useful to allow workers to start and finish batches at other locations than the beginning and end of the circuit.

The effects of using Bucket brigades

The most important benefit of using Bucket brigades is an increase in picking efficiency, which is based on two things. The first reason is that Bucket brigades are self-balancing and will reduce blocking. The second reason is that operating under Bucket brigades workers will spur each other to become more effective and less time tends to be spent on unproductive activities. Maximum picking capacity is also increased by Bucket brigades being able to assign more workers to an area than other order picking methods, without causing severe congestions. This is valuable as the evolution of modern concepts such as just-in-time, cycle-time reduction and quick response is making it increasingly harder to manage the order picking activities. Flexibility is improved compared to zone picking as it is easy to add or remove workers from a Bucket brigade line and there is no administrative burden of balancing the workload along the line. New workers can become productive more quickly as they will initially operate in a limited region of the warehouse that they will learn well. The behavior of Bucket brigade systems is smooth and predictable and work in progress is minimal.

Drawbacks of Bucket brigades are that workers can find Bucket brigades more monotonous than other order picking methods and that there is a risk of upsetting the slowest workers as their slow working pace is highlighted by them being placed in the beginning of the circuit.