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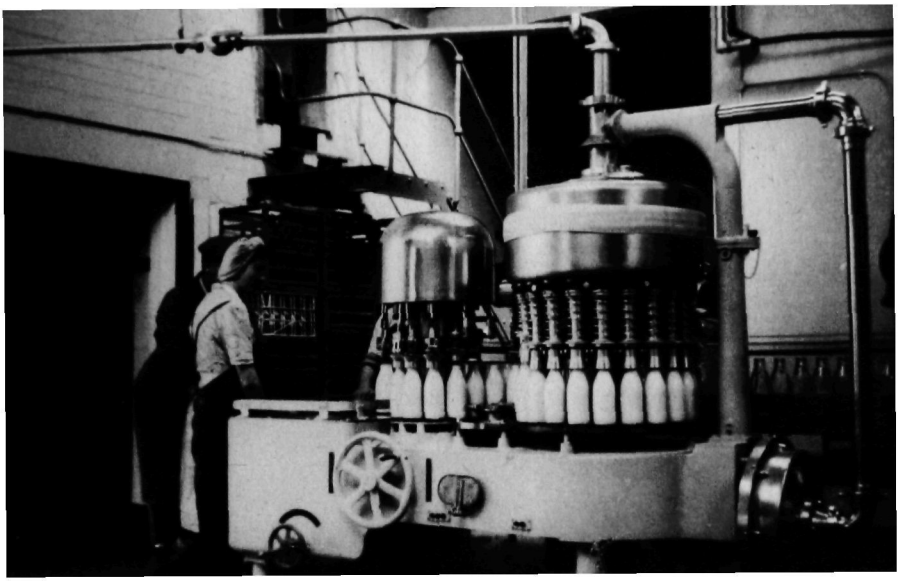

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University of Maine

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The photograph on the front cover is courtesy of East Lothian Council Library Service.

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INTRODUCTION

This publication is an extension of a study conducted for the Maine Milk Commission (MMC). The MMC is the non-industry commission responsible for implementing Maine's milk-related rules and regulations. The commission's responsibilities include establishing a minimum milk price at the farm level, and minimum margins at the processor and retail level. The MMC sponsors periodic major and minor revisions of the economic models used in regulating processor and retail margins. This study was conducted to update estimates of the minimum wholesale margin, calculated as the cost of processing and distributing fluid milk products in Maine. Prior to this current version, the most recent study was conducted by the University of Maine in 1997. Similar earlier work includes Anderson (1986), Jacobs and Criner (1990), Criner and Jacobs (1992) and Criner et al. (1995).

This study incorporates significant revisions into the computerized spreadsheet used to calculate the processor margin. It also captures improvements in dairy-processing technology such as new equipment and plant design. An industrial engineering firm specializing in the design of milk processing facilities, JAI Engineers, was subcontracted to design a modern dairy processing plant, to provide facility specifications, and to estimate construction costs.

Processing margins are estimated based upon a state-of-the-art model dairy that produces a line of milk products and fruit drinks in a variety of container sizes. The plant also purchases packaged products such as cheeses, yogurt, and other products from outside firms and wholesales these items to its clients. In past studies the model plant produced a "full line" of milk products. However, the proliferation of flavored milk products and packaging, combined with industry consolidation throughout the nation, has led Maine's dairies to rely more heavily on purchases or transfers from other company plants located outside of the state. In addition to the representative plant required by the Maine Milk Commission, three other models, with different weekly capacities and/or the addition of blow-molding bottle production technology, were developed and their processing costs estimated.

This report describes the methods used in estimating processing and distribution costs for the "limited-line" plants. A brief explanation of cost-modeling theory appears in the Economic-Engineering Methodology section. The facilities' physical descriptions plus operating and maintenance requirements can be found in the Facility Construction and Cost Data section. An overview of the allocation methods appears in the Cost Allocation Methodology section. The Plant Processing Costs section describes the expenditures, economic charges, and

calculations used in establishing processing costs. Post-processing distribution costs are discussed in the section Model Distribution Costs. The Summary of Cost section combines the results of the processing and distribution models to reveal per unit processor cost for all white milk package types. And lastly, the Change in Processing Cost 1993 to 2000 section reviews the change in milk processing and distribution costs in Maine over a seven-year period.

OBJECTIVE

The objective of this study is to provide an estimate of the theoretically lowest achievable costs of processing and distributing milk in Maine. This processing and distribution margin (referred hence as "margin") is estimated for a state-of-the-art processing plant assumed to be located in the Portland, Maine, area. The plant is assumed to produce and distribute a line of products including white milk, chocolate milk, orange juice, and other fruit drinks, and to distribute additional purchased products such as cheeses and yogurts. This report will present information for four plants to better study the impact of plant size and production scope on costs.

ECONOMIC-ENGINEERING METHODOLOGY

Economic-engineering models are mathematical representations of a production and/or marketing process where engineering and economic information are combined. The engineering information includes the technical specifics of the facility layout and inputs such as equipment, labor, utilities, and supplies. The economic component of the model involves determining costs for all plant inputs and distributing these costs based upon logical allocation rules. Economic-engineering models are particularly well adapted to allocating costs to different stages of production and then to production items. Cost allocations are based primarily upon utilization. For example, if a laborer works exclusively with one product, then that laborer's gross wages are allocated wholly to that product's cost.

FACILITY PRODUCTION AND CONSTRUCTION COST DATA

Plant Operation Specifications

Four model plants were developed for the Maine Milk Commission. The models increase in production capacity and the final two incorporate on-site blow molding of gallon and half-gallon containers.

Model 1 has a weekly white milk volume of 335,000 gallons, has no blow molding of containers, and packages product in six container types. Models 2 and 3 package 400,000 gallons of white milk per week in nine different containers. Model 2 does not have blow-molding technology whereas Model 3 does. Model 4 is the largest plant, producing 600,000 gallons of white milk per week. It also bottles product in nine containers and uses blow-molding technology. The two models with the blow-molding capacity produce gallon and half-gallon containers inside the plant. The other models rely upon purchased containers from an outside source. Based on statistics gathered from dairies within the state, the model plants produce by-products at a rate of 18.68% of white milk volume, or 15.7% of total plant volume.

Table 1 presents the weekly volume of total plant production by container. This information is broken down into container allocation and numbers by white milk and by-products in Table 2 and Table 3, respectively.

Raw milk is received on a seven-day basis and processed final product is distributed on a six-day schedule. Daily case distribution activity is presented in Table 4. There are drive-through tank-truck receiving bays for unloading the milk from the trucks. Raw milk is pumped out of the trucks, cooled by a 300-gallon-per-minute (GPM) plate cooler, and stored in any one of four to five 50,000-gallon milk silos. Clean-in-place (CIP) units clean the tank trucks before the trucks leave the receiving area. Two 10,000-gallon silos store hot and chilled water, and one 8,000-gallon tank is available for orange juice concentrate.

The processing and packaging of products occurs five days per week (these operations are not performed on Wednesdays or Sundays). Pasteurization of raw milk and by-products is performed by two High Temperature, Short Time (HTST) pasteurizers. The pasteurized milk is blended with the proper amount of butterfat and piped to 10,000- or 15,000-gallon surge tanks. Likewise, by-products are pasteurized and pumped to smaller surge tanks. From these surge tanks, the product is piped to the appropriate filler. Depending on weekly capacity, several fillers are required to package the various sizes and types of containers examined in this study. Table 5 lists the key differences in plant equipment and facilities by model.

In-plant blow-molding equipment casts plastic gallon and half-gallon containers in Models 3 and 4. One gallon and one half-gallon molders supply the necessary number of containers to feed the fillers. Resin for the containers is stored in an 80,000-lb capacity tank outside of the plant structure. Incomplete or defective containers are shredded, and the plastic is re-used. Five-gallon plastic and all paper

Table 1. Production capacity per week, white milk and by-products by model in gallons.

Container Type	Model 1 White	Model 1 By-Product	Model 1 Total	Models 2 & 3 White	Models 2 & 3 By-Product	Models 2 & 3 Total	Model 4 White	Model 4 By-Product	Model 4 Total
Plastic Quart	211,050	25,326	236,376	208,000	20,800	228,800	312,000	31,200	343,200
Plastic 1/2 Gallon	83,750	15,075	98,825	80,000	9,600	89,600	120,000	14,400	134,400
Plastic Quart	10,050	1,307	11,357	12,000	1,560	13,560	18,000	2,340	20,340
Paper 1/2 Pint	16,750	3,852	20,602	28,000	6,440	34,440	42,000	9,660	51,660
Bulk 5 Gal	6,700	200	6,900	12,000	360	12,360	18,000	540	18,540
Plastic Pint	6,700	2,077	8,777	12,000	2,520	14,520	18,000	3,780	21,780
Paper 1/2 Gallon				25,000	1,125	26,125	37,500	1,688	39,188
Paper Quart				13,000	455	13,455	19,500	682	20,182
Paper Pint				10,000	1,000	11,000	15,000	1,500	16,500
Totals	335,000	47,837	382,837	400,000	43,860	443,860	600,000	65,790	665,790

Table 2. White milk packaging volume, percentage and containers per week, by model.

Container Type	Model 1 % of Milk Volume	Model 1 Containers	Models 2 & 3 % of Milk Volume	Models 2 & 3 Containers	Model 4 % of Milk Volume	Model 4 Containers
Plastic Gallon	63	211,050	52	208,000	52	312,000
Plastic 1/2 Gallon	25	167,500	20	160,000	20	240,000
Plastic Quart	3	40,200	3	48,000	3	72,000
Paper 1/2 Pint	5	268,000	7	448,000	7	672,000
Bulk 5 Gal	2	1,340	3	2,400	3	2,600
Plastic Pint	20	53,600	3	96,000	3	144,000
Paper 1/2 Gallon			6	50,000	6	75,000
Paper Quart			3	52,000	3	78,000
Paper Pint			3	80,000	3	120,000
Totals	100	741,690	100	1,144,400	100	1,715,600

Table 3. By-product packaging volume, percentage and containers per week, by model.

Container Type	Model 1 % of By-Product Volume	Model 1 Containers	Models 2 & 3 % of By-Product Volume	Models 2 & 3 Containers	Model 4 % of By-Product Volume	Model 4 Containers
Plastic Gallon	12	25,326	10	20,800	10	31,200
Plastic 1/2 Gallon	18	30,150	12	19,200	12	28,800
Plastic Quart	13	5,226	13	6,240	13	9,360
Paper 1/2 Pint	23	61,640	23	103,040	23	154,560
Bulk 5 Gal	3	40	3	72	3	108
Plastic Pint	31	16,616	21	20,160	21	30,240
Paper 1/2 Gallon			5	2,250	5	3,375
Paper Quart			4	1,820	4	2,730
Paper Pint			10	8,000	10	12,000
Totals	100	138,998	100	181,582	100	272,373

Table 4. Daily case shipment (cases).

Day of the Week	Percentage of Cases	Model 1	Models 2 & 3	Model 4
Monday	21	20,521	24,357	36,536
Tuesday	23	22,475	26,677	40,015
Wednesday				
Thursday	22	21,498	25,517	38,275
Friday	19	18,567	22,037	33,056
Saturday	15	14,658	17,398	26,097
Sunday				
Weekly	100	97,719	115,986	173,979

containers are purchased in bulk volume and stored in the dry storage area of the plant. Plastic containers that are not blow-molded on-site (all plastic containers less than half-gallon in volume) are stored in trailer bodies that abut the plant. The same trailers that transport the containers to the dairy are used for the storage function.

Milk cases are cleaned by an overhead case washer and sent to the fillers on conveyors. The packaged products are placed in cases and then travel by conveyor to the cooler for palletizing or load out into trailers and trucks for delivery.

In addition to selling milk and by-products, the model facility also purchases products from outside producers for resale. These products are referred to as outside purchases and include such

Table 5. Major differences in plant equipment and facilties.

Decription	Model 1 #	Model 1 Size or Rate	Model 2 #	Model 2 Size or Rate	Model 3 #	Model 3 Size or Rate	Model 4 #	Model 4 Size or Rate
Raw Milk Silos	4	50,000 gal	4	50,000 gal	4	50,000 gal	5	50,000 gal
Surge Tanks-Large	7	10,000 gal	6	12,000 gal	6	12,000 gal	7	15,000 gal
Surge Tanks-Small	3	3000 gal	3	4000 gal	3	4000 gal	4	6,000 gal
Bottle Trailer Bays	7		7		4		4	
Fillers								
1 Gallon Plastic	1	90 BPM	1	90 BPM	1	90 BPM	2	90 BPM
1/2 Gallon Plastic			1	100 BPM	1	100 BPM	1	100 BPM
1/2 Gallon Paper	1	100 BPM	1	100 BPM	1	100 BPM	1	100 BPM
Quart/Pint Plastic	1	100/150 BPM	1	100/150 BPM	1	100/150 BPM	1	100/150 BPM
Quart/Pint Paper			1	80/100 BPM	1	80/100 BPM	1	80/100 BPM
1/2 Pint Paper	1	160 BPM	1	160 BPM	1	160 BPM	1	160 BPM
Labelers	3		3		3		4	
HTST	1	6000 GPH	1	8000 GPH	1	8000 GPH	2	6000 GPH
HTST	1	2500 GPH	1	3000 GPH	1	3000 GPH	1	4000 GPH
Homogenizer	1	6000 GPH	1	8000 GPH	1	8000 GPH	1	6000 GPH
Homogenizer	1	2500 GPH	1	3000 GPH	1	3000 GPH	1	4000 GPH
Separator	1	30000 lb/hr	1	30000 lb/hr	1	30000 lb/hr	2	30000 lb/hr
Cream Tanks	2	6000 gal	2	6000 gal	2	6000 gal	2	12000 gal
Debaggers	2		2		2		3	
Blow Molders					2		2	
Load Bays	7		7		7		8	

GPH = Gallons per hour
BPM = Bottles per minute

Table 6. Construction and equipment costs by model.

