

## **Title: Material Tracking in a Food Factory**

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### **Abstract:**

This case study involves the development of a real time material tracking system for an automated food packaging facility that produces shelf stable beef stew product. The case emphasizes information systems design and implementation. The case description is based on the 31,000 square foot Combat Ration Advanced Manufacturing Technology Demonstration Facility at Rutgers University. The facility consists of raw material and finished goods storage areas (including frozen storage) that supply the production line with three primary inputs including a sauce product, vegetables, and beef. The sauce product ingredients are premixed and the beef and vegetables are pre-processed on parallel manufacturing lines that feed an automated mixing, cooking, packaging, and drying line. Finished product flows back into the storage area. A facility floor plan and detailed diagrams of processing equipment are provided in the case study. In addition, ten points in the processing sequence are suggested as material tracking points.

Students are asked to: identify the data to be collected at each tracking point, develop material coding schemes for translating the data into bar codes, specify implementation hardware and software appropriate for the work environment including cost estimates and suggested vendors, develop a data communications diagram for the material tracking system, estimate the benefit of automated data collection, and prepare a report summarizing their analysis and recommendations.

# MATERIAL TRACKING IN A FOOD FACTORY

## I. INTRODUCTION

The Combat Ration Advanced Manufacturing Technology Demonstration (CRAMTD) Program at Rutgers University Center for Advanced Food Technology (CAFT) has the objectives of researching, designing, and demonstrating automated and flexible thermostabilization processes to manufacture shelf-stable food products. Although the primary food products are military rations for the U.S. Armed Services, the goal is to demonstrate flexibility in producing for the civilian market as well. Representative products include beef stew and beef cubes in pouches and trays.

The Food Manufacturing Technology Facility is depicted in Figure 1. It is a 31,000 square foot off-campus building. This "food factory" contains 7,500 square feet of U.S. Department of Agriculture/ Food Safety and Inspection Service approved manufacturing space. The facility consists of raw material and finished goods storage areas (including frozen storage) that supply the production line with three primary inputs including a sauce product, vegetables, and beef. The sauce product ingredients are premixed and the beef and vegetables are pre-processed on parallel manufacturing lines that feed an automated mixing, cooking, packaging, and drying line. Finished product flows back into the storage area. This factory space houses cooking equipment including a hot air impingement oven; a horizontal form/fill/seal packaging line for flexible pouches (Meals Ready to Eat or MREs); filling equipment including a 6-head liquid filler, a combination adjustable volume transfer cup filler and rotary volumetric filler, and a robot system; a variable speed tray pack packaging line; a commercial size sterilization retort with multiple heating modes (steam, steam/air, water spray, full water immersion, still, and agitated) for product sterilization; and a variety of drying equipment. An enlarged layout of some of the equipment in Process Area A is exhibited in Figure 2.

The "food factory" also contains a quality control laboratory, experimental kitchen, refrigerated and frozen storage, and other support space including an information resources room, a conference room, offices and a warehouse. Research is underway to integrate sensor systems for process and quality control. Also, the computer integration of the individual equipment is currently being addressed. In order to demonstrate a complete advanced technology manufacturing capability, the Research & Development staff have requested that a material tracking plan be developed and specified. You have recently been hired as an industrial engineering consultant by CRAMTD staff to design a material tracking plan for the MRE pouch line. Your plan needs to specify the data to be tracked, hardware and software requirements, and a data communications strategy as well.

