



Natural Blends Inc.

Background

Natural Blends, Inc., located in Orange Grove, Florida, manufactured orange juice concentrates¹, typically prepared for brand-name juice producers, such as Minute Maid, Tropicana or Sunkist. The market for premium orange juice concentrates with distinctive color, consistency and taste had become increasingly specialized in recent years, as national brands demanded a variety of customized juice blends. Natural Blends met these needs by blending its four different concentrates to customer specifications. **In light of rapidly changing customer needs, Natural Blends' management had decided to conduct a review of its existing operations and an analysis of its future plans.**

Recently, a team of bright and juice-conscious students from a well-known Eastern U.S. business school visited one of Natural Blends' smaller-sized facilities in Orange Grove, Florida. Utilizing knowledge and skills from their first-year operations course, they decided to first assess the facility's existing operations in order to advise Natural Blends management in their selection of production contracts for the coming year.

The Production System

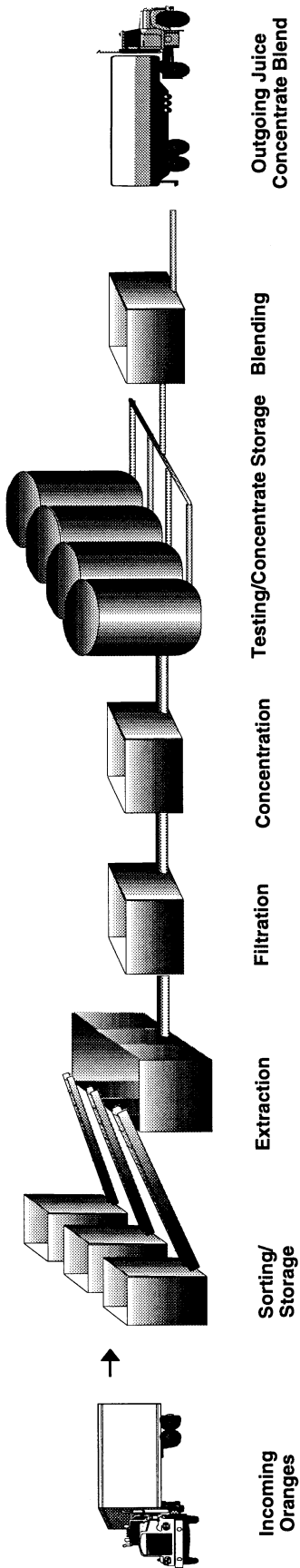
The facility operated at capacity, with one 8-hour shift per day, six days a week, for a total of 36 weeks per year during the prime orange growing season. **Exhibit 1** depicts the key elements of the continuous production process. The production process consisted of six operations: (1) sorting/storing, (2) extraction, (3) filtration, (4) concentration, (5) testing, and (6) blending. Comparing the capacity of different steps in the process was complicated by the fact that the product's volume was reduced (due to removal of seeds, water, etc.) as it moved through some of the process steps. To simplify matters, capacity was measured in terms of the equivalent amount of finished juice concentrate. Thus, to analyze each step, the production capacity or storage capacity was described in units of finished product actually achieved.

¹ Concentrate: liquid orange juice which has had some water removed.

Research Associate Karen Krause prepared this case under the supervision of Professors H. Kent Bowen and Ramchandran Jaikumar as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

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Exhibit 1 Schematic Representation of Natural Blends' Orange Juice Process