Construction & Equipment Costs	Model 1	Model 2	Model 3	Model 4
Construction Costs	$12,013,550	$12,611,338	$12,802,535	$14,358,394
Equipment Costs	$12,535,952	$13,700,068	$16,165,438	$18,896,810
Total	$24,549,502	$26,311,406	$28,967,973	$33,255,204
Construction Costs per Square Foot	$113.98	$114.86	$114.58	$110.25

items as cheese, butter, and yogurt. Outside purchases are received at the plant's cooler and repackaged into milk cases for preparation for delivery. Outside purchases account for 4% of total cased products.

A series of circular conveyors, called the production carousel, is used to accumulate assorted products into cases to meet customer orders. Two-thirds of all cased products are loaded onto straight body trucks in stacks, five high. The remaining cases are placed on pallets and loaded onto trailers.

Plant Structures

JAI Engineers designed the facility, determined construction engineering criteria, and provided an estimate of construction cost. The facility has three major building structures: the plant, corporate office, and truck service buildings. Average cost per square foot was estimated and adjusted for inflation and geographical location using the *2000 Means Construction Cost Data* (Mahoney 2000). Besides actual construction cost, additional construction costs include project support costs such as design, travel for construction employees, and an on-site trailer for project staff during the 18-month construction period. These charges accounted for approximately 6% of total construction costs. Table 6 presents construction and equipment costs for the four model plants. Appendix A, Table 1 shows the resulting total cost and cost per square foot for the construction of the three buildings in Model 3. A description of each of the building cost components is also contained in Appendix A.

Plant layouts are designed to specifically fit the needs of the model plants. Allocation of building cost to the models' cost centers is based on the total square footage of related areas. Table 7 lists the square footage of each of the facility areas.

Table 7. Plant facility areas (square feet).

General Area	Model 1	Model 2	Model 3	Model 4
Receive & Process	13,530	13,747	13,687	15,337
Blow Molding or Bottle Room	6,980	6,980	8,835	9,881
Dry Storage	9,578	9,866	9,866	12,542
Case - Store & Clean	7,227	8,103	8,103	11,135
Filling & Packing	6,912	8,256	8,257	9,000
Cooler	25,676	27,237	27,237	33,480
Corporate Office	8,500	8,500	8,500	8,500
Truck Service	9,300	9,300	9,300	9,300
Miscellaneous & Overhead	17,697	17,811	17,950	21,060
Total	105,400	109,800	111,735	130,235

Note: Model 4 includes a depot which is discussed later.

Facility Equipment

An attempt has been made to include all the equipment required to operate these facilities according to production specifications. Most of the data on equipment costs (which include taxes, freight, start-up, and training) and their useful lives is from JAI Engineers. Equipment capacities were based on plant packaging volumes and on an average daily run-time of 12 hours. Equipment was selected to meet the peak processing volume, which represents an 11.5% increase in average processing volume, and oversized under the assumption that it would be operated at approximately 85% efficiency.

Certain pieces of equipment, such as fillers, product tanks, and pasteurizers, have the added cost of piping. JAI Engineers provided an average piping requirement per unit of equipment.

A yearly cost for equipment was calculated by amortizing the equipment's cost, based upon its productive life, and the interest rate for borrowed funds to purchase the item. Based on recommendations from the engineer and dairy processing personnel, annual equipment upkeep costs were added to the capital recovery costs as a percentage of the purchase price. The upkeep amount varied depending upon utilization "wear-and-tear," with average annual amount approximately equal to 2.4% of the purchase costs. Appendix B lists the equipment used in Model 3 by cost center.

Labor

JAI Engineers supplied the model plant labor requirements. A five-day, two-shift schedule is assumed for process employees and a seven-day, single-shift schedule for milk receiving. Employees in the corporate office and truck service work on a five-day, single-shift schedule. All employees are assumed to work a regular 40-hour week. Given these assumptions, the number of employees required for each job is derived based on estimates of "on-job" time required for each shift.

To obtain information on wages by job tasks, a survey of Maine dairies was conducted, which provided pay rates for a variety of dairy facility jobs. These values were similar to wage data obtained from the Maine Department of Labor. Jobs were then placed into one of seven classes according to pay rate, and a weighted average pay rate for each class was determined. Table 8 presents the seven classes of employees and the applicable weekly gross pay.

Additional costs of taxes and benefits for the employees were also included in labor costs. Employee benefits include full coverage health insurance, workers' compensation insurance, FICA tax, and unemployment compensation tax. Appendix C lists all of the facility's employees along with their classification.

Table 8. Employee classifications and pay rates.

Classification	Weekly Rate	Position Description
Class 1	$515	Entry wage, low skill, etc.
Class 2	$560	More skilled & experienced
Class 3	$700	Supervisor, special skills
Class 4	$1,200	Highly skilled/lower level management
Class 5	$1,500	Mid level management
Class 6	$2,625	Upper level management
Class 7	$3,500	Corporate President/CEO

Source: Maine Department of Labor information and Maine Dairy survey.

Electricity

The cost of electricity is a function of total kilowatt hour (kWh) usage, peak demand, reactive demand (based on kVars), and seasonal usage. The applicable rate sheet was obtained from the regional utility and combined with plant electrical usage information to develop annual electricity costs. To make the necessary electrical cost allocations, JAI engineers supplied electrical usage for all major use items (e.g., blow molding, filling, cold storage). Table 9 lists the kilowatt usage by model, plant area and key equipment type.

Fuel Oil

Fuel oil is used to heat the buildings and to heat water for processing and sanitation. In Model 3, for instance, an average of 2,890 gallons of fuel per week is required to meet these needs. Estimates of the percentage of fuel used for heating the plant, corporate office, and truck service were 20.6%, 1.9%, and 3.2%, respectively. Fuel required for processing represents 38.4%, and the remaining 35.9% is needed for the clean-in-place systems.

Water, Sewer, and Product Loss

Large quantities of water are consumed by the plants for product processing and equipment cleansing. In Model 3, for example, JAI estimates that 386,400 gallons of water would be consumed weekly. Water would be obtained through the Portland Water District and wastewater discharged through the Westbrook sewer facilities. The basic sewer rate would be governed by water consumption.

In addition to the basic sewer rate, a surcharge for pounds of Biological Oxygen Demand (BOD) is assessed. To minimize this cost, returns and dated products are not disposed of in the sewer. Instead, this volume is dumped into a dedicated tank truck and

Table 9. Weekly electrical consumption.

Equipment	Kilowatt Hours per Week			
	Model 1	Model 2	Model 3	Model 4
Receive & Process	20,800	24,900	24,900	37,400
Blow Molders			43,400	64,700
Filling Machines				
Plastic Gallon	1,200	1,400	1,400	2,400
Plastic ½ Gallon	900	700	700	800
Plastic Quart	600	750	750	550
Paper ½ Pint	2,000	2,400	2,400	2,400
Bulk 5 Gallon	100	100	100	200
Plastic Pint	600	750	750	550
Paper ½ Gallon		1,000	1,000	1,000
Paper Quart		250	250	400
Paper Pint		250	250	400
Case Storage	3,600	3,900	3,900	4,200
Cooler	21,900	24,600	24,600	28,300
Plant Offices	1,000	1,000	1,000	1,000
Corporate Offices	1,800	1,800	1,800	1,800
Truck Service	2,100	2,100	2,100	2,400
Total kWh	56,600	65,900	109,300	148,500

transported to a swine farmer. However, BOD still enters the sewer through product loss (equipment wash, spillage, etc.), at approximately 0.5% of total milk volume. A BOD surcharge was calculated based on the rule that each gallon of milk loss represents approximately one pound of BOD.

The loss of 0.5% of total volume processed leads to an additional cost associated with the loss of the physical product. Milk cost per hundredweight (100 pounds) was obtained from the Maine Milk Commission and used to calculate the cost of milk product loss.

Operating Capital

To cover cash requirements from the time between when business expenses are paid and milk revenues are received, an operating capital line was estimated. Since this money is not collecting an interest return, the lost interest represents an economic business expense. The expense is equivalent to a nominal interest rate applied to the operating capital for the length of the deferral time (i.e., time between expenses paid and revenues received).

COST ALLOCATION METHODOLOGY

Constructing a cost model begins by defining the technical coefficients and prices of the project components. This represents the formulation and design of plant specifications, regulatory re-

quirements, facility engineering, and supplies. Once the project parameters have been defined, the cost of capital items and the expense of operation and maintenance are determined (Figure 1).

Capital investment costs represent the expense of items that normally have a useful life of a year or more. Since the investment in capital assets requires the commitment of money over time, part of the investment cost is captured in an interest payment. An investment cost must be included since the money for the investment has either been withdrawn from an interest-bearing account, or borrowed at an interest rate. Capital assets include items such as buildings and equipment.

To estimate the value of capital service provided by equipment with a lifespan of more than one year, capital expenditures were converted to an annual cost using the processes of amortization. Amortization converts capital expenditures to annual costs and include an interest payment. This procedure is also referred to as the "capital recovery method", since the annual payments are equivalent to the acquisition cost of the capital plus an interest payment.

The annual capital cost of a capital item depends on four factors: the interest rate, the useful life of the capital asset (term), salvage value, and the capital asset acquisition cost.[1] A classic example of

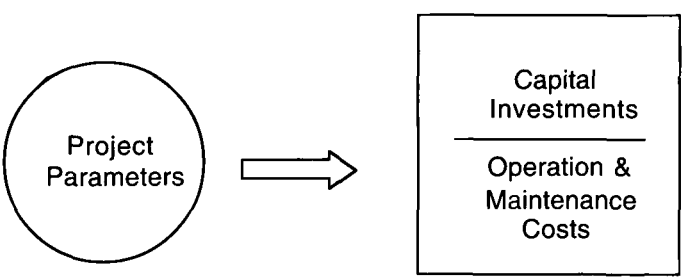

Figure 1. Accumulating facility costs from project parameters.

[1]This study assumed a zero salvage value for the buildings and all equipment. The zero salvage value was used because some equipment is expected to have no salvage value, or in some cases, a financial cost for removal. The salvage value and removal costs represent the selling price, or the disassembly and disposal cost for plant buildings and equipment when they are considered no longer useful to the facility.

the amortization process is the determination of monthly house payments based on length of the payoff period (term), interest rate, and loan amount. This study applies the same concept to durable plant assets with the exception that payments are determined annually instead of monthly.

While capital cost items have useful lives of greater than one year, operation and maintenance cost items have useful lives of less than one year. Typical operating and maintenance costs items include supplies, raw product, utilities, and labor.

In this study, costs are organized and allocated in five steps. Each step further refines allocations in order to derive the annual milk-processing cost for each container type packaged.

The first step in allocating costs is to categorize them according to the nature of the input (Figure 2). Each *cost category* represents a distinct group of costs that is attributable to the model facility. The electricity cost category, for example, contains the cost of electricity for office heating/air conditioning, processing equipment, building lighting and the corporate office. The labor cost category represents the wages, taxes, and benefits of employees for all tasks (product filling and packing, container blow molding, and corporate office staff) involved in the processing of milk.

Once the costs are properly categorized they are further divided into nine *cost centers* (Figure 3). The cost centers reflect either physical areas of the facility or logical production cost allocations. Seven of the nine cost centers in this model represent physical areas

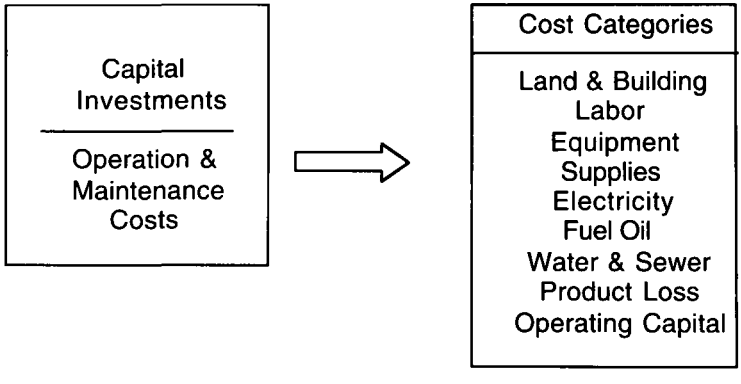

Figure 2. Separation of costs into cost categories.