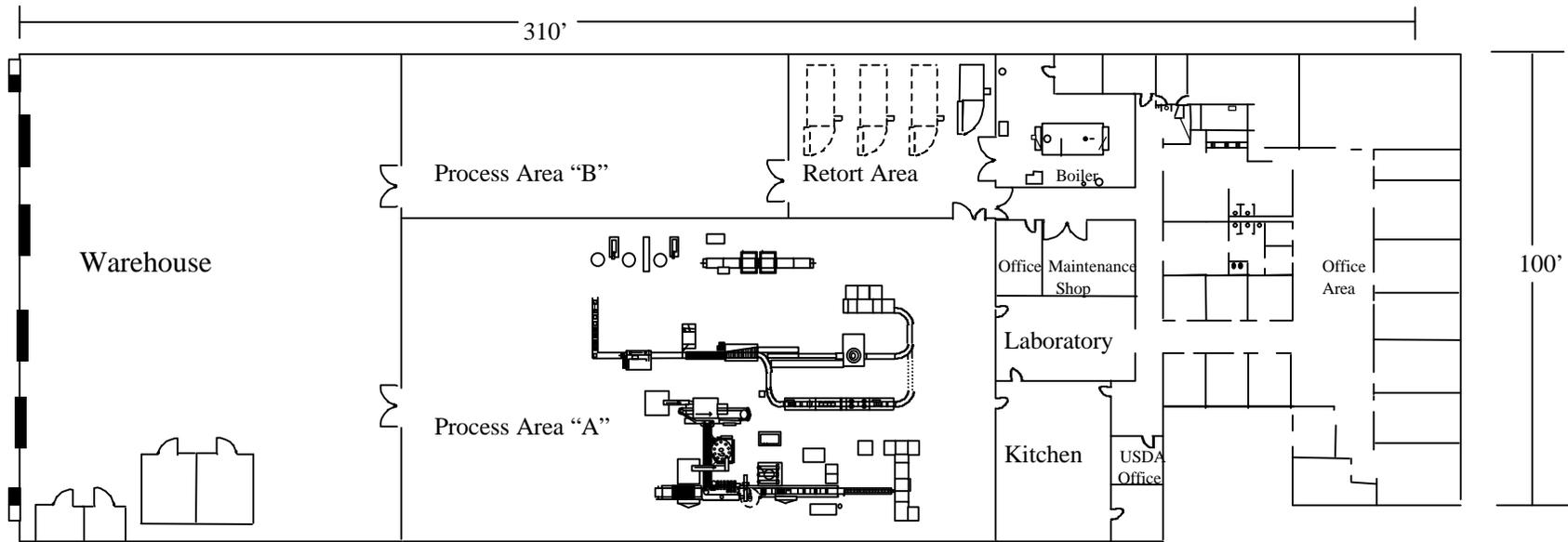


Figure 1. CRAMTD "Food Factory"

