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ECONOMIC AND MARKET FEASIBILITY
OF PACKAGING MICHIGAN POTATOES IN
INSTITUTIONAL SIZE RETORT POUCHES

presented by

Donald Lee Hinman

has been accepted towards fulfillment
of the requirements for

MASTER OF SCIENCE degree in Agricultural Economics

Thomas R Pierson
Major professor

Date November 6, 1990

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ECONOMIC AND MARKET FEASIBILITY OF PACKAGING MICHIGAN POTATOES IN INSTITUTIONAL SIZE RETORT POUCHES

By

Donald Lee Hinman

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1990

655-2130

ABSTRACT

ECONOMIC AND MARKET FEASIBILITY OF PACKAGING MICHIGAN POTATOES IN INSTITUTIONAL SIZE RETORT POUCHES

By

Donald Lee Hinman

Packaging potatoes in institutional size retort pouches is analyzed as a possible market outlet for Michigan potatoes. A two-pronged research approach involves estimation of unit costs of retort pouch potato products (RPP) and an assessment of the market potential for RPP in the food service industry. Break-even costs for a six-pound pouch is estimated to be $2.62 (44¢ per pound), which translates to a likely price disadvantage relative to competing products. Food service operators expressed general satisfaction with existing potato products and will not readily switch to use of retort pouch potato products.

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1990

To Carroll S. Hinman, whose memory I cherish and whose dedication to public service will always be a source of inspiration

ACKNOWLEDGEMENTS

I am very grateful to Dr. Thomas Pierson for suggesting the thesis topic, arranging the funding, and guiding my work. I learned a great deal about potatoes and the food industry in the process. I also want to express my appreciation to the Michigan Potato Industry Commission and the Agricultural Experiment Station of Michigan State University, whose financial support made this research possible. The other thesis committee members were Dr. Jerry Cash from the Department of Food Science Human Nutrition and Dr. Allen Shapley, Department of Agricultural Economics. Dr. Cash's knowledge of food processing was most valuable in getting this research completed. Dr. Shapley's thoughtful comments and suggestions were quite helpful and improved the final product considerably. Finally, I wish to thank my fellow graduate students for the camaraderie that made the graduate program so much more enjoyable.

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CHAPTER 1: INTRODUCTION

Michigan potato growers, especially growers of round white potatoes, have expressed concern that there is insufficient demand for their product and that developing and implementing new processing methods may be one way to improve that situation. This research considers the feasibility of establishing a plant to process potatoes employing a packaging technology not currently used in Michigan, the retort pouch. The research has two main parts: 1) determination of the costs of establishing and operating a commercial scale plant, and 2) performing a preliminary market potential assessment within the food service industry.

BACKGROUND AND IMPORTANCE

Potatoes are an important cash crop for Michigan. The 1.1 billion pounds produced in 1987 were valued at close to $57 million.[1] The bulk of Michigan potatoes are produced by about 400 major producers located in several regions of the state. The two highest producing counties are Montcalm County in west central Michigan and Bay County in the Thumb region.

There are two major types of potatoes grown in the U.S.: white potatoes and russet potatoes. Round whites are the most common kind of white potato, and these varieties are grown mainly in the Central and Eastern states. Russet potatoes are grown most extensively in the Northwestern states. Both types are grown in Michigan.

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[1]Michigan Department of Agriculture. 1988 Michigan Food and Fiber Facts.

One half of Michigan potato production consists of round white varieties.[2] A number of independent packers (many of them also growers), supply round whites for the fresh tablestock market. Several chippers (manufacturers of potato chips) also provide outlets for growers of round whites.

Problems in the Michigan Potato Industry

Chase argues that Michigan has great potential for expanding its potato industry. Michigan is endowed with the basic production factors: suitable climate and soil, water, interested growers, and available acreage.[3] Also available are transportation facilities and nearness to substantial population centers, and an established processing industry.

Since Chase made those arguments, however, the departure of Ore-Ida has raised concerns within the Michigan potato industry about market outlets. There are also other negative factors that impede the development of a more progressive and viable potato industry in Michigan. Several key shortcomings are discussed below.

Potato yields that are consistently below the national average result in higher per unit production costs that negate the lower distribution costs enjoyed by Michigan over Western growing areas.[4] Present production, handling, and storage methods

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[2]Lisa Allison, "A Comparative Cost Analysis of Packing Assorted Sizes and Small, Medium, and Large Sizes of Round White Potatoes in 10-Pound Consumer Bags in Small and Large Potato Packing Plants" (M.S. Thesis, Department of Agricultural Economics, Michigan State University, Michigan State University, East Lansing, 1986).

[3]Richard W. Chase, "Project Description: Improved Production and Utilization for Michigan Potatoes," Department of Crop and Soil Sciences, Michigan State University, East Lansing, 1985.

[4]Chase.

result in potatoes that arrive on the fresh market or are delivered to processors' plants with less than desirable quality characteristics.

Tight quality standards, uniform sizing and centralized packing, all characteristic of the potato industry in the U.S. northwest, are largely absent in Michigan. Michigan's independent packing operations usually pack to USDA #1 size standards with sizes ranging from 1 7/8 to 3 1/2 inches. The range of potato size within a single bag, and the presence of misshapen potatoes, mar the quality image for both wholesale buyers and consumers. In the U.S. northwest, the small, overly large, and misshapen potatoes are sorted out and the "sort-outs" are sent for processing (often into starch and flour). There is a relationship between the fresh market quality problem of Michigan potatoes and the lack of remunerative outlets for sort-outs. Establishing a processing plant that could provide such an outlet might also enhance the economic incentive to improve the fresh market quality through improved sorting.

The Need for Expanding Processing Opportunities

This research was undertaken on the premise that the problem of limited marketing opportunities for growers of round white potatoes could be addressed by investigating the feasibility of alternative processing methods to those now in use in Michigan. The purpose of providing additional marketing outlets for growers through expanding processing opportunities would be to increase total sales of round white potatoes as well as providing an outlet for sort outs from fresh packing. However, it is recognized that other varieties may also be appropriate candidates for the processing methods, including russets and relatively new varieties such as Yukon Gold and Michigold (which have a yellow, rather than white, flesh).

Food scientists and packaging specialists at Michigan State University indicate that one of the processing technologies that merits further investigation is packaging potatoes in retort pouches. This package is essentially a "flexible can." In the proposed retort pouch plant, raw peeled potatoes would be placed inside a pouch which is then sealed and retorted, yielding a sterilized, shelf-stable, cooked product. One of the pouch's main advantages is its thin profile compared to a can, which results in less time and energy required for sterilization. The reduced heating time allows the potato to maintain an improved texture since the need to sterilize potatoes in the center of standard cylindrical cans overcooks potatoes on the edges. Also, canned potatoes require added liquid (usually brine in the case of canned vegetables). Much less liquid is likely to be required for the retort pouch potato products, and perhaps none, depending on the product form. Potato products in retort pouches would be would be shelf-stable (requiring no refrigeration before opening), and may have shelf lives similar to cans; however, research experience at this time is insufficient to be more definitive.

ORGANIZATION OF THE THESIS

The thesis is organized as follows. Chapter 2 defines the research problem and explains the methods used to carry it out. Chapter 3 outlines the development of the retort pouch, including technological aspects. Chapter 4 focuses on the experiences of firms that have attempted to market food products packaged in retort pouches. Chapter 5 details the cost estimate per pouch and per pound for production of retort pouch potato products based on the model plant. The retort pouch packaging process is illustrated with a flowchart and a description of the stages in processing. Chapter 5 also explains how specific cost elements are estimated. Some sample calculations are provided for illustrative purposes. Chapter 6 covers the results of the attitude survey of food service buyers and institutional wholesalers toward the concept of using retort pouch potato products in their operations. Chapter 7 summarizes key points from previous chapters and provides as assessment of the prospects for this potential food product innovation, retort pouch potatoes.

CHAPTER 2: RESEARCH OBJECTIVES AND METHODS

This chapter begins by stating the research problem and explaining the three major objectives of this research project. The methods and procedures used in carrying out the research are then described, emphasizing the value of combining cost analysis with an assessment of market potential based on interviewing food service buyers and wholesalers.

THE RESEARCH PROBLEM

The basic question to be answered is: are there unexploited processing opportunities for Michigan potatoes? The particular processing method to be investigated in this regard is packaging potatoes in retort pouches. A key aspect of determining feasibility is to estimate the costs involved in setting up and operating a single small scale plant. "Small scale" in this instance is defined as a plant with one retort pouch filling machine and the complement of equipment necessary to keep that one filler operating at or near capacity. The methods and guidelines developed in this study can be used in follow-up work, such as investigating the costs of plants with different layouts, kinds of equipment, and levels of output.

The research problem has another element in addition to knowledge of costs: will the product sell? Of the two major market segments, retail supermarket operations and food service operations, focusing exclusively on the food service market is an appropriate goal for this study for several reasons. First, new and different products often find better initial acceptance in food services than if offered for sale on supermarket shelves. That is, many precooked entrees first achieve acceptance in restaurants and subsequently as consumer retail products. Frozen hash browns and chicken nuggets are examples.

A second factor is that supermarket test marketing has been done on retort pouch products, and it has met with very limited success. Despite early projections that the retort pouch would make significant inroads into the canned food market, several pouch manufacturers and food manufacturers found that retort pouch foods did not catch on with consumers.[1] The future of retort pouch foods in the general retail market is thus somewhat questionable. Even if sales through retail outlets including supermarkets are an eventual goal, the institutional market is the appropriate area to investigate for an initial investigation such as this one.

Objectives

One objective of this research is to familiarize potential decision makers with some key issues surrounding possible adoption of this food packaging innovation. Among the technical challenges to be faced are selecting the type of retort pouch and pouch filling machinery for the proposed plant.

The second objective is to estimate the costs of establishing and operating a small scale commercial retort pouch plant for packaging potatoes. Small scale in this instance is defined as a plant with one retort pouch filling machine and the equipment necessary to keep the filler operating at or near capacity. Cost figures are a necessary component in the determination of whether investment in this kind of plant is likely to be profitable. In addition, the cost figures provide an estimate of the cost per unit of product which facilitates the market potential aspect of the research. Costs are presented in a way that allows potential decision makers to take certain cost elements, substitute alternative estimates, and recalculate unit cost.

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[1]Stanley Sacharow, "Why the Retort Pouch Failed in the USA," Packaging (London, England) 54:645 (December 1983): 33-34.

The third objective is to determine the potential acceptance of these products by various elements of the food service industry. This attitude assessment will provide insights regarding likely food service market acceptance of the product - ie, what are the requisites of, and barriers to successful marketing of this product to the food service industry. A subgoal is to determine the characteristics of retort pouch foods that tend to make a food service operator more (or less) likely to purchase this product.

The Value of This Research Approach

The second and third objectives combine cost estimation with attitude assessment of potential buyers. A two-pronged research approach is an appropriate means to investigate the problem of the potential for expanded processing opportunities for Michigan potato growers. This new potato product would compete with canned, frozen and fresh products already on the market. The cost information resulting from this research facilitates useful comparisons of production costs of the proposed new product with market prices of its competitors. At the same time, interviews with potential buyers reveal perceptions of the usefulness of this new product in food service operations. Respondents can offer their opinion about the product with the knowledge of the approximate cost of the new product relative to the prices they pay for their currently used potato products, such as fresh, frozen, or canned potatoes.

In many feasibility studies, assessments of profit potential are undertaken. Commonly used methods to investigate economic feasibility are to estimate costs over a predetermined time horizon and calculate the internal rate of return or net present value. However, revenue projections would be highly conjectural in the case of institutional size retort pouch potatoes because the product has never been marketed in the U.S. Thus, the financial component of this study is limited to the cost side. New product costs, competing product prices and assessments of likely market acceptance of the new product provide highly useful, though not definitive, guidelines to Michigan potato growers concerning the likely success of such a venture.

METHODS AND PROCEDURES

The first phase of the project involves estimating the costs involved in establishing and operating a processing plant for preparing and packaging retort pouch potatoes. An economic engineering approach is used to specify a model plant. Fixed and variable costs of owning and operating the processing facility are estimated and used to calculate unit costs per pouch and per pound of finished product.

Although the cost estimates are presented in a manner designed to be as realistic as possible, the model plant method is based on certain assumptions, including the capacity of the plant as well as days and hours of operation. The figures are intended to serve as a guide for subsequent efforts to establish more precise budgetary estimates.

The food service buyer attitude assessment phase of the research consisted mainly of personal interviews with the principal food buyers of food service operations in the Lansing area and with executives from leading institutional wholesaling firms in southern Michigan. The Lansing area provided an adequate cross section of the kind of operations that would be potential purchasers of retort pouch potato products. Emphasis was placed on conducting interviews with a participant interactive approach.

Interviews with a selected, though not statistical, sample of institutional food buyers provided a useful assessment of the likely acceptance of this product. A majority of sales of these potato products would likely be made through institutional wholesalers rather than direct to end users -- restaurants and other food service institutions.

However, assessing in addition the attitudes of restaurant managers other food service end users (who are the customers of the institutional wholesalers) is a means of determining the wholesalers' likely willingness to carry the product.

In concept-based market research, the attributes of a potential new product are communicated verbally, in writing, through the use of visual aids such as photographs, and through displaying or describing similar products. In this project, interviewees were shown samples of retail-sized retort pouch food products, photographs of retort pouch foods, empty sample pouches, and an institutional size retort pouch containing 4 kilograms (8.8 pounds) of vegetables obtained from Ebbrecht, a German food manufacturer.

Interviews focused on examining both the current use of potato products by each of the food service operations and the potential uses for retort pouch potatoes. A key aspect was to ascertain attributes which were important and unimportant in terms of impacting or influencing the likelihood to buy this product. Respondents offered their opinions and perceptions of the products and whether they were likely to sue them after being told the approximate costs of the new products relative to currently used products, such as fresh, frozen, or canned potatoes.

Managers from institutional wholesale firms were interviewed to obtain their perspective on the current and future use of potato products and to provide a cross-check on the information in the other interviews.

A key factor in identifying key people with knowledge of retort pouch food product processing and marketing was attending one of the semiannual meetings of the Research and Development Associates for Military Food and Food Packaging Systems, Inc. Since the military is by far the largest purchaser of retort pouch food products in the U.S., this meeting brought together any of key people in this small, specialized industry.

Visits To Food Processing Facilities

Visiting various food processing facilities was an important step in gaining familiarity with the nature of food processing and packaging methods. At an early stage in the research process visits were made to the plants of Mid-American Potato Company (Grand Rapids, Michigan) to become familiar with how potatoes are handled, and the Fennville, Michigan plant of Michigan Fruit Canners, Inc., to see the equipment and processes involved in canning fruits and vegetables. Studying the layout of the carrot canning line at that latter facility provided useful insights from which to begin developing the model plant which was the object of this study. Personnel at both plants provided the names of equipment manufacturers and distributors.

Two plants that packaged food products in retort pouches were also visited, and discussions with their plant personnel on both technical aspects of retort pouches and on their marketing experiences proved to be valuable; these plants were Magic Pantry in Hamilton, Ontario, Canada and the Nabisco (Del Monte) plant in Lockport, New York.

Contacting Equipment Manufacturers and Distributors

With the help of the various academic and industry experts consulted, a list of food processing equipment manufacturers and distributors was compiled. Various firms were contacted to obtain figures on machinery prices, capacities, and associated labor needs to run the equipment. A description of the proposed processing method (see Chapter 5) was provided to guide them in drawing up the appropriate lists of equipment.

The first step in this information-gathering process was to determine the appropriate capacity of key pieces of machinery. Since the purpose was to develop a small-scale plant, the model plant was designed with a single form/fill/seal machine; Koch, Inc. supplied a cost estimate. Stock America, a well-known retort manufacturer, was contacted and their Automat 1300 model was included in the cost estimate; given the capacity of the 1300 retort, it was decided that two units would be required to allow the form/fill/seal machine to operate at its capacity. The remaining work involved determining the appropriate complement of equipment to use which would allow the retorts and filler to operate efficiently, given their output capacities.

An estimate was made of the quantity of raw potatoes required to keep the retorts and the filler operating at near capacity (see Appendix A, page 113). Using this information, an equipment distributor in Milwaukee, Wisconsin (BFM, Inc.) provided the equipment cost information for a potato canning line minus the actual can closing and sealing equipment (which, in the model plant is replaced by retort pouch form/fill/seal equipment). The BFM executive also provided an estimate of the number of people required to run this equipment. The specific list of equipment, the prices of those items, and the estimate of the associated labor needs to run that equipment, which was provided by BFM, was altered somewhat in consultation with executives from several other processing plants visited.

CHAPTER 3: AN OVERVIEW OF THE RETORT POUCH

This chapter begins by explaining different kinds of retort pouches and why one kind was chosen as the appropriate type for the model plant. The second part of the chapter explores the attributes of retort pouch foods in terms of what advantages and disadvantages they may have relative to other food packaging methods.

WHAT IS A RETORT POUCH?

One objective of this research is to familiarize potential decision makers with some of the technical challenges and choices among alternatives they will have to make in attempting to set up a retort pouch plant. This section begins by explaining alternative methods of retort pouch construction (that is, the different layers of material that make up the pouch laminate) and which alternative was chosen for the model plant. The size of pouch chosen as the basis for estimating plant costs is also explained and this section closes with a brief mention of other technical challenges facing potential investors in a retort pouch plant.

The retort pouch is a flexible package made from a laminate (several layers joined by adhesives) of three materials: polyester, aluminum foil and polyolefin (or polypropylene, depending on the pouch material manufacturer); hereafter whenever reference is made to the polyolefin layer, it is understood that polypropylene could be substituted for that layer. As the name implies, the retort pouch is capable of being retorted. In other words, foods are first sealed in the retort pouch, followed by heat sterilization as in a canning process. Food products contained in pouches of this basic construction have been marketed commercially in the U.S. since 1974. More recently, entree retort pouch products have been marketed with a non-metallic layer in place of the aluminum to allow for cooking in microwave ovens.

Retort pouches are designed to withstand the thermal processing temperatures and pressures that are required in food processing operations. The food product inside the pouch can achieve the same level of sterility as canned food, but with a shorter "cook" time. This reduced thermal processing time can mean both energy savings and higher quality food when compared to canning. These are considered to be two of the pouch's chief advantages.

Each of the three layers of packaging film serves a distinct function, and experimentation has been carried out on a number of materials since the late 1950's to select the most effective combination (see Appendix F, page 119). The inner layer of polyolefin performs two functions. Since it is inert, it does not react with any of the wide range of food products with which it may come in contact; it resists fat, oil and other food component penetration. Secondly, polyolefin is capable of strong heat seals that are necessary to withstand the pressure and high temperatures encountered in retorting. Aluminum was selected since it was one of the lower cost materials capable of providing a barrier against light, moisture, microorganisms, and gases (particularly oxygen). The outer polyester layer provides strength and printability.[1]

Retort Pouch Construction: Roll-Stock and Pre-formed Pouches

In clarifying just what is meant by the term retort pouch, there is another issue to consider. One pouch-filling method involves the use of pre-formed pouches purchased from a pouch manufacturer. An alternative is for the food manufacturing company to

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[1]David A. Heintz, "Marketing Opportunities for the Retort Pouch," Food Technology, 34.

make and fill pouches using roll stock of three-layer laminate on a form/fill/seal machine. Two separate laminates or "webs" are fed into the machine and are joined (sealed) on three sides; the food product is then pumped, placed, or extruded into the vertically-held pouches. Then the vacuum is drawn and the fourth side sealed. In this method, both webs are usually of the same thickness. Vertical filling either with roll stock or preformed pouches is the most common method for packaging retort pouch food products. Another method, described in the next section, involves the use of laminates of two different thicknesses and horizontal filling.

A Variation in Retort Pouch Construction: Use of Formable Pouch Material

The "typical", pre-made retort pouch has two sides or webs of the same thickness, and is generally filled vertically. In contrast, an alternate pouch construction involves using a lower web which is thicker than the upper one. Using a horizontal filling method, the lower web is pulled downward so that it conforms to a die or mold as it travels through the filling area of the form/fill/seal machine. In industry terminology, the web is "drawn" or "deep drawn" into the die. After the food product is placed into the tray-like cavity, an upper web covers the food and the package is sealed. The lower web is thicker than the upper web to withstand the additional stress that it must undergo. The resulting package is somewhat more rigid than vertical-fill pre-made retort pouches. Some in the food packaging industry therefore do not consider this second kind of package to be a "true" retort pouch. There is little industry agreement on what to call this container with webs of different thicknesses to distinguish it from "typical" retort pouches with two webs of the same thickness. Some refer to it as a formed container; the thicker gauge laminate is called formable retort pouch material. Two food processors that use this packaging method are So-Pak-Co (Mullins, South Carolina) and Land O'Frost (Lansing, Illinois).

However, there are only two firms that manufacture horizontal form/fill/seal machines for large retort pouches. The Multivac form/fill/seal machine from Koch, Inc. (Kansas City, Missouri) employs this kind of technology and was selected for the model plant. Horizontal filling is more likely to maintain several pounds of potatoes in good condition than would vertical filling. The form/fill/seal machine whose estimated price appears as part of the plant cost estimate in Table 1 on page 75 is a Koch Multivac.

Pouch Size

Since there are as yet virtually no U.S. firms currently packaging foods in institutional size pouches, there are no standard institutional sizes or even widespread industry agreement on what is an institutional size retort pouch. Beverly's view is that institutional pouches can vary anywhere from 10" X 14" to 12" X 18".[2]

A pouch size of 10.5" X 15" X 1.4" was determined to be an appropriate size to use for estimating the costs of owning and operating a plant for packaging potato products in retort pouches. The criterion for choosing that size was that those dimensions for length and width allowed for a racking configuration (placement of pouches on retort racks) that made for effective use of space in a Stock Automat 1300 retort. Increasing the pouch width from 10.5" to 12", for instance, would have allowed the placement of only four rather than six pouches per retort rack, meaning there would be many fewer pouches per retort load. The depth of the package (1.4") was the

[2]R.G. Beverly, J. Strasser and B. Wright, "Critical Factors in Filling and Sterilizing Institutional Pouches," Food Technology (September 1980), 48.

maximum "depth of draw" of the Koch Multivac form/fill/seal machine selected for the model plant.

Attempting to maintain flexibility by gearing up to produce several pouch sizes may not be cost effective; the racks themselves are expensive (estimated at $90) and should only be used for one size of pouch. Even a small-scale plant such as the model plant discussed in this chapter requires 400 racks to handle a single pouch size. The model plant in this study assumes a single size pouch.

ADVANTAGES/DISADVANTAGES OF RETORT POUCHES

There are benefits and drawbacks to a food production and marketing innovation such as packaging food in retort pouches. These need to be examined with regard to competing systems of food packaging and distribution, specifically, canning and freezing. Furthermore the arguments need to be examined in terms of who captures the benefits or bears the cost. Therefore, the advantages and disadvantages of retort pouch food packaging will be examined with regard to their effects on: (1) the food processing firm, (2) consumers/end users and (3) marketing channel participants including wholesalers and retailers.