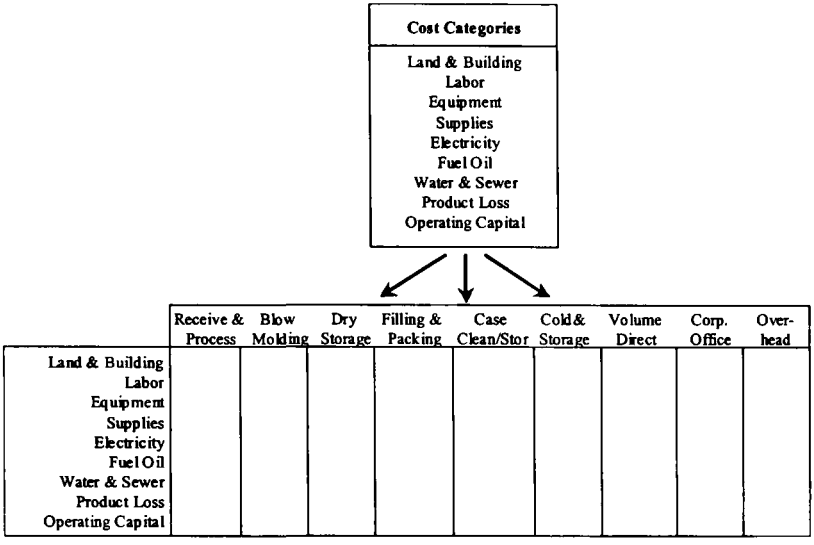

Figure 3. Subdividing cost categories across cost centers.

of the facility: receive and process, blow molding[2], dry storage, filling and packing, case clean/storage, cold storage, and corporate office. Volume direct and overhead are two non-physical cost centers used to allocate costs that do not readily conform to any of the physical cost centers. A brief description of each cost center follows:

1. *Receive and process*. The areas and functions of the plant where raw milk and by-products are received, stored, tested, blended, and pasteurized;
2. *Blow molding*. The production of plastic gallon and half-gallon containers and/or handling area for purchased containers;
3. *Dry storage*. The handling and storage of paper containers, by-product mixes, plastic caps, labels, and cleaning chemicals;
4. *Filling and packing*. The filling and packaging of products into containers;
5. *Case clean / storage*. The handling, cleaning, and storage of empty 16-quart milk cases;

[2]The blow-molding area of the plants with blow-molding operations is the same general area of the no-blow-mold plants where container handling occurs. For this reason and consistency within the text, these two operations, blow molding and bottle handling are referred to as the "blow-molding stage."

6. *Cold storage*. The casing, palletizing, organizing, and storing of packaged and purchased products;
7. *Corporate office*. All costs involved in corporate accounting, marketing, billing, and management. A separate building, the corporate office resides on the facility grounds. The cost of the structure, land, equipment, and employees are allocated here.
8. *Volume direct*. Various cost items that are most logically allocated to the final per container cost on a product-volume basis. Since some costs cannot be divided accurately among the physical cost centers, this cost center provides a means of avoiding those inaccuracies. For instance, the cost of water cannot sensibly be divided between the physical cost centers without an in-depth evaluation of water consumption by operation. Instead, the cost allocated in proportion to the volume of product packaged. Thus, if 50% of packaging volume were for gallon containers, 50% of the water cost would be applied to that container type.
9. *Overhead*. Any cost incurred by the processing plant that does not correspond with any of the above cost centers are considered overhead expenses. Salaries of plant executives and the cost of operating capital are examples.

Allocations to the cost centers are based primarily on utilization. Building costs are distributed according to square footage allotted; electricity cost is assigned according to usage by area or by individual electrical requirements of equipment. The details of allocations for each cost center are discussed in Appendix D-1.

Up to this point the analysis reflects the total cost for processing white milk and by-products and handling outside purchases. Since the Maine Milk Commission only regulates the margin on white milk products, the next step is to allocate cost between white milk production, by-product production, and outside purchases (Figure 4). Since it is the goal of this study to obtain per container costs for white milk only, the costs of by-product production and outside purchases must be factored out. For example, all fluid-milk-products plants utilize the receive and process equipment. Some of the equipment, however, is used specifically for white milk production, while other equipment is used specifically for by-products. The large, 50,000-gallon milk silos contain only white milk product, thus the annual cost of the silos is allocated directly to white milk costs. On the other hand, the orange juice concentrate tank is used strictly for a by-product, thus its cost is allocated to by-product costs. Equipment such as the

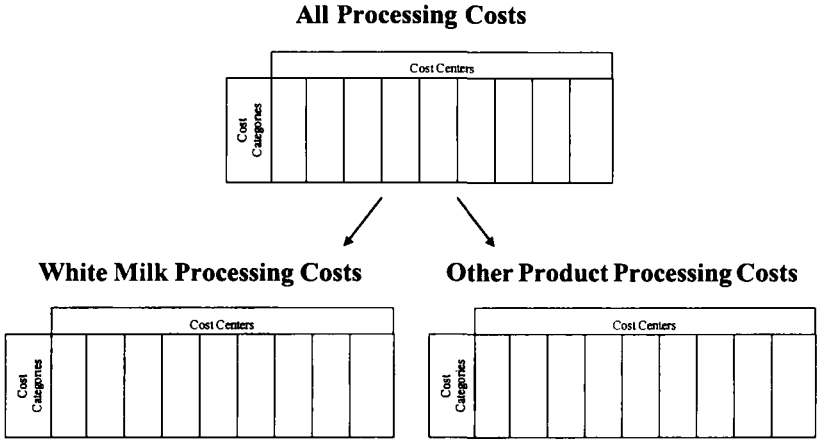

Figure 4. Dividing processing costs between white milk and other products.

pasteurizers is shared by white milk production and by-product production, so this equipment's annual cost is split according to the percentage of volume of white milk and by-product production. This process is done, in a similar fashion, for each element within the cost category/cost center matrix. The allocation algorithms used in this process are detailed in Appendix D-2.

Since this study is concerned only with white milk processing costs, the analysis of by-product and outside purchases is not carried further. The next step is to allocate white milk production costs to container types used in each of the models (Figure 5). The result is nine accounting matrices; each matrix represents a single cost center where the columns contain costs by container type and the rows contain costs by cost category. This process distributes production costs in each cost center to each of the container types. This allocation breaks the costs into the finest detail possible by the model. For instance, the annual cost of labor in the dry storage room, for any particular container type, is identifiable. The method used for making these allocations varies for each cost center and cost category. For example, in Model 3, the annual cost of equipment for filling and packing consists of six different filling machines and the associated installation costs. For the plastic gallon container the annual cost of the gallon filler is known and applied to the plastic

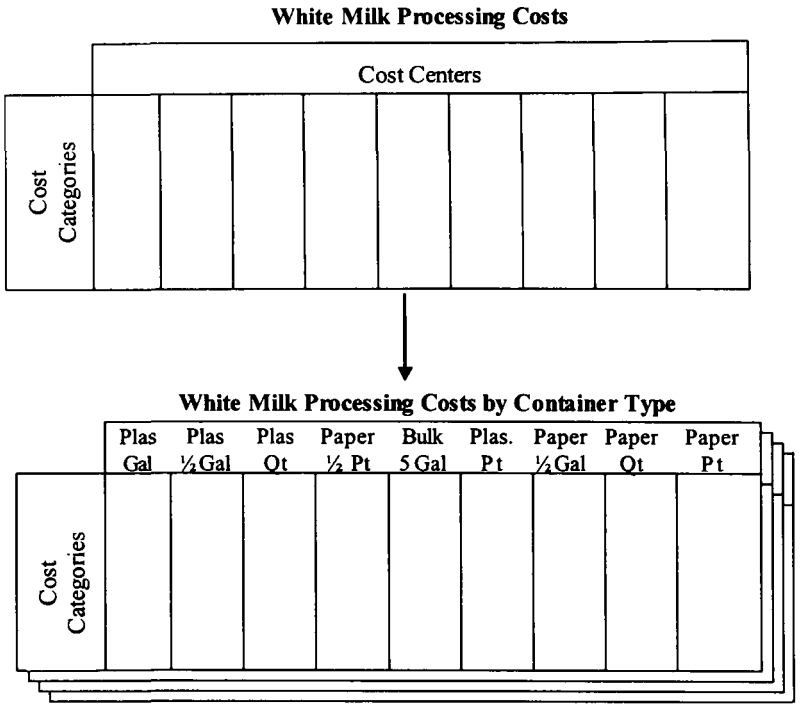

Figure 5. Allocation of costs to container types.

gallon container type. Some of the product fillers, however, are more diverse and require further analysis. The quart fillers are a good example since they are used to fill quart as well as pint containers. In this instance the equipment's annual cost is split among the two associated container types based on approximate filler run-time for each type of container. A complete description of each container cost allocation made can be found in Appendix D-3.

The last step in the allocation process involves summing the processing charges for each container across the cost categories (Figure 6). This summation calculates the total cost incurred in each of the physical and nonphysical cost centers. The cost center totals are finally added together to derive the total production cost attributable to a container type. Based on the total cost, unit costs are calculated dependent upon the container volume produced by the dairy.

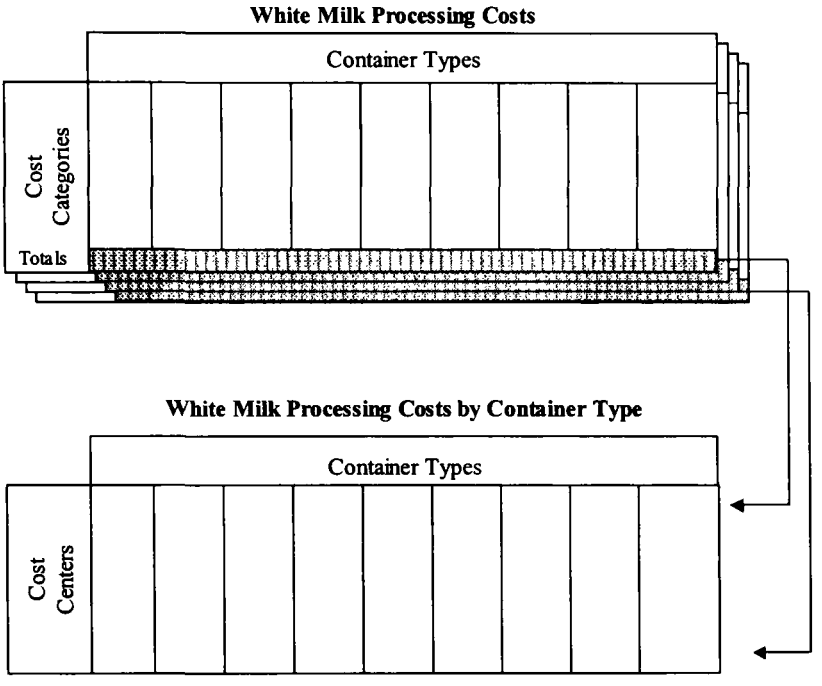

Figure 6. Summarizing container costs by cost center.

PLANT PROCESSING COSTS

The costs incorporated in the model reflect 2000 prices for the Portland, Maine, area. This hypothetical plant(s) resides in the town of Westbrook, adjacent to Portland. Property tax and water and sewer charges are based on current Westbrook rates. A description of costs by cost category follows.

Land and Building

The location of the facility was restricted to meet three basic criteria. First, based on prior studies, the facility was to be located in the Portland area. Second, easy access to a major highway was necessary to make product distribution plausible. And third, the construction site was to be within an industrial park, where the land is developed and ready to accept construction. Several industrial parks exist in the area that meet these criteria but the least costly is located in Westbrook.

Approximately eight acres of land are required to support the facility. From estimates provided by JAI Engineers, 28% of the acreage is allocated to the plant building, 70% is occupied by the truck service building, distribution vehicle parking areas, and facility grounds, and the final 2% is allotted for the corporate office. Land investment costs are assigned to the three buildings based on their assigned portion of total acreage

Land and building costs included land costs, construction costs, construction interest, taxes, and insurance. With the exception of land costs, all of the above components are allocated to each of the three buildings based on their portion of combined building square footage. Land costs were assigned to each of the three buildings based on the "footprint" of each building. Remaining acreage, largely parking and truck jockeying area, was allocated to the truck facility

A construction cost per square foot of area was developed by JAI Engineers (as discussed in the section, Facility Construction and Cost Data). Construction of the entire facility would be expected to take 18 months. During this time, costs would be incurred for a construction staff trailer and capital. The cost of the construction trailer was added to the original construction square foot cost. The cost of construction capital represents interest paid on money lent for purchase of the land and equipment, and the construction of the building.