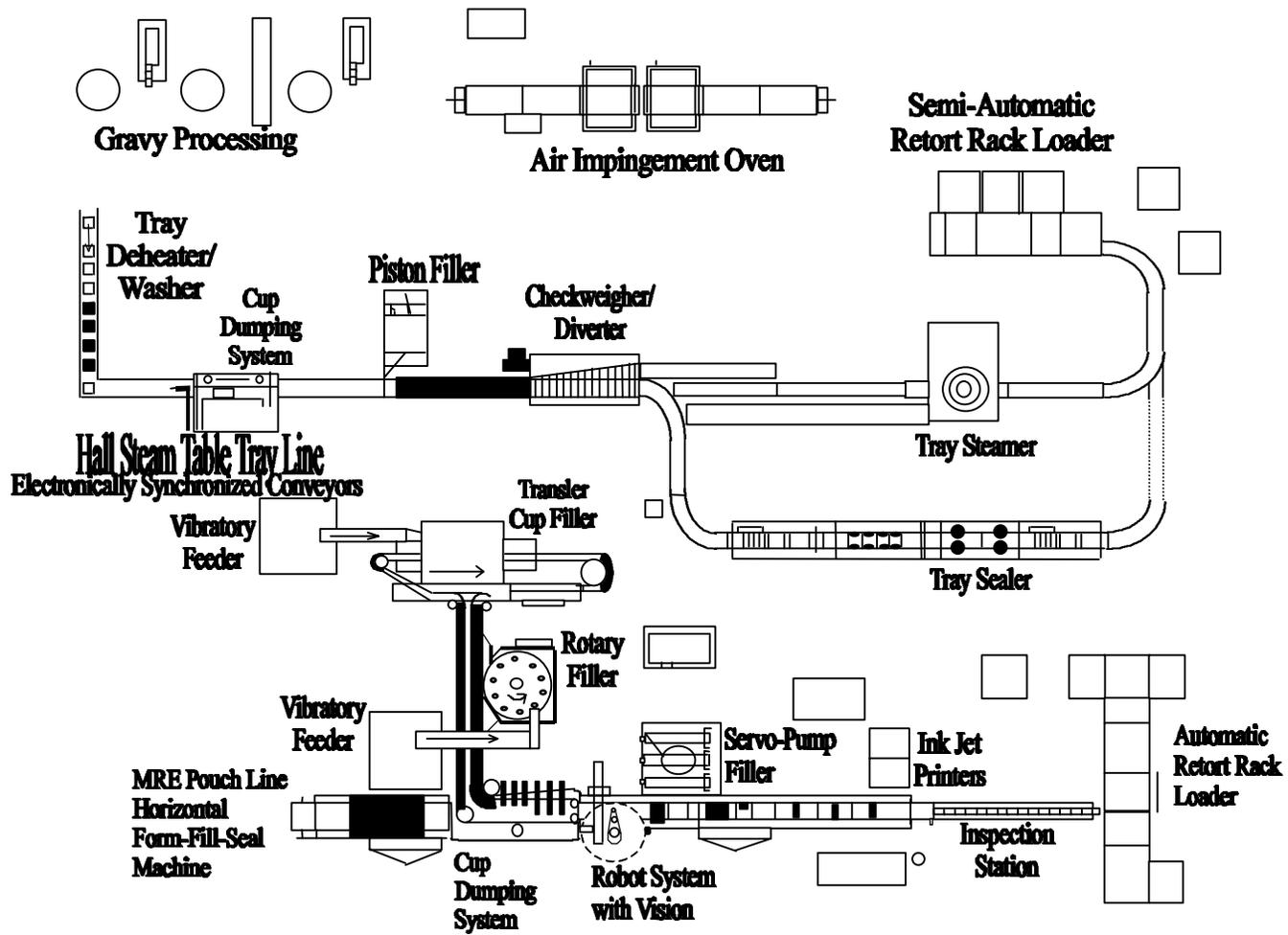


Figure 2. Cooking, Filling, And Packaging Equipment

## II. THE PROCESS FLOW

The CRAMTD staff have provided you with a flowchart of the major steps involved in the production of MRE pouches as exhibited in Figure 3. Ten different material tracking control points have been tentatively identified by them and these are labeled M1 through M10. For each of these 10 control points, you have been asked to specify the data that needs to be collected and the method and technology for collecting, storing, and retrieving data in the plant database. Data communications in the "food factory" will operate on a client/server architecture. ORACLE will be used as the plant database and Novell Netware will be the operating system. There will be an ethernet backbone running through the plant.

The essential material flow is that the raw material, such as the beef product and raw vegetables, will arrive to the "food factory" in boxes weighing 25 to 50 pounds. These smaller unit packages are more manageable by manual labor. Each pouch will contain approximately 4 ounces of beef product. Some of the raw material may require freezing. A sample of the raw ingredients will be taken, labeled, and sent to the quality control laboratory for testing. Thus, this flow represents a sub-flow for material tracking. Once a production order is generated, the raw material moves from the freezer to the refrigerator for temporary staging. A "walkie" will be used to transfer pallets between locations in the warehouse and the process areas.

Product "traceability" from the finished product to the work in process to raw materials is essential in the food processing industry. Your material tracking plan must include the development of a coding scheme for finished product, work in process, and raw materials that is hierarchical and that will permit backward tracing. It is also important to know, at any point in time, the location of product in the system.