Advantages/Disadvantages for the Food Processing Firm

1. Container Cost. To compare the packaging costs of retort pouch foods to the canned and frozen counterparts, it is not just the pouch itself that must be considered, but also the outer carton in which pouches are frequently placed for extra protection and the cost of the shipping container. The outer carton, in which all retail-sized pouches have been sold in the U.S., made the pouch more expensive than its steel can counterpart. However the institutional size pouch was expected to cost less than the #10

can, partly because it is anticipated that no outer carton will be needed. However, this cost savings will be partially offset by the fact that a considerably stronger shipping carton will be needed for pouches than for cans. Dwire estimated in 1982 that the costs for packaging sliced carrots were $4.38 per case of six #10 cans compared to $3.08 per case of 12" X 15" pouches.[3]

The trend in material costs must also be considered. The #10 can cost will follow closely the cost of steel, which is unlikely to fall and will probably rise rapidly at times. The same is likely also true of the aluminum component of the retort pouch. However, the cost of polyester and polyolefin will probably rise much more slowly, possibly leading in the future to a greater cost advantage in the future for pouches relative to cans.[4] However, cost calculations explained in Chapter 5 indicate a cost disadvantage for pouches.

2. Storage space. A frequently cited advantage of retort pouch foods is their shelf stable nature, which may afford a considerable reduction in refrigerated storage space compared to frozen or refrigerated foods.

Due to the shape of the containers, pouch foods make more effective use of "available space"; Dwire estimated percentage use of available space at 95% for pouch foods versus 78% for cans.[5] However, this advantage may be more than offset by the

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[3]Patricia E. Dwire, "Pouch Technology Seminar -- Notes," Unpublished company report, American Can Company (Greenwich, Connecticut), 10 June 1982.

[4]Robert Beverly, "Sterilization Methodology Applied to Pouches and Trays," in Food Sciences Institute, Purdue University, Proceedings of the Conference: Using the Retort Pouch Worldwide, Focus on the Present With a Look to the Future, 14-15 March 1979.

[5]Eugene Giannattasio, Louis Lacchin and Daniel Nelson, "The Feasibility of the Retortable Pouch Replacing the No.10 Can in the Institutional Food Service Market" (MBA Student Report, McMaster University, Hamilton, Ontario, Canada), 10.

fact that cans can be stacked up to 20 feet deep compared to 4 to 5 for pouches due to their more fragile nature.[6]

One considerable advantage for the pouch is in terms of in-plant storage of empty containers. Pouch material, either in the form of rolls of laminate or premade pouches will take up only a small fraction of the space required by empty cans.

3. Line speeds. Retail size pouch filling speeds in particular are quite slow in relation to the speeds of typical canning lines. Top pouch filling speeds of 200 per minute have been reported, but the typical speeds in the U.S. and Canada are in the 30-60 per minute range and most are closer to the lower end of that range. Some firms have resorted to running a number of pouch filling lines simultaneously to increase output, but this adds considerably to the capital and labor cost. Canning lines can handle 400-800 cans per minute.[7] Pouch lines will typically also have a higher rejection rate than a canning line due to faulty seals and other problems. This will be especially so for new firms getting themselves established. This problem can also be made worse by attempting to push up production rates to unrealistic levels. At a 1986 conference of firms producing retort pouch foods for the U.S. Army, a quality control study indicated that running lines too fast meant that a number of inadequately processed pouches got past the line inspectors resulting in an unacceptable number of leaking pouches being shipped out.[8]

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[6]Giannattasio, 6.

[7]Patrick Kwan, "The Retort Pouch," Frontiers, Weston Research Center, March 1981,3. Cited in Giannattasio, 11.

[8]Research and Development Associates for Military Food and Packaging Systems, Inc., "Report by the Meal, Ready-to-Eat (MRE) Task Force," Annual Fall Meeting, Natick, Massachussetts, September 1986.

The disparity in line speeds is not as great when comparing #10 can lines and lines for filling institutional size pouches. #10 can lines run at around 50 cans per minute; 50 units per minute is also not unusual for some frozen food lines (though boil-in-bag lines may run at 120 units per minute). There is no comparable track record for institutional size pouch lines; during the course of this study, this researcher did not find any firms packing vegetables or other products comparable to the potato products that are the subject of this study, except for one firm that is packaging fruit slices. However, the estimated speed of the form/fill/seal machine included as part of the "model plant" cost estimate in the next chapter is 10 pouches per minute. A food machinery manufacturer indicated they were developing a prototype that could fill large pouches at 50 per minute; however, that would probably be for sauces and soups. Particulates such as potatoes require slower speeds.

4. Labor costs. Retort pouch plants are quite labor intensive. There are a number of functions which are typically automated in canning lines but that are not so easily automated in pouch operations. The quality control procedures tend to rely on visual inspection, so a number of inspectors are required. Contractors supplying the Army are required to perform two "100% inspections" - that is, each pouch must be inspected before and after retorting. The slower line speeds may also not justify automation in packing in shipping containers or palletizing. Dwire estimated in 1982 that the comparative labor costs per case of sliced carrots in #10 cans and in 12" X 15" food service pouches was 21¢ and 47¢, respectively.[9]

5. Transportation/Distribution costs. There are large transportation cost savings in transporting empty pouches compared to the equivalent capacity of cans. This is most

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[9] Dwire.

pronounced in the case of large pouches; one truckload can carry the equivalent in pouches of 36 trucks of empty #10 cans.[10] This is of course an issue only if the food processing firm transports the containers; otherwise, it is just part of the delivered cost of the container. The shipping weight of filled containers is also much lower. This is due largely to the fact that because of the pouch's thin profile, it is not necessary to add nearly as much liquid. The amount of brine, syrup, or juice may be 1/2 to 2/3 less. Also, the institutional pouch itself weighs only 15% as much as a #10 can, according to Dwire's estimate.[11]

Cans can withstand more vigorous treatment than pouches. The extra care needed for handling pouches and moving them in and out of storage will add to a firm's costs.

6. Marketing cost. Launching any new food product usually requires considerable advertising and promotion expenditure, and retort pouch food products are certainly no exception. The vast majority of retail size retort pouch food products have been meat based, and several firms have test marketed entrees and then have pulled them off the market. This attests to the fact that a considerable consumer education effort will be required to convince consumers to trust the concept of meat-based entrees that are not refrigerated or frozen. Canned and frozen foods are well established in the market, but any firm undertaking sales of retort pouch foods will likely incur substantial costs in the form of advertising and promotion.

The institutional market, however, may not require such high promotional expenses. Many fewer buyers have to be convinced, and food service operators are in

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[10]Dwire.

[11]Dwire.

general more willing to experiment with alternative food products that offer cost, convenience, or other attributes.

8. Development Costs. There will be substantial costs to the firm for selecting the specific food products to be produced and sold. With canned and frozen foods, once the formulations have been established, there is a large amount of experience to draw on to determine the proper methods to sterilize and package the food. With retort pouch foods, however, "the general technical sophistication, knowledge, and experience" is considerably less.[12] Sizes are not standardized, so choosing the correct size for the market segment becomes important. It is costly to have the capability to package several sizes of pouches, so it is important to choose the size correctly at the outset. After the formulations and size(s) have been chosen, other factors in product development include determining the proper sterilization method, and setting up the best means to ship the pouches; important considerations in shipping are the strength of the shipping carton, the height to which cases can be stacked, whether the pouches should be shipped with a horizontal or vertical orientation, and the appropriate number of pouches per shipping case. Because there is as yet so little production of retort pouch food products, these development costs represent a substantial burden, relative to canning and freezing methods, to any firm attempting to launch a retort pouch operation.

9. In-plant energy consumption. The Williams study indicates that due to the pouch's thinner profile, it takes 30-50 percent less time to reach sterilizing temperatures at the center of the food than it does for cans or jars;[13] substantial fuel savings in

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[12]Jeffery R. Williams,"An Economic Analysis of the Feasibility of the Retort Pouch for Packaging Fruit and Vegetable Commodities in an Environment of Rising Energy Prices" (Ph.D. dissertation, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, 1980), 31.

[13]Williams, 30.

making hot water and steam are evident. This amount of reduced time will vary considerably with the product: in 1982 Dwire indicated that the sterilization time for 12" X 15" pouches of sliced carrots was 70 minutes compared to 80 minutes for a #10 can of the same product. The can thus requires 14% more time.[14]

A 1982 report from one of the laminate manufacturers, Reynolds Metals, makes the following argument on energy savings:[15]

> "In-plant energy consumption of a retort pouch food operation is already far less than for freezing food, about on a par with canning. As energy costs escalate during this decade, this cost differential will become more dramatic...economic analysis shows in-plant energy costs for frozen food to be four times more costly than shelf-stable pouches by 1990. Opportunity exists for even greater energy savings by taking advantages of the pouch's reduced sterilization time in continuous retorts."

Energy prices have not accelerated as fast as was expected when that report was written, so the magnitude may not be that great; however, a substantial savings is still possible.

10. Ingredient cost. Large cans require substantial quantities of brine, syrup, or juice to aid in the transfer of sterilizing heat to the food contents. The thin profile of the pouch makes much of this unnecessary; one study indicated that while a #10 can of sliced carrots would contained 30 ounces of water, the equivalent pouch would require only 7 ounces.[16]

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[14]Dwire.

[15]Reynolds Metals Company, Richmond, Virginia, "Flex-Can Laminate Pouch Comparative Analysis -- Executive Summary," Unpublished company report, 1 October 1982.

[16]Dwire.

11. Capital investment. The initial capital outlay for a retort pouch food line is higher than the canned or frozen food equivalent; one estimate indicated a tenfold difference between a canning line and a pouch line (though not for the whole plant).[17] However, it is important to note that the amortization of the capital investment is a small portion of the annual cost per unit (see Table 5 on page 81 in Chapter 4). A Reynolds Metals report argues that "cost savings gains in packaging, energy and distribution will more than offset disproportionate capital requirements. In addition, second generation, highly efficient filling and retorting equipment is expected to be developed which should make the retort pouch capital outlay fall somewhere between canned and frozen food."[18]

Advantages/Disadvantages for the Consumer/End User

1. Food quality. Mermelstein points that the thinner profile of the pouch means that the product near the surface of the container is not overcooked, as it may be with cans or jars. He contends that most products' quality is generally maintained in a pouch -- the product is truer in color, firmer in texture, fresher in flavor, and there is likely less nutrient loss. More specifically, "because of the shorter processing time...foods will undergo less thermal deterioration which means less carmelization of sugars and starches, less breakdown of protein, less destruction of heat sensitive vitamins, and less hydrolysis of flavor components. This is especially true for seafood, high quality entree items, and sauces."[19]

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[17]Giannattasio, 11.

[18]Reynolds Metals.

[19]Neil H. Mermelstein, "Retort Pouch Earns 1978 IFT Food Technology Industrial Achievement Award," Food Technology (June 1978): 22-23.

Some have argued that retort pouch food product quality approaches that of frozen food.[20] Others have even a more favorable view: "The product is as good or better than frozen and over an extended period the quality favors the pouch - a 6-month old pouch is better than a frozen entree which may have undergone several freeze-thaw cycles in distribution."[21] There are those with experience in the food industry who contend, however, that as yet no retort pouch products can really match the quality of frozen food, especially regarding the color of vegetables and some other components.[22]

2. Safety. Safety is an issue in food service operations. Dropping a 100 ounce #10 can on one's foot can cause considerable injury, as can the sharp metal edges of the open can. Metal slivers from a can may also fall into the food. Pouches have none of these problems.

3. Disposability. Pouches are as easy to dispose of as frozen food containers and pose much less of a problem than empty cans, which take up much more space.

4. Convenience in preparation. Pouches are easy to open, tearing from a notch in the seam, and no can opener is required. Fewer pots and pans will be required in preparation; the food can be heated by placing the pouch directly in hot water. One person points out that one point in favor of food service adoption of more retort pouch foods is that their use requires little or no change in existing equipment; for instance, the bain marie (frequently found in food service kitchens for keeping food warm) adapts

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[20] Office of Technology Assessment, "Emerging Food Marketing Techniques: A Preliminary Analysis," 1978. Cited in Williams, 15.

[21] Quick Frozen Foods, "Real Test of Retort Pouch Potential Due As Packer Interest Begins to Quicken," November 1981.

[22] Williams, 26.

easily to pouch use. Pouches can be placed horizontally in the gently simmering water and removed and opened at any time. Another advantage is that no thawing will be needed, as is required for some frozen foods.[23]

5. Menu selection in food service. One advantage of frozen food over canned is that just the amount needed can be thawed; it lends itself to portioning better than canned foods. Small size pouches can also be designed to provide single servings to the specifications of special diets in hospitals food services. On the other hand, one disadvantage of pouch foods is that since they are little used as yet, there are no standard sizes, and thus few food service recipes. Many food service recipes today are designed around #10 cans. Depending on the various technical factors involved, the quantities of potatoes determined to be optimal to place in large pouches may or may not correspond to the quantity in a #10 can.

6. Refrigerated and frozen storage space can be economized with the use of retort pouch foods.

Advantages/Disadvantages for Marketing Channel Participants

1. Wholesaler warehouse handling. A disadvantage from the wholesaler's perspective is that pouches will likely require more care in handling; potentially rough treatment in a warehouse will have less serious consequences for cases of cans than for cases of pouches. Pouches also will make less effective use of vertical space in that pouches will probably not be able to be stacked more than 4 or 5 deep, and cans can be stacked several times that high.

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[23]Keith M. Ebben, "Producing Pouches and Trays to Meet Particular Needs." See Food Sciences Institute, 27-30.

2. Retail outlet energy savings. Retailers may have more reason to favor retort pouch foods than their customers. Consumer surveys have indicated that shelf stability (no need to refrigerate) is not the main concern of consumers in selecting foods, so this may not be a strong selling point. In addition, as previously noted, many consumers do not trust the idea of non-refrigerated meat products. However, retailers are increasingly concerned about the crowding of their frozen food cases, and may welcome the opportunity to promote shelf-stable entrees. An estimate made in 1981 indicated that "frozen food display cases account for 38% of the average supermarket's energy bill...in-store energy savings on retortables can range from 8-17¢."[24]

System-Wide Energy Savings

It is also instructive to note some of the arguments made on behalf of retort pouch food packaging systems in terms of energy savings. These estimates were made in the early 1980's but nevertheless may provide a general idea of the possible energy savings associated with the retort pouch. Mermelstein reported that from harvest to consumption the total energy required was about 60% less for vegetables in retort pouches compared to frozen vegetables. When compared to canned vegetables, retort pouches required approximately 15% less energy.[25] A 1982 Reynolds Metals report estimated that "frozen food distribution costs are close to 25% higher than the equivalent retort pouch system...including all of the secondary packaging. Also in the Reynolds it was established that it would "cost three times as much to distribute a frozen entree

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[24]Quick Frozen Foods.

[25]Mermelstein 1978. Cited in Williams, 31.

versus the same product in the established, streamlined version of the retortable pouch."[26]

[26]Reynolds Metals.

CHAPTER 4: MARKET EXPERIENCES WITH RETORT POUCH FOOD PRODUCTS

This chapter begins with a brief chronology of several key market and technological developments in the evolution of the retort pouch foods. The numerous difficulties encountered by various firms in their attempts to make a commercial success of pouched foods are outlined, followed by some propositions on why most of them failed. The commercial success in Japan is also noted. Most of the efforts at commercialization have emphasized meat-based entrees, but the final two sections explain the efforts to date in packaging vegetables in general, and potatoes in particular.

CHRONOLOGY OF TECHNOLOGICAL AND MARKET DEVELOPMENTS

Two different manufacturers of retort pouches are mentioned in the chronology below. One firm has been referred to at various times in its history as Continental Can, Continental Flexible Packaging (division of Continental Can), and Ludlow Flexible Packaging. Below it is referred to as "Continental" and then as "Ludlow". Another manufacturer, Reynolds Metals Company, is referred to as "RMC". Another firm mentioned is a food processor named ITT Continental; despite the similarity of names, it should not be confused with Continental Can.

1959 - U.S. Army, Continental, RMC start preliminary development and testing efforts

1960-68 - Continental supplies pouches for U.S. Army tests and supplies retort pouch technology to licensees in other countries; RMC supplies testing equipment and pouches to a Wisconsin firm

1967 - First commercial market introduction of retort pouch food products - sliced meats and sausages sold in England (Continental license to Otto Nielsen)

1968 - Retort pouch commercially introduced in Japan (Continental license to Toyo Seikan); Japanese market later becomes largest in world - over 400 million pouches in 1985.

1969 - Retort pouch foods reach the moon with Apollo astronauts.

1969-73 - U.S. Army contract to Swift and others to establish production capabilities; Army tests viability of complete equipment system for cake, fruit, and meat-based items; development of 30 pouch per minute form/fill/seal machine.

1973-76 - Development of machinery lines in England (Metal Box, Ltd.) and Japan; retorts and pouch form/fill/seal machines developed by European and Japanese companies, plus Bartelt and FMC in U.S.

1974-75 - Potato products in retort pouches introduced by Nu-Foods (Michigan) and Creston Valley Foods (British Columbia, Canada); Lustucru in France introduces line of vegetables including potatoes.

1975 - Approval of pouch as a food container withdrawn by Food and Drug Administration (FDA) pending further studies.

1977 - Approval granted by FDA to Continental and RMC; ITT Continental Baking is first to enter U.S market with line of entrees; Hormel launches line of entrees targeted at camping market.

1978 - USDA authorizes use of retort pouch foods in U.S. Army rations. Magic Pantry begins operations in Canada.

1978-79- Lustucru (France) invests in high-speed automatic retort pouch line for vegetables (first outside of Japan) but shuts down the following year; the two potato product operations in North America, Nu-Foods and Creston Valley, cease operations.

1980 - Magic Pantry expands Hamilton, Ontario plant to 50,000 sq. ft. and becomes the largest North American facility totally devoted to retort pouch food packaging. 3 firms begin test marketing - Specialty Seafoods, Libby, Kraft 1980-81- Introduction of prototypes of fill/seal machines for institutional size pouches; Ludlow introduces institutional pouch (Pantry Pack HRI).

1981 - ITT Continental drops its line of retort pouch products.

1985 - Kraft drops its line of retort pouch entrees.

1987 - Angelus introduces prototype of high-speed filler for large pouches

RETAIL RETORT POUCH FOOD PRODUCTS IN NORTH AMERICA

Efforts at retail marketing of retort pouch foods can be considered in several categories. The first category is firms that introduced entrees with the idea of developing a line of products that could be eventually be marketed nationally through retail outlets, particularly supermarkets. Another set of firms focused on more limited, specialized market segments. Some of those firms introduced entrees, but others had such varied items as seafood, salad dressing, and fruits and vegetables. Subsequent sections will describe the experience with fruits and vegetables in general, and with potatoes in particular.

Entrees in Retort Pouches (North America)

Four firms have introduced entrees to be sold in supermarkets - ITT Continental Kitchens (subsequently part of RJR-Nabisco), Kraft, Miss Molly and Magic Pantry. The first three are U.S. firms, and the fourth is located in Ontario, Canada. The majority of these entrees were single-serving (8 ounce) beef-based meals, though some used chicken, pork, or veal. Certain mid-size cities were chosen for test marketing. By mid-1985 , only Magic Pantry and Miss Molly were still producing retort pouch entrees for the general retail market. Miss Molly was based in Knoxville, Tennessee and marketed a line of entrees that were "co-packed" (packaged under contract) by Magic Pantry. ITT Continental and Kraft had ceased production (other firms were, however, producing entrees for certain specialized markets - see next section). The parent company of Magic Pantry acquired the St. Louis - based Kretschmar, Inc., through which they began to market retort pouch meat products in 1986; the products are packaged at the Hamilton, Ontario plant. These marketplace results are discussed in more detail below.

Test marketing for Continental Kitchens Division of ITT Continental Baking Company began in September 1977. Their production facility was expanded when market demands outstripped supply. Their Flavor Seal product was displayed near canned meat items and above freezers where the frozen dinners were located; the pouch was advertised as a substitute to both categories of goods. Test markets were expanded, but results were not as favorable. Williams noted that two issues that appeared to affect sales were the price of the product and its positioning in the store. Average prices for their 8 ounce entrees in 1979 were just under $2.00. Attempts to locate the optimum supermarket sales location ranged from canned meats, frozen foods, dried soups, and boxed dinners section.[1] In 1980, Continental Kitchens underwent a series of ownership changes, finally ending up as part of RJR-Nabisco in 1986. In 1981, while the retort pouch facility was in the Del Monte division, a shift in marketing philosophy was evident from the addition of the Deli On Your Shelf line - sandwich fillings and two kinds of potato salad (deli-style and German). Consumer testing had indicated the need for low-priced retortables not commonly found in prepared forms elsewhere; these items were to be positioned in the prepared dinner section. The above mentioned acquisitions were viewed by some as an important breakthrough for the retort pouch because of Del Monte's marketing knowhow and its commitment to the development of retortable packaging technology. The fact that Del Monte was part of a broader-range food company (R.J. Reynolds) was viewed as a possible key to success in national markets.[2]

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[1] Williams, 20.

[2] Quick Frozen Foods.

However, all of the items were subsequently dropped and Del Monte has since used the equipment exclusively to produce pouch foods for the military.[3]

Kraft introduced several entrees under the a la Carte label in 1980. A survey of wholesalers and national grocery chains indicated that a large percentage would try the pouch entree line.[4] The Kraft line had considerable introductory support - TV and print advertisements, direct-mail couponing, sampling, in-store demonstrations and product publicity.[5] This line was also positioned in the prepared dinner section; one writer noted that their criterion for product introduction was "fashionable but familiar." Retort pouch products were viewed as convenience foods; the firms involved were aiming at marketing a distinctly different and readily identifiable food product. These firms are able to spend a good deal on product research and development and promotion of the product. Competition among these firms was related significantly to advertising and promotion. Kraft's primary competition was ITT Continental and Stouffer's, the latter of which was the national leader in frozen entrees.[6] One view of Kraft's primary target was that it consisted of the significant portion of U.S. households occupied by singles, young, and childless couples, older "empty nesters" whose children have left home, or larger families who members have varied eating schedules.[7] Early test market results indicated good repeat purchases and favorable sales forecasts. Nevertheless, by 1985,

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[3]Jack Mans, "Retort Pouch: Military, Retail, and Food Service," Prepared Foods, (May 1985).

[4]Williams, 23.

[5]Quick Frozen Foods.

[6]Williams, 23.

[7]Quick Frozen Foods.

Kraft apparently decided that it did not meet their sales requirements and the entire line was dropped.