A total of more than $29.2 million would be required to complete the construction of the plant represented by Model 3. At the suggestion of JAI Engineers, it was assumed that the construction costs would be incurred at equal installments over the 18-month construction period. The cost of construction capital was derived based upon this expenditure pattern and was converted to a square foot basis. The cost of construction capital was added to the square foot construction cost. Using the combined cost as the asset value, an expected useful plant life of 33 years and a nominal interest rate of 10%, the annual cost per square foot for facility construction was calculated.

Two recurring costs are added to the facility construction annual cost: property tax and fire and liability insurance. Property tax is based on total property value (the worth of land, buildings, and equipment). Current Westbrook rates were used to calculate annual property tax. The total tax was divided by total facility square footage and added to the annual square foot cost. A cost for fire and liability insurance was established based on MMC records of three Maine milk plants and information supplied by the dairies. The cost for each of these plants was adjusted by the ratio of the model plant milk volume (400,000 gallons per week) to each plant's milk volume. These adjusted insurance costs were then averaged and converted

to a cost per square foot and then added to the building annual square foot cost.

The resulting annual square foot construction cost was added to land costs to produce an estimate of yearly land and building costs. In reality, actual square foot construction cost may vary depending on the intended use of the area (e.g., dry storage versus processing). A more detailed method of determining costs by area was not readily available and thus not incorporated into the study. Based on discussions with JAI Engineers, and a sensitivity analysis of processing costs, the authors conclude that any biases created by using a facility-wide average square foot construction cost are negligible.

Labor

Labor requirements for the dairy are presented in Table 10. Total labor costs include wages, vacation and sick time, taxes, and benefits. Appendix C lists all of the jobs and wages related with the Model 3 processing plant and corporate office. Wages were based on a six-level pay scale (as discussed in the section, *Facility Construction and Cost Data*). Each employee works 40 hours per week and was allotted an average of two weeks paid vacation and an average of 5% of working hours as sick time.

Taxes to be paid include FICA and unemployment compensation tax. FICA tax is calculated as 6.20% of employee wages on up to $76,200 of earnings. Unemployment compensation tax is calculated as 2.64% of the first $12,000 of an employee's earnings. In 1993, a "Fresh-Start Surcharge" was added to the unemployment compensation tax paid by employers. This surcharge, calculated as

Table 10. Number of employees allocated to dairy cost centers.

Cost Center	Model 1	Models 2 & 3	Model 4
Cooler	17	18.5	26.5
Cases and Returns	4.5	5	9
Blow Mold and Bottle Handling	4	6	12
Milk Receiving	1.5	1.5	3.5
Laboratory	3	3	4
Processing	3	3	3
Filling and Packing	9	10	14.5
Dry Storage	2	2	3
Maintenance	6	6.5	8
Sanitation	4.5	4.5	5.5
Corporate Office	31.5	31.5	31.5
Miscellaneous	10	10	13.5
Total	96	101.5	134

6.32% of a firm's total unemployment compensation tax, is added to the total tax paid.

Employee benefits consist of workers' compensation insurance and a full coverage health insurance plan. Worker's compensation insurance averaged $4.64 per $100 of earnings for plant workers in the milk processing industry. For employees not working in the plant facility or truck facility the worker's compensation insurance is calculated as $0.56 per $100 of earnings.

The employee health insurance is through Anthem Blue Cross/ Blue Shield. It provides 100% medical coverage with a $100 deductible. The cost to the employer is $105 weekly, per employee. This is an average of three rates based on whether the employee's spouse and/or dependents are covered under the policy.

Supplies

A large portion of supply costs results from the purchase of product packaging, including lids and labels for the plastic containers. Plastic and paper container prices vary according to the volume purchased and the number of colors with which they are printed. Effective use of the plant's dry storage area allows for higher volume purchases and thus lower cost per container. By examining the distribution of weekly container packaging and the available capacity of dry storage, purchasing quantities were calculated. Container prices were obtained from a survey of Maine dairies, based on the quantities calculated and a two-color print. The container prices include transportation charges.

The purchased plastic containers remain on the trailers until used for processing, rather than being moved into dry storage. An estimated price for the container was provided by the Maine dairies, and the prices of plastic caps and product labels were added. Also purchased is the five-gallon bulk container.

In Models 3 and 4 the plastic gallon and half-gallon containers are blow-molded with the in-plant facilities. Required supplies are plastic resin pellets, plastic caps, and product labels. The cost for resin was based on a quote from a plastics supplier and includes shipping to the facility. The amount of resin used to mold a container was suggested by JAI Engineers and set at 55 grams for the gallon and 40 grams for the half-gallon containers. The cost of caps and labels were obtained from the dairies. A 2% damage rate, suggested by JAI Engineers, applies to all purchased containers.

Another supply cost is milk cases, which are considered supplies because of the high replacement factor (approximately 25% annually). Costs were obtained from the Maine dairies and include shipping.

A few remaining supply costs were also accounted for, such as cleaning and maintenance supply costs, as estimated by JAI Engineers. Supplies for the corporate office (paper, forms, mailings) were derived from MMC records for Maine dairies.

Electricity

The electricity industry has been deregulated since the previous study. In the past Central Maine Power (CMP) would provide and deliver electrical service for a facility located in the Portland area. Under deregulation, CMP no longer generates the power it delivers. The total electrical charge now includes a delivery charge and a charge for the actual power. Several rate structures exist and vary in accordance with the peak demand required. For this facility, CMP's large general service primary system rates apply. Within this rate structure, charges exists for kWh (kilowatt hour) usage, peak kW (kilowatt) demand, and reactive demand (based on volt ampere reactance, kVars). Time of day and time of year also influence this rate.

JAI Engineers provided electrical usage and demand figures (see Table 9). To allocate the electricity rate according to time of day, it was assumed that the plant is operated at the "on-peak" period for 70% of the time, and at the "shoulder" period for the remainder. In accordance with the CMP rate structure, times of year rates were simply applied as eight months for summer and four months for winter.

Water, Sewer, and Product Loss

The Model 3 processing plant would use an estimated 52,000 cubic feet of water weekly. Water for Westbrook is obtained through the Portland Water District, and Portland water rates apply. Both water and the basic sewer charges are based on the quantity of water consumed. The rate applied to discharge of BOD is based on Portland rates. These rates are used rather than Westbrook rates since the sewer department in Westbrook has never dealt with a facility of this nature. In the Portland area the rate is calculated on a per pound basis with the first 250 gallons of effluent processed at no additional charge. Product loss is rated at 0.5% of total process volume.

Operating Capital

Calculation of operating capital for this model assumes a four-week lag between the time that expenses are paid and income is received. All expenses involved in the processing of products (supplies, taxes, insurance, labor, utilities) were totaled and the operating capital for a four-week period calculated. This four-week amount

is not available throughout the year for investment elsewhere. Using the Prime interest rate plus one percent, the annual interest lost on the operating capital was determined.

DISTRIBUTION COSTS

Distribution costs include expenses associated with delivering packaged products to retailers and maintaining a transportation fleet. Assumptions concerning the size of a distribution route (miles, number of stops) are consistent with practices of Maine dairies (Table 11).

A survey of Maine milk processors revealed general background information on the size and number of trucks used by processors in the state. From this information, two truck classes were identified: long tractor-trailers and long straight bodies. Because the capacities of these trucks differ, they are used for different routes depending on the level of service and the length of the route. The survey also provided insight into the percentage of plant production carried on each type of truck route. Using this information and the "cases per load," shown in Table 11, the number of trucks required in the distribution fleet was calculated using an estimate of peak-day shipping demand (Table 12).

In Models 1 through 3, the distribution of products is divided into three "route" environments. One of the routes is handled by tractor-trailers, which are used to deliver milk to high-volume retail outlets such as large grocery stores. The two other routes, metro and non-metro low-volume outlets, are serviced by long straight body trucks. These route types are "full-service" where the driver delivers and replenishes the shelves. In terms of the model, the major difference between these route types is the amount of time the driver spends at each stop (the full-service stops require extra time for the driver to stock the products in the store coolers). The primary

Table 11. Processed milk distribution route characteristics.

	Truck Route Types		
		Long body	
Route Characteristic	Tractor-Trailer	Metro	Non-Metro
Route time (Hours)	9	11	11
Time to 1st stop (min.)	25	10	30
Non-driving time per case (min.)	0.45	1.5	1.6
Driving time between stops (min.)	20	12	15
Time to return to plant (min.)	25	10	20
Route length in miles	150	90	150
Stops	5	20	20
Cases per stop	150	20	15
Cases per load (peak)	955	458	394

Table 12. Distribution fleet characteristics.

Vehicle Type	----- Model 1 ------ % Cases	# Trucks	-- Models 2 & 3 -- % Cases	# Trucks	---- Model 4 ---- % Cases	# Trucks
Tractor-Trailer	55	11	55	13	55	19
Straight Long-Body						
Metro	12	5	12	6	12	8
Non-Metro	33	16	33	19	33	28
Tractor-Trailer (depot)					33*	11
Fleet Truck Numbers		32		38		55

* Cases transported to the depot must be handled twice and require a separate vehicle fleet to handle the volume.

difference between the metropolitan and non-metropolitan routes is the number of stops and number of cases delivered per stop. Fleet characteristics are listed in Table 12.

Model 4 has a weekly capacity of 600,000 gallons of white milk per week. It was assumed that a plant of this size would deliver milk to the entire state. The MMC believes that a plant of this size with such a large distribution area would require a "depot" in Aroostook County to service the northern part of the state. Therefore, Model 4 also includes a depot in its distribution model. The depot is modeled as a "back-to-back" truck facility. Under this system tractor-trailers from the plant would simply unload their cargo into trucks at the depot through the trucks' doors. Depot trucks would then make the local deliveries. The infrastructure in this scenario is modest. It would include a space large enough to park and unload/load trucks, a power source so that the local trucks can be plugged in to maintain the proper temperature regime, and a small truck maintenance facility. Model 4 also includes the previously mentioned route types used by Model plants 1, 2, and 3.

Determination of distribution costs was based predominately on the information given. Most of the costs were directly allocated to a particular route (e.g., driver wage, truck cost, fuel). Other costs, however, (land and building, utilities, service equipment) could not be allocated directly and are classified as overhead costs. Total distribution overhead costs were apportioned to the whole distribution fleet based on fleet mileage. Overhead costs were derived for four areas: land and building, service equipment, service labor, and service utilities and supplies. Direct costs were split into three cost areas and standardized on a per route basis. The three cost areas are vehicle costs, fuel and service costs, and driver costs.

Vehicle costs include the purchase price of the truck, trailer/body, and refrigeration (reefer) unit. In addition to these costs, taxes, registration, and insurance are included. All prices were obtained from the Maine dairies and corroborated with independent information from trucking firms. Fuel and service costs cover operation and maintenance costs associated with a vehicle. Truck miles per gallon and reefer gallons per hour were provided by Maine truck dealers and the Maine dairies and used to estimate total fuel usage per route. Vehicle service was determined for the life of a vehicle based on actual service records provided by a fleet operator from a previous study and verified by the Maine dairies. Service cost includes parts, oil, and outside services only. Most repairs would be handled within the milk facility's own service garage. A separate cost was derived for re-treading of tires based on truck yearly mileage.

Truck driver hourly wages, for heavy and light-duty trucks, were supplied by the survey of Maine milk processors and corroborated with state wage data. Appropriate taxes and insurance were included (as in the processing model) along with an additional cost for uniforms.

Service equipment represents the tools required to perform vehicle maintenance, including jacks and hoists, compressors and hand tools. As with equipment costs in the processing plant, the annual cost of the service equipment was determined by amortizing the total acquisition cost with expected useful life of the equipment and the interest rate.

Estimates of the required labor for the truck service were based on a similarly sized Maine-based trucking fleet, and these findings were reviewed by the Maine dairies. The employee roster includes four mechanics, a parts manager, a secretary/clerk, and one service supervisor. Wages, taxes, and insurance costs were calculated in the same manner as the processing plant labor. An additional cost for employee uniforms was included.

Lastly, the cost of utilities and supplies are added into total overhead cost. These items represent the cost of electricity, heating fuel, water and sewer, waste disposal, and the investment of capital in parts inventory. Electricity and heating costs were based on information provided by JAI Engineers. Water and sewer costs reflect water usage for truck washing.

Combining the route direct and route overhead costs provides a final distribution cost by route. A cost of distribution per case is derived to determine the minimum distribution cost. As can be seen in Table 13, there is a large variation in distribution cost per case by route, with the tractor-trailer route being the lowest due to its higher volume.

Table 13. Distribution cost summary by route and plant model.