Some of the raw materials will move to the filling areas and some will move to the gravy or sauce preparation area (Process Area A). Again, it is vitally important to record the time of each move as once the beef product leaves the refrigerator, it must be to the retorting or sterilization stage (Process Area B) within two hours due to the perishable nature of the product. The beef product is dumped into a volumetric filler where the precise amount of beef is filled into a cup. This cup is transferred by a series of conveyors to another filling station where vegetables may be piston filled if beef stew is being produced. The cup then moves to the horizontal form/fill/sealing machine for further processing.

Along the horizontal/form/fill/seal machine, the bottom layer of the pouch is stretched over die cavities in the shape of the MRE pouch. Six pouches index at once, so the filling position number of the nozzle needs to be recorded on the pouch. These nozzles are used to fill the pouch with "sauce" or gravy. After gravy filling, the top layer of the pouch is formed, a vacuum is drawn and the product is cooled. An ink jet coding machine is integrated into this line, so essential information, such as the product type, establishment number, Julian date, weight, nozzle number, etc. can be easily printed onto each pouch. Although the production rate is designed to be 106 pouches/minute, it must be remembered that this is a "demonstration" facility, and that the line does not run for 8 hours per day.

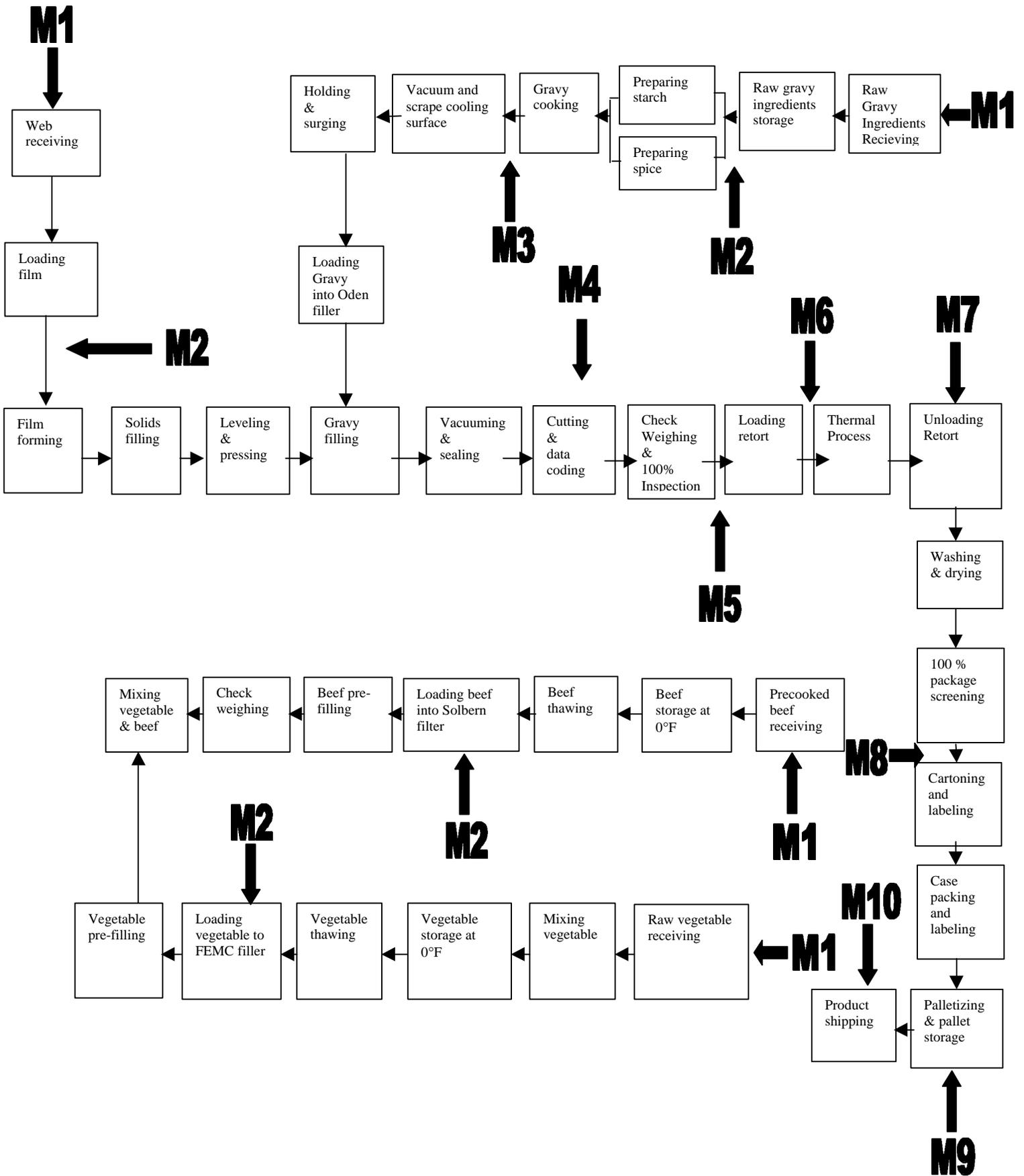


Figure 3. Material Tracking Control Points for MRE Pouch Line

Once the pouches have been sealed, cut, and labeled, they will be placed in crates for transportation to the retorting area. It is important to maintain a First-In-First-Out (FIFO) queue, so you have been asked to devise a coding scheme for labeling the crates to ensure the FIFO system. There are two retorts available and the military specifies that the retort "cook" number and retort cycle number must be recorded on each pouch.

After retorting, the pouches are cleaned, dried and transported via conveyor to the final packaging area. The pouches are placed into small folders and then approximately 72 folders are placed into a larger box for shipment. Since the MRE product has a shelf life of 3 years, it is extremely important to ensure product traceability back through the production process in case there are quality control problems or product recalls. Management must have a way of identifying when the product was produced and information about the raw material received to identify assignable causes.

Material handling equipment in the facility includes the use of walkies, a small lift truck, and moveable retort cages.