Magic Pantry's stated intention was not to compete with frozen or canned. Their initial product was Ukrainian cabbage rolls. A company official indicated in 1979 that more products were being planned to compete with home cooking, using only ingredients that a housewife has at home and avoiding the use of chemicals. They were also packaging pouches for the Canadian Armed Forces.[8] They subsequently expanded their product line to include meat-based entrees. In 1985-86 they began co-packing for Miss Molly, Inc., in the U.S. The Miss Molly test market area included Michigan. An employee of a Grand Rapids, Michigan supermarket who was familiar with the Miss Molly brand commented that they had tried to position it at several places in the store: in a mid-aisle display in front of the frozen dinners; in the prepared dinners section; and finally in the section where they sold rice. In none of those places was their any significant movement, so by March 1987 they decided no longer to carry the line. A representative of Magic Pantry indicated in early 1987 that they had not received orders from Miss Molly for several months. The ultimate success of that product is thus very much in doubt.

As noted above, Kretschmar, Inc., is a processor/packer of fresh meats in St. Louis, Missouri, which was acquired by the parent firm of Magic Pantry. In preparing to launch a new line of retort pouch foods, note was taken of the market results of the pioneering firms. Beginning in 1986 a different marketing approach was attempted - precooked meat entrees in all-plastic microwaveable retort pouches. Even though the pouches are shelf stable, the Kretschmar line has been positioned in the fresh meat

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[8]Roman Dacyshyn, "Products Suitable for Pouches and Trays: Technical and Marketing Aspects." See Food Sciences Institute, 82-83.

refrigerator cases of grocery stores. Consumer surveys had found that American consumers are still reluctant to buy unrefrigerated meat-containing products in flexible packaging; consumers also preferred refrigerated to frozen meats, because they are more convenient to prepare, requiring no thawing time. Since sales volume in the fresh refrigerated meat case is declining, this product may provide the different, more convenient meat products that consumers are looking for.

Other Market Segments (North America)

Two firms have developed lines of meat-based entrees but have made a conscious decision to focus on the camping/recreational market and sell mainly through retail outlets that feature sporting and camping goods. The George A. Hormel Company began production in The fall of 1977 at its Austin, Minnesota, plant. The ease of handling and preparation, and the superior quality compared to freeze dried foods made it a succesful market niche. Hormel also supplied retort pouch foods to Sky Lab Foods in Elmsford, New York, who also catered to the recreational market.

The Van Rich Company in Illinois also sells a number of meat-based entrees distributed through recreational outlets under its "Smoky Canyon" label. The pouch foods are packed by Land O'Frost, a meat specialty company that also has a military contract.

Another successful specialty niche for retort pouches is the market for nutritionally controlled foods. Nutri/System sells retort pouch entrees as part of weight loss/control program through its 700 stores nationwide; their products are packaged by both Magic Pantry in Canada and Land O'Frost in Illinois. Medical Nutrition of Bogota, New Jersey, sells 7 ounce low calorie meat items in retort pouches. Gourmet Choice

International of Carlsbad, California markets low sodium content retort pouch foods for people with heart conditions.[9]

Libby, McNeill, and Libby, Inc., of Chicago, Illinois selected the retort pouch as the most suitable flexible package for its House Dressing line of concentrated salad dressings. The dressing is added to an additional quantity of milk before using. Advantages cited included freshness, ease of dispensing, low packaging cost, and no bottle breakage.[10]

Specialty Seafoods of Anacortes, Washington has found another market niche by using the retort pouch to package its top-of-the-line Gold Seal brand of oysters and smoked salmon products. It is gift boxed and sold in gourmet food shops and through "up-scale" mail order catalogs.[11]

The idea of mail order meals pioneered by Specialty Seafood has been cited as an additional target for expanding the retail market. Sales through vending machines is an another possibility, especially now that microwaveable pouches are available.

THE FOREIGN EXPERIENCE IN RETORT POUCHES

The retort pouch has had its greatest success in Japan. Retort pouch products were introduced commercially beginning in 1968. Their success has been attributed partly to the fact that, unlike the U.S., canned and frozen goods were not firmly entrenched in the minds of the consumer. Retort pouch and canned goods "have grown up together" and were positioned as a convenience food before frozen foods were

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[9]Mans.

[10]David Heintz, "Marketing Opportunities for the Retort Pouch," Food Technology, (date unknown): 32-38, 102.

[11]Williams, 12.

significant; even today, the "cold chain" in Japan is not nearly as extensive as the one in the U.S. A 1978 estimate gave retort pouch foods 8.7% of the total packaged foods market in terms of value; canned and frozen were 59.2% and 32.1% respectively.[12] By 1985, supermarkets were selling "a wide variety of food in retort pouches, ranging from curry and soup to precooked rice and Chinese seasonings." Curry is a popular item, containing meat, potatoes, and carrots.[13]

In 1979, total European sales were estimated at 40-50 million pouches, considered a small market.[14] One solid part of the market in which retort pouches were established was packaging sausage and frankfurters in hard vacuum retort pouches; Denmark has such brands as Arovit, Plumrose, and Royal Dane; such items are also sold in Britain.[15]

After Japan, France had the greatest variety of products and brands in retort pouches. Nestle's Trois Couronnes and Colgate Palmolive's Barbier Dauphin compete in the high price entree market; the volumes remain small. Buitoni sold pizza base and toppings in pouches.[16] In the late 1970s two French firms, Lunar and Lustucru, were selling vegetables in retort pouches. However, Lustucru ceased selling pouched vegetables in 1979.

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[12] Yotaro Tsutsumi, "New Technology Applied to Pouches and Future Trends," See Food Sciences Institute, 24-26.

[13] K. Yamaguchi, "Current Status of Containers for Thermo-processed Foods in Japan," Address to the International Packaging Conference, Michigan State University, September 1985.

[14] Keith Ebben, "Retort Pouch: Latest Developments in Europe," Food Engineering, (September 1979): 109-12. Cited in Williams, 24.

[15] Keith Ebben, "Products Suitable for Pouches and Trays: Technical and Marketing Aspects." See Food Sciences Institute, 70.

[16] Ibid.

Early sales forecasts of retort pouch foods tended to vastly overstate the eventual market position established. Contributing factors appeared to be the oil crises in the 1970's, high inflation, and the fall in the proportion of food expenditures out of income. A British laminate manufacturer argued that unrealistic expectations "created by these high volumes when not achieved had a definite detrimental effect on people's attitudes to and acceptance of pouches in our market place. It is to be avoided in the U.S."[17] As Sacharow points below, however, unrealistic expectations were also generated in the U.S.

U.S. MARKET RESULTS AND FUTURE PROSPECTS

Retort pouches have been characterized as "one of the big contradictions of the prepared foods industry. Introduced with glowing hopes...they have more than lived up to their hype for the military, been a dismal failure in the retail market, and may just be coming in to their own in food service and industrial markets." The bright spot is military feeding; it is "the engine driving the retort pouch market. It has proven to be a booming success, with each year's contract larger than the one before." The 1985 contract was for 40 million MREs (Meal Ready-to-Eat) for $120 million.[18] Three nationally known firms (Pillsbury, Hormel, and Del Monte) and several other firms produce the pouch foods for the Army. The other firms currently or previously producing pouch foods are Land O'Frost, Shelf Stable Foods, SoPakCo, Star Foods, Sterling Bakery, and Thermal Stabilized Foods.

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[17]Ebben, "Products." See Food Sciences Institute, 70.

[18]Mans.

This generally bright picture, however, was marred by a food safety scandal involving one of the MRE suppliers which was brought to national attention by the 20/20 television program of ABC News on January 15, 1987. In the newscaster words: "Last year, the Army had millions of Meals Ready to Eat stored in warehouses waiting to be medically cleared or condemned. Thousands of others were destroyed as unsafe. There remains a cloud of suspicion about the safety of the rations, and last fall, the largest MRE producer, Star Foods, shut down." He also asserted that several other firms had similar problems, though on a smaller scale. The long-term impact of this negative publicity remains to be seen.[19]

But what happened in the retail market? Even by 1983 Sacharow had noted that the retort pouch is "hardly news anymore." That observation was confirmed by this researcher in the course of gathering material for this study; the vast majority of articles on retort pouches were written in the few years just before and after 1980. Most major food processors have had projects involving retort pouches, but then have drawn negative conclusions and never gotten as far as test marketing. Sacharow's views on what went wrong are instructive. Potential use of retort pouches for pumpable products may have been displaced by the onset of aseptic packaging, and the delay in FDA approval of the laminating adhesive was not helpful. More significant factors were probably an overly optimistic marketing approach, slow machine speeds and technical factors in the nature of the pouch itself.

A possibly overly optimistic marketing approach was evident back in the 1960's when the pouch was first introduced to food processors; it was believed that retort pouch would replace the tinplate can for commodity type foods. Attempts to use the pouch as

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[19]ABC News, 20/20, (Transcript, Show #703) 15 January 1987, 2-6.

a package for vegetables and sauerkraut failed. Sacharow believes that the laminate manufacturers underestimated the importance of the can in the consumer's mind and the "time and thought" needed to capture such a huge market. "Commercialization would have been swifter if...these converters would have flirted with the more sophisticated markets such as prepared entrees, camping foods, and HRI markets. It was later determined that it was these very markets which would be natural for the retort pouch." He goes on to point out, "In the United States market, where frozen foods processing, warehousing transport, and marketing are well established, it is quite difficult to conceive of products that will be better and cheaper than frozen." Despite the resources devoted to the effort by Kraft and ITT Continental, there was apparently not a sufficiently large "educational and advertising campaign aimed at the consumer to point out that a shelf-stable flex-pack containing a prepared entree is both safe and acceptable."[20] Kretschmar's decision to market retort pouch meats through the refrigerated meat case (even though it is shelf stable), shows a recognition of this problem. There is also other evidence that even if consumers did trust the concept of non-refrigerated meat, they may still not think it is particularly important characteristic because many do not lack refrigerator space.[21] An additional factor is slow machine speeds. Filling and sealing speeds of 30-60 pouches per minute on single form/fill/seal machines do not compare favorably to can operations which are capable of 300-500 cans per minute. Several of the firms currently packaging retort pouch foods use pre-made pouches, but this option is

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[20]Stanley Sacharow, "Why the Retort Pouch Failed in the USA," Packaging (London, England) 54:645 (December 1983): 33-34.

[21]Richard Abbott, "Producing Retort Pouches to Suit Particular Needs." See Food Sciences Institute, 44.

too "cumbersome and costly" for large volume US food processors, who could use premade pouches only for short-term market tests.[22]

Thirdly, the pouch itself is not without problems, in terms of possible stress on the pouch surface and adequacy of the seals. Very tight quality control is necessary to ensure safety and proper seals and this has contributed to the pouch's slow acceptance in the food industry. Similarly, one observer noted the "debacles in Europe via packers who have gotten into the business who thought it looked good - 'let's take a shot at it.' And they produced 90% leaking packages; they never did produce a satisfactory closing seal."[23] In addition, it was assumed that the lower sterilizing heat required due to the pouch's thin profile would always yield a better quality product; such was not always the case. Finally, perhaps Sacharow's strongest argument:[24]

> "...the basic pouch geometry was wrong...the flexible retort pouch is basically a two-dimensional container and one that has to be unnaturally distorted to accept product fill. It is this very distortion that creates the stress points that eventually fracture. Because overfilling tends to enhance the possibility of wrinkles and pleats in the pouch, and lengthen the retort time, it must be carefully controlled. The net result is that many retort pouches tend to be 'slack filled.' The pouches must also not exceed three quarters of an inch in depth. In a production operation, the non-ideal geometry of the flexible pouch for a heat-processed food makes the cost per package per unit of product disproportionately high. When the cost of the outer carton is added the net cost often far exceeds cans."

He points out that more "geometrically sound" alternative systems are in use for small portion packs in Europe. Heavy gauge laminates are drawn into smooth wall, semirigid three dimensional containers and are sealed with peelable lids made from lighter gauge laminates. These firmer containers do not require the individual cartons

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[22]Sacharow.

[23]Alan Corning, "Sterilization Methodology to Pouches and Trays." See Food Sciences Institute, 93.

[24]Sacharow.

needed to protect the retort pouch.[25] Technology similar to this is used by the form/fill/seal machine included in the plant cost estimate provided in Chapter 4.

VEGETABLES AND FRUITS AND IN RETORT POUCHES

The first subsection offers some comments on the general subject of packaging fruits and vegetables in retort pouches. The experience of several firms in packaging potatoes is characterized in the following subsection.

General Aspects of Retort Pouch Packaging of Vegetables and Fruits

In the 1960's and 1970's, a number of food industry observers and participants held the view that retort pouch packaging would be highly appropriate for commodity products. Fruits and vegetables in pouches would replace at least a portion of the canned and frozen counterparts. The previous discussion indicated that it did not turn out that way. Due to the expense to the packaging method and other reasons, retort pouch packaging has found only a few low-volume specialty niches involving mostly meat-based high value-added products. There may yet be a market for commodity goods in large-size institutional pouches, but no firm in the U.S. is currently attempting this, with the single exception of Truitt Brothers, Inc., of Salem, Oregon, who is marketing fruit slices (apples and pears) to food service operations.

"Few commodity processing firms, which tend to compete on efficiency of operation and distribution instead of brand name and differential product characteristics, have attempted to enter the market with retort pouches. This is primarily due to the amount of uncertainty regarding the economic and technical processing and distribution

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[25] Sacharow.

aspects of such products."[26] Those words were written in 1980, but are still largely true today.

Williams reported on two sets of consumer tests conducted in the 1970's on the quality of vegetables in retort pouches. Among the products tested were peas, corn, cut green beans, and mixed vegetables. The taste of pouched vegetables was found to be superior to the canned equivalent, and in one case, also better than frozen vegetables; nevertheless, "the overall acceptability was less, due to the fact that frozen products had superior color."[27]

These generally positive results led to glowing predictions, such as the statement that, beginning in 1981, "commodity-type foods such as canned corn and green beans, pears and peaches in #10 cans will be replaced by institution retort pouch packs...the institutional market should be easier to penetrate with a package and product having better quality and comparable or lower cost...only a few buyers need to be convinced...The institutional buyers are trained to recognize quality differences between products in #10 cans and the same products in pouches."[28] A number of the technical and market factors cited above prevented this from occurring, not the least of which is the likelihood that pouched fruits or vegetables cannot yet be produced for "comparable or lower cost."

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[26]Williams, 24.

[27]Williams, 26.

[28]Arthur F. Badenhop and Howard P. Milleville, "Institutional Size Retort," Food Processing, (January 1980): 82-83.

Potatoes in Retort Pouches

Several firms in Europe and the United States have attempted to package potato products in retort pouches. Only one firm continues to do so today: Ebbrecht in Germany markets institutional size pouches of roechsti (shredded potatoes ready for frying, popular in Germany and Switzerland). Lustucru in France marketed several vegetables, including potatoes, on a limited basis for about three years. They then built a facility to expand this operation in the late 1970's, but that unit had ceased operations altogether within two years.

Two U.S. firms have produced German potato salad; this is a high acid product which has less rigid processing requirements than low acid ones. SoPakCo currently supplies the military with such a product. The other firm was ITT Continental, which also produced a low-acid "deli-style" potato salad as part of its Deli On Your Shelf line in 1981; as described above, ITT Continental was bought out and no longer produces any pouch foods for the retail market.

Two firms, one in Canada and one in the U.S., attempted to set up operations in the 1970's for the sole purpose of packaging potatoes in retort pouches; neither lasted more than a few years. The Canadian firm was set up around 1975 in Creston, southeastern British Columbia, under the name of Creston Valley Foods (a.k.a. Swan Valley Foods). A grower cooperative was one of the interested parties, and exploratory work was done at the University of British Columbia. Various sources hinted at the reasons for its demise. One factor may have been the that the project was apparently launched with the promise of government financial support, which was subsequently cut off.[29] Another was apparently the high cost and low reliability of the film at that

[29] Dacyshyn, "Products." See Food Sciences Institute, 82.

time; there were significant delamination problems.[30] Creston Valley Foods packaged potatoes in several forms - silver dollar, crinkle cut, cubes, and french fries. The silver dollar and french fry cuts in particular also had a problem of sticking together. Finally, the plant was established in a potato growing area, but was quite distant from the likely markets in Calgary and Vancouver.

Nu-Foods, Inc. began production in a plant in Edmore, Michigan in November 1974. Their line included sliced, diced, and shredded potatoes for use by their customers in "preparation of potato salad, mashed potatoes, au gratins, American fries, scalloped and broasted potatoes." The following quote gives the firm's description of their product:[31]

> "Potatoes in Chef Farms plastic pouch are selected from the best quality raw product, sized and graded to eliminate any defects, then peeled in large commercial peelers with steam pressure. Potatoes are again inspected for defects, washed and dried on special equipment, then automatically packaged without added liquid, the air evacuated and the pouches sealed under vacuum. The product is then processed in special equipment under special temperatures and pressures to ensure a complete cook and a sterilized product. The removal of air by vacuum packaging, absence of packing liquid, and gas-tight seals, assures that maximum flavor and nutrients are 'locked-in' every potato piece."

Plans called for expansion to "include sales to institutional wholesalers, direct large account distribution and possible consumer pack sales to retail chains under the brand name Chef Farms"[32] Nu-Foods also experienced delamination and film quality

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[30]William Piper, formerly with Creston Valley Foods, Inc., Creston, British Columbia, Canada. Personal communication.

[31]Kelly Harrison, et al, The Michigan Potato Industry: A Market Analysis, Agricultural Economic Report No. 294. Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, April 1976.

[32]Harrison.

problems similar to those of Creston Valley Foods. There were other negative factors, and by 1978 Nu-Foods had also ceased operations.

Interest in this kind of operation has not disappeared, however. Studies are periodically undertaken. One source indicated in 1985 "a definite project to package sliced or diced potatoes" by an unnamed firm.[33] By 1990, however, no such product had emerged.

Any attempt at breaking into the food service market with retort pouch products must take account of the strongly entrenched position of frozen potatoes in food services. An executive of Trend West, a firm in the western U.S., indicated that he had dropped plans to package potatoes in retort pouches because his cost calculations in 1987 had indicated that he could not produce the product for anywhere near the selling price of frozen potato products with which his product would compete (he estimated the average price of competing frozen potato products in his area at 20¢ per pound). Scale may also be an important factor; one estimate was that for a retort pouch firm to operate profitably, the minimum quantities of raw potatoes processed through the plant should be 4000-8000 pounds per hour.[34]

Several technical factors relating to potatoes complicate the search for the appropriate method for packaging in pouches. One is the sensitivity of potatoes to oxygen - they tend to darken quickly when exposed to air. This means that peeled potatoes must be bathed in a chemical solution to maintain the whiteness that is so important in the consumer's perception of potato quality. Sulfites are commonly used for this purpose, but they have come under the scrutiny of the FDA because of possible

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[33]Mans, 113.

[34]Piper, Creston Valley Foods. Personal communication.

allergic reactions in some people. Alternatives may have to be found. In addition, air left in a sealed pouch may also darken the potato pieces. Air removal is a key part of the filling/sealing process. The methods that remove the most air from a pouch may put stress on the potato pieces or pouch material; the proper balance must be found. Finally, much has been made of the problem of the integrity of the heat seals; potato starch can adversely affect the strength of a seal if it gets on the edges of the pouch.

The history of potato packaging in retort pouches is not propitious. After examining costs in Chapter 5, Chapter 6 looks at the attitudes of potential buyers of retort pouch potatoes.

CHAPTER 5: DETERMINATION OF PROCESSING COSTS

This chapter begins by explaining the cost analysis process. The concept of annual use cost of durable assets is introduced, followed by an explanation of the cost collection framework, including a figure that depicts how various cost components are combined to yield the cost per pouch and per pound of packaging potatoes in retort pouches. Then follows a section that states several conditions related to plant operation that affect cost calculations. The proposed processing method is explained in detail in Figure 2 and illustrated with a flow diagram (Figure 3 on page 58). An example shows how annual use cost is calculated. Specific cost items found in Tables 1 through 5 are then explained, and cost calculations (per pouch and per pound) are shown. Costs are presented in detail in Tables 1 through 5, found on pages 75 through 81. Frequent references are made to these tables. Following the five tables, retort pouch cost per pound is compared to competing potato product prices. The chapter closes with sensitivity analysis that examines the impact on unit costs of variations in certain assumptions.

THE COST ANALYSIS PROCESS

The purpose of this cost analysis is to determine what it costs to package potatoes in retort pouches. The cost estimate summarizes all fixed and variable costs into a unit cost that can be compared to the unit sale price of competing potato products. Even though comparing <u>costs</u> of one product to <u>prices</u> of competing products appears akin to comparing apples and oranges, the comparison is nonetheless useful. For example, if production costs of one product are equal to or greater than market prices of competing products, it is apparent that the first product will have to have a higher market price, putting it at a price disadvantage in the market relative to existing competing products.

In this study fixed and variable costs are calculated and summarized as annual unit cost (per pouch and per pound). The annual use cost method of determining fixed costs is described below, followed by a section that explains how fixed and variable costs are summed to yield annual unit cost.

Determination of Annual Use Cost

Durable assets are assets that serve to produce other goods, yet are not "consumed" or used up in a single period. Machinery and buildings fall into this category. Labor services and materials are resources that are used up in a single production period such as one year. In contrast, durable assets produce returns and decline in value over a number of years.

A related consideration is that if money is invested in machinery and buildings, the income from alternative investments is forgone. Thus astute managerial decision-making should include this imputed opportunity cost of making an investment.

The annual cost of buildings and equipment thus has two components: 1) the annual depreciation, or the amount of the facility that is "consumed" in one year, and 2) the forgone annual income on what would have been earned had the financial resources been applied to some alternative (opportunity cost).

One form of annualized cost is often referred to in finance literature as an <u>annuity</u> . However, to emphasize that an annuity in this case represents the annual cost of using durable assets, the term annual use cost (AUC) is employed in this study.[1]

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[1]The term "annual use cost" comes from class lectures on capital budgeting decisions by Dr. Roy Black, Department of Agricultural Economics, Michigan State University.

The AUC is an annual charge to account for the repayment of invested capital plus interest that could be earned on the unrecovered balance of the investment (opportunity cost). The "cornerstone" of the AUC is the annuity factor (Present Worth of an Annuity or PWA), which converts a lump sum into an equivalent annuity. Another way to express PWA is as the present value of a uniform series of payments.

It is thus clear that calculating an annuity to represent the annual use cost of employing durable assets is a practice that is grounded in established cost theory. This method is analogous to determining a loan payment given the term and interest rate. Even though this approach has not been widely applied for cost analyses, it is very appropriate for this purpose. The application is straightforward; the annuity is calculated by dividing the original value of the asset by the PWA factor. If a durable asset is valued at its purchase price of $10,000 the annual use cost would be calculated as follows (using a PWA factor for 10 years at 9%):

Value of Asset/PWA = $10,000/6.4177 = $1,558

Table 10 in Appendix H (page 137) shows how the principal and interest relate to the $1,558 annuity for each year over a 10-year period. This annuity (annual use cost) is comparable to what appears in column 13 of Tables 2a and 3a (page 80). Table 2a presents how the annualized ownership cost of machinery is calculated, based on the machinery costs provided in Table 2. Similarly Table 3a presents annualized land and buildings costs related to costs provided in Table 3. However, in Tables 2a and 3a there are additional steps taken in calculating annual use cost of durable assets (beyond the simple division in the formula above) that account for estimated salvage value at the end of durable assets' useful life and for the tax savings from the stream of depreciation.

