Boosting the bottom line by improving your material handling ergonomics — Part I

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Ergonomics concerns the fit between people, the tasks they perform, and the environments they work in. In dry bulk material handling, ergonomics is about selecting and arranging material handling machines and related equipment so that workers can safely and efficiently interact with it. In this two-part article, an engineer who plans, designs, and manages plant expansions explains how improving material handling ergonomics can be a tool for boosting your plant’s bottom line. Better ergonomics can reduce injury risks to workers, cut labor costs, reduce ingredient waste, and improve product quality. This article details these benefits by following one bulk solids manufacturing plant’s quest to improve its ingredient handling line ergonomics. Part I covers the plant’s original handling line and its problems; Part II (October) describes how the handling line was redesigned.

A plant’s material handling lines are prime candidates for ergonomic improvements. As material handling operators move and empty heavy containers, handle and stack filled packages, and interact with a host of different machines, they twist, bend, reach, push, and pull. They assume awkward postures, perform repetitive motions for hours at a time, and experience cold temperatures, vibration effects, and other stresses that can lead to back injuries and other musculoskeletal disorders. By redesigning your material handling line’s ergonomics so that operators’ tasks better match their physical capacities, you can minimize such injury risks.

But alleviating ergonomic problems does much more than prevent injuries. Better ergonomics in your handling line can also increase your company’s profits by cutting high labor costs, minimizing slow and messy manual material handling, reducing material waste, and reducing manual batching errors that lead to poor product quality.

The following information details the case of a food products manufacturer that worked with an engineering firm to redesign its inefficient dry bulk ingredient handling line. The plans for the redesigned line proposed by the engineering firm included multiple ergonomic improvements that could reduce the plant’s operating costs.

Original ingredient handling line

In its dry ingredient handling line, the food manufacturer uses many ingredients in different proportions to formulate dry batches of multiple ingredients for dry and liquid final products. Each dry ingredient in a batch is proportioned according to a given product recipe, and the batch is blended before it’s moved to a subsequent production step. (For instance, a batch for a dry food product is simply sent to a packaging area where the batch is packaged in pouches; a batch for a liquid food product is transferred to another mixer to be blended with a liquid before being bottled.)

The dry ingredients include large volumes of salt and sugar (the major ingredients) and over 100 other food-grade bulk powders (the minor and micro ingredients). The breakdown of these dry ingredients by category in terms of annual usage and number of ingredients is shown in Table I. (The table lists two groups of minor ingredients based on differences in annual usage.)

Trucks deliver the major, minor, and micro ingredients to the plant in individual 50-pound bags, various-sized cartons, and drums, or in pallet loads of these containers, depending on the quantity required. Warehouse operators move all ingredient containers by forklift to a warehouse for storage. Based on food product recipe orders, the operators assemble various ingredient containers for delivery to the plant’s dry blending room, either manually or with a forklift.
The dry blending room is 50 feet wide, 50 feet long, and 25 feet high with a 20-by-50-foot mezzanine. As shown in Figure 1, two mixers for blending ingredients are mounted on the mezzanine, and each mixer has two operators: one on the floor and one on the mezzanine. The ingredient containers are moved manually or by forklift to staging areas on the floor and mezzanine.

To add ingredients for a product recipe into a mixer, the mixer’s floor operator selects the ingredients from the floor staging area, manually opens and weighs each ingredient from its bag, carton, or drum according to the recipe proportions, and feeds the ingredient to a bucket elevator that lifts the ingredient to the mezzanine for dumping into the mixer. The mixer’s mezzanine operator simultaneously dumps the ingredients from that staging area directly into the mixer. The operators for the second mixer follow the same procedure.

Once each mixer has blended the dry ingredients, the batch is discharged into a rigid intermediate bulk container for delivery by forklift to the next production step.

**Problems with the line**

Handling the dry ingredients is a complex, inefficient process that wastes material. Operators move and open multiple containers of different types and scoop out or empty ingredients from them at both the floor and mezzanine levels. The process requires two operators per mixer, one on each level, and the tasks they perform put them at risk for back injuries and other musculoskeletal disorders. The need for four operators has resulted in high labor costs, and the mixers remain idle during the lengthy manual batching process, slowing production. Some ingredient residue remains inside the discarded containers, creating waste; the empty containers must be discarded; and excessive housekeeping is required to clean up dust and spills.

<table>
<thead>
<tr>
<th>Dry ingredient category</th>
<th>Annual usage (pounds)</th>
<th>Number of ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>&gt;500,000</td>
<td>2</td>
</tr>
<tr>
<td>Minor¹</td>
<td>500,000 to 250,000</td>
<td>5</td>
</tr>
<tr>
<td>Minor II</td>
<td>250,000 to 50,000</td>
<td>8</td>
</tr>
<tr>
<td>Micro</td>
<td>&lt;50,000</td>
<td>±100</td>
</tr>
</tbody>
</table>

¹Note: Minor ingredients are subdivided according to annual usage.
Getting engineering help

The plant owner decided that eliminating or minimizing the dry ingredient handling line’s problems would require overhauling the line. For help in developing a workable solution, the owner approached a firm that provides engineering services for manufacturing plants.

First, the plant owner explained the plant’s needs:

- To simplify dry ingredient handling.
- To eliminate risks of musculoskeletal disorders in operators.
- To minimize ingredient waste.
- To improve operating efficiencies.
- To reduce operating costs.

Based on this list, the engineering firm proposed doing a feasibility engineering study. As shown in Figure 2, this study is the first phase of a process that has four engineering phases: feasibility, preliminary, design, and implementation. The feasibility engineering study for this project would include four steps: setting project goals, collecting data about the existing ingredient handling line and subsequent production steps to understand the plant’s needs, an-
alyzing opportunities (including available equipment and layout options) for configuring a new ingredient handling line, and developing a conceptual master plan for the new ingredient handling line.

Next month: Part II describes how the handling line was redesigned.

For further reading

For more information on recognition and control of ergonomics in industrial plants and work-related musculoskeletal disorders, see the US Department of Labor’s Occupational Safety and Health Administration Web site at www.osha-slc.gov/SLTC/ergonomics.

Find more information on designing handling systems and batching operations in articles listed under “System or equipment design, fabrication” and “Weighing and batching” in Powder and Bulk Engineering’s comprehensive “Index to articles” (in the December 2001 issue and at www.powderbulk.com).

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