Since the purpose of the "food factory" is to demonstrate advanced automation, you have been asked to develop specifications for "real time" material tracking. Advanced technology, such as hand-held bar code scanners and Radio Frequency units, needs to be investigated. Real time inventory control could be implemented as a result of tracking data on work in process and finished goods. These production quantities could be reconciled with the incoming receipt and inspection quantities to determine reorder points and reorder quantities.

### **III. YOUR TASKS**

To summarize, your consulting tasks involve the following:

- A. Identify the data to be collected at the ten material tracking control points labeled M1 through M10 in Figure 3. Remember the importance of product "traceability" in developing the linkages between data.
- B. Develop a coding scheme for finished product, work in process, and raw materials. CRAMTD staff have indicated that bar coding must be used and that the military uses Code 3 of 9. Discuss how your coding scheme will be translated into bar codes.
- C. Specify the hardware and software required to completely implement your tracking plan in this "food factory" from receipt of raw materials to finished product. Discuss the advantages/disadvantages of alternative Automatic Data Collection (ADC) systems.

You have been requested to investigate the use of advanced technology to implement "real time" tracking in both the warehouse and process areas. Your discussion should focus on the use of wireless communications such as Radio Frequency.

*(Be careful to consider the effects of the range in temperatures from freezing to high temperature retorting when specifying material tracking equipment and bar code labels.)*

- D. Develop a data communications diagram indicating the major components in this client/server architecture.
- E. Develop cost estimates for your material tracking plan. Present a list of possible vendors to CRAMTD staff.
- F. Summarize the benefits of Automatic Data Collection. Attempt to quantify these benefits.
- G. Summarize your recommendations for an advanced material tracking plan into a cohesive Final Report to present to CRAMTD management.

**NOTE:** Since food processing operations are novel to most students and instructors, it is suggested to briefly survey the literature. There will probably be a need to make some assumptions in the analysis, and this is actually encouraged. Logically think about the major processing steps and what data are important to collect to understand and control the fundamental production process.

For detailed information about the CRAMTD plant, write to:

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