



Simio December
2018 Student
Competition

Seed Production
Facility Simulation



Forward Thinking

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Corn seed manufacturing consists of several processing steps from the time it is harvested in the field and delivered by the trucks to the manufacturing facility through customer delivery. Within the manufacturing facility, we will specifically look at the process steps from the bulk storage to the packaging lines ignoring some of the intermediate steps for the sake of simplicity.

The physical operations from the bulk storage bins to the packaging lines are of a continuous flow or batching (discrete) type based on the stage in the process. The bulk storage carries seed of over a hundred varieties that are then further sized into four sub-batches and treated with one of three treatments before getting packaged into a bag or a seed pack box. Considering that there are multiple customer orders, each specifying the unique variety, size, treatment, packaging type, along with the weight of the seed, it becomes essential to release the right amount of seed from the bulk bins to fulfill an order and balance the order fulfillment and capacity utilization considering setups between variety, treatment, and packaging type switch overs.

As a simulation expert, you have been asked to identify the bottlenecks in the system and suggest operational improvements.

Process Flow Details

In this section, we present the process flow details of the manufacturing site, an abstraction of which is presented in Figure 1 below (also in the Tower Schematic PDF). Additional data can be found in the Simio Problem Competition Data Excel file. This file has 8 tabs. The 'Miscellaneous' tab contains information about general information about the system.

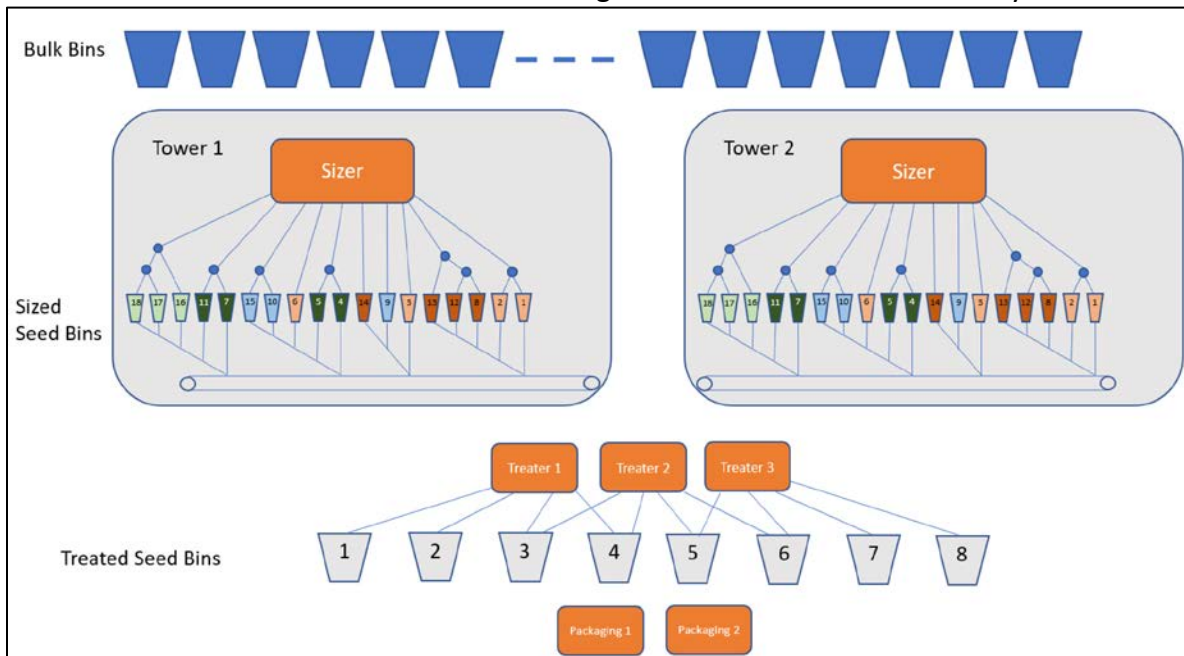


Figure 1 - Tower Schematic

Bulk storage: Consists of an unconstrained amount of grain and number of bins, with each bin carrying a unique variety of corn seed kernels. One corn seed variety can span several bulk storage bins. Once a quantity of seed of a given variety is released into the tower it cannot be retracted back to the bulk storage. A batch of seed is taken from bulk storage and transported to the towers.