	Model 1			Model 2 & 3			Model 4			
		Straight	Long-Body		Straight	Long-body			Straight	Long-Body
Cost Category	Tractor	Metro	Non-Metro	Tractor	Metro	Non-Metro	Depot	Tractor	Metro	Non-Metro
Vehicle	$107.58	$75.00	$75.00	$107.58	$75.00	$75.00	$107.58	$107.58	$75.00	$75.00
Fuel & Services	$90.92	$58.88	$75.09	$90.92	$58.88	$75.09	$116.04	$90.92	$58.88	$75.09
Driver	$247.92	$195.25	$191.76	$245.80	$187.04	$191.96	$211.19	$245.96	$191.76	$184.29
Overhead/Route	$69.66	$41.80	$69.66	$59.44	$35.67	$59.44	$56.29	$36.08	$21.65	$36.08
Total Cost	$516.08	$370.93	$411.51	$503.74	$356.59	$401.49	$491.10	$480.54	$347.29	$370.46
Cost per Case	$0.60	$0.90	$1.17	$0.59	$0.88	$1.15	$0.55	$0.56	$0.78	$1.05

RESULTS AND ANALYSIS

This section presents a summary of processing costs along with several analyses. First, a summary of the processing and distribution costs is presented. Following this summary, an analysis of the sensitivity of processing cost changes is presented where 10% changes in five major cost categories are simulated. These cost changes are presented in percentage terms. The impact of various interest rates on container processing costs is also presented.

Summaries of the processing and distribution costs for each of the models are shown in Tables 14 through 17. The processing costs represent a theoretical lowest achievable cost to receive, process, and distribute fluid white-milk product. The purchase price of the raw milk product and the cost of applicable taxes were obtained from the MMC. Processing costs decrease as the size of the processing facility increases reflecting decreasing fixed costs per unit of output. This effect of spreading fixed costs across more units of output is also magnified in Models 2, 3, and 4 as the product lines are increased.

Distribution cost was determined by selecting the long-body metropolitan distribution route. Distribution costs per case were allocated to unit costs according to the number of units per cases

As previously mentioned, Model 4 includes a depot in northern Maine to facilitate distribution in the northern part of the state. To calculate an overall distribution cost, a weighted average distribution cost was calculated based upon the observation that approximately one-third of production would pass through the depot and the remainder would be distributed directly from the plant. The inclusion of the depot in Aroostook County requires additional trucks, drivers, and facilities. The next to last line in Table 17 gives the processing and average distribution costs including servicing the depot.

Table 14. Summary of costs by container type, Model 1.

	Plastic Gallon	Plastic ½ Gallon	Plastic Quart	Paper ½ Pint	Bulk 5 Gal	Plastic Pint
Unit Cost						
Processing	$0.514	$0.320	$0.257	$0.079	$3.556	$0.266
MMC Taxes	$0.003	$0.002	$0.001	$-	$0.017	$-
Total Processing	$0.518	$0.322	$0.257	$0.079	$3.573	$0.266
Raw Milk	$1.479	$0.740	$0.370	$0.092	$7.396	$0.185
Total Unit Cost	$1.997	$1.062	$0.627	$0.171	$10.969	$0.451
Distribution Costs	$0.151	$0.067	$0.037	$0.008	$0.603	$0.075
Total Processing & Distribution	$0.665	$0.387	$0.294	$0.087	$4.159	$0.341

Table 15. Summary of costs by container type, Model 2.

Costs	Plastic Gallon	Plastic ½ Gallon	Plastic Quart	Paper ½ Pint	Bulk 5 Gal	Plastic Pint	Paper ½ Gallon	Paper Quart	Paper Pint
Unit Cost									
Processing	$0.461	$0.281	$0.227	$0.062	$2.397	$0.231	$0.260	$0.153	$0.099
MMC Taxes	$0.003	$0.002	$0.001	$-	$0.017	$-	$0.002	$0.001	$-
Total Processing	$0.465	$0.283	$0.228	$0.062	$2.414	$0.231	$0.262	$0.154	$0.099
Raw Milk	$1.479	$0.740	$0.370	$0.092	$7.396	$0.185	$0.740	$0.370	$0.185
Total Unit Cost	$1.944	$1.022	$0.597	$0.154	$9.810	$0.416	$1.001	$0.524	$0.284
Distribution Costs	$0.148	$0.066	$0.036	$0.011	$0.591	$0.049	$0.066	$0.037	$0.021
Total Processing & Distribution	$0.609	$0.347	$0.263	$0.073	$2.988	$0.280	$0.326	$0.190	$0.120

Table 16. Summary of costs by container type, Model 3.

Costs	Plastic Gallon	Plastic ½ Gallon	Plastic Quart	Paper ½ Pint	Bulk 5 Gal	Plastic Pint	Paper 9 Gallon	Paper Quart	Paper Pint
Unit Cost									
Processing	$0.462	$0.313	$0.233	$0.061	$2.380	$0.237	$0.258	$0.152	$0.098
MMC Taxes	$0.003	$0.002	$0.001	$-	$0.017	$-	$0.002	$0.001	$-
Total Processing	$0.465	$0.314	$0.234	$0.061	$2.398	$0.238	$0.259	$0.153	$0.099
Raw Milk	$1.479	$0.740	$0.370	$0.092	$7.396	$0.185	$0.740	$0.370	$0.185
Total Unit Cost	$1.944	$1.054	$0.604	$0.154	$9.794	$0.423	$0.999	$0.523	$0.283
Distribution Costs	$0.147	$0.065	$0.037	$0.012	$0.591	$0.050	$0.065	$0.037	$0.021
Total Processing & Distribution	$0.609	$0.378	$0.270	$0.073	$2.971	$0.287	$0.323	$0.189	$0.119

Table 17. Summary of costs by container type, Model 4.

Costs	Plastic Gallon	Plastic ½ Gallon	Plastic Quart	Paper ½ Pint	Bulk 5 Gal	Plastic Pint	Paper ½ Gallon	Paper Quart	Paper Pint
Unit Cost									
Processing	$0.399	$0.272	$0.211	$0.055	$2.083	$0.216	$0.227	$0.134	$0.087
MMC Taxes	$0.003	$0.002	$0.001	$-	$0.017	$-	$0.002	$0.001	$-
Total Processing	$0.402	$0.274	$0.212	$0.055	$2.100	$0.222	$0.229	$0.134	$0.087
Raw Milk	$1.479	$0.740	$0.370	$0.092	$7.396	$0.185	$0.740	$0.370	$0.185
Total Unit Cost	$1.881	$1.013	$0.582	$0.148	$9.496	$0.402	$0.968	$0.504	$0.272
Distribution Cost	$0.139	$0.062	$0.035	$0.011	$0.557	$0.047	$0.062	$0.034	$0.020
Total Processing & Distribution	$0.538	$0.334	$0.246	$0.066	$2.640	$0.263	$0.289	$0.168	$0.107
Distribution Cost	$0.410	$0.180	$0.100	$0.030	$1.640	$0.140	$0.180	$0.100	$0.060
Total Processing & Distribution	$0.810	$0.450	$0.310	$0.090	$3.720	$0.350	$0.410	$0.240	$0.150
Weighted Average Costs									
Average Delivery Charge	0.229	0.102	0.057	0.018	0.917	0.076	0.102	0.057	0.033
Total Processing, Distribution, Depot	0.628	0.374	0.268	0.073	3.00	0.293	0.329	0.191	0.12

To test the stability of the processing cost results, several sensitivity analyses were performed. The effects on the total processing cost of changing prices on five major items was examined. These five items are wages, utilities, building construction, facility equipment, and supplies. Each was independently increased by 10%, and the effect on per unit costs calculated. Model 3 is used as the basis for this and the following discussion. Table 18 lists the sensitivity of per unit cost for each container type.

Generally, the fluctuations in cost are minimal; however, a 10% change in supply or labor costs does have a notable effect. Supplies consist of paper containers, plastic resin, milk cases and office paper among other things. A large portion of supply costs (over 80%) is accountable to product packaging (containers, resin, caps, and labels). Table 18 reveals that a change in supply costs has a greater impact on products that are packaged in purchased containers than products packaged in the blow-molded containers. This is because packaging represents a larger portion of processing cost; for example 50% of the small half-pint's processing cost is devoted to container cost as compared to only 25% for the plastic gallon. Labor is also a major cost category. A 10% increase in labor costs increases processing costs by an average of 2.7%.

An additional analysis was performed to view the impact of varying the capital investment interest rate. As suggested in the Economic-Engineering Methodology section of this document, processing costs were calculated with the interest rate set at 10%. Because of historic variations in interest rates over time[3], several interest

Table 18. Percentage change in per unit processing costs from a 10% change in five major cost categories in model 3.

Container Type	Wages	Utilities	Construction	Equipment	Supplies
			%		
Plastic Gallon	2.7	1.1	0.4	2.2	1.7
Plastic ½ Gallon	2.5	1.0	0.3	1.4	2.6
Plastic Quart	2.6	0.3	0.4	1.3	4.6
Paper ½ Pint	2.8	0.4	0.4	1.3	4.3
Bulk 5 Gallon	2.8	0.6	0.6	1.9	2.9
Plastic Pint	2.5	0.2	0.4	1.4	4.9
Paper ½ Gallon	3.0	0.6	0.5	1.9	2.9
Paper Quart	2.7	0.5	0.7	1.8	3.1
Paper Pint	2.6	0.4	0.6	1.6	3.7

[3]Within a few months of completing this study, the Prime interest rate dropped nearly two percentage points from 9.5% to 7.8%.

rates were applied to the processing model and the results recorded. The impacts of various interest rates on per unit costs are shown in Table 19.

Cost Comparisons 1993 to 2000

Current model results are compared with results from 1993 to determine the annual percentage change in annual processing costs between 1993 and 2000 for the nine cost categories and for the total cost of processing. To compare similar facilities, the 400,000-gallon-per-week blow-molding plants are considered. Overall real processing costs (adjusting 1993 costs to 2000 dollars) for the model plant have increased by 18% over the 1993 to 2000 period, which equates to a 2.4% annual increase.

The total increase over the time span equates to a 2.4% annual increase in production costs per year. Fuel, labor, and equipment costs are the primary sources of the cost increase. The largest increase has occurred in the equipment category reflecting a higher borrowing interest rate in addition to the continued adoption of automation technology. In 1993, the interest rate was 8% as compared to 10% in 2000. Between 1993 and 2000 the model plant experienced substantial investment in computer and related automation. The complete flow of milk is now tracked by computer, including information of tank levels, valve settings (on/off), milk temperature, and flow rates. From 1993 to 2000, annual costs for computer-related equipment has increased from $20,000 per year to $74,000 per year, not including sensors and other automation technology included within the plant's milk lines. A substantial cost was incurred to provide handheld computer equipment for the truck drivers.

In addition, labor rates have increased significantly over the intervening period. Across all comparable wage levels, real labor costs have increased between 4% and 47%, reflecting a tighter labor

Table 19. Per unit processing costs at various interest rates.

Container Type	8%	9%	10%	11%	12%	13%
Plastic Gallon	$0.445	$0.453	$0.462	$0.470	$0.479	$0.488
Plastic ½ Gallon	$0.304	$0.308	$0.313	$0.317	$0.322	$0.327
Plastic Quart	$0.228	$0.231	$0.233	$0.236	$0.239	$0.241
Paper ½ Pint	$0.060	$0.061	$0.061	$0.062	$0.063	$0.063
Bulk 5 Gallon	$2.305	$2.342	$2.380	$2.420	$2.461	$2.503
Plastic Pint	$0.232	$0.235	$0.237	$0.240	$0.243	$0.246
Paper ½ Gallon	$0.250	$0.254	$0.258	$0.262	$0.266	$0.270
Paper Quart	$0.147	$0.149	$0.152	$0.154	$0.157	$0.160
Paper Pint	$0.095	$0.097	$0.098	$0.100	$0.101	$0.103

market and higher health insurance costs. The average plant wage has increased 3.3% above the rate of inflation between 1993 and 2000. Energy costs have risen as well.

In comparison to a previous cost estimate conducted in 1993, overall processing costs have increased 18% over the seven-year period, or 2.4% above the rate of inflation on an annual basis. Since the 1993 and the 2000 facilities have the same weekly volume of white milk (400,000 gallons), these cost changes approximate per gallon cost increases in addition to total cost increases.

There are several reasons for this increase in cost. First, the analysis conducted for this study is artificial since the facility has been required to maintain a constant fluid milk output, while at the same

Table 20. The percentage change in costs for each cost category 1993 to 2000.

Cost Categories	1993*	2000	Total Change %	Annual Rate %
Operating Capital	$34,297	$94,164	175	15.5
Land & Building	$1,475,906	$1,920,522	30	3.8
Product Loss	$172,943	$177,466	3	0.4
Equipment	$1,505,063	$3,101,635	106	10.9
Fuel Oil	$127,755	$174,565	37	4.6
Supplies	$5,121,108	$4,135,125	-19	-3.0
Water & Sewer	$160,949	$157,314	-2	-0.3
Labor	$3,666,298	$4,714,420	29	3.7
Electricity	$736,196	$824,291	12	1.6
Total	$13,000,514	$15,299,502	18	2.4

* Values in 2000 dollars

Table 21. Comparative processing costs across models.