- (1) *Sorting/Storage.* Florida growers delivered three sizes of oranges (small, medium and large) to the Orange Grove plant on a daily basis. Natural Blends ordered only what it needed to meet daily production requirements. Oranges were sorted by size and stored in three separate bins. (Time spent sorting and filling bins was negligible.) Each storage bin had a capacity of 80,000 pounds. (This meant that each bin could have held the number of oranges required to produce 80,000 pounds of finished juice concentrate.)
- (2) *Juice Extraction.* In this process step, the extractor had to be setup to extract the juice from one of the three sizes of oranges. The time required to change over the extractor when switching from a bin of one size to another size was 20 minutes. When it ran, the extractor had the capacity to produce up to 20,000 pounds/hour of finished juice concentrate, irrespective of the orange size it was processing.
- (3) *Juice Filtration.* After extraction, the juice flowed to the filtration operation where seeds and small pieces of orange peel (that remained following the extraction step) were filtered from the juice and discarded. The filtration step had a processing capacity of up to 20,000 pounds/hour of finished concentrate. After it ran (filtering juice) for 90 minutes, the machine's filter had to be changed to clear the debris. The time required to shut down the machine, change the filter, and restart the machine was 30 minutes.
- (4) *Juice Concentration.* Once the juice was filtered, it flowed directly into the concentrator where some of the water in the juice was removed (as it flowed through the machine). The concentrator had a processing capacity of up to 18,000 pounds of finished concentrate per hour. No setups were required for this operation.
- (5) *Juice Testing/Storage.* Concentrated juice was tested frequently for characteristics such as color and sugar content and separated into one of four large storage tanks. (The time to do this testing was negligible.) The four tanks could have stored a total of 250,000 pounds of concentrate.
- (6) *Blending.* An industrial customer contracted with Natural Blends, Inc. for a certain number of orders per week, where each order was for a standard number of pounds of concentrate with a specific color and sugar content. That is, all orders from that customer were identical. Natural Blends achieved each customer's specifications by mixing from the four tanks of concentrate in the appropriate proportions. The blending operation mixed juice concentrate at a rate of up to 22,000 pounds of finished product per hour. A 40-minute setup time was required to change from one blend to another or from one order to another, even if it was another order from the same customer.

The movement of oranges from delivery (and sorting) to storage bins and from bins to extraction occurred with conveyor belts. Following extraction, the liquid (juice) was pumped through pipes from one process step to another. The residue from extraction (the remains from the oranges) was removed and discarded continuously during the extraction step.

At the start of each workday, it took only a few minutes for the initially processed oranges to move as juice through the process to the testing/storage step. Similarly, at the end of the day, it took only a few minutes for the last of the day's processed oranges to flow through the process to testing/storage. The production run rates provided above accounted for these and other minor variations that occurred during a production day.

Production Planning

Production planning for Natural Blends was completed on a weekly basis to match the oranges to be bought with the blends to be shipped. The scheduling of production in the plant was performed on a daily basis, with one schedule for the concentrate production and another for the blending. The purpose of the two schedules was to coordinate the setups/changeovers when necessary. (The size of the oranges had no relationship to the sugar content or the color of the resulting concentrate.)

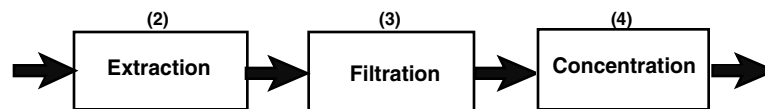
Over the course of a week, oranges delivered to the plant were equally distributed between small, medium and large oranges; e.g., each size comprised one-third of the total weight delivered for the week. The relative amount of each size on a daily basis was a choice that management could have made. Thus, the weekly plan for concentrate production required equal amounts of the three orange sizes to be purchased and processed. The weekly production plan for blending was determined by the annual contracts for orders placed by industrial customers.

Questions

To facilitate your understanding of the Natural Blends plant, please answer the following questions.

PART A

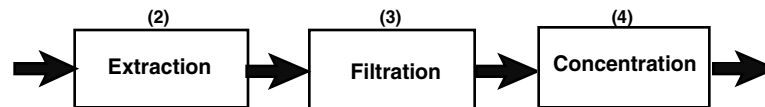
Assume that the production system was running only one size of oranges. Consider just process steps two through four: extraction, filtration, and concentration.