Towers: The batch of seed variety can go into two towers (Figure 1), each housing a sizer and a set of sized seed bins. The towers can both run the same variety of seed, but they typically each run a different variety. There is a minimum weight a purchase order must be greater than to split the batch between both towers. Once the seed variety enters a given tower, it must go through the sizer and the sized seed bins before it can be treated in the treaters due to piping and conveyor restrictions.

Sizer: Each tower has one sizer where the corn seed kernels are sized and segregated into four primary seed sizes S1-S4, each indicated by a different bin color in Figure 1. At a given time, the sizer can process, at most, one variety of corn seed. This operation is a continuous flow operation, but it could be modeled discretely, continuously, or combined. The seed kernels from bulk storage have the following size composition: S1 20%, S2 30%, S3, 30%, S4 20%. Seeds flow out of the Sizer at the same rate they enter. However, if the system backs up, the Sizer has a maximum weight of sorted seeds it can hold, and each seed size has a maximum weight.

More information about the towers and sizers can be found in the Tower tab in the Excel data.

Sized Seed Bin: Once the seed is sized, the sized seed traverses through the pipes designated for each size and is stored in the sized seed bin before it can be treated downstream. Each tower has an exclusive set of sized seed bins from which a conveyor carries the seed to the treaters. A few of the bins are designated as an 'open' bin which means that bin can hold any single size of a seed variety. The bins are cleaned when the variety of seed changes and when the Purchase Order changes. Only one pipe is functional at a time per seed size. If all the bins of a seed size fill up, it backs up to the Sizer, and if the Sizer reaches maximum weight capacity (total weight or weight of one of the seed sizes), then the Sizer is shut down.

Rules for sized seed bins:

- a. Each sized bin can hold a particular seed size of a given corn variety.
- b. At no point will two different seed varieties ever be mixed in a single bin.
- c. The dark circles (piping joints) in Figure 1 represent a two-way valve. Only one outlet at each valve can be operating at any point in time.
- d. Bins can be filled and emptied at the same time if the content is the same.
- e. Only one bin of a seed size is filled at a time, and bins of the same sized seeds are always filled left to right to break the tie.

More information about the seed bins can be found in the Sized Seed Bins tab in the Excel data.

Treaters: At this operation, the sized seed is treated (coated) with various fungicides and biologicals to prevent it from pest/fungus pressure prior to germination. In this facility, there are three treaters of which one treater is exclusive to a given tower along with a treater that can be accessed by both towers. Due to conveyor restrictions, if two treaters are opened to a tower, the treaters are restricted to run the same variety and seed size, however, the treatments in the treaters may vary. A sized seed bin does not have to be filled to capacity to be released to the treaters, and only one bin in a tower feeds the treater at a time. A small percentage of seed is lost when the bin empties onto the conveyor. There is a transit time for the first grains to get to the treater, then it flows at the same rate as the treater process. There are three different treatments that are applied to the seed based on the customer order. This is a batch operation, requiring frequent cleanups and setups. A setup is required every time the treatment changes. The processing time varies based on the type of the treatment. Each Treater can do one treatment at a time and applies to everything in the treater. A small batch of seed goes into the treater, is treated, then is removed from the treater (not a continuous flow operation). In order to switch which tower is using the middle treater, both towers must finish batch operations. A sized seed bin does not have to be filled to capacity to be released to the treaters.

More information about the treaters can be found in the Treatment and Changeover Treatment tabs in the Excel data.

