Implementation of continuous mixing

- At Culinar AB

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This article is an extract of our master thesis in Engineering Logistics at Lund Institute of Technology. The thesis is written on behalf of Culinar AB, a subsidiary of Lyckeby Stärkelsen AB. The intention with the thesis is to chart the flow of in-house production in order to find problems and suggest feasible improvements. The focus of this article is within the production of instant mashed potatoes.

1 Introduction

Lyckeby Stärkelsen is a producer of starch based products and bi-products with an annual turnover of more than 1 billion SEK\(^1\). The company is owned collectively by close to a thousand potato farmers in southern Sweden. Culinar is a subsidiary specializing in mixes and spices with solutions for every taste.

Culinar has over the past few years substantially increased its output due to higher sales. The production capacity has been improved by investment made in more blenders and growth has, almost solely, been within existing facilities. Culinar's production facility in Fjällinge, Sweden is today a crowded place. In order to cope with the increasing demands the firm is forced to use both external and temporary storage. The growth within existing facilities is likely to be responsible for non-optimal production flows and inefficient production. Especially the operation of weighing ingredients is suspected to be functioning less than optimal.

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2 Method

Initially we investigated the facilities in-house production flow. To chart the flow we used flow diagrams, arranged by Japanese industrial standard JIZ 8206\(^2\). Some minor adjustments to the standard were made due to specific needs induced by the facility. Most notably was the addition of a symbol for transportation with lifting, a consequence of production at many levels (four including ground level). An arrow was used for transportation as recommended by American standard ASME 101.

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1 Lyckeby Stärkelsen Årsredovisning 2002, s. 5
2 Ishiwata (1991)
Next step in our study was a close examination of the company’s products. We used Product Profiling, a tool for examining the relations between the company’s market, its products and the means of production. With the help of this tool we arranged the products in two groups of products, determined by production volume and frequency. These groups differed not only in volume and frequency but it could also be shown that they required different production processes. A detailed study showed that the production of the different variances of instant mashed potatoes differed enough in size and frequency to form a group of its own. It was by far the largest group of articles (more than 12 % of the total factory output) and consisted of only a few variances, each sufficiently large to be one of the companies 15 largest articles by itself. A closer look at Instant mashed potatoes reveals that it is produced in two steps, first the mixing of a pre-mix in exact sizes (23.6 kg) containing the individual flavour and later the mixing of 1/10th pre-mixing and 9/10th potato granules. The latter step is the same for all variances of instant mashed potatoes.

The theoretical framework of Focused plants, and especially the concept of plant within a plant made up the base for our further studies. Focused plants means a production dedicated to a certain product or group of products. Our design was to divide the factory in two specialised flows. One dedicated to a flexible flow with small batches and volumes, suited for the group of products with these characteristics. The other a highly automated production line, dedicated to a group of products with large production volumes, large batches and few variations in production processes. In essence this means the construction of a dedicated line for instant mashed potatoes.

3 Theory

Mixing of solids is a more complicated process than it may seem at a first glance. Industrial mixing is a thoroughly studied and complex process. An academic definition follows:

*The term mixing is applied to operations which tend to reduce the nonuniformities or gradients in composition, properties, or temperature of material in bulk. Such mixing is accomplished by movement of material between various parts of the whole mass*.

Normally the aim with mixing is to create a homogenous blend of different ingredients. The mixing of solids is usually divided into two mechanisms:

1. Convection is defined as the movement of larger groups and aggregations of particles and occurs with mixing by blades, screws or similar devices.
2. Diffusion is the random movement of sole particles. When mixing gases and liquids this is equal to Brownian motion but in the case of solids external energy is required.

The two mechanisms normally occur parallel when mixing solids. It can be seen as macro- and micro mixing. Mixing of solids always generates a randomly arranged blend, even if mixed for extremely long times. Optimal mixing time is effected by the particles size, size distribution, density, the nature of particles surface and the mixing process.

Two general mixing processes can be identified, continuous and discontinuous (batch) mixing. Batch mixing is characterised by sequential loading, mixing and unloading. The blender is loaded with ingredients then mixed for a specific amount of time and then unloaded. Batch mixing is flexible, relatively cheap and is best suited for small batches. Continuous mixing generates a steady output and is constantly loaded with ingredients. Loading, mixing and unloading is parallel. Continuous mixing is has longer set up times than batch mixing and combined with specialised loading makes it less flexible. But when the continuous mixer is up and running it is generating much more output. Another advantage compared with batch mixing is that even

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3 Hill (2000)

4 Weinekötte & Gericke (2000)
highly productive continuous mixers can be made compact and small.

4 Analysis

The idea of separating the existing flow into a general, flexible flow and a specialised flow for mashed potatoes resulted in two optimal solutions based on the charted flow. Optimal solutions were constructed without the restriction of budgets or the limitations set by the existing facility. The reason for this was to let our creativity flow free and encourage “out-of-the-box”-thinking. This approach generated numerous ideas, most noteworthy the implementation of continuous mixing of instant mashed potatoes.

The individual flavouring of mashed potatoes, the pre-mixing, is not suited for continuous mixing due to the many ingredients. However it is ideal for the general, flexible flow. The second step involving only two ingredients, pre-mixing and potato granules, is well-matched for continuous mixing. With the support of potato granules in silo the improvements made can be substantial.

Implementation of the proposal above would make mixing cell 1, today dedicated to instant mashed potatoes, available for production of other articles. The change of mixing process would eliminate storage of 2-3 days due to batch mixing blending air into the mix. Overall steps in production would be reduced, mainly less transports are needed, but also fewer visits in storage. The change of process will generate a continuous flow directly to packing eliminating transportation and increasing productivity. Pre-mixing can be unloaded in bigger bags and exact weighing is eliminated. More importantly it reduces overall handling of more than 10% of total weight passing through production. Furthermore it would reduce the need for storage by same amount of space today occupied by potato granule, approximately 10% of total storage.

5 Conclusions

The implementation of continuous mixing of instant mashed potatoes looks promising indeed. With the support of potato granules in silo the improvements possible are substantial. The prospect of reducing storage with more than ten percent within a crowded facility combined with increasing capacity within the existing facility is probably tempting. However, the proposed improvements are made from a theoretical point of view and the business side of the investment has not been studied. Nonetheless, it is our firm belief that the implementation of a continuous mixing process would be an interesting proposal for Lyckeby Culinar AB to investigate further.

References

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Lyckeby Stärkelsen Årsredovisning 2002

Weinekötter, R. & Gericke, H., 2000, Mixing of solids, Dordrecht