The specific calculations are discussed on page 60 in the section entitled "A Five-Step Procedure for Calculating Annual Ownership Cost of Equipment."

Cost Collection Framework

Figure 1 on page 52 shows how costs were categorized to summarize the annual investment and operating costs of the plant. Operating (variable) costs are those directly attributable to plant operation, including hourly labor wages, material, utilities and operating capital.

The first elements listed under equipment costs are annualized costs of durable assets. Other costs, including repairs, taxes, and insurance, are added to yield annual ownership costs of equipment. Building and land costs are calculated in an analogous manner. Administrative costs include salaries and fringe benefits of the managerial staff, whose work is not directly related to the number of hours of plant operation. The sum of the four components yields total annual cost. Total annual cost represents all costs except for: a) the cost per pound of potatoes in each pouch, and b) brokerage. The reason for separating out these costs and adding them subsequently is so that future users of this research can supply their own estimates. Potato costs vary substantially depending on sources of supply, time of year, and variety. Brokerage cost is the only selling or marketing expense which is included in the cost estimate. Three percent was suggested as a reasonable estimate. Selling costs other than brokerage such as trade promotion and advertising take such a wide variety of forms and vary so much in amount that it was judged best to leave these costs out of the calculation. Thus, costs as determined are likely to be somewhat understated.

As shown in Figure 1, total annual cost divided by total number of pouches produced per year results in total annual cost per pouch. In the next step, total annual cost per pouch is summed with the cost of potatoes packaged in each pouch, plus brokerage cost. The sum of those three items equals cost per six-pound package. Cost per pound is calculated by dividing cost per pouch by the number of pounds per pouch.

FIGURE 1 - SUMMARY OF THE COST ANALYSIS PROCESS

OPERATING COSTS

Hourly Labor Cost) Annual
X No. hrs. per yr.)= Labor
+ Fringe benefits) Cost

+ Materials
+ Utilities
+ Operating Capital
= Annual Operating Cost

EQUIPMENT COSTS

Total Value of Equipment + PWA = Annualized Cost of Equipment

+ Repairs
+ Taxes
+ Insurance
= Annual Ownership Cost

[PWA = Present Worth of an Annuity]

BUILDING AND LAND COSTS

Total Value of Building + PWA = Annualized Cost of Building

+ Land Cost
+ Repairs
+ Taxes
+ Insurance
= Annual Ownership Cost

ADMINISTRATIVE COSTS

Salaries of Managers and Permanent Employees

+ Fringe Benefits
= Annual Administrative Costs

COST SUMMARY

Operating Cost
+ Ownership Cost-Equipment
+ Ownership Cost-Building,Land
+ Administrative Cost
Total Annual Cost

COST PER POUCH AND PER POUND

Total Annual Cost + Total No. Pouches = Total Annual Cost per Pouch
↓
Total Annual Cost per Pouch
+ Potato Cost (6 lbs. per pouch)
+ Brokerage Cost (3% of prod. cost)
Cost per Pouch of RPP
↓
Cost per Pouch + No. lbs./pouch = Cost per Pound

The unit cost per pound of the retort pouch potato product is the key figure that results from the analysis. It provides the best available estimate of the minimum (break-even) cost for which the retort pouch potato products could be produced. No assumption is made as to an appropriate marketing margin covering profits. Users of this cost estimate can determine what margin is acceptable and/or possible given market conditions.

COST CALCULATIONS: PROCESSING PLANT OWNERSHIP AND OPERATION

The main cost collection process was limited to determining processing and handling costs from the "front door to the back door" of the plant. That is, the first operational stage of the model plant is receiving raw potatoes and the final stage is placing finished product into temporary storage preparatory to shipping. These boundaries were placed on the cost estimation process to keep the analysis manageable.

This section begins by noting certain assumptions regarding plant specifications and operating conditions. Next a "Description of Stages in Processing Potatoes in Retort Pouches" explains in sequence the process required to package potatoes in retort pouches. A corresponding flow diagram follows the description. What follows is a discussion of how the cost information is organized, with an example demonstrating the method of calculating "annual use cost" of durable assets. The subsequent subsection entitled "Summary of Annual Costs" describes how the total cost figure is converted into a unit cost figure (per pouch and per pound of finished product). This unit cost is then compared with the prices of competing potato products. In the next subsection, sensitivity analysis is used to point out the range of possible variation from the central cost estimate. Finally, reasons for the high cost of retort pouch processing are suggested.

Specification of Plant Operations and Operating Conditions

Three key assumptions for the "baseline" calculations are given below. In the sensitivity analysis, certain "baseline" factors and assumptions are varied to determine the effect on the product cost.

1. Hours of operation - This study assumes that the plant will operate on a schedule of two eight-hour shifts per day, five days per week. Eight months of operation per year is considered to be the most likely option, since the plant could operate using only Michigan potatoes. In contrast, year-round operation would require purchase of potatoes from out of state for four months out of each year. Eight months of operation translates to 2880 hours of operation per year. Year-round operation (52 weeks) works out to 260 days or 4160 hours. As part of the sensitivity analysis, separate cost calculations are made based on varying the number of months of operation per year. Appendix 5 shows the number of hours per year corresponding to different number of months of operation per year.

2. Operating standards - Certain rules of thumb were determined, including the amount of "down time" for a processing line as well as the percentage of the raw product that will end up as finished product -- that is, the amount of potato waste from peeling, culling, and trimming. In consultation with plant managers of two leading Michigan potato processing firms, it was determined that about 1½ hours would be a good estimate for time used up in breaks and lunches in a 16-hour day. Thus 14.5 hours is considered to be the actual number of hours of plant operation in a 2 shift per day operating schedule. An average loss of 45% of the weight of the raw potato to waste would be a reasonable assumption, assuming that the bulk of the potatoes supplied to

the plant are of grade U.S. #1 or higher.[2] For B's, the proportion of waste would be greater.

3. Costing period - To arrive at a cost figure per pouch, the costs for given unit of time must be calculated and then divided by the volume of output for that time period. Periods that are convenient from an accounting and managerial point of view are a quarter and a year. A year is the costing period in this study.

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[2]Generally accepted potato industry standard from Professor Jerry Cash, Department of Food Science and Human Nutrition, Michigan State University.

FIGURE 2 - STAGES IN PACKAGING POTATOES IN RETORT POUCHES

Stage 1 - RECEIVING POTATOES

The potatoes are unloaded from the trucks and move along an inclined conveyor to a water bath destoner. The product continues up to a grading reel, where the potatoes are separated into wholes, slicers, and dicers. Both are conveyed to their respective storage bins; the plant will process one or the other at a time. A take-away conveyor carries the whole or sliced potatoes to the plant infeed conveyor.

Stage 2 - POTATO PREPARATION

Once the product is in the plant, a hydro-lift/destoner removes the stones and elevates the potatoes into the washers. A brush washer removes dirt and a preheater brings the product temperature up in preparation for the peeling. An elevating conveyor with a surge hopper controls the batching operation of the steam peeler.

The steam peeler removes the peel and a discharge auger removes the potatoes from the batching hopper of the peeler; this step helps ensure the continuous flow of product through the remainder of the processing operations. An abrasive roll scrubber removes the excess peel ("tags"). A retention auger removes other impurities mixed in with the potatoes.

A waste auger picks up the trash from the roll scrubber and transports it to the sludge pump; the sludge pump moves the waste to trucks.

A hydro-pump moves the potatoes from the peeling area to the inspection area; a dewatering shaker removes the excess water. The potatoes are channeled onto an inspection table where 6 inspectors sort out bad and unpeeled potatoes and do some trimming. The potatoes move to a slicer/ dicer unit (including take-away conveyor). The sliced potatoes move into a surge tank (dip tank) with sprays (of whitener solution for potatoes) and discharge conveyor. Whole potatoes skip the slicing/dicing operation and move directly from the inspection table to the surge tank.

If plain potatoes (sliced/diced/small whole) are to be packaged, the potatoes go into a solids filler (or one of a series of fillers) that has a gravity feed which drops a predetermined weight (i.e., 6 pounds) of potatoes into containers. These containers are conveyed to the filler via a circulating conveyor.

If additional ingredients are to be added to make a value added product (i.e., potato salad or soup), the potatoes do not go into the gravity feed hoppers, but instead go into a mixing vat. The other ingredients are added to the vat at this point. The mixture is transferred manually into containers for weighing and then conveyed to the pouch filling machine.

Stage 3 - PRIMARY PACKAGING

The filler is a horizontal form/fill/seal that uses two rolls of laminate. The lower web is "deep drawn" into a tray-like cavity. The containers arrive by conveyor from the previous stage. An operator at the filling machine manually dumps the contents into the open pouch area. If the product is plain potatoes, a small quantity of brine is added, air is evacuated by a mechanical vacuum and the pouch is sealed. At this point a pouch coding machine sprays ink onto the pouch surface to identify the pouch lot.

Each pouch is check-weighed, then conveyed to an accumulation area preparatory to retorting.

The containers will circulate on a conveyor until the contents are placed in a pouch. The empty containers will go to a washing area before being reused.

Stage 4 - THERMOPROCESSING

Pouches are placed six to rack, which are in turn placed in cages/baskets and are stacked 15 deep. Prior to being placed in the racks, the first of two "100%" inspections is performed - every pouch must be examined for defects (punctures, incomplete seals, etc.) and defective pouches are discarded. The cages/baskets are wheeled into the retorts. A complete retort cycle takes 1 hour and 45 minutes with a "cook time" of about 50 min at 250°F. The remainder of the time is loading, coming up to temperature, cooling down, and unloading.

After the retort is unloaded, the cage/basket is wheeled over to an area where the racking process is reversed - racks are lifted out one by one and the pouches removed. Here the second 100% inspection takes place - workers examine each pouch for defects (the same as in the previous stage, but delaminations may be more in evidence at this stage) and sends them on a conveyor to a drying machine.

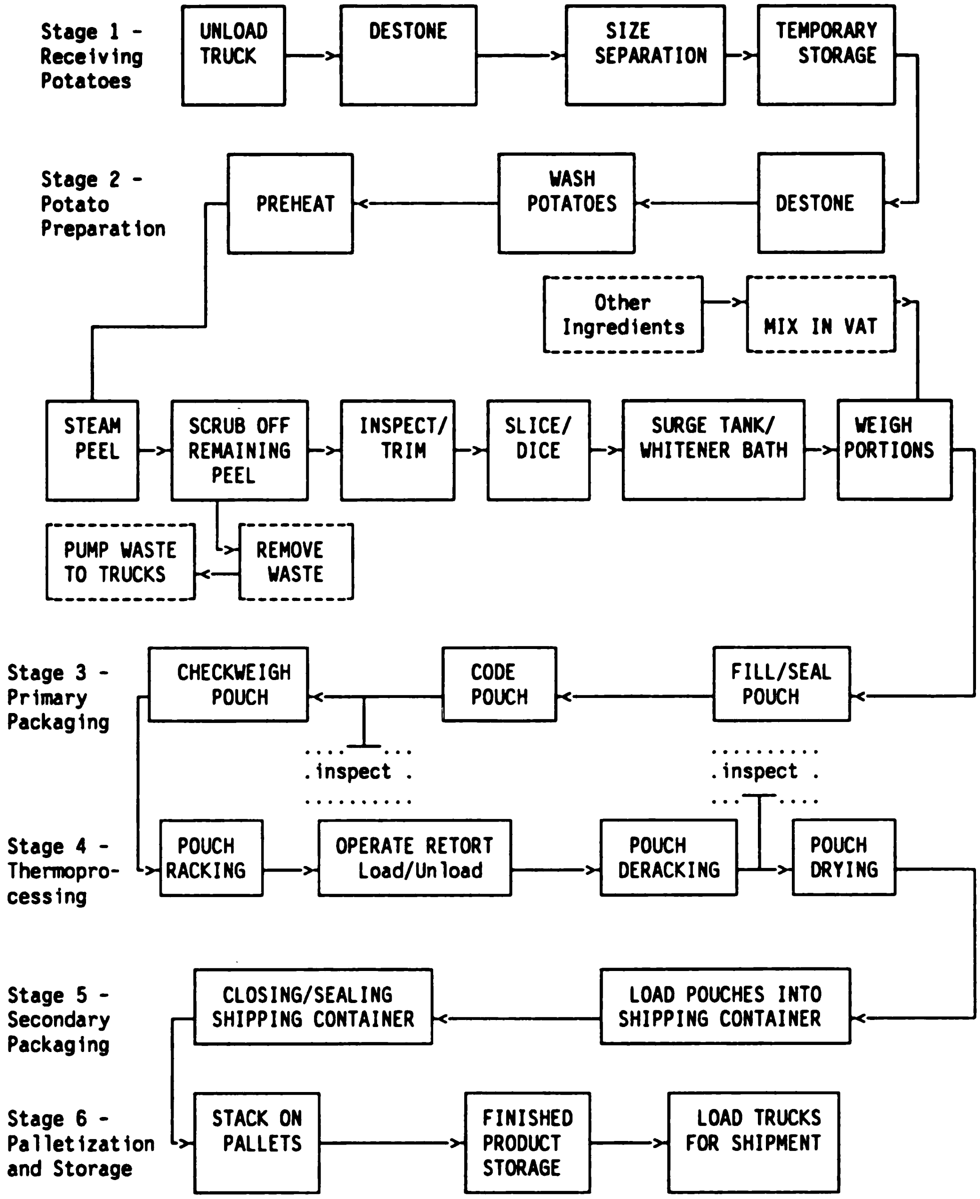
Stage 5 - SECONDARY PACKAGING

When the pouches emerge from the dryer, they are conveyed to the station where they will be placed in shipping containers. A 48-inch diameter discharge type pack-off table circulates the pouches continually until the workers can pick them up for placement into the fiberboard shipping containers (shippers). The shippers are picked up and formed to the proper shape by hand, and then the workers place the pouches into the shippers. A total of six pouches are placed into each shipper, separated by fiberboard dividers. A key factor in maintaining pouch integrity in shipping is for the pouches to fit snugly and to move as little as possible inside the shipper. If some pouches are not completely filled, yet are within a predefined tolerance, extra dividers may be placed in the shipper to maintain the tight fit. The open shipper is then conveyed to a taping machine which tapes both top and bottom of the shipper at the same time.

Stage 6 - PALLETIZATION AND STORING

The full shipping containers arrive in the palletizing area and are stacked on pallets manually. Full pallets are covered by stretch wrapper which will help maintain their stability during shipment. The full pallets are moved by forklift to the finished product storage area to await shipment.

FIGURE 3 - FLOW DIAGRAM OF STAGES IN PACKAGING POTATOES IN RETORT POUCHES



Organization of the Cost Information

One objective of this portion of the study is to determine annual costs of the fixed inputs (durable capital assets) over their varying life spans while accounting for the cost of capital and depreciation. To carry out this procedure, certain cost factors must be selected for use in the calculations, specifically, cost of capital (discount rate) and appropriate depreciation periods for the building and equipment. The cost of capital was chosen to be equal to the yield of an alternative investment; long term Treasury bills were designated as the alternative investment and they were yielding around 9% at the time of the study.

The appropriate period over which to depreciate the capital assets is the estimated useful life of the asset. The standard factors for depreciation were determined through interviews with personnel from food processing firms and from reviewing other cost studies: 10 years for all equipment and 25 years for buildings. In actual food processing firms various depreciation methods would be used, depending on specific tax situations of the firms. However, determination of optimal tax strategy is not among the objectives of this project, so straight line depreciation, the simplest depreciation method from a computational point of view, is used.

Specific items of equipment for the proposed plant listed in Table 3 may have useful lives that vary considerably from the 10 years assumed for the annual use cost calculation. However, trying to estimate separately the useful life of each machine or item in Table 3 would add little to the precision of the cost estimate, since fixed costs make up only about 21-22% of total annual costs. Thus the 10-year estimated useful life for all equipment is a reasonable assumption that simplifies considerably the calculation of annual use cost.

The annual use cost technique is used to determine annual costs of fixed assets. The calculation method yields an annual factor cost equal to an annual payment on a regular annuity, accounting for the tax shield from the stream of depreciation and the salvage value at the end of the durable assets' useful lives. A five-step procedure achieves this result.

A Five-Step Procedure for Calculating Annual Ownership Cost of Equipment

An example of the calculation of annual ownership cost of durable equipment is shown below. The example applies to the Total Value of Equipment ($1,163,600), which appears in column 5 of Table 2 (page 77). The calculations were made with a Lotus 1-2-3 electronic spreadsheet. Table 2a (page 80) takes the Total Value of Equipment figure from Table 2 and applies the calculation method described here. In the example below, in each case where the result of a calculation is shown, the column in Table 2a in which that number appears is indicated in parentheses. The steps are as follows:

STEP 1. Determine the Present Worth of an Annuity for the appropriate time period and cost of capital. The calculation shown below relates to processing plant equipment, which has an estimated useful life of 10 years; the cost of capital is 9%. There are equivalent terms for PWA in various finance textbooks; another commonly used term is the Present Value of a Uniform Series. In most financial tables the PWA is expressed as a figure that is equal to the present value of $1.00 received annually at the end of each year for a given number of years (in this study the number of years is the estimated useful life of the fixed asset). The PWA is the figure by which the Factor Cost should be divided to calculate the annuity, or annualized cost.

(PWA, 10 Years, 9%) = 6.4177 (col. 10, Table 2a)

STEP 2. Determine the present value of the factor investment (which in this example is the equipment for the proposed plant). This equals the purchase price of $1,163,600 (f.o.b. manufacturer) plus the estimated 12% additional cost attributable to delivery, installation and engineering. The result is termed Factor Cost.

$1,163,600 (col. 1) X 1.12 = $1,303,232 (col. 2) = Factor Cost

STEP 3. Determine the present value of the tax shield from the stream of depreciation. The factors in the calculation are:

Total Depreciation Over the Estimated Useful Life of the Input X The Marginal Tax Rate X PWA = PV of Tax Shield

Steps a) through d) achieve this result:

a) Salvage Value = $1,303,232 X 10% = $130,323 (col. 3)

b) Total Depreciation Over Life of the Input
= Factor Cost - Salvage Value = $1,303,232 - $130,323 = $1,172,909 (col. 4)

c) Annual Depreciation = Total Depreciation ÷ Input life = $1,172,909 ÷ 10 = $117,291 (col. 8)

d) Annual Depreciation X Marginal Tax Rate X PWA = PV of tax shield

= $117,291 X 0.34 X 6.4177 = $255,929 (col. 11)

STEP 4. Determine the present value of the salvage value:

Salvage Value Received at End of Input's Life X Present Value of $1.00 Received in Salvage Year (9%, Year 10) = PV of Salvage Value

$130,323 X 0.4224 = $55,050 (col. 7)

STEP 5. Determine the annualized cost of the durable capital asset, which equals the algebraic, present value sum of the above three factors:

$$\frac{\text{(Factor Cost) - [(PV of Tax shield) + (PV of Salvage Value)]}}{\text{Present Worth of an Annuity}}$$

= [2 - (3 + 4)] ÷ PWA = Annualized Cost of Capital Asset

= [$1,303,232 - ($55,050 + $255,929)] ÷ 6.4177 = $154,613 (col. 13)

This figure of $154,613 is the Annualized Value of Equipment, which appears in the final column (column 13) of Table 2a. The Annualized Value of Equipment cost figure also appears near the bottom of Table 2; the cost of insurance and tax are added to give the Total Annual Cost of Equipment which is $163,340.

The annualized cost of the building and sewage treatment facility (excluding land cost) appears in column 7 of Table 3 (page 79) and totals $118,679. That figure was calculated using the same method described in this section, but with a PWA factor of 9% for 25 years (9.8226, column 10), due to the estimated 25 year useful life of the buildings.

Input Cost Items in Tables 1-5

As mentioned above, Tables 2, 3 and 4 summarize the fixed costs and Table 1 the variable costs. What follows is a description of the cost-producing inputs from these tables and the different types of economic costs associated with each of them. Actual calculations are shown where appropriate.

Table 1: Input Items

An important factor that relates to a number of the input items in this chapter is the number of hours worked per year. That factor is used in several calculations in addition to direct labor wages: chemicals, forklift fuel, water, and sewage disposal services. The number of hours worked per year is calculated by assuming a 16-hour day (two shifts), a 5-day work week, and with various assumptions on the number of weeks per year. The calculation below assumes 8 month operation:

16 hours/day X 5 days/week X 36 weeks/year = 2880 hours per year

Direct Labor. Determination of the labor required to run the plant was based on the equipment distributor's estimate of the number of workers required to operate the various pieces of equipment. These original estimates were supplemented and adjusted after checking with several processing plant managers. This category includes all of the direct labor (directly associated with particular stages in the production process); the indirect and supervisory labor is accounted for in Table 4. Every category of worker except the clean-up crew is assumed to have two shifts. Since the number of workers that appear in the table are the number of workers per shift, the actual number of workers per day is 25 X 2 = 50 workers plus 6 clean-up for a total of 56 workers. Assuming a $7.50 per hour wage, the annual labor cost for yard workers is calculated as follows:

2 Yard Workers X 2880 hours/year X $7.50/hour = $43,200/year (col. 7)

Materials. By far the most important item in this category is the cost of the retort pouch material, referred to as the laminate or roll stock. Other costs include the corrugate for the shipping carton, chemicals (the potato whitening agent and other chemicals for cleaning) forklift fuel, pallet stretch wrap (plastic material to wrap around the cartons on pallets to stabilize them) and bobcat fuel (the bobcat is used in the yard in the unloading of raw potatoes from the delivery truck).

1) The laminate costs $1.10 per 1000 square inches for the upper web. As discussed in Chapter 3, the type of retort pouch used on the horizontal form/fill/seal machine requires a heavier gauge lower web, and this additional strength is reflected in a higher cost: $1.70 per 1000 square inches. The pouch size is 10.5" wide by 15" long; these are the dimensions of the upper web. The lower web is drawn into a cavity with a depth of about 1.4". Therefore about 1.5" should be added to the dimensions of the lower web to account for this extra surface area; the dimensions of the lower web are thus estimated to be 12" X 16.5".