Treated Seed Bin: Once the sized seed of a particular variety is treated, it is stored in the treated seed bins before it can be released to the packaging lines. Each bin carries seed of a particular variety by size by treatment to avoid contamination of orders.

More information about the treated seed bins can be found in the Treater to Bin Connections in the Excel data.

Packaging Lines: At the packaging lines, the treated seed is either bagged or boxed (in seed packs) based on the customer order and is then stored in the warehouse before it is delivered to the dealers/customers. One packaging line is for seed bags and one line is for seed pack boxes. A treated bin can fill one packaging line at a time but can switch lines if need be. Both packaging lines can be in operation simultaneously but will be filled by different treated bins. Packaging is a batch operation requiring setups when the variety, seed size, or treatment changes between runs. and the processing time varies based on whether the seed is being bagged or boxed.

More information about the packaging line can be found in the Packaging Line tab in the Excel data.

Customer Orders: Throughout the harvest season, we receive orders from the customers specifying their requirements that include corn seed variety, seed size, and treatment packaged in a bag or a box specifying quantity by weight. All the purchase orders are then passed on to the manufacturing planner who is tasked with creation and execution of the production plan.

Sample orders for this period are in the Production Data tab in the Excel file.

One of the key decisions the planner needs to make is to determine the quantity of seed that needs to be released to meet all the SKU requirements within the purchase order. For instance, if a particular SKU line item in a batch has the following specifications:

Purchase Order	Seed Variety	Grade Size	Weight (pounds)	Treatment Code	Packaging Type
197874330	LD3309HKNT	S3	14280	Treatment 2	Bags

The planner in this instance must release at least 47,733 pounds of seed from the bulk to create 14,320 pounds of seed of S3 size (as per the seed size distributions listed in the earlier section). Further, the planner needs to account for seed loss on the conveyor between the sized seed bins and the treaters.

In case too little seed quantity is released from the bulk, this purchase order cannot be satisfied, on the other hand, if too much seed quantity is released from the bulk, then at the treaters, the seeds will only be treated for Treatment 2 for required 14,320 pounds and the excess seed is passed through the treater without any treatment applied to it. While the treated seed is packaged in the bags, the excess seed is flushed out of the seed pack packaging line and is considered to be wasted material unless it can be applied to another customer order.

More information about customer orders can be found in the Production Data tab in the Excel data.

[Download the Excel data -](#)

https://cdn.simio.com/StudentCompetition/2018Dec_StudentProblemData.xlsx.

[Download the PDF of the Tower Schematic -](#)

https://cdn.simio.com/StudentCompetition/2018Dec_TowerSchematic.pdf.

Since many of the processes in this facility are a combination of batch and continuous processing, the system could be modeled discretely, continuously (using Flow Library), or possibly some combination.

Analysis:

1. Our objectives are to produce all the orders as quickly as possible with the least amount of wasted or unused material. How would you determine the processing order and production batch sizes at each stage to meet those objectives? What logic or rules do you recommend?
2. Given the metric of interest is the overall make-span of all the customer orders elaborate on the policy/strategy you would employ for the shared treater, if any.

3. Identify any system bottlenecks/constraints. If applicable, what changes could be made to improve the system such that the bottleneck situation is improved? And how would you quantify the improvement?
4. Does the decision logic to batch seeds change if gross weight of orders increases by 10%?
5. The seed manufacturing department has room in their budget for some new equipment, either seed bins, treated bins, or a packaging line. What equipment should they propose, how many, and how are they assigned?
6. The team is considering adding a separate conveyor to treater 2. This would allow two seed varieties to go to the treaters at once or the same variety could fill 2 treaters at once. What is the benefit of adding a separate conveyor in each tower to treater 2?
7. Should bins be reassigned to other sizes to make the system more efficient? The towers do not have to have the same configuration.

BONUS QUESTION

8. Create a production order using Simio's scheduling and risk analysis capability that includes
 - a. Tower assignment for the variety
 - b. Treatment type and treater assignment
 - c. Packaging line assignment