

Decisions, decisions: Automated versus manual batching

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Should you replace your hand scoops with feeders? Deciding whether to switch from manual to automated batching can be difficult. Typical batch sizes can range from grams to tons, and each batch can involve hundreds of ingredients. Ingredients can be delivered to your plant in bags, bulk bags, drums, rigid intermediate bulk containers, trucks, and other containers and can be transported to your batching station by hand, pneumatic conveying, or mechanical conveying. Rather than tell you that automated batching is better than manual, this article outlines a step-by-step approach to helping you decide whether automated batching is really the better choice for your plant.

Making up a batch by hand looks messy and labor-intensive — and it is. Typically, workers scoop ingredients by hand into a container placed on a bench scale. Some material spills as it's dropped into the container. When the workers change ingredients, they fold over the tops of partially emptied bags and take them back to their storage rack.

Even though this method of batching has been practiced for years, it's not pretty to watch — especially if you want to impress customers with your concern for product quality. Besides looking messy, manual batching can lead to cross-contamination between batches and can produce inaccurate batches — even missed ingredients.

In many plants, this labor-intensive mess drives management to mandate a switch to automated batching. That is, they decide to replace those hand scoops with feeders, use feeder hoppers rather than partially filled bags, and automate the ingredient addition to get better accuracy per ingredient and verify that all ingredients are included in the batch.

While this sounds simple enough, for every 10 plants that look into automating their batching process, only 1 makes the switch. Even then, the plant may automate the addition of only a few ingredients — the majors — creating only a partially automated batching operation.

What is it that makes the decision to switch from manual to automated batching so difficult? The answer is not one, but many factors, including the complexity of an automated batching system, its high capital cost, the concern that the batching accuracy or reliability won't be appreciably better ("the devil you know" syndrome), and the likelihood that labor costs won't be reduced as much as expected.

Evaluating the options step-by-step

This article can help you decide whether automated batching is right for your plant by helping you analyze each of your operation's obstacles to making the switch. The information here isn't intended to provide the final answer — rather, it can help you evaluate all the factors in this decision. The approach is presented in the form of questions you need to ask when assessing an automated batching system's benefit to your operation.

Some questions are interrelated, so be aware that while your answer to one question may indicate that one method is best, your answer to another question can eliminate that method from consideration. Included under each question

is an explanation of what you need to consider in answering the question. Some explanations also include tips for making a decision.

1 What are my ingredients and how are they received at my plant?

To answer this question:

- Identify your ingredients.
- Consider that you'll probably add a few more ingredients in the future, because your batch recipes and the ingredients are likely to change.
- Identify any toxic ingredients.
- Identify any ingredients whose dust can create an explosive air-dust mixture.
- Explore any benefits — particularly cost savings — to changing the packages you currently receive ingredients in to other small or semibulk packages (such as small bags, bulk bags, or rigid intermediate bulk containers) or to receiving them in bulk (such as in truck or railcar loads).
- Prepare a table listing all your ingredients and the packages or containers they currently arrive in at your plant.

Tip: If your ingredient supply is switched from small bags or other containers to semibulk or bulk containers, using an automated batching system can be more practical.

2 How much ingredient storage do I need?

To answer this question:

- Review your current ingredient usage rates, the availability of the ingredients from your supplier (for example, whether the supplier can deliver them daily or weekly or only monthly or bimonthly), the ingredients' shelf life, your plant's available storage space, and your company's policy on storing ingredient inventories rather than ordering ingredients on a just-in-time basis.
- Consider how variations in your monthly production rate can affect your storage requirements for certain ingredients.

Tip: Switching from manual to automated batching may change your storage space layout because more of the ingredients are stored in bulk containers and bulk storage vessels.

3 Where will my ingredients be stored?

To answer this question:

- Consider that ingredients are normally stored both in a storage location and at the "use" location (the batching station).
- Determine how your ingredients will be stored — whether in the packages they arrive in or other storage containers, such as in-plant containers. In-plant containers can be of various types and sizes to accommodate the quantity of an ingredient required for a particular recipe.

Tips: In manual batching, other than moving the ingredient's receiving package to the batching station, there's little ingredient handling. A worker simply scoops a portion out of the package for the batch.

In automated batching, the amount of ingredient handling is greater, which can deter some users from switching to this method. Each ingredient must be transferred from the receiving package, perhaps into an in-plant container, and then into a feeder hopper. Each of these steps is typically manual. This often adds labor costs and requires additional operations — such as elevating the package for complete dumping and collecting dust — not always required by hand-scooping. After batching, transferring the ingredients back to storage can require several more steps: emptying the ingredient from the feeder, placing the ingredient in an in-plant container or back into the receiving package, moving the container or package to storage, and cleaning the feeder. (Find more information on cleaning feeders under question 8.)