Container Type	Model 1	Model 2	Model 3	Model 4	Cost Difference Model 4 over Model 3
Plastic Gallon	$0.518	$0.465	$0.465	$0.402	-13.5%
Plastic ½ Gallon	$0.322	$0.283	$0.314	$0.274	-12.7%
Plastic Quart	$0.257	$0.228	$0.234	$0.212	-9.4%
Paper ½ Pint	$0.079	$0.062	$0.061	$0.055	-9.8%
Bulk 5 Gallon	$3.573	$2.414	$2.398	$2.100	-12.4%
Plastic Pint	$0.266	$0.231	$0.238	$0.222	-6.8%
Paper ½ Gallon		$0.262	$0.259	$0.229	-11.6%
Paper Quart		$0.154	$0.153	$0.134	-12.4%
Paper Pint		$0.099	$0.099	$0.087	-12.1%

time, the complement of equipment and labor has changed to reflect current trends. In reality, dairy processing firms that remain in existence increase their fluid output, thereby increasing their total costs of operation, but it is hoped lowering their per gallon processing cost. Therefore, the model plant is in effect modernizing, as it is updated from 1993 to 2000, but instead of fluid volume increasing, the study parameters require the plant to remain at 400,000 gallons per week. While milk processing facilities in reality would have processing expansion to offset cost increases, this model facility is restricted to a constant processing volume.

To show this, consider Models 3 and 4. Model 3 has a weighted average milk processing cost of $0.75 per gallon, which is above the 1993 model cost of $0.631 (after adjustment to 2000 dollars). However, with an expansion of white milk processing volume to 600,000 gallons per week, the weighted average processing costs equals $0.637 per gallon. This comparison shows that had a 400,000 gallon per week plant been modernized from 1993 to 2000, it would have had to increase volume processed to 600,000 gallons per week to gain the economies of size sufficient to offset technology and industry cost increases.

Economies of Size

Economies of size implications can be derived by comparing per unit costs across the three models. Higher volume of production allows the distribution of fixed costs over more units. Larger product lines in Models 2, 3, and 4 also allow for fixed cost distribution over more container types. Table 22 shows processing costs for the four plants with the percentage difference between Models 3 and 4 in the final column. These models are comparable since both have blow-molding technology and the same container mix.

Processing cost reductions range from 8.9% for the plastic pint container to 13.6% for the plastic gallon container. The container that accounts for the most milk volume, the plastic gallon, with just over 50% of all volume, experiences 13.5% processing cost reduction with the expanded volume.

However, the above analysis only looks at processing costs. Table 22 shows processing and distribution costs for Models 3 and 4. Once the additional costs of the depot in Aroostook County are incorporated into the distribution model, the 400,000-gallon plant without blow molding (Model 2) is the most efficient plant from a total cost perspective. This finding is consistent with the result presented in Kezis et al. (1983), where a 400,000-gallon plant is most economical when processing and distribution costs are included.

Table 22. Comparative processing and distribution costs.

Container Type	Model 1	Model 2	Model 3	Model 4	Cost Difference Model 4 over Model 3
Plastic Gallon	$0.665	$0.609	0.609	$0.628	3.1%
Plastic 1/2 Gallon	$0.387	$0.347	0.378	$0.374	-1.1%
Plastic Quart	$0.294	$0.263	0.27	$0.268	-0.7%
Paper 1/2 Pint	$0.087	$0.073	0.073	$0.073	0.0%
Bulk 5 Gallon	$4.159	$2.988	2.971	$3.000	1.0%
Plastic Pint	$0.341	$0.280	0.287	$0.293	2.1%
Paper 1/2 Gallon		$0.326	0.323	$0.329	1.9%
Paper Quart		$0.190	0.189	$0.191	1.1%
Paper Pint		$0.120	0.119	$0.120	0.8%

On-Site Blow Molding

Models 3 and 4 are equipped with on-site blow-molding capabilities. This section of the report will document the analysis used to quantify the cost savings associated with packaging the plastic gallon and plastic half-gallon with on-site blow-molding technology.

For analysis of the costs savings achieved with this technology, Models 2 and 3 can be compared. Models 2 and 3 are virtually identical 400,000-gallon-per-week model facilities, with the exception of the blow molding of the gallon and half-gallon plastic containers that occurs in model 3. On-site blow molding is replaced with the purchase and storage of plastic gallon and plastic half-gallon containers in Model 2.

The first change made to the processing facility is the removal of the equipment associated with blow molding. This includes the removal of the blow-molders, the removal of the resin storage tank, the removal of special ventilation equipment, and the removal of the plastic container grinders. This change in equipment needs for the facility represents a reduction of $2,656,000 in equipment costs.

Further changes to the processing facility include adjustments to the facility's electrical and water usage. Electrical usage declined in terms of both total kWh per year and peak usage values. Electrical cost reductions for the facility totaled $617,000 annually.

To compensate, plastic gallon and plastic half-gallon containers must be purchased from outside vendors. The container costs used for this study were obtained from the Maine dairy processors. The quoted delivered prices are $0.12 for gallon containers and $0.095 for half-gallon containers. The costs of labels and plastic caps are added to these costs. The plant square footage previously allocated to blow molding was allocated to the handling of empty plastic

containers. In addition, two trailers have been purchased for on-site storage of additional empty plastic gallon and half-gallon containers.

No changes in total labor requirements for the processing facility were deemed necessary by the engineer, although job tasks were reassigned in accordance with the change-over from blow molding to the purchase and storage of plastic gallon and plastic half-gallon containers.

With the above adjustments to the processing facility, the quantified difference in per unit processing costs between on-site blow molding and the purchase of plastic containers is obtained. Due to limited volume of gallon containers used in this facility, the cost for plastic gallons does not changed over the purchased container scenario. The processing cost for half-gallon containers increases with blow molding. Both the engineer and dairy processors indicate that a weekly volume of 400,000 gallons per week is probably not sufficient to justify investment in blow-molding equipment

CONCLUSION

This report presents milk processing costs for Maine dairies derived through an economic-engineering cost model developed in 2000. The model uses technical production coefficients and current prices and simulates the total cost of production for three different plant volumes to derive the minimum cost to produce and distribute fluid white milk in Maine.

All fixed costs of production were annualized and added to variable costs in order to derive an estimate of total production costs for each cost center. Total cost was then divided between white milk and by-products. The resulting white milk cost was allocated to containers based upon allocation rules relating to machinery utilization, production levels, and space occupied.

The importance of economies of size and on-site plastic blow-molding technology is revealed by the analysis. A 50% increase in processing volume reduces per unit plastic gallon processing costs by 6.3 cents, but on-site blow molding alone has little impact on per unit plastic gallon processing cost and raises plastic half-gallon processing costs by 3 cents. In addition, geographical constraints increase total cost in the largest plant so that size efficiency gains are negated by high distribution costs.

Analyses were conducted to assess the impact of input price changes on per unit processing costs. Results indicate that changes in supply (comprised primarily of packaging costs) and labor costs have the greatest impact on per unit processing costs. An analysis documenting the effect of varying interest rates was conducted. A 1%

change in the interest rate changed processing costs by approximately 1.5% across all containers.

Other factors contributing to increased costs include the higher interest rates, with a resulting impact on operating capital and annual equipment and facility costs, and the growth in the labor force and wages. The total number of employees has grown from 88 to 101 over the 1993 to 2000 period. The facility area with the greatest growth is the corporate office, but several other areas have experienced modest growth in employee numbers. Within the corporate office, several new management positions have been created and the computer department has expanded. Although not a specific area of inquiry of this analysis, it is suspected that greater regulations, computerization, and continued efforts to improve quality (and shelf-life) have been the major factors in labor force expansion.

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APPENDIX A

Description of Building Square Foot Cost

Site and General Construction

The site cost component includes the earthwork required to shape the site for roads and drainage, storm water drains and piping to street service, concrete pavement at truck ramps, heavy duty asphalt for truck drives, light duty asphalt for auto drives and parking, and property fencing plus landscaping and grass around office and visitor areas.

General construction of the buildings includes concrete foundations, compacted fill, concrete floors, and pre-cast concrete structure including columns, beams, and roof structure. Class A roof assembly with 3" insulation over general areas and 6" over coolers. Cooler walls are 4" metal-faced, urethane-insulated, factory-made panels.

Exterior walls are pre-cast concrete with 2" backup insulation (urethane). Interior walls are concrete block.

Acid-proof brick floors are used in all process areas and in part of the tank-truck-receiving area. Quarry tile is used in rest rooms, halls, and lunch room. Offices have asphalt tile. Fork truck areas include Anviltop along docks and at palletizers, and in remaining areas, metallic hardeners such as Masterplate 200[4]

Process areas include stainless steel doors and frames. Other areas include painted steel doors and frames, except cold storage doors used in coolers and freezer. Process area ceilings are epoxy finish on concrete structure. All walls that do not have tile or cold storage panels are painted.

Mechanical trades, refrigeration, and electrical

This cost component includes the cost of heating ducts, plumbing, ventilation, cooling system, and electrical wiring.

Rigging

Rigging includes the cost of receiving, unloading, uncrating and setting in place all dairy machinery and equipment.

Services

This component includes surveying, soil and concrete testing as well as engineering and architectural design services.

Contingency

Contingency is a cost component used to allow for unforeseen changes in the scope of work.

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[4] Any mention of particular brand names were supplied by JAI Engineers and are given as examples only

Table A-1. Total and per square foot construction, equipment and land costs for Model 3.

	Plant	Corporate Office	Truck Facility	Total
Land Cost				
Land Acreage	2.2	0.2	5.6	8
Cost per Acre	$33,000	$33,000	$33,000	
Total Land Cost	$71,163	$6,439	$186,398	$264,000
Interest Rate	10.0%	10.0%	10.0%	
Land Cost per Year	$7,116	$644	$18,640	$26,400
Land Cost per Sq Ft	$0.076	$0.076	$0.076	$0.227
Building Cost				
Total Bldg Area (Sq Ft)	93,935	8,500	9,300	111,735
Const. Project Services	$1,481,304	$134,040	$146,656	$1,762,000
Const. Cost per Sq Ft	$114.58	$114.58	$114.58	
Subtotal Direct Costs				
Building Cost	$10,763,021	$973,925	$1,065,589	$12,802,535
Land Cost	$71,163	$6,439	$186,398	$264,000
Equipment Cost	$15,226,419	$486,156	$452,863	$16,165,438
Total Bldg & Equip Value	$26,060,603	$1,466,521	$1,704,849	$29,231,973
Interest Expense				
Const. Period (months)	18	18	18	
Interest Rate	10.0%	10.0%	10.0%	
Construction Interest	$1,930,627	$108,643	$126,299	
Cost to Bldg per Sq Ft	$20.55	$12.78	$13.58	
Const. & Int. Cost/Sq Ft	$135.13	$127.36	$128.16	
Depreciation				
Expected Plant Life (Yrs)	33.3	33.3	33.3	
Interest Rate	10.0%	10.0%	10.0%	
Bldg Depr/Sq Ft/Year	$14.10	$13.29	$13.38	
Annual Maintenance Escrow				
2% per year	$215,260	$19,479	$21,312	$256,051
Cost to Bldg/Sq Ft/Yr	$2.29	$2.29	$2.29	
Property Tax				
Property Tax per Year	$659,073	$37,088	$43,116	$739,277
Cost to Bldg/Sq Ft/Yr	$7.02	$4.36	$4.64	
Fire and Liability Insurance				
Insurance per Year	$15,688	$1,420	$41,092	$58,200
Cost to Bldg/Sq Ft/Yr	$0.17	$0.17	$4.42	
Yearly Bldg Cost/Sq Ft	$23.58	$20.11	$24.72	

APPENDIX B

Full-Line Plant Equipment List for Model 3

Receive and Process	Qty	Total Cost	Lifespan	Depreciation per Year
Raw Milk Silo (60,000g)	4	$372,000	25	$47,257
Orange Juice Shell (8,000g)	1	$38,000	25	$5,656
Cream Silo (6,000g)	2	$56,000	25	$6,945
Silo (10,000g)	2	$68,000	25	$9,326
Silo (8,000g) (Sweetener)	3	$90,000	25	$12,615
Single Shell Past. (12,000g)	6	$204,000	25	$27,663
Single Shell Past (4,000g)	3	$72,000	25	$9,403
Single Shell - Mix (3,000g)	3	$78,000	25	$11,655
Processor (2,000g)	1	$40,000	25	$4,546
Dump Tank (2,000g)	2	$34,000	25	$3,996
HTST (8,000 GPH)	1	$102,000	14	$24,046
HTST (3,000 GPH)	1	$63,000	14	$15,545
Vacuum Reclaim	1	$30,000	16	$4,200
Raw Milk Plate Cool (300GPM)	1	$36,000	14	$8,320
Homogenizer (8,000 GPH)	1	$146,300	16	$37,708
Homogenizer (3,000 GPH)	1	$80,000	16	$21,723
Separator (30,000 lb/hr)	1	$360,000	16	$86,206
Parts Sinks	3	$36,000	16	$5,385
On-line Standardizer	1	$80,000	16	$11,966
Blender	1	$32,000	16	$4,786
Receiving Filter	1	$20,000	10	$5,020
Receive & Blend Rm Catwalks	1	$80,000	10	$13,820
Piping & CIP	26	$1,622,400	10	$296,486
Total		**$4,210,025**		**$758,367**