Lower Web: 10.5" X 15" = 157.5 square inches per pouch

157.5 sq. in./pouch X \$1.10/1000 sq. in. = \$0.173/pouch

Upper Web: 12" X 16.5" = 198.0 square inches per pouch

198.0 sq. in./pouch X \$1.70/1000 sq. in. = \$0.337/pouch

Total Laminate Cost per Pouch = \$0.173 + \$0.337 = <u>\$0.51</u>

The number of workdays per year is 5 days/week X 52 weeks = 260 days

The number of pouches produced per 16 hour day is 8640 (see App. A, page 113)

The number of pouches produced per year is therefore:

8640 pouches/day X 180 days = 1,555,200 pouches/year (col. 3)

Annual cost of laminate is: 1,555,200 pouches X \$0.51/pouch = \$793,152 (col. 7)

2) The unit price for the <u>corrugate</u> is \$0.90 per shipping carton, each of which is assumed to hold 6 pouches. This cost is higher than that required for shipping cans (around \$0.50 per carton). The pouches require stronger corrugate for greater protection. The annual corrugate cost is:

1,555,200 pouches ÷ 6 pouches per carton = 259,200 cartons (col. 3)

259,200 cartons X \$0.90/carton = \$233,280 (col. 7)

3) <u>Pallet stretch wrap</u>. A plant manager indicated in an interview that a reasonable cost estimate would be about \$35 per case. One case covers approximately 585 pallets. Eight months of operation per year would mean 2880 hours, producing 1,555, 200 pouches.

585 pallets X 16 cartons/pallet = 9360 cartons (with 6 pouches each)

1,555,200 pouches per year / 9360 (cartons per case) = 28 cases per year

(28 cases per year) X (\$35 per case) = \$969 (col. 7)

4) Forklift fuel. The plant is assumed to operate with a single propane powered forklift. The first step is to estimate the fuel cost per hour of operation of the forklift. The factor used in the Allison study was adopted for this project; that study assumed that a forklift ran 8 hours on a tank. Since the fuel costs about $8 per tank, the fuel cost is estimated at $1.00 per hour. The cost calculation is thus:

Annual cost of forklift fuel = 2880 hours/year X $1.00 = $2880 (col. 7)

5) Bobcat fuel. The bobcat is estimated to consume about a gallon per hour of operation in the yard, unloading the raw potatoes. Delivery of the raw product is assumed to occur only during one shift, so the hours are one half of the yearly total, or 1440.

6) Fuel oil (for boiler). A rate per hour of fuel oil was adapted from fuel use figures from a study on costs of a vegetable canning plant. The calculation to arrive at the hourly cost figure is explained in Appendix D on page 117.

7) Chemicals. One input cost for which no adequate estimate could be found was for chemicals - cleaning solutions and the whitening agent for potatoes (sulfites). No figures for those items are therefore included in the cost estimate.

Utilities. Utilities include water, sewage disposal services, and electricity for heats, light, and running the equipment. Estimates of annual water usage and sewage disposal were determined in consultation with an engineer with experience in food plant waste disposal. Electricity use was determined to be proportional to that of a vegetable canning plant (see Appendix C on page 116). Rates were obtained from local utility companies. That information was used to calculate an estimated cost per hour of operation for water and sewage. The details of how those factors were calculated are in

Appendix B at the end of this chapter. An example of the calculation of the annual water cost is shown below:

Annual water cost = 2880 hours X $23.84/hour = $68,659 (col. 7)

Maintenance and Repairs. A portion of the building and maintenance costs and all of the machinery costs are assumed to be variable costs. For buildings, the variable maintenance cost is estimated at $0.40 per square foot per year.

20350 sq. ft. X $0.40 per sq. ft. = $8140 (col. 7)

Variable machinery maintenance cost is estimated as follows with a factor of 0.6 for complex machines and 0.3 for simple machines:

(Base Cost) X (0.3 to 0.6) = Repair Cost (over life of equipment)

The midpoint in this range (0.45) was selected as the appropriate factor to multiply times the total value of equipment in the model plant. To estimate the cost per hour of plant operation, the following calculation was made:

{[(Total Equipment Cost) X 0.45] ÷ (Machinery Life)} ÷ Maximum Hrs per Year

= Machinery maintenance cost per hour of operation

= {[$1,163,600 X 0.45] ÷ 10 years} ÷ 4160 hrs per year = $12.59 per hour (col. 7)

Operating Capital. Operating capital is the amount of money borrowed to cover the expenses of operation. The costs are the interest payments made over the length of the loan. A cost study of vegetable processing plants indicated that it is common practice to borrow enough to cover all of the operating (variable) expenses, and that is the assumption made in this calculation. The length of the loan repayment is assumed to equal the maximum possible period of operation, which is 12 months. A typical borrowing rate of 10% per year is assumed.

Amount of Operating Loan = Total Operating Expenses = $2,135,044

Interest Expense on Operating Loan = Amount of Loan X Interest Rate

= $2,135,044 X 0.12 = $256,205 (col. 7)

Table 2: Input Items

The long list of items of equipment that make up this table are depreciable capital assets and the economic costs are the capital costs and depreciation. The sample calculation earlier in this chapter show how the annualized cost of equipment is determined. The annual personal property tax is based on an assessed value of 50% of the original purchase price of the equipment and is calculated in the same manner as for the building, as explained in the following section. Insurance costs are calculated in a manner identical to the following section.

Table 3: Input Items

Land. Land is a non-depreciable capital asset and the economic cost of the land on which to build the processing plant is the cost of invested capital (assuming neither capital gains nor losses on the ultimate disposition of the land). An average price per acre was assumed to be the cost of zoned industrial land near one of the potato-producing areas in Michigan. The $30,000 per acre cost is the average estimate from various real estate brokers for parcels of land under 10 acres for industrial use in much of the Midwest.[3] The annual ownership cost of land is the opportunity cost of capital which could be invested in an alternative investment; a Treasury Bond yielding 9% is designated as the alternative investment. The total square footage of the model plant is estimated at 20,350 square feet and the total land area requirements are estimated at approximately four times the plant area itself (four times 20,350 square feet is approximately 2 acres). The land is assumed to border roadways and utility hookups are readily available. Thus no expense for roadwork or extending electric and water lines is assumed.

Number of acres X Cost per Acre X Cost of Capital

2 acres X $30,000/acre X 0.09 = $5400 (col. 7)

Site Preparation. The cost of preparing the land for building is estimated at $28,000 per acre.[4] The annual costs of site preparation were calculated via the same method used for the annual land input cost.

Buildings. The building that will house the processing facility is assumed to be a single structure divided into a number of sections, including processing area, storage areas, and office space. The building is a durable capital asset subject to capital costs and depreciation. The surface area (in square feet) of each of the sections and the cost per square foot were approximations based on interviews with several canning plant managers and with an engineer[5] with a consulting firm specializing in food processing

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[3]Daniel Surfus, engineer from Mead and Hunt, Inc. (consulting engineers), Madison, Wisconsin. Personal communication.

[4]Surfus.

[5]Surfus.

plant design. The costs were assumed to include all fixtures and piping. The useful life of the building was assumed to be 25 years with a 10% salvage value at the end of the useful life. The pumps, screens and related equipment for the sewage treatment system (assuming processing wastes are fed into a municipal wastewater treatment system) were assumed to be $50,000; that figure was annualized in the same manner as the building costs. Shown below is a cost calculation for one part of the plant:

Processing Area: (7,000 sq. ft.) X ($72/sq. ft.) = $504,000 (col. 5)

Fixed Building Maintenance Cost. Fixed annual repair and maintenance costs were estimated at $0.20 per square foot of structure.[6] These maintenance costs would be incurred whether or not the plant was operating.

20,350 sq. ft. X $0.20/sq. ft. = $4,070 (col. 7)

Property Taxes. Property taxes are based on the assessed value of land and buildings. Interviews with farm management specialists at Michigan State University were carried out to ascertain an appropriate relationship of the assessed value of land and buildings to their market value. The assessed value was determined to be 50% of the purchase price of the land and buildings. A representative annual millage rate of $45 per $1000 was determined (which appears below as the factor 0.045). The method for calculating annual property taxes is as follows:

[6]Surfus.

Initial Investment in Land and Buildings X 0.50 = Assessed Property Value

$1,394,800 X 0.50 = $697,400 (col. 3)

Property Tax = (Millage Rate per Year) X (Assessed Property Value)

= 0.045 X $697,400 = $31,383 (col. 7)

Insurance. An annual insurance cost was calculated by multiplying the rate times the value of the building. Plant managers indicated that a premium of $5.00 per $1000 of property was a reasonable estimate; this estimate appears as the factor 0.005 below.

(Rate per Year) X (Value of Building) = 0.005 X $1,278,800 = $6,394 (col. 7)

Table 4: Input Items

Administrative Costs. The administrative costs are the annual salaries of the general manager and plant manager, supervisory labor (foremen), and indirect labor (not directly associated with the production process - office workers and the Quality Control Supervisor). The labor that is directly associated with the production process are accounted for in Table 1 as variable costs. Nonwage expenses such as social security, unemployment insurance, and worker's compensation were determined as a percentage (30%) of the total salary cost and were grouped under the heading of fringe benefits. Below is an example of the annual administrative cost calculation:

Salary of Foreman (Processing) X No. of Foremen = $20,000 X 2 = $40,000 (col. 5)

RESULTS OF THE COST ANALYSIS

This section is organized as follows. The method for determining cost per pouch and per pound is explained, followed by five tables that summarize all costs. The resulting cost per pound is then compared to the prices of competing potato products. Due to the uncertainty regarding certain cost elements, this section closes with sensitivity analysis that illustrates the impact on the total cost estimate of variation above and below the "best estimate" or "baseline" cost figures.

Summary of Annual Costs

Tables 2 through 5 summarize all the fixed and variable costs of owning and operating the retort pouch processing plant. Tables 2, 3, and 4 make up the fixed costs. In the baseline case with the assumption of eight months of operation per year, the sum of fixed costs from those three tables add up to about 21.6% of total annual costs. The variable costs are summarized in Table 1 and make up 79.4% of total annual costs. Most operating cost figures in Table 1 are expressed in a unit cost per hour basis, which simplifies the job of re-calculating costs under different scenarios of the duration of plant operation per year. To estimate 8 months and 12 months of operation per year, for example, only the hours of operation per year need be changed, and all costs can easily be recalculated.

The key results are the cost per pouch and per pound. Cost per pouch is obtained by dividing the total annual costs by the estimated number of pouches produced per year. Pouches produced per day are estimated as shown in Appendix A (page 113).

8640 Pouches per Day X 180 Working Days per Year = 1,555,200 pouches per year

Total Annual Costs of \$3,811,556 ÷ 1,555,200 Pouches/Year = \$1.94 = Cost per Pouch

Estimated unit cost of packaging potatoes in retort pouches is $1.94 per pouch not including cost of potatoes or brokerage.

A six pound estimate for average weight of pouch contents is based on interviews with executives from several retort pouch food manufacturing firms and an examination of retort pouch packages from a German food manufacturer.[7] However, since it cannot be precluded that the average pouch contents will vary by as much as one pound, the implications of a one pound variation above and below six pounds are considered as part of the sensitivity analysis.

The raw product cost estimate must account for the fact that on average potatoes will lose approximately 45% of their weight as waste during processing; the 0.55 factor in the denominator of the formula below represents the 55% of the original potato weight remaining after processing. Costs per pound of the raw product is thus expressed in terms of the pounds of potatoes in the finished product, so that it can then be added to

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7 The six pound per pouch estimate was based largely on comparing the dimensions of the estimated pouch size for the model plant in this study with the dimensions of a retort pouch containing 4 kilograms (8.8 pounds) of shredded potatoes obtained from Ebbrecht, a German food manufacturing firm. The German pouch was packed very tightly with shredded potatoes. The model plant design specifies that four different product forms will be produced. The smaller dimensions of the pouch for the proposed model plant, plus the smaller quantities of whole or sliced potatoes that could be packaged relative to the 8.8 pounds of shredded potatoes, in the Ebbrecht package indicate that six pounds is a reasonable estimate of the average weight of pouch contents.

the processing cost calculated above. The average price for U.S #1 bulk potatoes in Michigan has averaged 5.5¢ per pound in recent years.[8]

(\$0.055 per pound) ÷ 0.55 = \$0.10 per finished product pound of potato

= \$0.60 for six pounds

The final figure needed for the unit cost estimate is the brokerage cost; plant managers from several leading potato processing firms in Michigan indicated that 3% of the above mentioned costs was a reasonable estimate:

3% X (\$1.94 + \$0.60) = \$0.076 or approximately 8¢ brokerage cost

Using these cost figures, the unit cost per pouch of retort pouch potato product is calculated as follows:

	\$1.94	**Total annual cost per finished product pouch**
+	**0.60**	**Cost of potatoes**
+	**0.08**	**Brokerage cost**
equals	**\$2.62**	**Unit cost per pouch of RPP**

Cost per pouch is divided by six to get the price per pound:

\$2.62 ÷ (6 lbs. per pouch) = 44¢

This figure, 44¢ per pound, is the key figure that emerges from this analysis; it is an estimate of the break-even cost to produce the retort pouch product, following the

[8]If production continues beyond 8 months, Michigan storage potatoes will likely be exhausted, and potatoes must be purchased out of state, costing several cents more per pound. If for example, potatoes were purchased at \$0.08 instead of \$0.055 per pound, then the price for those potatoes would be calculated in the same manner:
(\$0.08 per pound) ÷ 0.55 = \$0.145 per finished product pound

To calculate the cost of potatoes going into the pouch requires using a weighted average of \$0.10 for 8 months (69% of the year, indicated by the 0.69 factor) and \$0.145 for 4 months:

[(\$0.08/pound X 0.69) + (\$0.145/pound X 0.31)] X 6 lbs.
= \$0.68 for six pounds.

assumptions made in the design of the model plant, and given that the pouch will be designed to hold 6 pounds of potatoes.

TABLE 1 - ESTIMATED ANNUAL OPERATING COSTS FOR A PROCESSING PLANT FOR PACKAGING POTATOES IN RETORT POUCHES

Item	Units	No. Units	Cost/ Unit	No. Hours/ Year[9] (2 shifts)	Cost/ Hour	Annual Cost (3)X(4) or (3)X(5)X(6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
STAGE 1 - RECEIVE POTATOES						
Yard Worker-Receiving	each	2		2880	$7.50	$43,200
STAGE 2 - FOOD PREPARATION						
Product Inspectors	each	6		2880	$6.75	$116,640
Food Preparer	each	2		2880	$7.50	$43,200
Portion Weigher	each	1		2880	$7.00	$20,160
STAGE 3 - PRIMARY PACKAGING						
Form/fill/seal Operator	each	2		2880	$7.50	$43,200
Pouch Filler	each	2		2880	$6.75	$38,880
STAGE 4 - THERMOPROCESSING						
Rack Loader/Pouch Inspector	each	2		2880	$6.75	$38,880
Retort Operator	each	1		2880	$9.00	$25,920
Rack Unloader/Pch.Inspector	each	2		2880	$6.75	$38,880
STAGE 5 - SECONDARY PACKAGING						
Case Packer	each	2		2880	$6.75	$38,880
STAGE 6 - PALLETIZE AND STORE						
Pallet Stacker/Forklift Operator	each	1		2880	$7.00	$20,160
OTHER DIRECT LABOR						
General Maintenance	each	2		2880	$9.00	$51,840
Clean-up Crew (1 shift only)	each	6		1440	$6.75	$58,320
Subtotal (net of fringe ben.)		31				$578,160
Fringe Benefits (30% of annual pay)						$173,448
Subtotal Labor Compensation						$751,608

[9]Based on 8 hours/shift, 2 shifts/day, 5 day work week, 36 weeks of operation per year. 36 weeks (8 months) is the approximate length of time that the proposed plant would operate each year, because that is the time that the firm could be supplied with Michigan potatoes. Beyond that time, the firm would need to purchase potatoes from out of state, significantly raising the cost of potatoes.

TABLE 1 - OPERATING COSTS (continued)

Item	Units	No. Units	Cost/ Unit	No. Hours/ Year (2 shifts)	Cost/ Hour	Annual Cost (3)X(4) or (3)X(5)X(6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
MATERIALS						
Laminate-Roll Stock	pouch	1555200	$0.51			$793,152
Corrugate (cartons)	carton	259200	$0.90			$233,280
Forklift fuel	hour	2880	$1			$2,880
Pallet Stretch Wrapper	case	28	$35			$969
Bobcat Fuel	hour	1440	$1			$1,440
Fuel Oil (for boiler)	hour	2880	$24.00			$69,120
UTILITIES						
Water	hour	2880	$23.84			$68,659
Sewage Disposal Services	hour	2880	$48.87			$140,746
Electricity	hour	2880	$10.00			$28,800
MAINTENANCE & REPAIRS						
Buildings	sqft	20350	$0.40			$8,140
Machinery	hour	2880	$12.59			$36,251
Subtotal (non-labor costs)						$1,383,437
Subtotal (labor + non-labor)						$2,135,045
OPERATING CAPITAL	$	2135044	0.12			$256,205
GRAND TOTAL						$2,391,250

Sources: Unpublished data. Wage rates obtained from Michigan-based food processing plant managers. See page 62 for assumptions and calculations for deriving cost figures.

TABLE 2 - ESTIMATED INITIAL INVESTMENT REQUIREMENTS AND ANNUAL OWNERSHIP COSTS: EQUIPMENT FOR A RETORT POUCH PLANT FOR PACKAGING POTATOES

Item	Unit	No. Units	Cost/ Unit	Initial Investment (4)X(5)	Annual Cost
(1)	(2)	(3)	(4)	(5)	(6)
STAGE 1-RECEIVE POTATOES					
Feed Hopper	ea.	1	$16,000	$16,000	
Bobcat	ea.	1	$9,000	$9,000	
Inclined Conveyor	ea.	1	$20,000	$20,000	
Water Bath Destoner	ea.	1	$8,000	$8,000	
Grader Reel	ea.	1	$10,000	$10,000	
Storage Hoppers	ea.	3	$50,000	$150,000	
Take-away Conveyor	ea.	1	$7,000	$7,000	
STAGE 2-FOOD PREPARATION					
Hydro-lift/Destoner	ea.	1	$13,000	$13,000	
Brush Washer	ea.	1	$27,000	$27,000	
Preheater	ea.	1	$18,000	$18,000	
Elevating Conveyor	ea.	1	$11,500	$11,500	
Steam Peeler	ea.	1	$40,000	$40,000	
Discharge Auger	ea.	1	$13,000	$13,000	
Abrasive Roll Scrubber	ea.	1	$27,000	$27,000	
Waste Auger	ea.	1	$4,000	$4,000	
Sludge Pump	ea.	1	$1,500	$1,500	
Hydro-pump	ea.	1	$15,000	$15,000	
Inspection Table	ea.	1	$15,000	$15,000	
Slicing Unit	ea.	1	$35,000	$35,000	
Surge Tank	ea.	1	$15,000	$15,000	
Solids Filler	ea.	1	$2,000	$2,000	
Cups	ea.	500	$1	$500	
Mixing Vats	ea.	5	$200	$1,000	
Cup Washing Machine	ea.	1	$1,000	$1,000	
Stage 3-PRIMARY PACKAGING					
Form/Fill/Seal	ea.	1	$154,000	$154,000	
Vacuum Pump	ea.	1	$5,800	$5,800	
Brine Filler	ea.	1	$3,000	$3,000	
Pouch Coder	ea.	1	$20,000	$20,000	
Checkweigher	ea.	1	$3,000	$3,000	

TABLE 2 - EQUIPMENT (continued)

Item	Unit	No. Units	Cost/ Unit	Initial Investment (4)X(5)	Annual Cost
(1)	(2)	(3)	(4)	(5)	(6)
STAGE 4- THERMOPROCESSING					
Pouch Racking Table	ea.	1	$500	$500	
Pouch Racks	ea.	400	$90	$36,000	
Retorts	ea.	2	$122,000	$244,000	
Data Logger (computer)	ea.	1	$6,000	$6,000	
Pouch De-Racking Table	ea.	1	$500	$500	
Pouch Dryer	ea.	1	$40,000	$40,000	
Lift Station	ea.	1	$17,000	$17,000	
STAGE 5-SECONDARY PACKAGING					
Pack-off Table (48")	ea.	1	$4,800	$4,800	
Taping Machine	ea.	1	$9,000	$9,000	
STAGE 6-PALLETIZE,STORE					
Pallets	ea.	50	$10	$500	
Forklifts	ea.	1	$12,000	$12,000	
GENERAL EQUIPMENT					
Sewage Treatment Equip.	ea.	1	$10,000	$10,000	
Air Compressor	ea.	1	$6,000	$6,000	
Boiler	ea.	2	$28,000	$56,000	
Refrigerator	ea.	1	$21,000	$21,000	
Laboratory Equipment	ea.	1	$5,000	$5,000	
Conveyors(entire plant)	set	1	$50,000	$50,000	
Total Value of Eqpt.				$1,163,600	
Annualized Value of Eqpt.[10]					$154,613
Insurance	$	1163600	0.005		$5,818
Personal Property Tax (assessed at 50% of value)	$	581800	0.005		$2,909
Total Annual Cost					$163,340

Source: Unpublished data. All costs are "ballpark" price estimates. Price of retorts from Stock America, Inc. Price of form/fill/seal machine from Koch, Inc. Other machinery prices from BFM, Inc.

[10] Calculation of Annualized Value of Equipment (annual use cost), accounts for capital costs depreciation, tax effects of depreciation, and for estimated salvage value at the end of durable assets' useful life. This cost figure comes from column 13 in Table 2a (page 80), which shows how the calculation is carried out. See also page 60 of this report for details on the calculation.

TABLE 3 - ESTIMATED INITIAL INVESTMENT REQUIREMENTS AND ANNUAL OWNERSHIP COST FOR A RETORT POUCH PLANT FOR PACKAGING POTATOES: LAND, BUILDING, AND SEWAGE

Item	Unit	No. Units	Cost/ Unit	Initial Invstmt. (3)X(4)	Annuali- zation Factor	Annual- ized Cost
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Land	acre	2	$30,000	$60,000	0.09	$5,400
Site Preparation	acre	2	$28,000	$56,000	0.09	$5,040
Building						
Processing Area						
Sanitary	sqft	7000	$72	$504,000		
Other	sqft	3000	$44	$132,000		
Refrigerated Storage	sqft	450	$50	$22,500		
Laboratory Area	sqft	900	$85	$76,500		
Dry Storage Area	sqft	5000	$44	$220,000		
Boiler/Maint./Elec.	sqft	2000	$43	$86,000		
Office	sqft	600	$103	$61,800		
Lunch & Locker Room	sqft	1400	$90	$126,000		
Total square feet	sqft	20350				
Sewage Treatment Plant	plnt	1	$50,000	$50,000		
Total Value (excl. land)	$			$1,278,800	from> Table> 3a [11]	$118,679
Total Value (incl. land)	$			$1,394,800		
Fixed Bldg. Maint. Cost	sqft	20350	$0.20			$4,070
Property Tax (bldg, land assessed at 50% of value)	$	697400	0.045			$31,383
Insurance	$	1278800	0.005			$6,394
Total Annual Cost						$170,966

Source: unpublished data. Square footage and land value estimates from Mead and Hunt, Inc. (consulting engineers), Madison, Wisconsin. See page 67 for assumptions and calculations for deriving cost figures.