You can reduce ingredient handling in automated batching by limiting each ingredient's containers to two — the receiving package and feeder hopper.



The weighed receptacle on this gain-in-weight feeder tilts to dispense a minor ingredient to a batch in an automated batching system.

For a major ingredient received in a *bulk bag* (or other *semibulk container*), transport the bulk bag to and from the bulk bag discharger (or other unloading station) at the feeder's location. Use the discharger to empty the bulk bag directly into the feeder hopper. If possible, dedicate each semibulk ingredient to one feeder to reduce cleaning requirements. Install many dust collection pickups at container opening points.

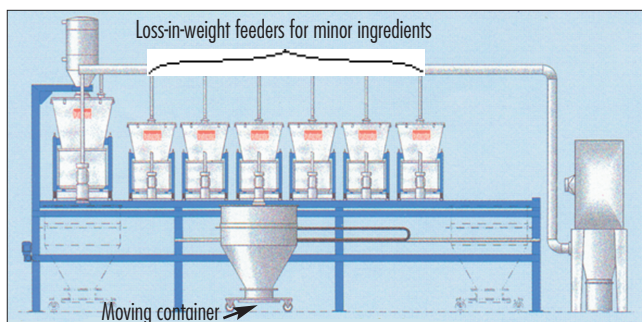
For a minor ingredient received in a *small package* (such as a *small bag, box, or drum*), limiting ingredient transfers isn't as easy, which can complicate the switch to automated batching. This is because you may have 30, 40, or 100 minor ingredients, even though only 5 to 10 are used in any one batch recipe. Obviously, it would be impractical to have a separate feeder for each minor ingredient. However, you can keep the batch station small by limiting the number of feeders to the greatest number of ingredients in any one batch recipe. But you'll still have to store the additional minor ingredients and clean the feeders between recipes, increasing your labor requirements. (Also see information under question 8 for an efficient way to handle multiple ingredients in automated batching.)

4 How will I transfer ingredients from storage to feeder hoppers to minimize ingredient handling in automated batching?

Consider how you'll transfer ingredients received in semibulk containers and small packages.

Tips: For major ingredients in *semibulk containers*, as detailed under question 3, move the containers to the stationary feeder for unloading.

For minor ingredients in *small packages*, when you have 10 or fewer ingredients and each feeder can be dedicated to one ingredient for a long period (see more information under question 8), you can probably move the small pack-



In this automated batching system, loss-in-weight feeders dispense minor ingredients into a moving container.

ages to the feeder and empty them directly into the feeder hopper. (Again, with a greater number of ingredients, this won't be possible, and the process will be less efficient. You can provide some automation, however, by feeding the most-often-used ingredients with feeders and adding the rest by hand.) You'll need to work out a procedure for carefully handling the empty packages to reduce dusting and batch contamination.

5 How will automated batching handle the maximum and minimum batch weights for each of my ingredients and the time my production rate allows to dispense the finished batch?

To answer this question:

- List each ingredient's batch weight.
- Determine the time available to dispense the batch based on how many finished batches your production rate requires per unit of time (such as 10 batches per hour).
- If you dispense finished batches directly into the process vessel (such as a mixer), then you may be able to dispense each batch into the vessel over the full time allowed for making a batch. This is because you don't have to allow extra time for discharging the batch to another container or conveyor first before it enters the process vessel.

Switching from manual to automated batching may change your storage space layout.

6 What feed method will reliably feed my ingredients?

To answer this question, consider these facts:

- Not all ingredients are free-flowing powders. Some are sticky or floodable powders. Others are fibers, flakes, granules, or large chunks.
- A scoop, as used in manual batching, can handle almost any ingredient type.
- A volumetric or gravimetric feeder in an automated

Where to find batching basics

You'll need a solid grasp of batching basics to help you decide whether to switch from manual to automated batching. Though providing such information is beyond this article's scope, you can find batching information in the following resources:

"Batching of dry ingredients," Terry Fahlenbock, *Proceedings of*

the Powder & Bulk Solids Conference, June 1990, Cahners Exposition Group (copies are also available from the author).

These *Powder and Bulk Engineering* articles also include batching information:

- "Automation to the rescue: Accurately batching minor ingredients in bags," Steve Cunningham, May 1998.
- "Delivering better feeding accuracy with loss-in-weight bulk batching," Terry Fahlenbock, December 1995.
- "Improving batch weighing accuracy with statistical process control," Richard K. Peelle, September 1992.

• "Microingredient batching systems: Matching the automation level to your needs," Jerry Kramer, September 1993.

• "Selecting an automated system for weighing minor ingredients," Carl E. Anderson, September 1990.

• "Using an automated batching system to improve product quality, operating efficiency, and inventory management," James W. White, September 1991.