Laboratory (charged R&P)	Qty	Total Cost	Life (Dairy)	Depr/Year
Benches & Cabinets	1	$43,680	8	$8,624
Farm Sample Refrigerator	1	$8,295	8	$1,638
Refrigerator	1	$945	8	$187
Freezer	1	$1,365	8	$270
Autoclave	1	$5,460	8	$1,078
Incubator	2	$21,840	8	$4,312
Babcock Tester	1	$4,305	8	$850
Automated Milk Tester	1	$72,345	8	$14,284
Computer Terminal	1	$3,255	5	$891
Calculator	1	$420	5	$115
Glassware	1	$1,890	5	$517
Total		**$163,800**		**$32,766**

Blow Molding/Bottle Rm	Qty	Total Cost	Life (Dairy)	Depr/Year
Debagger	2	$74,000	15	$5,605
Unscrambler	1	$45,000	10	$8,224
Empty Bottle Conv. (1 Gal)	1	$18,000	12	$3,002
Empty Bottle Conv. (½ Gal)	1	$18,000	12	$3,002
Empty Bottle Conv. (QT/PT)	1	$32,000	12	$5,336
Conveyors	508	$182,880	12	$60

Controls	1	$12,000	12	$2,001
Dedicated Installation	1	$36,000	12	$6,003
Dock Seals, Bumpers, Shelter	7	$36,750	7	$8,642
Blow Molding Equipment	1	$2,944,000	18	$712,243
Line Controls	3	$24,000	12	$1,334
Total Blow Molding/Bottle		**$3,422,630**		**$755,452**

Dry Storage	**Qty**	**Total Cost**	**Life (Dairy)**	**Depr/Year**
Push-in racks	270	$34,020	10	$4,813
One Deep racks	306	$22,491	10	$3,182
Dock Leveler	3	$17,640	10	$3,800
Dock Seals, Bumpers, Shelter	3	$15,750	5	$4,312
Fork Truck	1	$50,400	4	$18,017
Total Dry Storage		**$140,301**		**$34,123**

Case Storage/Clean	**Qty**	**Total Cost**	**Life (Dairy)**	**Depr/Year**
Stack Conveyor	356	$99,057	11	$17,761
Overhead (One High)	361	$67,471	11	$10,896
Topout Unstacker	1	$29,400	11	$4,745
Stack pusher	2	$12,600	10	$2,137
Case Washer	1	$58,800	12	$9,983
Dedicated Installation	1	$58,800	12	$9,983
Controls	1	$10,500	12	$1,783
Hydraulics (Pumps and Piping)	1	$21,000	12	$3,565
Dock Seals, Bumpers, Shelter	4	$21,000	5	$5,750
Total Case Storage/Clean		**$378,628**		**$66,602**

Filling And Packing	**Qty**	**Total Cost**	**Life (Dairy)**	**Depr/Year**
Accumulation	50	$31,500	20	$4,330
Stack Full Case	219	$60,225	20	$8,279
One High	185	$32,930	20	$4,527
Line Divider	1	$8,000	20	$1,100
Single Pushers	2	$12,000	11	$2,454
Single Stacker	2	$44,000	10	$7,677
Double Stacker	2	$56,000	20	$7,698
Drop Packer	2	$130,000	20	$17,870
Rotary Packers	2	$96,000	20	$13,196
Dedicated Installation	1	$209,045	12	$35,490
Controls	1	$57,750	12	$9,804
Hydraulics (Pumps and Piping)	1	$59,850	12	$10,161
Palletizer	1	$165,000	11	$35,469
Stretch Wrap	1	$48,000	20	$6,598
Stack Conveyor Production	136	$40,800	11	$7,237
Vertical Stacker	1	$25,000	11	$4,989
Spot Pack	1	$50,000	11	$9,977
Supply Conveyor	66	$10,890	12	$1,960
Pallet Roller (Blend)	14	$3,990	12	$718
Labeler (1 Gal)	1	$110,000	9	$30,980
Labeler (1/2 Gal)	1	$110,000	9	$30,992
Plastic Filler - Gal	1	$285,000	10	$49,609
Plastic Filler - 1/2 Gal	1	$285,000	9	$60,453
Plastic Filler - Quart/Pint	1	$265,000	9	$51,069

Paper Filler - ½ Pint Paper	1	$460,000	9	$95,455
Paper Filler Quart/Pint	1	$581,000	9	$120,564
Paper Filler ½ Gal	1	$190,000	9	$39,427
Labeler (QT/PT)	1	$96,000	10	$16,584
Bag in Case Filler	1	$62,000	10	$10,681
Refrigeration System	0.25	$297,500	20	$49,819
Piping & CIP	11.5	$717,600	15	$99,369
Total Filling And Packing		**$4,600,080**		**$844,534**

Cooler & Cold Storage	**Qty**	**Total Cost**	**Life (Dairy)**	**Depr/Year**
Accumulator Conveyor	380	$239,400	12	$37,290
Stack Full Case Conveyor	1385	$380,875	11	$62,069
Refrigeration System	0.5	$595,000	20	$99,638
Palletizer	1	$197,400	11	$42,000
Unitizer	1	$71,400	11	$11,816
Stack Pusher	2	$12,600	11	$2,822
Flow Rack	320	$119,280	12	$18,699
Fixed Push-in Rack ($120/Pallet)	172	$21,672	12	$3,397
One-Deep (Ingredients & OF)	48	$3,528	12	$553
Fork Truck	2	$100,800	5	$27,599
Controls	1	$42,000	5	$11,499
Hydraulic Pumps and Piping	1	$36,750	5	$10,062
Dedicated Installation	1	$170,100	5	$46,573
Vertical	1	$25,000	20	$3,436
Line Divider	1	$12,000	20	$1,650
Loadout Conveyor	576	$172,800	20	$23,753
Stack Sorter	1	$17,640	11	$3,191
Polyethelene Pallets	1000	$83,475	3	$34,401
Truck Leveler	3	$64,890	7	$13,966
Dock Leveler	4	$23,520	7	$5,544
Dock Seals, Bumpers, Shelter	7	$36,750	7	$8,642
Total Cooler		**$2,426,880**		**$468,601**

Miscellaneous	**Qty**	**Total Cost**	**Life (Dairy)**	**Depr/Year**
Desk	15	$6,678	8	$1,317
Chair	15	$3,339	8	$659
Ref. Table	7	$2,573	8	$507
Computer Terminal	7	$16,905	5	$4,626
Calculator	15	$1,166	5	$319
Copier	2	$2,671	5	$731
Lunch Table	4	$1,470	8	$290
Lunch Chair	16	$3,562	8	$703
Locker	120	$18,018	8	$3,554
Waste Basket	20	$273	5	$75
File	20	$4,116	8	$812
Telephone	24	$21,370	5	$5,847
Intercom	12	$6,010	5	$1,645
TV Monitor	8	$21,815	5	$5,969
Time Clock	3	$4,341	5	$1,188
Detection System	1	$21,926	5	$6,000

Cold Return Crusher	1	$37,800	12	$7,098
Truck Scale	1	$71,400	12	$15,092
Elevator	1	$26,250	25	$3,417
Trash Compactor	1	$40,625	5	$11,242
Fork-Lift Truck	1	$50,400	5	$15,409
Total Miscellaneous		**$362,706**		**$86,499**
Corporate Office	**Qty**	**Total Cost**	**Life (Dairy)**	**Depr/Year**
Desk	25	$11,130	8	$2,198
Chair	25	$5,565	8	$1,099
Conference Table & Chairs	1	$3,228	8	$637
File Cabinet	20	$4,116	8	$813
Telephone	25	$22,260	5	$6,095
Calculator	20	$1,554	5	$425
Waste Basket	25	$420	7	$90
Computer (Mainframe & Operating Software)	1	$52,500	10	$9,069
Enterprise-wide software for admin, dist, etc.	1	$52,500	10	$9,069
Vendor support during implementation	1	$26,250	10	$4,535
PCs for interface with hand held terminals	2	$5,250	10	$907
Printers, other I/O Devices	1	$10,500	10	$1,814
Cabling/wiring for terminals, LAN, etc.	1	$10,500	10	$1,814
Dumb terminals for data entry	8	$8,400	10	$1,451
PCs, software, printer, etc.	10	$26,250	10	$4,535
Hand Held Terminals & Printers for Routes	45	$236,250	10	$40,811
Photo Copier	1	$1,336	5	$366
Facsimile	1	$946	4	$308
Safe	1	$1,336	8	$264
Lunch Table	4	$1,470	8	$290
Lunch Chair	16	$3,562	8	$703
Clock	15	$835	8	$165
Total Corporate Office		**$486,156**		**$87,457**
		Investment		**Annual**
TOTAL Cost		$15,712,575		$3,091,192

APPENDIX C

Plant List of Employees: Model 3

This appendix lists the employees required for the dairy facility. Distribution employees are not included.

	# Employees	Class	Weekly Rate	Weekly Wages	Taxes & Benefits	Weekly Total
Cooler						
Load Routes at Night						
Truck Jockey	1	1	$515	$515	$167	$682
Inside Truck	1	1	$515	$515	$167	$682
Select High Volume	1	1	$515	$515	$167	$682
Select Low Volume	4	1	$515	$2,060	$668	$2,728
Supervisor	1	3	$700	$700	$187	$887
Load Trailers Daytime						
Fork Truck & Jockey	1.5	1	$515	$773	$250	$1,023
Select High Volume	1	1	$515	$515	$167	$682
Select Low Volume	2	1	$515	$1,030	$334	$1,364
Incoming Product						
Purchased Items	1	1	$515	$515	$167	$682
Production First Shift	2	1	$515	$1,030	$334	$1,364
Production Second Shift	2	1	$515	$1,030	$334	$1,364
Cooler Supervisor	1	3	$700	$700	$187	$887
Total Cooler	**18.5**			**$9,898**	**$3,129**	**$13,027**
Cases & Returns						
Feed Production 1st Shift	1	1	$515	$515	$167	$682
Feed Production 2nd Shift	1	1	$515	$515	$167	$682
Unload Trucks 1st Shift	1	1	$515	$515	$167	$682
Unload Trucks 2nd Shift	1	1	$515	$515	$167	$682
Returns and Dumps	1	1	$515	$515	$167	$682
Total Cases & Returns	**5**			**$2,575**	**$835**	**$3,410**
Blow Mold (or bottle handling)						
First Shift	1	2	$560	$560	$172	$732
Second Shift	1	2	$560	$560	$172	$732
Blow Mold	2	2	$560	$1,120	$344	$1,464
Bag 1 Gallon	1	2	$560	$560	$172	$732
Bag ½ Gallon	1	2	$560	$560	$172	$732
Total Blow Mold	**6**			**$3,360**	**$1,032**	**$4,392**
Milk Receiving (7 Days)						
Receive Raw Milk	1.5	1	$515	$773	$250	$1,023
Total Milk Receiving	**1.5**			**$773**	**$250**	**$1,023**
Laboratory						
Lab & Q.C.	2	1	$515	$1,030	$334	$1,364
Lab Super	1	3	$700	$700	$187	$887
Total Laboratory	**3**			**$1,730**	**$521**	**$2,251**

	# Employees	Class	Weekly Rate	Weekly Wages	Taxes & Benefits	Weekly Total
Processing						
HTST (1 per shift)	2	2	$560	$1,120	$344	$1,464
Blend (1 shift only)	1	2	$560	$560	$172	$732
Total Processing	**3**			**$1,680**	**$516**	**$2,196**
Filling & Packing						
Plastic Gallon	2	2	$560	$1,120	$344	$1,464
Plastic ½ Gallon	2	2	$560	$1,120	$344	$1,464
Plastic Quart	1	2	$560	$560	$172	$732
Paper ½ pint	2	2	$560	$1,120	$344	$1,464
Bulk 5 Gallon	0.5	2	$560	$280	$86	$366
Plastic Pint	1	2	$560	$560	$172	$732
Paper ½ Gallon	0.5	2	$560	$280	$86	$366
Paper Quart	0.5	2	$560	$280	$86	$366
Paper Pint	0.5	2	$560	$280	$86	$366
Total Filling & Packing	**10**			**$5,600**	**$1,720**	**$7,320**
Dry Storage						
Receive & Feed Operations	2	1	$515	$1,030	$334	$1,364
Total Dry Storage	**2**			**$1,030**	**$334**	**$1,364**
Maintenance						
Chief Engineer	1	4	$1,200	$1,200	$241	$1,441
On Floor Each Shift	2	3	$700	$1,400	$374	$1,774
Lubrication	1	3	$700	$700	$187	$887
Preventive Maintenance	2	3	$700	$1,400	$374	$1,774
Boilers & Refrig.	0.5	3	$700	$350	$93	$443
Total Maintenance	**6.5**			**$5,050**	**$1,269**	**$6,319**
Sanitation						
CIP Lines	1	1	$515	$515	$167	$682
CIP Fillers	1	1	$515	$515	$167	$682
Janitor (1 per shift)	2	1	$515	$1,030	$334	$1,364
Waste Recycling	0.5	1	$515	$258	$83	$341
Total Sanitation	**4.5**			**$2,318**	**$751**	**$3,069**
Corporate Office						
Corporate Management						
Corporate President/CEO	1	7	$3,500	$3,500	$205	$3,705
V.P. Operations	1	6	$2,500	$2,500	$200	$2,700
V.P. Sales and Marketing	1	6	$2,500	$2,500	$200	$2,700
Secretary/Clerk	2	1	$515	$1,030	$303	$1,333
Finance & Accounting						
Department Head	1	6	$2,500	$2,500	$200	$2,700
Dept. Head Assistant	1	3	$700	$700	$190	$890
Secretary/Clerk	3	2	$560	$1,680	$417	$2,097
Secretary/Clerk	1	1	$515	$515	$189	$704