[11] Calculation of Annualized Cost of Building (annual use cost), accounts for capital costs depreciation, tax effects of depreciation, and estimated salvage value at end of durable assets' useful life. This cost figure comes from column 13 in Table 3a (page 80), which show how the calculation is carried out. See also page 60 for details on the calculation.

TABLE 2a - CALCULATION OF ANNUALIZED COST OF EQUIPMENT

Initial Invest-ment (Total Value, col. 5, Table 2)	Asset Value incl. 12% Installat. Cost (1) + 12%	Salvage Value (2)X10%	Net of Salvage Value (3)-(2)	Esti-mated Useful Life (yrs)	PV Factor [PV of $1 (9%,10yr)]	PV of Salvage Value (2)X(6)	Annual Depre-ciation (4)/(5)	Tax Shield (8)X34%	PWA of $1 (9%,10yr)	PV of Tax Shield (9)X(10)	Net of Salvage Value and Tax Shield [(2)-(7) - (11)]	Annual-ized Value of Eqpt. (12)/(10)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
$1,163,600	$1,303,232	$130,323	$1,172,909	10	0.4224	$55,050	$117,291	$39,879	6.4177	$255,929	$992,253	$154,613

TABLE 3a - CALCULATION OF ANNUALIZED COST OF INITITAL INVESTMENT IN BUILDING AND EQUIPMENT

Initial Invest-ment (Total Value, col. 5, Table 3)	Asset Value Incl. 5% Engineer-ing Cost (1) + 5%	Salvage Value (2)X10%	Net of Salvage Value (3)-(2)	Esti-mated Useful Life (yrs)	PV Factor [PV of $1 (9%,25yr)]	PV of Salvage Value (3)X(6)	Depre-ciation (4)/(5)	Tax Shield (8)X34%	PWA of $1 (9%,25yr)	PV of Tax Shield (9)X(10)	Net of Salvage Value and Tax Shield [(2)-(7) - (11)]	Annual-ized Cost (12)/(10)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
$1,278,800	$1,342,740	$134,274	$1,208,466	25	0.1160	$15,571	$48,339	$16,435	9.8226	$161,435	$1,165,733	$118,679

TABLE 4 - ESTIMATED ANNUAL ADMINISTRATIVE COSTS FOR A PROCESSING PLANT FOR PACKAGING POTATOES IN RETORT POUCHES

Item	Units	No. Units	Cost/ Unit	Annual Cost (4)X(5)
(1)	(2)	(3)	(4)	(5)
General Manager	each	1	$45,000	$45,000
Plant Manager	each	1	$35,000	$35,000
Office Worker	each	2	$20,000	$40,000
Quality Control Supervisor	each	1	$20,000	$20,000
Foreman - Receiving	each	1	$20,000	$20,000
Foreman - Processing	each	2	$20,000	$40,000
Foreman - Whse/Shipping	each	1	$20,000	$20,000
Subtotal (net of fringe ben.)				$220,000
Fringe benefits (30% of annual pay)				$66,000
TOTAL				$286,000

Source: Interviews with Michigan food processing plant managers.

TABLE 5 - ESTIMATED ANNUAL COST SUMMARY FOR A RETORT POUCH PLANT FOR PROCESSING POTATOES

Item	Cost	Percent of Total
Operating (Variable) Cost	$2,391,250	79.4%
Ownership Cost-Equipment	$163,340	5.4%
Ownership Cost-Land, Bldg	$170,966	5.7%
Administrative Cost	$286,000	9.5%
TOTAL	$3,011,556	100.0%

Source: Tables 1 through 4.

Comparisons With Competing Potato Products

A key conclusion derived from this research is that retort pouch potato products would need to command higher prices than those of several traditional competing products. Table 1 shows that at a cost of 44¢ per pound (for a 6-pound pouch) the new retort pouch potato product would be at a price disadvantage relative to several competing products. Note that 44¢ per pound is the estimated break-even cost of producing retort pouch potatoes. Sales costs, other than brokerage, as well as profit and marketing margins were not included in the cost calculation. Thus if the product is manufactured and sold, the selling price would need to be even higher than 44¢. In contrast, wholesale market prices are quoted for a number of competing potato products. If the estimated cost of retort pouch potatoes is higher or only slightly below the market prices of competing products, this is evidence that the retort pouch product is at a price disadvantage.

In Table 6, the 44¢ manufacturing cost of retort pouch potatoes is, with one exception, about the same as the lower range of wholesaler list prices. Wholesale prices for "fresh-processed" or "peelers" (fresh potatoes delivered peeled and ready to use), range from 45¢ to 57¢. However, it appears likely that the price of retort pouch potato products, including promotion and advertising expenses, would likely be above wholesaler prices for "fresh-processed" and frozen potatoes. When further necessary allowances are made for manufacturing profit margins as well as wholesaler margins, the price situation becomes even more disadvantageous. Thus, it appears unlikely that retort pouch potatoes could gain customer acceptance based on price considerations alone.

TABLE 6 - COMPARISON OF RETORT POUCH POTATO PRODUCT MANUFACTURING COSTS AND WHOLESALER PRICES FOR COMPETING PRODUCTS

PRODUCT	COST/PRICE PER LB.[1]
1. Retort pouch potatoes	44¢ Cost
2. Fresh-processed	45-57¢ Market prices
3. Frozen, various products	43-54¢ Market prices
4. Frozen hash browns	50-67¢ Market prices
5. Canned - sliced/diced	44-45¢ Market prices

1.Wholesale market prices from survey of food service operations in Lansing, Michigan.

Sensitivity Analysis

The figures in Tables 1 through 5 summarize the best estimates of numerous cost elements. In this section of the analysis, these figures are termed the Baseline Scenario. Higher and lower estimates are calculated around these base figures. Sensitivity analysis focuses on cost elements that are both uncertain and also large enough that a change in the estimate would alter substantially the final cost calculation.

Table 5 sums the cost estimates from Tables 1 through 4. Operating Costs (Table 1) make up 79.4% of the total cost of the final product. Examination of Table 1 reveals that the largest cost figures in that table are (1) labor and (2) materials (specifically, laminate and packing cartons). These cost items are obvious candidates for sensitivity analysis. Other figures about which there is some uncertainty appear in Table 4 -- the salaries of managers and other permanent employees whose pay does not vary directly with the level of operation (they are paid salaries, not on an hourly basis). The sensitivity analysis proceeds by estimating the effect on total cost of changes in those three categories of cost figures. The explanations that appear below Table 7 indicate the magnitude of the estimated variability of those figures.

The results of the sensitivity analysis are presented in Table 7. Each figure arrayed in that table represents the total annual cost per pound (excluding cost of potatoes and brokerage). Three figures in Table 7 are distinguished by a box. The baseline figure of $1.94 represents the best estimate of the cost of packaging potatoes, calculated by the method on page 73. The highest and lowest cost estimates in Table 7 are also boxed to distinguish them. Those figures are $2.06 and $1.69. The figures demonstrate that the assumption with the greatest impact on the total annual cost per pound is the estimated number of pounds of potatoes in the pouch. For that reason, the results are presented showing a range of figures between 5 and 7 pounds, which are judged to be the likely lower and upper limits. Note that in Table 7, Total Annual Cost per Pouch is the same for five, six, and seven pounds. The cost of production would of course not be the same with differing quantities going into the pouches. However, the cost is the same for all three weight levels because the one-pound range on either side of the six-pound estimate represents a lack of certainty about average weight of pouch contents, not alternative sizes to be produced by the plant.

Table 8 then takes the most likely scenario (8 months of annual operation, Baseline Scenario) and compares those figures to the very highest and lowest total annual cost per pound figures from Table 7. These three sets of total annual cost figures (Baseline, Lowest Cost and Highest Cost) appear in column 3 of Table 8. Table 8 completes the cost calculations (for Baseline, Lowest Cost and Highest Cost), using the formula for calculating unit cost given on page 73 at the end of the previous section. The 6-pound baseline cost estimate is $2.62 per pouch or 44¢ per pound. Still considering the Baseline Scenario, the figures indicate that cost per pound estimate can vary by up to 6¢ above and below 44¢ if a 5 or 7-pound estimate of average pouch contents is used.

Sensitivity analysis of the cost estimate in Tables 7 and 8 indicates that retort pouch potatoes may be somewhat cost competitive with some products, but only if certain conditions occur. Those conditions include being able to fit an average of 7 pounds of product in the pouch and being able to produce according to the "Lowest Cost" scenario as shown in Table 8. The "Lowest Cost Scenario involves operating 12 months per year (versus 8 in the baseline scenario). It also involves low estimates relative to the baseline of several cost elements: salaries ($2500 less per year), wages (50¢ less per hour), laminate cost (5¢ less than baseline cost of 51¢ per pouch) and carton cost (10¢ less than baseline cost of 90¢). The basic conclusion reached in this study, that retort pouch potato products are not likely to be cost competitive, is based on the assumption that the baseline conditions are more likely to occur than the lowest cost conditions and that the 44¢ per pound is the most likely cost estimate. If the "High Cost" conditions occur, the price of retort pouch potato products will be even greater relative to competing traditional products.

Reasons for the High Cost of Retort Pouch Processing

An important question to ask is: Why is the new product so expensive? One key factor resulting in high cost estimates is that given present technology, horizontal-fill retort pouch operations have a relatively slow line speed and are more labor-intensive than other food processing methods, such as canning and freezing. The relatively high labor requirement for pouch processing results from several points where pouches must be manually handled. Also, every pouch must be visually inspected twice.

Materials are also relatively costly. The laminate for one pouch is estimated to cost 51¢, a high proportion of total costs. That compares to a cost of 40-45¢ for a No. 10

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can. Additionally, shipping cartons are expensive relative to those for No. 10 cans because pouch cartons must be considerably stronger to protect the pouches.

The high cost of packaging retort pouches raises the question of whether this kind of pouch product, even with its positive attributes, can be sold in high enough volumes at the higher prices required. The answer to this question is suggested by interviews carried out as part of the market assessment discussed in the next chapter.

TABLE 7 - BASELINE COST FIGURES COMPARED TO LOW AND HIGH COST SCENARIOS FOR PACKAGING POTATOES IN INSTITUTIONAL SIZE RETORT POUCHES

Duration of Operation per Year(1):	EIGHT MONTHS (2880 hours)			TEN MONTHS (3520 hours)			TWELVE MONTHS (4160 hours)		
Cost Scenario	Total Annual Cost(2)	Pouches Produced per Year(3)	Cost Per Pouch(4)	Total Annual Cost(2)	Pouches Produced per Year(3)	Cost Per Pouch(4)	Total Annual Cost(2)	Pouches Produced per Year(3)	Cost Per Pouch(4)
LOW WAGE, SALARY, AND MATERIALS	$2,807,478	1,555,200	$1.81	$3,297,991	1,900,800	$1.74	$3,788,503	2,246,400	$1.69
LOW WAGE, SAL.	$2,923,600	1,555,200	$1.88	$3,439,917	1,900,800	$1.81	$3,956,234	2,246,400	$1.76
LOW WAGE	$2,952,850	1,555,200	$1.90	$3,464,167	1,900,800	$1.83	$3,985,484	2,246,400	$1.77
BASELINE	$3,011,556	1,555,200	$1.94	$3,540,919	1,900,800	$1.86	$4,070,282	2,246,400	$1.81
HIGH WAGE(5)	$3,052,440	1,555,200	$1.96	$3,540,889	1,900,800	$1.89	$4,129,337	2,246,400	$1.84
HIGH WAGE, SAL.(6)	$3,081,690	1,555,200	$1.98	$3,620,139	1,900,800	$1.90	$4,158,587	2,246,400	$1.85
HIGH WAGE, SALARY, AND MATERIALS(7)	$3,197,812	1,555,200	$2.06	$3,762,065	1,900,800	$1.98	$4,326,318	2,246,400	$1.93

Source: Baseline costs for eight months of operation per year (shown in box) come from Table 5 on page 81. Table 5 summarizes all variable and fixed costs from Tables 1 through 4. Cost calculation method is explained on pages 60 and 52. Other cost figures are derived from the same spreadsheet tables recalculated with alternative figures for wages, salaries, materials, and number of hours of operation per year.

(1) Number of annual hours of operation based on assumption of:
8 hours/shift X 2 shifts/day X 5 days/week X (No. weeks of operation per year)

(2) Total Annual Cost does NOT include cost of potatoes or brokerage. These costs are subsequently added as shown in Table 8 and explained on page 73.

(3) Number of pouches produced per year is based on an estimate of 8640 pouches per day as explained in Appendix A on page 113.

(4) HIGH (LOW) WAGE = All wages are $0.50/hour above (below) Baseline (Table 1, page 75).

(5) HIGH (LOW) WAGE, SAL. = High (Low) Wage as indicated in (4) plus all salaries are $2500 above (below) Baseline salaries (Table 4, page 81).

(6) HIGH (LOW) WAGE, SALARY, AND MATERIALS = Same conditions as (5) plus high (low) materials cost. High (low) materials cost means that laminate cost is $0.05 above (below) the baseline cost of $0.51 per pouch and carton cost is $0.10 above (below) baseline cost of $0.90 per carton.

TABLE 8 - BASELINE COSTS PER POUCH AND PER POUND OF PACKAGING POTATOES IN INSTITUTIONAL SIZE RETORT POUCHES AND COMPARISON TO HIGHEST AND LOWEST COST ALTERNATIVES

Cost Scenario	Lbs. of Potato per Pouch(1)	Total Annual Cost per Pouch(2)	Potato Cost(3)	Brokerage Cost (3%)	Total RPP Cost per Pouch(4)	RPP Cost per Pound(5)
HIGHEST COST	5	$2.06	$0.50	$0.08	$2.64	$0.53
	6	$2.06	$0.60	$0.08	$2.74	$0.46
	7	$2.06	$0.70	$0.08	$2.84	$0.41
BASE-LINE	5	$1.94	$0.50	$0.07	$2.51	$0.50
	6	$1.94	$0.60	$0.08	$2.62	$0.44
	7	$1.94	$0.70	$0.08	$2.72	$0.39
LOWEST COST	5	$1.69	$0.57	$0.07	$2.33	$0.47
	6	$1.69	$0.68	$0.07	$2.44	$0.41
	7	$1.69	$0.80	$0.07	$2.56	$0.37

Source: Table 7 for Total Annual Cost per Pouch.

(1) Six pounds is most likely estimate of average weight of pouch contents. However, a one-pound variation in average weight cannot be precluded, so calculations are also made using five and seven pound estimates. See page 84 for more details.

(2) Total Annual Cost per Pouch is the cost of packaging potatoes in retort pouches, excluding the cost of potatoes and brokerage, which appear in the following columns. The three columns are summed to equal RPP Cost per Pouch. Total Annual Cost does not vary with the estimated pounds of pouch contents because the 1-pound range represents a lack of certainty about average weight of pouch contents, not alternative sizes to be produced by the plant.

(3) Potato cost per pound is multiplied by pounds of potatoes per pouch (column 2). Cost per pound in terms of finished product is estimated at $0.10 for the eight months that Michigan potatoes are available and $0.145 for the remaining four months when out of state potatoes would be purchased. Since LOWEST COST scenario assumes 12 months of operation, potato cost is a weighted average. See page 73 for details.

(4) Equals the sum of the previous three columns. RPP = retort pouch potatoes.

(5) Equals RPP Cost per Pouch (in previous column) divided by estimated average weight (in second column).

HIGHEST COST = 8 months operation per year; High Wage, Salary, and Material Cost of Table 7.
BASELINE = 8 months operation per year; baseline scenario
LOWEST COST = 12 months operation per year; Low Wage, Salary, and Material cost of Table 7.

CHAPTER 6: MARKET POTENTIAL ASSESSMENT

Acknowledging the fact that the pouch is a relatively expensive container for potatoes, a key question to ask is: Are there attributes of the product which would still make it attractive to the food service market? On balance, as indicated in the discussion that follows, the answer appears to be no; there are insufficient attractive features of retort pouch potatoes to induce widespread switching away from traditional potato products in current use by food service operations.

Market potential for retort pouch potato products was assessed through interviews with executives from leading Michigan institutional wholesalers and with managers of food service operations in the Lansing, Michigan area. Each of these is discussed in turn.

RETORT POUCH FOODS AND THE FOOD SERVICE MARKET

Retort pouch packaging of food products is not a new idea. Packaging foods in large pouches was actively discussed in the 1970's. As far back as 1972, a hospital feeding study was undertaken in which the authors concluded that "...the institutional sector does not require the extensive education required for entry into the consumer market. Food service operators quickly perceive the advantages of pouched foods and see future opportunities for modified foods, solid meat entrees, and breakfast foods."[1] A representative of one of the retort pouch manufacturing firms wrote in 1982, "In a typical food service operation, speed of preparation and efficient utilization of available space are key concerns. The shelf stable bulk foods retort pouch will allow rapid

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[1]Richard Abbott, "Producing Retort Pouches to Suit Particular Needs," Food Sciences Institute, 45.

preparation of high-quality foods, without the cost and space needed to refrigerate or freeze food."[2]

A pouch manufacturer conducted a concept market survey in the late 1970's to study the retort pouch as a possible replacement for the #10 can. That firm found that "end users" (food service operators) were willing to try the pouch; the main reasons cited for wanting to find a substitute for the #10 can were safety and disposability. At the time, their prediction was that pouched food products would command a premium due to their better quality, and that the introduction of pouch technology was an opportunity for the introduction of new food products.[3]

One source classified the #10 can market into 3 main segments and noted possible opportunities for pouch packaging in each of them; those categories were "hotfill pumpables", "high-acid particulates", and "low-acid particulates." In 1980 their figures showed that three classes of products made up 78% of the 700 million #10 cans sold. The three classes were tomato products (hotfill pumpables, with 32% of the market), fruits in syrup (high-acid, with 22% of the market), and vegetables (low-acid, with 24% of the market). They estimated that pouched foods could make inroads into each of those categories, and that additional foods with market potential included potatoes, mushrooms, seafood, and entrees. They also expected some penetration into the frozen food market.[4]

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[2]David A. Heintz, "Marketing Opportunities for the Retort Pouch," Food Technology, 38.

[3]Edmund G. Astolfi, "Market Opportunities for the Institutional Size Retort Pouch," Unpublished company report, American Can Company (Greenwich, Connecticut), 1 May 1981.

[4]Astolfi.

However, pouched foods have not made significant inroads except for tomato products, and that has been on a limited scale. It should be noted that ketchup and tomato paste packaged in pouches are not retort pouch foods, because the commercial sterility of those products is achieved in the hotfill process; they do not have to be retorted after filling. Only one firm is attempting to build a market for fruit slices in institutional size retort pouches (Truitt Brothers, Salem, Oregon) and no firms are selling vegetables in institutional size pouches.

THE INTERVIEWEES

The market survey portion of this research focused on two groups: a) institutional wholesalers, and b) the end users (food service operators, who are the customers of the wholesalers). Interviews were conducted with personnel from four different institutional wholesale operations: Gordon Food Service (GFS), Kraft, Miesel, and Evans. GFS is the largest operation in the regional market consisting of Michigan and portions of surrounding states. There are numerous small food service wholesalers and the market share represented by these firms was not determined. However, Muggio indicates that those four firms represent a large portion of the market for Michigan and surrounding states and are among the more progressive firms (meaning that those firms are more willing to introduce new products).[5] Thus the consensus that emerges from interviews with representatives of those firms provides a solid basis on which to draw preliminary conclusions about the market potential.

Interviews were also conducted with people in several different kinds of food service operations: eight family-style restaurants, one hospital, one nursing home, one

[5]Bari Muggio, Gordon Food Service, Grand Rapids, Michigan. Personal communication.

golf course restaurant, one "deli", one catering company, two college food service operations, and one food service company that runs a number of different food service operations in schools as well as in business and industry. This cross-section of sixteen operations provides a good representation of the different segments of the market to which manufacturers of retort pouch potato products may have to appeal.

VIEWPOINTS OF INSTITUTIONAL WHOLESALERS ON MARKET PROSPECTS

The general view of the wholesaler personnel interviewed was that the critical element for success of this new product is the ability of the new potato product firm to create demand for this product on the part of the wholesalers' customers. All of the institutional wholesalers emphasize the need for a substantial promotion effort if a market for retort pouch potato products is to be created. They contend that "the product will not sell itself." Two key limitations to widespread sales of RPP emerged from the interviews. The first is the fact that there are numerous alternative potato products currently on the market with which food service operators are generally satisfied; these products will not easily be displaced. Inertia in displacing products in the wholesalers' product lines is an additional hindrance to the succesful market introduction of retort pouch potato products. Each of these two key limitations will be considered in turn.

There are numerous alternatives for institutional users of potato products: frozen, dehydrated, canned, fresh, and "fresh peeled", also referred to as "fresh processed" or "peelers." This last category consists of potatoes that are peeled and placed in plastic tubs or bags, usually treated with a whitening agent (sulfites) and may be sold in various weights; 30 pounds was a common weight. The potatoes may be whole or cut. One wholesaler indicated that they had their own peeling and bagging operation; the others contracted this out. Seven days was cited as the likely shelf life of the fresh peeled potatoes, so deliveries to food service operations need to be frequent. However, the wholesalers are able to organize their operations to make frequent deliveries of a number of different perishable items, including "peelers." Since this system works reasonably well, the shelf stability feature of retort pouch potatoes is not viewed as a great advantage.

Shredded potatoes provide a good example of the competition that retort pouch potatoes face. An important use for shredded potatoes in retort pouches would be to make hash browns, but all of the wholesalers indicated that there is an effective competitor already on the market. That product was referred to as "semi-cooked" hash browns; though it requires refrigeration, it has an estimated 30-day shelf life and sales have been quite good. There are other examples of potato products currently on the market with which the proposed retort pouch potato product may have a tough time competing.

The institutional wholesaler interviews also revealed that it is not easy to place new food products into one of the thousands of "slots" from which their salesmen supply their customers. Most sales calls on customers are of short duration and salespeople typically devote very little time to introducing new products. If retort pouch potatoes were to be sold by their firm, the product would have to prove to be more lucrative for the salespeople and for the company than products that they are currently carrying. To be more lucrative for the salespeople, the volume of retort pouch food sales must exceed that of some other product that they are currently carrying, or the margin that salespeople earn on the new product must be substantially above the margin that they are currently earning. It may be possible to convince them that the new potato product should be in their line of products, but not without a substantial promotional effort. Part of the promotional effort by the food manufacturer could be to engage in "preselling" in which inducements to increase sales of a product come from subsidizing the margin on the product earned by salespeople. Promotional expenses may add substantially to the unit cost of the product, making it even less cost competitive. Large scale promotions are generally undertaken by large food manufacturing firms, not new pioneering food firms.