Also find information on feeder selection in articles listed under "Feeders" in *Powder and Bulk Engineering's* comprehensive "Index to articles" (in the December 1999 issue and at www.powderbulk.com).
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batching system that can handle one ingredient type — such as a free-flowing powder — probably won't be able to handle another type — such as flakes.

- The feeder supplier should test any ingredient with unknown flow properties to determine which type of feeder can handle it. [*Editor's note:* For information on how to select feeders, see the above sidebar, "Where to find batching basics."]

7 Which of my ingredients should be added by hand and which by a feeder?

To help you decide, keep an open mind about the degree of automation that's right for your batching operation.

- As a start, select the major ingredients that are used in most batch recipes and that can be received in semibulk containers or in bulk for adding by feeder, because automating their feeding can save money. Keep in mind, however, that the feeders will consume floor space and headroom and must be easy to access, especially when ingredients from semibulk containers will be loaded into them.

- Next, consider your frequently used minor ingredients, which are received in small packages such as bags and drums. If you want to use feeders for these ingredients, develop a feeder hopper filling method that reduces ingredient spillage and batch contamination.

- Hand-scooping your infrequently used minor ingredients is probably best. Consider how you will add these to the rest of the batch, such as by scooping them directly into the batch receptacle (the weighed container that is part of the system's scale) or the process vessel. You may be able to retain some of your existing manual system for these hand adds.

8 What's involved in switching from one ingredient to another in automated batching?

Changing ingredients is a tedious process in automated batching. If your floor space is limited or you have too many ingredients to dedicate one feeder to each, you'll need to empty and clean each feeder before loading a new ingredient into it. You'll also probably want to save the removed ingredient and put it into storage while protecting it from contamination. Feeders tend to be close together too, making them hard to access for emptying and cleaning.

Tips: When you need many ingredients to make your range of batch recipes, but each recipe uses only a few ingredients, you can design the automated batching system with a few feeders for each recipe. These feeders can be mounted on loss-in-weight scales or can feed ingredients into one (or more) gain-in-weight hopper (a container on a scale).

Consider dedicating each feeder to a different ingredient and making all the feeders portable so they can be easily emptied and cleaned. You can do this by placing each on a portable cart or placing all the feeders in a row on a low-elevation roller conveyor that moves the feeders to a central loading location. For example, when you use dedicated portable feeders mounted on a roller conveyor for minor ingredients, each minor ingredient is emptied from a small bag or package into the hopper of one dedicated portable feeder that has been moved to the central loading location. Any feeder that contains an ingredient that has been only partially dispensed is moved back to storage by the conveyor. Quick-disconnect electrical and pneumatic connections maintain each feeder's sealed inlet and outlet. The conveyor needs to be low enough so workers don't have to lift the feeders, and the feeder hoppers must be small enough to make the feeders easily portable.

Manual batching is typically based on gain-in-weight weighing, but automated batching can use either that method or loss-in-weight.

9 How will I transfer my finished batch to the next process stage?

If your finished batch will be pneumatically or mechanically conveyed to a process or packaging station, make sure the entire batch reaches the destination. Any loss can affect batching accuracy, whether you use manual or automated batching. You'll need to discard or rework a batch that's compromised during transfer. With automated batching, make sure the system design accommodates equipment for handling this.

10 How will my finished batches be dispensed or packaged?

Each finished batch — whether or not it contains any ingredients added by hand — eventually must be dispensed from the batch receptacle to a process. This can happen either immediately after batching, or the finished batch can

be packaged for later dispensing to a process, perhaps at another location.

- If you need to dispense the batch immediately to your process, you can design the manual or automated batching system to dispense the batch directly to the process in one of two ways: by feeding each ingredient one at a time to the process or by dispensing a finished batch as a whole to the process.
- If you need to package the batch for future use, design the batching system to place each batch into a package that can be sealed.

11 How can I measure an automated batching system's accuracy?

The system's batching accuracy is based on several factors:

- The system's scale capacity — that is, the maximum load the scale can weigh, including the dead load (typically the empty batching receptacle's weight) if this load isn't mechanically counterbalanced.
- The system's scale sensitivity — that is, the smallest weight the scale can accurately sense. This is determined by adding known weights to and subtracting them from the scale while observing the scale readout and thus determining the smallest weight increment that can be added or subtracted over the scale's full range to always produce a correct readout. The scale sensitivity is given as a ratio of this weight increment to the scale's full range. The scale sensitivity can be affected by your installation conditions, such as vibration transmitted from other equipment through the plant floor, impacts from forklifts and other moving items, and air currents.
- The feeders' ability to stop flow when the batch is completed (or the control system's allowance for a free-falling ingredient after feeding is cut off).
- The loss of any portion of the batch during transfer to a subsequent process stage.