	# Employees	Class	Weekly Rate	Weekly Wages	Taxes & Benefits	Weekly Total
Computer Operators	2	2	$560	$1,120	$303	$1,423
Computer Operator/ Analyst	1	3	$700	$700	$190	$890
Sales & Marketing						
Department Head	1	5	$1,500	$1,500	$194	$1,694
Dept. Head Assistant	1	4	$1,200	$1,200	$193	$1,393
Sales Person	4	4	$1,200	$4,800	$546	$5,346
Supermarket Contact	1	4	$1,200	$1,200	$193	$1,393
Route Check-in/Cashier	1	2	$560	$560	$189	$749
Route Organizer	1	4	$1,200	$1,200	$193	$1,393
Route Supervisor	2	3	$700	$1,400	$305	$1,705
Ordering Staff	2.5	2	$560	$1,400	$360	$1,760
Secretary/Clerk	1	2	$560	$560	$189	$749
Human Resources						
Department Head	1	4	$1,200	$1,200	$193	$1,393
Dept. Head Assistant	1	3	$700	$700	$190	$890
Secretary/Clerk	1	1	$515	$515	$189	$704
Total Corporate Office	**31.5**			**$32,980**	**$5,331**	**$38,311**
Miscellaneous						
Manager	1	5	$1,500	$1,500	$194	$1,694
Assistant Manager	1	4	$1,200	$1,200	$193	$1,393
Manager & Purchase	1	4	$1,200	$1,200	$193	$1,393
Secretary/Clerk	0	2	$560	$0	$0	$0
Vacation (2 wks/person)	3	2	$560	$1,680	$417	$2,097
Work. Comp. Fresh Start Surcharge						$114
Relief & Absent (5%)	4	2	$560	$2,240	$687	$2,927
Total Miscellaneous	**10**			**$7,820**	**$1,684**	**$9,618**
GRAND TOTAL	**101.5**			**$74,814**	**$17,372**	**$92,300**

APPENDIX D-1

Allocation of Cost Categories to Cost Centers

Land and building

The annual cost of owning land, constructing the facility, plus the annual cost of the completed facility are distributed across the physical cost centers based on associated cost center square footage. The cost of miscellaneous areas, such as in-plant offices, rest rooms, hallways, and the lunchroom, are assigned to the overhead cost center.

Labor

Employee costs are allocated to the physical cost centers based solely on each individual's job description. For example, those employees who work with the filling machines have their wages accounted for in the filling and packing cost center. Certain employees were assigned to the overhead cost center if their contribution to the operation was not specifically related to any particular physical cost center.

Equipment

Equipment annual costs are either assigned to the appropriate physical cost center, or if they do not coincide with any one cost center, they are allocated to the overhead cost center. For example, filling machine costs are assigned to the filling and packing cost center.

Supplies

The cost of supplies includes paper containers, purchased plastic containers, resin for blow molding, plastic caps, container labels, milk cases, and cleaning and maintenance materials. The cost of paper containers, plastic containers, including bulk five-gallon containers, and the required number of caps and labels are allocated to the filling and packing cost center. For the plastic gallon and plastic half-gallon containers the cost of resin and the cost of caps and labels are applied to the blow-molding cost center. The cold storage cost center is assigned the cost of purchasing and replacing milk cases. Lastly, cleaning and maintenance supply costs are placed in the overhead cost center.

Electricity

Electricity requirements were derived based on the needs of specific equipment and other demands (e.g., lighting) and assigned to the appropriate cost centers. The electrical requirements for the in-plant offices are included under the overhead cost center.

Fuel oil

Fuel oil is used for building heating, product processing, and equipment cleaning. The cost of heating the in-plant offices and rooms is assigned to the overhead cost center. Heating cost for the corporate office is assigned to the corporate office cost center. Lastly, the cost of fuel oil for processing and cleaning is assigned to the volume direct cost center.

Water and sewer

The costs of water and sewer are assigned to the volume direct cost center since water usage to a very large extent is associated with volume of product processed.

Product loss

The cost of product loss is allocated to the volume direct cost center.

Operating capital

The interest lost on operating capital is assigned to the overhead cost center.

APPENDIX D-2

Allocations between White Milk and By-Products

Land and building

Receive and process. Area used specifically for by-product production (orange juice freezer, blend room) is allocated directly to by-product receive and process (R&P) area. The remaining areas of R&P are shared by white milk and by-products (process room, pasteurization tank hall). These areas are apportioned based on volume processed. For example, if approximately 15.7% of processing volume is by-products, then 15.7% of the shared R&P square footage is allocated to by-products. The total square footage allocated to white milk is the total R&P area less the calculated area of by-product R&P.

Blow molding. Two blow molders exist in the plant, each occupying one half of the blow molding area. From the number of containers blown on each machine, and the number of those containers that were used for by-products, the respective areas can be apportioned to white milk and by-product blow molding. Land and building costs are then applied according to cost per square foot.

Dry storage. By-product and white milk dry storage area is split on a simple percentage of space basis. According to JAI Engineers, by-product ingredients and supplies occupy approximately 50% of the dry storage floor space. Thus, the cost of the land and building for the dry storage area is split equally between white milk and by-products.

Filling and packing. The cost of the filling and packing area shared by both milk and by-products is split based on portion of total volume packaged.

Case clean / storage. Allocation of land and building cost is based on number of cases used. By-products include the additional number of cases for any outside purchases that are repacked into cases.

Cold storage. Allocation of cold storage land and building cost is based on the number of cases held in cold storage. By-products receive the cost of the additional area used to store outside purchases.

Corporate office and overhead. Corporate office and overhead costs are allocated between white milk and by-products consistently across all cost categories (land and building, labor, equipment). The costs are split between white milk and by-products according to the

percentage of total direct costs (all other costs except corporate office and overhead) assigned to white milk and by-products. For example, in the land and building cost category, 30% of direct costs are allocated to by-products As a result, 30% of the corporate office and overhead costs are allocated to by-products. The remaining 70% would be applied to land and building white milk costs.

Labor

Receive and process. The cost of by-product-specific labor (ex: product blending) is assigned directly to by-product labor cost. The remaining R&P labor cost is divided between white milk and by-products based on portion of volume processed.

Blow molding. Labor cost for blow molding is allocated based on the number of containers blown for white milk and by-products.

Dry storage. The cost of dry storage labor is split according to percentage of space allotted to white milk and by-products.

Filling and packing. Approximate hours of filling time spent to fill white milk versus by-product packages is used to split filling and packing labor cost.

Case clean / storage. Labor cost for case clean/storage is split based on number of cases used for white milk versus by-products. By-products are also allocated the labor cost associated with handling cases used for outside purchases.

Cold storage. Labor cost is split based on number of white milk versus by-product cases stored. By-products include the cost for storing cases of outside purchases.

Corporate office and overhead. Cost is split according to total cost of labor assigned to white milk and by-products from the previous cost center allocations.

Equipment

Receive and process. By-product-specific equipment cost is assigned directly to by-product cost. White milk-specific equipment cost is assigned directly to white milk cost. The remaining receive and process equipment cost is shared between white milk and by-products according to volume processed.

Blow molding. Gallon and half-gallon molding equipment cost is shared between white milk and by-products based on number of containers cast for each.

Dry storage. The dry storage equipment cost is divided between white milk and by-products based on the portion of space occupied.

Filling and packing. Equipment cost for filling and packing is allocated according to approximate hours of run-time for white milk and by-products.

Case clean / storage. Equipment cost is split based on number of cases used. By-products share of this cost also includes cases used for outside purchases.

Corporate office and overhead. Cost is split according to total cost of equipment assigned to white milk and by-products from the previous cost center allocations.

Supplies

Blow molding. Blow-molding supplies represent the costs of resin, caps, and labels. This is divided between white milk and by-products on a container basis.

Filling and packing. The cost of purchased containers are accounted for under filling and packing supplies. This is divided between white milk and by-products on the basis of number of containers processed.

Cold storage. The cost of initially purchasing and future replacement of milk cases is allocated to cold storage. This cost is split between white milk and by-products based on the number of cases of each stored.

Volume direct. Cleaning and maintenance supply costs are distributed according to the volume processed for white milk and by-products.

Corporate office and overhead. Cost is split according to total cost of supplies assigned to white milk and by-products from the previous cost center allocations.

Electricity

Receive and process. Electricity cost for receive and process is distributed between white milk and by-products based on volume processed.

Blow molding. Electricity cost for blow molding is split according to number of containers blown for white milk and by-products.

Filling and packing. For those fillers that fill both white milk and by-products, the electricity cost is split according to filler run-time.

Case clean / storage. Electricity cost is split based on number of white milk versus by-product cases. By-product's share of cost also includes outside purchases.

Corporate office and overhead. Cost is split according to total cost of electricity assigned to white milk and by-products from the previous cost center allocations.

Fuel Oil

Volume direct. The cost of fuel oil in processing milk is assigned to white milk and by-products on a percentage of processing volume basis.

Corporate office and overhead. Cost is split according to the total cost of fuel oil assigned to white milk and by-products from the previous cost center allocations.

Water and Sewer

Volume direct. Water, sewer, and waste disposal costs are divided between white milk and by-products on a percentage of processing volume basis.

Product Loss

Volume direct. The cost of product loss is divided between white milk and by-products on a percentage of processing volume basis.

Operating Capital

Overhead. Cost is distributed between white milk and by-products according to total process cost for the total of all cost categories.

APPENDIX D-3

White Milk Cost Center Allocations to Containers

Receive and process

The cost of the receive and process cost center is based primarily on the volume throughput. For this reason packages are allocated their portion of the receive and process cost based on the packaged volume.

Blow molding

Blow-molding costs apply only to the plastic gallon and half-gallon packages. Two blow molders are used in the full-line plant: one for casting gallon containers and the other for half-gallon containers. Because of this, one-half of the land and building, labor, and electricity costs are allocated to the plastic gallon packages and one-half of these costs are allocated to the plastic half-gallon packages. Equipment cost for the blow molders is known, so annual cost is applied to each package accordingly. The cost of resin is allocated to the packages according to the container's resin requirements. Electricity requirements are directly allocated to the molders based upon production requirement.

Bottle-handling labor is included in this category also. It consists of unloading trucks, debagging the bundles and feeding the filler lines with the containers. This cost is allocated based on the space utilization of each container type.

Dry storage

Paper containers, plastic caps, and product labels are kept in dry storage on pallets. From the number of containers on hand and the number of containers per pallet, the relative amount of dry storage space occupied by paper containers is calculated. Space allocated to plastic caps and labels is set at 11% of dry storage space, based on information provided by JAI Engineers. By utilizing these space allocations, the cost of land and building and equipment are allocated to the packages respectively.

Filling and packing

All of the fillers occupy approximately the same amount of floor space, with the exception of the bulk filler. Land and building cost was allocated to the packages based on the estimated percentage of area occupied. Labor cost was assigned to the packages according to filler run-time.

The individual cost of each filler is known; thus the equipment annual cost is assigned to the respective packages. Those fillers that

fill more than one type of package have the cost split according to filler run-time for those packages.

Filling and packing supplies account for the purchasing price of the paper and purchased plastic containers. The cost is assigned to the packages respectively.

Approximate electrical utilization for each of the fillers was given by JAI engineers. This allows for a reasonable breakdown of electricity cost to fillers and then, based on filler run-time, to each of the packages.

Case cleaning/storage

All costs associated with case cleaning/storage are distributed across the package types according to the number of cases used by each.

Cooler

All costs associated with the cooler are distributed across the package types according to the number of cases used by each.

Volume direct

This cost center is apportioned according to total product volume packaged for each container type.

Corporate office and overhead

The total cost allocated to each container type, from the cost centers discussed above, is used to apportion the total costs of the corporate office and overhead cost centers.