One of the wholesalers also noted that if retort pouch potato products were successfully introduced, other existing potato products would be displaced. In response, suppliers of these displaced products would likely retaliate with lower prices or increased promotional efforts, which would in turn mean the retort pouch firm would have to fight even harder to stay in the market. Any such effort would further add to the promotional cost of launching the new potato product.

A Michigan firm began selling potatoes in retort pouches in 1974. One institutional wholesaler indicated that a number of customers had been quite pleased with the product, and that family-style restaurants in particular used the sliced potatoes for American fries; diced potatoes also sold well. Several hospitals were good customers.[6] That firm went out of business after only a few years. A contributing factor to the firm's demise was the tendency of the pouch material to delaminate. The packaging process needed improvement.

Improvements in retort pouch technology have taken place, and a retort pouch potato product developed today would have many fewer problems with the integrity of the package. However, there have also been advances in the development of many other potato product forms with which retort pouch potatoes would have to compete (such as the semi-cooked hash browns mentioned above).

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[6]Morrie Gabrielse, Gordon Food Service, Grand Rapids, Michigan. Personal communication.

TABLE 9 - FOOD SERVICE INTERVIEW RESPONSES

Type of Operation	Now Using Fresh Pot.?	Now Using Processed Potatoes?	May Use RPP?	Product Form of RPP That Firm May Use			
				Whole	Diced	Sliced	Shredded
Hospital	No	FrPr,De,Pwd	Yes	Var.	Var.	AmFries	
Caterer	No	FrPr,Fz,PS	Yes		Soup,PS		
Business & industry F-S	No	Fz,Cn,De	Yes		Soup	Scall.	
Nursing Home	No	Pwd	No				
College Food Svc. (LCC)	Much	De, Cn	No				
College Food Svc. (MSU)	Some	Cn,Fz	No				
Golf Course	Much	Fz,De	No				
Deli	Much	De	No				
Restaurant #1	Much	Fz, S-C	No				
Restaurant #2	Some	Cn,Fz,De	No				
Restaurant #3	Some	Fz	No				
Restaurant #4	Much	Fz,	No				
Restaurant #5	No	FrPr,De, Fz	Yes			AmFries	HashBR
Restaurant #6	Much	De, S-C	Yes			Amfries	HashBr
Restaurant #7	Much	Fz	Yes			Amfries	HashBr
Restaurant #8	No						

Cn=canned; De=dehydrated; Fz=frozen; FrPr=Fresh-processed; Pwd=powdered; PS=potato salad; S-C=semi-cooked hash browns; HashBr=other hash browns; Scall.=Scalloped; Var.=various uses

TABLE 9 - FOOD SERVICE INTERVIEW RESPONSES (continued)

Type of Operation	Refrigerated storage is a problem?	Does RPP store well in dry storage?	RPP dis-posability is an advantage?	Concerned with pouch leakage?	Pouch safer than cans?	Unused portions problems w/ RPP?
Hospital	n.a.	YES	NO	n.a.	n.a.	n.a.
Caterer	YES	YES	YES	NO	n.a.	n.a.
Business & Industry F-S	n.a.	n.a.	YES	YES	YES	YES
Nursing Home	YES	NO	n.a.	n.a.	n.a.	YES
College Food Svc. (LCC)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
College Food Svc. (MSU)	n.a.	NO	NO	n.a.	n.a.	n.a.
Golf Course	YES	n.a.	n.a.	YES	n.a.	n.a.
Deli	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Restaurant #1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Restaurant #2	NO	n.a.	NO	YES	YES	n.a.
Restaurant #3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Restaurant #4	n.a.	YES	n.a.	n.a.	n.a.	n.a.
Restaurant #5	YES	YES	n.a.	n.a.	n.a.	n.a.
Restaurant #6	n.a.	YES	YES	n.a.	YES	n.a.
Restaurant #7	NO	YES	n.a.	n.a.	n.a.	YES
Restaurant #8	NO	n.a.	n.a.	n.a.	n.a.	n.a.

n.a.= no answer or question was not posed

Source: Survey of food service managers conducted in Lansing, Michigan.

FOOD SERVICE BUYER ATTITUDES TOWARD RETORT POUCH POTATOES

One result of the ready availability of potatoes in numerous forms is that many of the Lansing area restaurant managers that were interviewed expressed the idea that they were in general satisfied with the potato products that they were using and saw no compelling reason to switch to retort pouch potato products unless they were obviously of superior quality to what they were using, or at least of comparable quality and with a lower price. The cost analysis indicated that a firm selling potatoes would probably be unable to sell them profitably at a lower price.

The frequency of responses to certain questions is indicated in Table 10. Out of the 16 establishments visited, eight were restaurants and eight represented other kinds of food services. Due to the busy schedules of food service managers, many of the interviews were short in duration, leaving insufficient time to ask every question to each person interviewed. In several cases, the respondent noted that they were content to continue using the potato products they were currently using and thus answered few other questions. This is the reason for the large number of non-responses in Table 10. This indicates a lack of enthusiasm on the part of a number of food service managers for the retort pouch concept, which does not bode well for the market prospects for retort pouch potato products.

However, for those respondents that would consider using the retort pouch potato product in their food service operation, sliced potatoes for use in making American fries was preferred by four out the six that indicated that they may use the product if it were available. The next most common response was shredded potatoes for hash browns (mentioned by three). Three respondents suggested that they would consider using diced potatoes (two of them for soup). Only one of the food service operators indicated an interest in possibly using whole potatoes. Ten other food service managers out of the sixteen interviewed said they would not be likely to use retort pouch potatoes in their operation.

ATTRIBUTES OF RETORT POUCH POTATO PRODUCTS

The literature review turned up a number of attributes of retort pouch foods that promoters of the pouch technology said would be the main selling points or advantages. One of the main objectives of the interviews was to determine how these attributes are viewed by potential purchasers of retort pouch potato products.

Disposability. The table indicates that there is little consensus on this issue. Three of the food service managers indicate that the ease of disposal relative to #10 cans is an attractive feature of pouches, but two others do not. Several of them also replied that they did not consider disposal to be a large problem because there are always slack periods during the day during which they could assign their workers to the task of smashing cans into a smaller size to make them more disposable. In addition, most of the #10 cans that they handle are for products other than potatoes, so elimination of canned potatoes alone would change little. Most of the other potato products, such as frozen, fresh, or dehydrated have no more disposal problems than would use of the pouched product.

Employee Safety. The managers also generally agreed that cans do cause occasional injuries to employees, but that this was not a significant problem in their operations. Three agreed that pouches would be safer than cans, but just as with the disposability factor, several managers remarked that even if they used retort pouch potatoes, they would still be handling numerous other products in cans. This relates to a theme that ran through several of the interviews: if there were already widespread use of pouched foods, the addition of potatoes to the list might be welcome. However, since their operations are currently tailored for using canned or frozen goods, they were not interested in having to handle this one product somewhat differently.

Storage. Some of the wholesalers and food service operators echo another theme noted in the literature review: that refrigerator and freezer space are typically in short supply. The shelf stable aspect of the retort pouch potato product could thus be an advantage. Four of the seven that responded to this question indicate that refrigerated storage was indeed a problem. However, other food service people counter that a number of establishments had taken care of this problem by building large amounts of refrigerated storage and that for them, it is dry storage space that is cramped. One nursing home operator notes that they are short of both kinds of space, but they resolved that problem by maintaining low inventories. Due to the frequent deliveries from their institutional wholesaler, this proves to be a satisfactory solution.[7]

A number of food service operations have also made substantial investments in special shelving that facilitates the use of #10 cans. Though they may in principle see the advantage of using pouched foods, they are likely to continue to use canned potatoes due to their prior investment in their current method of storage.

One additional negative perception expressed by several respondents relates to the likelihood that the pouched potatoes would have to remain in their original cartons in their storage rooms. There are two reasons for this. First, the slippery surface of the package may make it unsuitable for stacking on shelves once they are removed from the cartons. A second problem is illustrated by the comments of one restaurant operator; he noted that he likes his workers to be able to readily identify canned products and get

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[7]Carol Sichterman, Health Care and Retirement Corporation, Grand Rapids, Michigan. Personal communication.

them quickly from the shelf. While this is no problem for his canned goods, he foresees difficulty in this regard for pouched products.

Echoing that concern, a nursing home food service manager says that another aspect that could make the pouched food disadvantageous is that state health inspectors sometimes require them to remove goods from cartons and stack them for easy visibility. In distribution of pouched food products, reliance is likely to be placed on identifying the product from the outside carton, not through labeling of the pouch material itself.

Handling. One theme that emerged from magazine articles reviewed for this project was the view that retort pouch foods would fit easily into existing food service operations (most of those articles were written in the late 1970s). However, the representatives of only one firm interviewed expressed agreement with this view. That firm services a number of business and industry cafeterias. One of their managers indicated that the pouched potato product might be easily placeable into steam tables on serving lines.

A key issue in handling is the perceived strength of the package. The closest comparison between retort pouch potatoes and products that food services are currently handling are the "pouch packs" of ketchup and tomato paste; some of their customers have ceased using pouches for ketchup because of leakage problems. Two of the wholesalers interviewed noted that one of the main factors in their customers' resistance to using pouched foods is concern over leakage and breakage. The pouch is perceived by some to be a weak container with possibly faulty seals. and three respondents have a specific concern with possible leakage problems. One respondent also indicated concern with the possibility that pinhole leaks may result in unsafe food.

Another concern is what to do with partially empty containers. A perceived advantage of frozen foods is that the user can take just the quantity needed and leave the remainder in the freezer; frozen foods thus lend themselves to portion control. A partially empty can may be left out or in a refrigerator for at least part of a day before it is either used up or transferred to another container. The contents of partially empty pouches, on the other hand, would likely have to be transferred to another container immediately, and this is viewed by three interviewees as a distinct, if rather minor, disadvantage.

Warehouse handling. One conclusion drawn from the literature review for this project is that institutional wholesalers might be quite concerned about difficulties in handling pouched foods. A food service market survey undertaken by a pouch manufacturer concluded that some of the key factors on which the success of retort pouch foods might hinge are solutions to several technical problems related to distribution and handling. Three problems mentioned are: 1) the lack of automatic handling equipment for pouches, 2) the fact that pouches could not be stacked very high in warehouses, and 3) the fact that the general susceptibility to abuse during shipping was greater for pouches than for cans.[8] Another survey quoted a distributor as saying, "It is up to the manufacturer to provide the product wrapped in a case compatible with our warehouse distribution system."[9]

The interviews in Michigan turned up only one case where the low stacking heights of pouched foods was perceived to be a problem: a manager of the central food service warehouse for Michigan State University indicated that space was at such a premium that they were unlikely to handle pouched foods if they could not be stacked as high as cans. In contrast, the institutional wholesalers acknowledged although that such

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[8]Astolfi.

[9]Giannattasio, et al, 16.

products would be more difficult to handle, they would be able to accommodate them if demand for pouched foods materialized. They are handling increasing quantities of fragile products, and even today pallets are frequently placed on individual racks in their warehouses. Gordon Food Service has the most positive outlook on the future of pouched foods and has constructed a warehouse especially equipped to handle pouched products.

Sulfiting of Potatoes. Peeled potatoes darken quickly upon exposure to air. Although the darkening of the potatoes poses no particular health hazard to the typical American consumer, whiteness is an important part of the visual appeal of potatoes. Manufacturers and purveyors of potato products must therefore go to considerable lengths to assure that their handling methods do not allow the potato to darken. This is typically done by immersing peeled potatoes in a solution of sodium bisulfite, a chemical whitening agent. The institutional wholesalers that handle the fresh-peeled potatoes state that those potatoes have been treated with sulfites. The model plant design in this study also calls for the potatoes to be immersed in sulfite after peeling, but before being placed in the pouches. This is necessary given the present technology, because there is a period of several minutes of exposure of the potatoes to the air before being placed in the pouches.

Sulfites have recently come under the scrutiny of the Food and Drug Administration (FDA) because of several cases of death and illness apparently caused by allergic reactions on the part of certain people. The allergic reactions documented to date have been caused by consumption of salads from salad bars where the sulfites had been applied to the food items to maintain a fresh appearance. Though there have apparently been no deaths attributed to industrial uses of sulfites (such as in institutional sales of potatoes), industry observers note that restrictions on the use of sulfites will remain an issue. The state of Michigan requires labeling in instances where sulfites are used. The institutional wholesalers note that efforts are underway to find substitute whitening agents, but no effective substitutes have yet been identified.

Hospitals in particular are concerned about avoiding sulfite-treated potatoes. Their reasons have as much to do with the importance of sodium-controlled (low salt) diets as with the concern over allergic reactions (the whitening agent is sodium bisulfite). One wholesaler has responded by supplying hospitals with 25-30 pound tubs of fresh-peeled potatoes completely immersed in water to avoid darkening.

If the retort pouch facility could be designed to avoid the use of sulfites on the potatoes, that could be a distinct advantage in appealing to certain segments of the food service market. As yet, however, that does not appear to be possible.

OTHER FACTORS RELATED TO MARKET POTENTIAL

Another factor is that certain categories of the food service market are heavy users of potato products, but are not using the product forms that retort pouch potato products could readily replace. Two prime examples are nursing homes and schools. Nursing homes serve large quantities of mashed potatoes, which are usually supplied to them in granular form. Schools tend to use mainly frozen products, especially french fries and "tater tots". Schools and some other publicly funded institutions such as medical facilities are also recipients of large quantities of potato products from the USDA commodity distribution programs; they are not likely to purchase retort pouch potato products, especially if priced at a premium, which appears to be a necessity.

A number of restaurant operators like to maintain an image of using fresh products and thus prefer to purchase raw potatoes or "peelers" for many of their menu items. They are thus not likely to be purchasers of retort pouch potato products.

One category of restaurant to which it was initially assumed the retort pouch potato product would appeal are "Mom and Pop" restaurants and establishments that do a large breakfast business. Hash browns are by far the most important product in this regard, and that is one product that is definitely already available in various forms: frozen, dried, and the relatively new "semi-cooked" fresh version. Thus inroads into this market niche may also be difficult.

CHAPTER 7: SUMMARY OF KEY FINDINGS AND ASSESSMENT OF POTENTIAL SUCCESS

This study was undertaken in response to an expressed need from leaders in the Michigan potato industry for expanded processing opportunities for potatoes. The purpose was specifically to examine the feasibility of establishing a small scale commercial plant to package potatoes in retort pouches. This study focused on institutional size retort pouch potato products because the poor record of success in consumer product sales and because food product innovations often find better initial acceptance in foodservice operations than in retail sales direct to consumers. This chapter summarizes key points from preceding chapters and draws conclusions about the likely success of the proposed retort pouch potato product. The final section explains limitations of the research and suggests extensions which could be the subject of future research.

The research method employed a two-pronged approach. One part of the research involved estimating the costs of establishing and operating the plant, and expressing the costs in a form that could be used to compare the finished product cost to prices of traditional, currently used potato products. The second aspect was to carry out interviews to assess foodservice industry attitudes toward the proposed new potato product. Summarizing the opinions of end users such as restaurant managers, and of the institutional wholesalers that supply them, helped draw conclusions regarding the probable success of the product in the marketplace. The two-pronged approach was especially useful in that interview respondents could be told that the price of retort pouch potatoes would likely not be lower than the price of competing potato products that they were currently using. With this knowledge, respondents could make judgments about whether there were other advantages to using retort pouch potatoes to justify use to that product in their operations.

TECHNICAL CHALLENGES IN ESTABLISHING AND OPERATING THE PLANT

Since retort pouch technology is neither currently in use in Michigan, nor widely used nationwide, a key objective of the study is to familiarize potential decision makers with the key issues surrounding possible adoption of this food packaging innovation. Considerable technical expertise is required in making the technological choices required in designing the plant largely because there is a very limited track record of firms processing institutional size pouches. Consequently, little knowledge is available to draw on except that of packaging small size pouches. As described in Chapter 3 (page 14), choosing the type of pouch construction and filling method (vertical or horizontal) involves one set of choices. In addition, meeting federal government requirements for sterilization and other aspects of establishing the plant (some of which are detailed in Appendix G, page 121) also pose substantial challenges due to the pioneering nature of this processing method.

SUMMARY OF MARKET PROSPECTS

The historical record indicates that the commercial success of retort pouch foods has fallen far below expectations. Major reasons for this include higher costs associated with packaging, processing, and handling as well as lack of familiarity among potential users. The technology is not new; retort pouch products have been available for commercial use for over a decade. Most of the firms currently manufacturing retort pouch foods sell primarily to the U.S. armed forces. Retail sales are limited to specialty niches such as recreational markets. Early expectations were that institutional pouches might displace No. 10 cans of vegetables in the food service market, but this has not yet happened. Only one product (fruit slices) currently is processed and sold in the United States in institutional size retort pouches. Thus a major obstacle to succesful development of retort pouch potato products is that such an undertaking involves entering relatively uncharted territory, in which entrants have not had significant success to date.

Major factors in the negative market outlet for retort pouch potatoes are the current availability of competing potato products to meet food service operators' needs and the high cost of packaging potatoes in retort pouches. Among the likely contributing factors to the high cost of retort pouch processing are high labor input, slow line speeds, and high cost of materials.

Executives from four Michigan-based institutional wholesalers were interviewed; the four firms surveyed represent a large portion of the market for Michigan and surrounding states. They emphasized the need for a substantial promotion effort to stimulate sales and that the product will not sell itself, largely because there are numerous competing potato products currently on the market with which food service operators are generally satisfied. They also stressed that existing products will not easily be displaced. Inertia in displacing products in the wholesalers' product lines is an additional hindrance to the succesful market introduction of retort pouch potato products. There are a limited number of warehouse slots and items carried by wholesalers. Furthermore, executives interviewed indicated that their salespeople tend to concentrate on selling high volume current products, devoting little time to introducing new products.

Table 6 (page 83) provides information suggesting that retort pouch potatoes may need to be sold for higher prices than most competing products. Since retort pouch potatoes are relatively expensive, restaurant managers and other food service managers were interviewed to determine if there were positive product attributes that would induce the operators to purchase them despite the likelihood of higher prices. Six out of sixteen food service managers interviewed indicated some interest in trying the product if it was available. The remaining ten managers expressed little or no interest in the product and were satisfied with the potato products they were currently using.

Certain attributes that were initially considered to be major selling points of the product appear not to be important issues with the majority of the food service operators interviewed. Some of the key attributes on which the idea of retort pouch foods have been promoted in the past are shelf stability (needs no refrigeration) and ease of handling and disposability relative to cans. Those attributes were not considered sufficiently important by a majority of respondents to induce them to purchase the product. Some disputed whether pouches are really easier to handle, and others argued that even if there are advantages relative to cans, they would be realized only if there were numerous pouch foods available in institutional packages and they could switch away from buying many products in cans. Out of the numerous products handled in their food service operations, changing only potatoes from cans to pouches was not considered to be a great advantage. Handling potatoes in pouches with different methods than other foods could be viewed as a nuisance. Also, many potato products are in frozen or powdered form, and retort pouch potatoes have fewer handling advantages relative to those two products. Thus, at least in the case of potato products, certain features of retort pouch foods are not as attractive to potential buyers as retort pouch promoters have suggested.

Some food service managers did agree that the fact that retort pouch potatoes would not have to be frozen or refrigerated was an attractive feature, but for others, frozen and refrigerated storage was not so significant a problem in their operation that they viewed switching to retort pouch potatoes as a particular advantage.

Several interviewees also expressed concern about leakage and breakage of pouched foods in general and that retort pouch potatoes may be subject to the same problem. Storage of unused contents of a pouch once it has been opened was another perceived problem.

Restaurants emphasizing fresh products are not likely to be attracted to retort pouch potatoes for use with their menu items. Schools and medical facilities receive large USDA commodity donations and are thus unlikely to purchase retort pouch potatoes, especially if priced at a premium.

Costly promotional efforts would likely be necessary for succesful market introduction of retort pouch potato products. A small-scale pioneering food firm is likely to find this is quite difficult relative to the promotional capabilities of large scale food manufacturing firms whose products the retort pouch potato firm would try to displace.

In summary, the food service market potential assessment indicates that few positive considerations are present that would help overcome the likely price disadvantage of retort pouch potato products.

CONCLUSIONS AND IMPLICATIONS

Packaging potatoes in institutional size retort pouches was investigated as a possible market outlet for Michigan potatoes. Unit costs of retort pouch potato products were estimated and market potential in the food service industry was assessed. Break-even costs for six-pound pouches were estimated to be $2.62 (44¢ per pound), which suggest significant cost and price disadvantages.

The market potential assessment yielded generally negative results. Food service operators interviewed expressed general satisfaction with their current potato products and will not readily switch to retort pouch potato products. Institutional wholesalers indicated that an introduction of retort pouch potato products would necessitate costly promotional efforts to displace existing potato products with no guarantees of success.

The research results suggest that it is difficult to market a plain, low-value "commodity" type of product in a relatively expensive nontraditional container. A number of industry executives and researchers believe that the greater expense of retort pouch packages and processing technologies, with associated texture, handling, and distribution benefits, can best be justified in combination with more value-added ingredients such as meats, or perhaps potato products in sauces with spices and flavors added. To the extent that higher value ingredients make the overall product worth more, higher cost retort pouch packaging, processing, and handling constitute a smaller portion of total costs and perhaps the total product becomes more acceptable to purchasers. What such retort pouch food products might be, and whether some could be potato-based value-added products, is a subject for future research.

LIMITATIONS OF THE RESEARCH AND SUGGESTED EXTENSIONS

One limitation relates to the design of the model plant. The cost estimation was focused on determining the cost of various pieces of equipment that would make up the particular configuration judged to be the most reasonable. That judgment was based on a review of the relevant literature and consultations with various industry experts. It is however, just one of many possible configurations. A differently designed plant might have different costs and output capacity, which may yield higher or lower cost estimates than the ones presented in this volume. The model plant was designed with a single form/fill/seal machine, because the volume generated by even one machine is substantial. The quantity generated by more than one machine might be so large relative to any potential market that it could not be sold. In addition, each machine is fairly costly - $144,000. Nevertheless, cost estimates from future research efforts could include cost projections involving several fillers and a number of retorts. However, without major design breakthroughs, cost differences of differing configurations are expected to be fairly marginal.

To simplify and make the cost estimation process more manageable, one factor that was ignored was the possibility that unit cost of output might be lowered if one considered various tax strategies relating to purchase and depreciation of machinery and buildings. The method chosen for this research was to use an annuity method for calculating "annual use cost" of machinery services. Annualized costs of building and equipment were computed as shown in Tables 2a and 3a on page 80. Use of the annuity method means that tax savings from depreciation are a function of "straight line depreciation," which is probably not the depreciation method that leads to the least cost result in the early years of operation. Thus the annuity method is a simplification of cost calculation that does not minimize short run depreciation costs. However, depreciation costs are a small proportion of overall costs and any differences between the method used and an alternative depreciation scheme are likely to have little impact on the cost per pound of retort pouch potatoes, which is the key cost estimate upon which these research results are based.