Tip: The typical effects of installation conditions and the feeders' ability to stop flow when the batch is completed result in an overall weightment accuracy of ± 1.5 multiplied by the scale's capacity multiplied by the scale's sensitivity. This provides a safety factor for determining the automated system's achievable batching accuracy.

Here's an example:

Scale capacity	= 300 pounds
Scale sensitivity	= $\frac{1}{5,000}$
Expected batch accuracy	= $\pm 1.5 \times 300 \times \frac{1}{5,000}$ = ± 0.09 pounds

So, if your batch size is 80 pounds and your desired accuracy is ± 0.5 percent, the automated system's batching accuracy (in weight units) is ± 0.4 pounds (that is, $\pm 80 \times 0.005$). You can conclude from this that the system can meet your desired batching accuracy and that the smallest batch size you can achieve within ± 0.5 percent accuracy is 18 pounds ($^{0.09}_{0.005}$).

12 Which weighing method is best for automated batching — loss-in-weight or gain-in-weight?

Manual batching is typically based on gain-in-weight weighing, but automated batching can use either that method or loss-in-weight. To choose a method, consider your batch sizes, required batch accuracy, batch timing, available headroom, order of ingredient addition (also called *sequencing requirements*), and other factors. [**Editor's note:** For more information on gain- and loss-in-weight batching, refer to the paper "Batching of dry ingredients" and other articles listed in the sidebar, "Where to find batching basics."]

Recognize that some ingredient spillage is inevitable, and design the batching system to minimize it.

13 How can I contain dust in automated batching?

Dust control in many manual batching operations is less than adequate because the batching receptacle and packages aren't enclosed, making dust containment more difficult. While scooping the ingredients typically creates little dust, the amount of dust raised when a worker opens and handles the packages often depends on the degree of care the worker uses during these steps. Dust is also released when the batch is dispensed to the next process

stage, and the half-empty ingredient packages kept around the manual batching station are dusty as well.

In automated batching, much dust is generated when ingredient packages are emptied into feeder hoppers because the ingredients are dumped rather than scooped and displace a lot of air. While this requires more dust control than in manual batching, dust control in automated batching can be easier because you can use a commercially available unloading station equipped with vacuum dust collection to contain dust when you empty small bags, drums, and bulk bags into the feeder hoppers. You can also improve dust control by transferring ingredients as few times as possible; in fact, as discussed under question 4, transferring an ingredient once — from the package to the feeder hopper — is ideal.

Dust in automated batching can also be released when an ingredient falls from a feeder into the automated system's batch receptacle and displaces the air in it. You can enclose the feed stream to contain this dust. But if the batch receptacle is moved from feeder to feeder during batching, the receptacle requires a movable seal at the inlet for attaching to each feeder. In this case, installing a vacuum dust pickup at the receptacle inlet may work better than an enclosed feed stream. To reduce dusting, also minimize the distance from each feeder outlet to the batch receptacle.

Control dust when the batch is dispensed by enclosing the batch receptacle's discharge or minimizing the distance between the discharge and the next process equipment. Use vacuum dust collection at the discharge to capture fugitive dust.

14 How can I prevent cross-contamination?

Cross-contamination in manual batching can occur when the wrong ingredient is added to a batch or dust and spillage contaminate the finished batch. In automated batching, the same problems can occur. Containing the dust, as discussed under question 13, is the first step in eliminating cross-contamination for manual and automated batching. Also recognize that some ingredient spillage is inevitable, and design the batching system to minimize it.

In an automated system, consider every location where ingredients can spill, reduce the risk of spills at those spots (for example, by ensuring that feeder hoppers are low enough to load easily), and reduce adverse consequences of spills (for example, by ensuring that there are no nooks or crannies to collect spilled material and that spilled material can't fall into the batch receptacle).

15

What should I expect an automated batching control system to do?

The control system should be able to:

- Control simultaneous batching (adding all ingredients at once, which loss-in-weight weighing allows) or sequential batching (adding each ingredient in sequence, which gain-in-weight weighing requires).
- Provide adequate scale sensitivity for minor ingredients.
- Store and download batch recipes.
- Initiate, pause, and abort batches.
- Refill feeder hoppers.
- Control batching feedrates with fast, dribble, in-flight compensation, and jogging functions.
- Record batch weights.

- Print out batch data.
- Provide control at the batching station and from a remote location.

Making the decision

As you consider switching to automated batching, use your answers to the questions here to document your decision process. Your answers will describe both your current manual operation and the proposed automated system, including the benefits you expect the automated system to provide. Not only will this documentation make your decision easier, it will also provide the background information that automated batching system suppliers need to prepare a detailed system cost proposal for you. Plan to give this information to two or three suppliers so you can compare a range of proposals.

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