- 1a. How much orange juice concentrate can be processed in one 8-hour workday?
- 1b. Assume extraction had previously been setup for the size oranges being processed. How much idle time will there be in the extraction operation during one 8-hour workday?
- 2a. If you could add storage capacity somewhere between steps two and four in this production line in order to increase daily output, where would you place it? How much storage would you add?
- 2b. Why?
- 3a- If the cost of adding storage was \$30/pound and the cost of reducing setup time by 50% using additional fixtures was \$20,000 for the filter process and \$10,000 for the extraction process, what action would you recommend in order to maximize the output of this production line?
- 3b. How much will your recommended improvement(s) cost? How much additional capacity do you create?

PART B

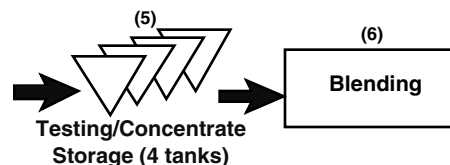
Assume that the production system was running three sizes of oranges: large, medium and small in equal amounts every week. Furthermore, assume that Natural Blends requires that each orange size be processed at least once per day, but that as long as equal amounts of all three sizes were processed during a week, equal amounts of all three sizes do not need to be processed on any single day. Again, consider just the process steps of extraction, filtration and concentration and assume none of the improvements you recommended in Part A (Question 3) have been implemented.



- 4a. How often during an 8-hour workday would you have a setup change in the extraction process (e.g., how often would you changeover to another size of orange)?
- 4b. Why?
- 4c. What quantity of oranges of a particular size would you process before switching to another size?
- 4d. What was the total amount of juice concentrate you can process through the three process steps (two through four) in one 8-hour workday?

PART C

Assume that improvements you recommended in Part A have not been implemented. Following the initial four steps in the production process, Natural Blends Inc. mixes juice from the four tanks of concentrates to achieve the specifications of any order from its industrial customers. That is, in order to fill each specific order, it carries out step six using the output tested and stored previously.



For the coming year, management received several requests in the form of annual contracts for weekly order rates (number of shipments) (see **Table A**). Contract proposals A, B, C and D were for customized blends. Contract proposal S was for a standard blend without tight specifications that Natural Blends can produce each week after it had completed production of its custom orders. The standard blend was run in an order size of 24,000 pounds or less. Natural Blends can sell as much of this lower margin blend as it can produce.

A 40-minute setup change during blending operations was required for each order processed. (Setups were required between each order, even multiple orders from a single customer, as well as between orders from different customers.) Assume that the characteristics of the concentrate stored in the four tanks was adequate to accommodate the blend variations required to fill any sequence of orders from **Table A**. Also, assume that Natural Blends wants to end each week with a predetermined but constant level of tested concentrate in storage.

Table A Proposed Juice Concentrate Contracts for Next Year (1997)^a

| Industrial Company Contract | Contracted Number of Orders per Week | Quantity per Order (pounds) | Contribution per Pound (\$/pound) |
|-----------------------------|--------------------------------------|-----------------------------|-----------------------------------|
| A | 24 | 8,000 | 0.030 |
| B | 18 | 16,000 | 0.028 |
| C | 15 | 24,000 | 0.026 |
| D | 10 | 18,000 | 0.024 |
| S | no limit | 24,000 or less | 0.020 |

^aTypically, an industrial customer placed a contract for a specific juice blend in the form of orders of a particular amount and delivery frequency. This blend was transported to the customer's own plant for additional processing. (Generally, the concentrate was diluted and packaged for a particular market segment. For example, the industrial company representing contract "A" planned to process 24 separate batches per week at its own plant.)

5. How much time does it take for the blending operation to process one 8,000-pound order from Company A?
- 6a. Which set of contracts in Table A would you recommend that Natural Blends accept?
- 6b. Why?
7. Once again, management was considering improvements but this time to the entire system. Which of the following improvements would you recommend to maximize the output of this plant? Why?
 - a. Adding storage between process steps 2, 3 or 4, at a cost of \$30 per pound.
 - b. Reducing the extraction changeover time from 20 minutes to 10 minutes at a cost of \$10,000.
 - c. Reducing the filtration setup time from 20 minutes to 10 minutes at a cost of \$20,000.
 - d. Reducing the blending setup time from 40 to 30 minutes at a cost of \$50,000.