Another factor is that the State of Michigan or certain local governments might offer property tax breaks, reduced utility rates, grants or other incentives to firms locating in particular jurisdictions as a means to promote economic development. Such incentives were not considered in this study, though they would also lower cost of production.

Finally, interviews were carried out with a limited number of food service industry participants who were judged to be sufficiently representative to provide a useful market assessment. A larger sample of food service managers may provide a more comprehensive view of the market potential for retort pouch potato products. Additional interviews could also be the subject of a future research project which would expand our knowledge of this potential food product innovation.

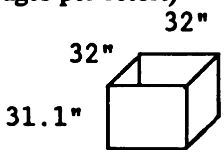
APPENDICES

APPENDIX A

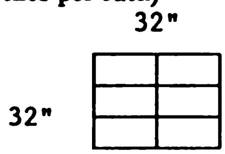
PLANT CAPACITY FOR INSTITUTIONAL SIZE RETORT POUCH POTATO PRODUCT

Assume retorts are STOCK AUTOMAT 1300

Cage dimension are: (6 cages per retort)



Rack dimensions are: (6 pouches per rack)



1. CALCULATE NUMBER OF POUCHES PER RETORT BATCH

Assume each rack 2" high; Height of cage = 31.1

31.1" / 2" per rack = 15.6 ~ 15 racks

15 racks X 6 pouches/rack = 90 pouches/cage

90 pouches X 6 cages = <u>540 pouches per retort batch</u>

2. CALCULATE NUMBER OF POUCHES PER DAY IN THE PLANT

Length of retort cycle: 55 min at 250°F, 50 min load, come up, cool down, unload

55 min + 50 min = <u>105 min per retort cycle</u>

Assume 16-hour workday(Two 8-hour shifts, retorts run continuously)

16 hrs.X 60 min = 960 min/day

(960 min/day) / (105 min/cycle) = 9.1 ~ 9 batches per retort per day

Due to staggered retort cycles and down time, assume that the 2 retorts do an average of 16 rather than 18 batches per day

16 batches X 540 pouches/batch = <u>8640 pouches per day</u>

3.CALCULATE AVG. FILLER SPEED, QUANTITY OF POT. TO SUPPORT OPERATION

Assume filler operates 14.5 hours/day (870 min) due to 1.5 hours of breaks

(8640 pouches per day) / (870 min) = <u>10 pouches/min</u> (avg. filler speed)

Assume 5.5 lbs. potatoes per 10.5" X 15" X 1.4" pouch (expect 10% loss, 5 lbs. of product after retorting)

8640 X 5.5 = <u>47520 lbs. of potatoes per day</u>

Assume 45% loss due to peeling and culling;55% (.55) of raw product wt. remains

47520 / .55 = <u>86400 lbs. (daily quantity of raw potatoes needed)</u>

(86400 lbs./day) / (14.5 hrs)=5960 lbs./hr. (avg. qty. raw potatoes through plant)

(47520 lbs./day) / (14.5 hrs)=3277 lbs./hr.(avg. qty. finished potatoes through plant)

APPENDIX B

CALCULATIONS - WASTE DISPOSAL AND WATER USE

Note that waste charges are usually stated in terms of a sewer charge per 1000 gallons (mgal) plus a surcharge for the waste above a given threshold level (300 mg/l)

1. Determination of processing plant throughput in tons/hour

   Throughput of raw potatoes 5960 lbs/hr (from Appendix A)

   (5960 lbs/hr) ÷ (2000 lbs/ton) = 2.98 tons/hour

2. Factors used in determination of water use and pollutional strength of wastewater
   For the entire potato processing operation, the assumptions were(1):

Water use	4000 gal/ton of raw potatoes
BOD	55 lb/ton
TSS	45 lb/ton

3. Conversion of factors in #2 to hourly figures

Water use	4000 gal/ton X 2.98 tons/hr =	11920 gal/hr (11.92 mgal/hr)
BOD	55 lb/ton X 2.98 tons/hr =	164 lb/hr
TSS	45 lb/ton X 2.98 tons/hr =	134 lb/hr

4. Determination of the strength of the pollutants on which the municipal charges are assessed

The relationship between the pounds of waste and its concentration in wastewater is stated in the following equation (concentration is stated in mg/l - milligrams/liter):

$$\text{lbs waste} = \frac{8.34 \text{ X (conc. in mg/l X (water flow in gal.)}}{1{,}000{,}000}$$

Manipulating this equation to state the result in mg/l:

$$\frac{1{,}000{,}000 \text{ X lbs. waste}}{8.34 \text{ X (water flow in gal.)}} = \text{concentration of waste in mg/l}$$

Calculating the strength of BOD and TSS:

$$\frac{1{,}000{,}000 \text{ X } 164 \text{ lbs}}{8.34 \text{ X } 11{,}920 \text{ gal}} = 1650 \text{ mg/l BOD}$$

$$\frac{1{,}000{,}000 \text{ X } 134 \text{ lbs}}{8.34 \text{ X } 11{,}920 \text{ gal}} = 1348 \Rightarrow \text{Round to } 1350 \text{ mg/l TSS}$$

5. Determination of charges for water and waste treatment

Charges are assessed for excess strength above 300 mg/l; rates must be applied to a percentage of the pounds of waste representing the excess strength

$\frac{1650 - 300}{1650} = 81.8\%$ (BOD) $\frac{1350 - 300}{1350} = 78.4\%$ (TSS)

Calculate the hourly rates assuming that the surcharge for excess strength for BOD is $0.10/lb and also $0.10/lb for TSS.

$0.10/lb X 164 lbs X 81.8% = $13.41/hr. for BOD

$0.10/lb X 134 lbs X 77.8% = $10.43/hr. for TSS

6. Determination of water and sewer charges per hour of plant operation

Water Use: $2.00/mgal X 11.92 mgal/hr = $23.84/hr

Sewer Charge $2.10/mgal X 11.92 mgal/hr = $25.03/hr

7. Determination of total cost per hour for wastewater treatment

Sewer Charge	$25.03/hr
BOD Surcharge	$13.41/hr
TSS Surcharge	$10.43/hr
TOTAL	$48.87/hr

8. Determination of total cost per year for water use and wastewater treatment; assume a 16-hour workday (2 shifts)

16 hrs/day X 5 days/wk X 52 wks/yr = 4160 hrs/yr

Water Use:	$23.84/hr X 4160 hrs/yr = $ 99,174/yr	{under {Utilities,
Wastewater Treatment:	$48.87/hr X 4160 hrs/yr = $203,299/yr	{Table 1

(1) These three factors were approximations of figures that appeared in Table 1.10, Wastewater and Generated Pollution Loads by Commodity - Fruits and Vegetables (page 21) in A Guide for Waste Management in the Food Processing Industry, Allen M. Katsuyama, editor, The Food Processors Institute, Washington, D.C., 1979. The actual figures for potato canning were 4300 gallons, 52 pounds BOD and 44 pounds TSS, and they were adjusted in consultation with Dr. Roy E. Carawan, Department of Food Science, North Carolina State University, Raleigh, North Carolina. Dr. Carawan's assistance in preparing this estimate is gratefully acknowledged.

APPENDIX C

COST OF ELECTRICITY

A University of Georgia study on the costs of operation of a multiline vegetable canning plant indicated electricity usage of 243,936 KWH for 1936 hours of operation.[1]

243,936 KWH / 1936 hrs = 126 KW per hour of plant operation

126 KW per hour of operation was for a plant capacity of 400 cases per hour of 24/303's of vegetables. 400 cases per hour translates to raw product throughput of 3.2 tons/hour of green beans or 5.3 tons per hour of sweet potatoes.[2] The throughput of raw potatoes through the model plant in the present study is estimated at 3 tons per hour, somewhat less than the 5.3 tons of sweet potatoes. Therefore a level of electricity use of 100 KWH was judged to be a reasonable estimate for the model plant. A representative of Consumer's Power Company of Michigan indicates that $0.10 per KWH is a reasonable estimate of the cost of electricity, though the actual rates vary, depending on whether the firm selects Rate B or Rate C.[3] The calculation for cost of electricity for the model plant is (assuming 36 weeks or 2880 hours of operation per year).

100 KWH X $0.10 = $10.00 per hour (column 4 of Table 1)

2880 hours X $10.00 = $28,800 (col. 7 of Table 1)

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[1]James E. Epperson, Charles T. Lewis and Ronald J. Williams, Cost Analysis of a Multiline Vegetable Processing Plant by Size with Special Reference to Use of the Cost Generator Model, Research Bulletin 285, College of Agriculture, University of Georgia, p. 50 of Appendix.

[2]Epperson, et al, 13.

[3]Michael Nowak, Consumer's Power Company, Saginaw, Michigan. Personal communication.

APPENDIX D

FUEL OIL FOR BOILER

The University of Georgia study of the costs of operation of a multiline vegetable canning plant indicated a level of usage for fuel oil for boilers to provide hot water for the retorts of 76,588 gallons/year for 1936 hours of operation.[1]

(76,588 gal/yr) / (1936 hrs/yr) = 39.54 gal/hr

As indicated in Appendix 3, since the volume of the raw product for the model plant is somewhat less than for the Georgia example, a level of 80% of the Georgia plant's level of fuel oil consumption was judged to be reasonable.

39.54 gal/hr X 80% = 31.6 gal/hr or approximately 32 gal/hr

At a price of fuel oil of about $0.75 per gallon, usage per hour in the model plant works out to:

32 gal/hr X $0.75 = $24/hr (col. 4 of Table 1)

2280 hours X $24/hr = $69120 (col. 7 of Table 1)

[1] Epperson, et al, Appendix, 48.

APPENDIX E

DURATION OF PLANT OPERATION PER YEAR

Number of Months	No. of weeks	Percentage, relative to 52 weeks/year	No. of hours*
7	32	62%	2560
8	36	69%	2880
9	40	77%	3200
10	44	85%	3520
11	48	92%	3840
12	52	100%	4160

*Based on 8 hours/shift X 2 shifts/day X 5 days/week X (No. of weeks/year)

APPENDIX F

TECHNOLOGICAL DEVELOPMENTS IN POUCH CONSTRUCTION

Laboratory studies on thermal processable films began in 1959. Commercial introduction of retort pouch foods began in Europe in the late 1960's, but the first practical U.S. application was in the Apollo space program beginning in 1968. The U.S. Army Natick Laboratory sought an alternative to the combat soldier's C-ration served in conventional rigid metal cans, but with quality at least equal to canned foods. The retort pouch had a number of desirable characteristics: it was light, durable, and easy to open and dispose of; it could be easily heated (a few minutes in boiling water); it could be carried without interfering with normal movement, fit conveniently into combat uniforms, and would not injure the soldier if he fell on it.[1]

Natick laboratory personnel evaluated the durability and storage stability of the pouch, its resistance to bacteria, and thermal processing temperatures and procedures. The possible migration of pouch material extractives to the food was also examined; polyolefin and polypropylene were both determined to be appropriate inner layer material due to their inert nature; they would not react with any of a wide variety of food products. Natick also studied whether overwrapping the pouch by paperboard envelope or carton would be necessary; they concluded that it was. Several firms joined in an effort beginning in 1968 to determine suitable pouch manufacturing and processing methods: Swift, Pillsbury, Continental Can, Rexham Corporation, and FMC. Swift established a pilot pouch processing line in 1970 and received USDA approval for Army usage and testing.

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[1]Williams, 15.

Two major kinds of testing were undertaken: reliability and abuse testing. A variety of 5 ounce food items were packaged at the abovementioned pilot facility and were tested for reliability factors: seal integrity, sterility, and overall defects. Natick laboratories examined the resistance to damage from rough handling and abuse. Overall results compared favorably to the performance of metal cans.[2]

Several of the cooperating firms then began to work independently on the pouch and related processing equipment. Rexham and FMC proceeded to design and improve the packaging and processing equipment. Continental Can actively pursued commercialization of the pouch and purchased the pilot plant from Natick Laboratories.[3]

One significant issue hampered the early commercialization efforts of retort pouch foods: concern over the adhesive used to hold the three layers of the pouch material together at the high sterilization temperatures. As early as 1974 the USDA gave its approval to a number of food processors to market meat and poultry products in the retort pouch, providing that the pouch material met Food and Drug Administration regulations. FDA studies in 1975 indicated possible problems with the adhesive components and USDA approval was withdrawn. To address these concerns, Continental and Reynolds Metals introduced different thermal adhesives and bonding agents. By 1977, the modified pouches were approved by the FDA, and subsequently, the USDA.

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[2]Neil H. Mermelstein, "The Retort Pouch in the U.S.," Food Technology, (February 1976). Cited in Williams, 18.

[3]Mermelstein 1976. Cited in Williams, 18.

APPENDIX G

EQUIPMENT CHOICES FOR THE MODEL PLANT

Planning the retort pouch processing facility requires a number of choices among alternative technologies and kinds of equipment. Choices fall into the following categories and each of these is addressed in turn: (1) pouch size, (2) pouch fabrication method, (3) pouch filling machines (choice of features), (4) retorting method and (5) potato peeling method. The appendix concludes with a summary of choices regarding specific items included in the model plant cost estimate.

Pouch Size

Since there are as yet virtually no U.S. firms currently packaging foods in institutional size pouches, there are no standard institutional sizes or even widespread industry agreement on what is an institutional size retort pouch. Beverly's view is that institutional pouches can vary anywhere from 10" X 14" to 12" X 18".[1] The thinner pouch profile relative to cans is a major reason for adopting retort pouch technology. This is a key issue. Starting with a given weight of product to be filled, product design must consider what thickness of pouch is feasible relative to the length and width. For instance, Beverly notes that to fill a pouch with 105 ounces of product (equivalent to a #10 can), two alternative sets of dimensions are 12" X 18" X 1-1/8" and 10" X 14" X 2-1/4". He notes that there are higher cost implications as well as advantages in choosing larger pouches: "The thicker the pouch becomes, the longer the sterilization

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[1]R.G. Beverly, J. Strasser and B. Wright, "Critical Roles in Filling and Sterilizing Institutional Pouches," Food Technology (September 1980): 48.

process required; this results in a higher capital investment for the same production. More than offsetting this increase in initial investment, however, is the increase in savings per year resulting from the use of smaller pouches." Beverly also offers advice to food processors in selecting an appropriate pouch size and offers several reasons why this is an important decision.[2]

> "... the food processor should abide by the recommendations of his pouch supplier and recognize that there could be some possible negative effects of trying to fill too much in a given pouch size: (1) Pouch seals could be unduly strained with too much fill; (2) The greater the fill, the greater the likelihood of contamination of the seal area; and (3) The thicker the pouch, the greater the possibility of product quality degradation from overprocessing."

Hutchinson also cautions against allowing the pouch to become too thick. To place the equivalent weight of product of a #10 can into a 12" X 12" pouch, it would have to be 2-1/2" to 3" thick, which is too thick for efficient heating. Preferable pouch thicknesses, he contends, are 1-1/2" to 1-3/4".

Pouch Fabrication Method

Pouches are machine-filled one of two ways; either using preformed pouches or with roll-stock:

1. Preformed pouches. Within this category there are again two possible methods:
    a) Manufacturer-supplied pouches (which arrive already sealed on three sides); the pouches are stacked in a hopper that dispenses them as needed into the filling machine.
    b) Pouches made "in house" with a separate pouch-forming machine.

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[2]Beverly, et al, 48.

2. Using roll-stock in which the laminate is fed into a form/fill/ seal machine. Methods vary with different machines, but the pouches are filled and sealed on four sides as part of a continuous process.

With option number one, the amount spent on pouches will generally be greater, and the investment in machinery will be less than for a comparable form/fill/seal machine. This is the method in general use in Japan and the Japanese have developed machinery that can fill retail size pouches at high speeds. In the U.S. fillers designed for use with premade pouches have been much more available than form/fill/seal machines.

Strength of pouch seals is an additional issue that relates to the type of machine chosen. Some processing experts contend that better control of pouch seals is achieved through purchase of premade pouches, where the quality control (except for the final seal) is the responsibility of the laminate manufacturer. This was probably true in the 1970's - witness the delamination problems Nu-Foods and Creston Valley Foods whose experiences were described at the end of Chapter 4. However, both the quality of the film and of the form/fill/seal machines have improved considerably.

Others experts argue that today form/fill/seal is the superior method and that food processors themselves should control seal quality.

A manager in Del Monte's retort pouch division noted in an interview that there are numerous technical details and problems to contend with in getting a new food processing facility into operation. In that vein, it is argued, starting out with a pre-made pouch system would simplify the process. Since form/fill/seal equipment requires sealing on all four sides during the process, installing a pre-made pouch system would mean one less quality control factor with which the processor would have to contend.

Regular deliveries of pre-made pouches would also mean that the processing firm need not maintain a large inventory.[3]

For filling large pouches, however, the choices of equipment narrow considerably. Only two firms contacted in the course of this research produced machines capable of filling institutional size retort pouches; both firms' machines were of the form/fill/seal type using a horizontal filling method. Though in principle there are choices among competing technologies, in selecting the pouch fabrication method, the use of roll-stock laminate is the only commercially available option.

Pouch Filling Machines

Pouch filling machines fall into two broad categories - vertical-fill and horizontal-fill. Vertical fillers can be sub-divided into two sub-categories. Circular fillers are "constant motion" machines; they are widely used in Japan, but not in the U.S. more commonly employed in the U.S. are the straight-line or "intermittent motion" machines (which have slower line speeds than the "constant motion" machines). Currently, most retort pouch food products are sauce based entrees, stews, or similar food products that lend themselves to vertical filling. However, potatoes and other foods that are large-size particulates can create problems with any vertical filling method - there can be product accumulation at the bottom of the pouch. One expert pointed out that sliced potatoes could stack up as they hit the bottom of the pouch, causing a wider than desirable pouch. One solution would be to design a filler with a "magazine" - a rigid form that would hold the pouch at the desired thickness from the filling through the sealing stage. Other possible solutions include a) allowing only a small pouch opening

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[3]Stephen Hauser, Del Monte, Inc., Lockport, New York. Personal communication.

for filling and b) mechanically flattening the pouch after filling; this latter method would likely damage the potato pieces.[4]

At present there are no commercially available vertical-fill machines for institutional pouches. However, two firms were identified that manufacture horizontal-fill machines for institutional size pouches. The filling machine selected for the model plant is a straight-line form/fill/seal machine in which pouches are filled in a horizontal orientation with the "formable" pouch material (with two webs of different thicknesses as described in the previous chapter). The filler is called a Koch Multivac.

Although the line speed of the Multivac is slow compared to vertical fillers (10 pouches per minute), it does have advantages. Considering the physical nature of potatoes, the horizontal form/fill/seal is a good choice. As mentioned above, potatoes are large-size particulates that do not flow into a pouch as readily as a sauce. Potatoes are also susceptible to damage from pressure, so they must be packaged and handled with some care. Given these problems, the "formed container" retort pouch system appears to have the capability to maintain a good quality potato. Filling the horizontal tray with potatoes as it passes by the filling station is a superior method to vertical filling for ensuring proper distribution of the potatoes in the pouch. In addition, the added strength of the pouch material will protect the potato pieces more effectively, which is especially important in packaging sliced and small whole potatoes (though less so for diced and shredded potatoes).

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[4]Tedio Ciavarini, U.S. Army Research Development, and Engineering Laboratories, Natick, Massachussetts. Personal communication.

Type of Air Evacuation in Filling Machines

A key step in packaging food in retort pouches is removing excess air before the final seal is made. Hutchinson points out that when packaging potatoes, only a very small amount of gas should remain in the pouch. This is because potatoes are quite sensitive to oxygen and will darken upon exposure. When this occurs, the food product is frequently perfectly safe, but may not be an acceptable product in the eyes of many consumers who place a high value on whiteness. This removal of air can be accomplished by a number of different methods. As Peterson explains, "Retort pouches are usually vacuum sealed either by being placed into a vacuum chamber or by use of a snorkel type of apparatus placed inside the pouch. Pouches can also be steam flushed with either saturated or superheated steam just prior to sealing. The steam takes the place of the headspace gas and condenses when cooled."[5]

Some argue that the vacuum chamber method is the most appropriate one for evacuating air in the packaging of large volume solid food products. In this method the pouch enters a chamber from which the air is removed mechanically (by a pump). The pouch is sealed and then air is allowed to re-enter the chamber. Due to the difference in pressure, the pouch collapses around the food contents, becoming fairly rigid.[6] Kruse notes that this process may work better with round white potatoes than with shredded potatoes. He argues that the shredded potato can trap lots of air among the small pieces, but with whole potatoes, the pressure will cause the pouch to conform to the

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[5]Wayne Roger Peterson, "Heat Transfer Variables Affecting Process Determinations in Conduction Heating Institutional Size Retort Pouches," Ph.D. dissertation, University of Florida, Gainesville, Florida, 1984, 22.

[6]Ciavarini.

potato and the air removal will be more complete; some of this pressure will be released during the retorting process as moisture is released by the potatoes.[7]

Others contend that the vacuum chamber process can damage the potatoes. Netterburg argues that the more one tries to remove air from a pouch by using a vacuum chamber, the tighter the container gets around the potatoes, causing stress.[8] Christensen agrees, stating that "pulling a straight vacuum", as the vacuum chamber method is sometimes called, has a tendency to distort the product. He recommends gas flush (which uses a small amount of nitrogen) a better system. The gas flush takes a few seconds longer than a vacuum chamber, resulting in slower line speeds; the result, however, is a better quality food product.[9]

A related issue is the amount of brine in the retort pouch. In a canned product, the brine is added largely to facilitate the transfer of heat to the food product through convection currents; the conduction that occurs in the absence of brine results in a slower sterilization process. Brine also serves the useful purpose of displacing air in the package, contributing to the air removal process. However, the mechanical vacuum process cannot be used for products that include brine, because the vacuum will cause the brine to boil. Steam injection is better used with a product that includes brine. One of the advantages of retort pouches relative to cans is the large reduction in the amount of brine needed. However, in planning the precise nature of the potato products to be packaged, another possibility is no brine. While this will allow the use of a vacuum

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[7]Gunter Kruse, Gunter Kruse Packaging, Inc. Personal communication.

[8]John Netterburg, Shelf Stable Foods, Inc. Evansville, Illinois. Personal communication.

[9]Robert Christensen, formerly with Creston Vally Foods, Creston, British Columbia, Canada. Personal communication.

chamber, it means that there may be lots of head space (entrapped air). The use of vacuum to get out this large amount of air can cause stress on the package. Hutchinson contends that it is difficult to get below the level of 20 cc of air without the use of brine, but that 2-3 cc is the appropriate target to achieve a fairly long shelf life and to maintain the whiteness of the potatoes. This discussion on one technical detail, air evacuation, serves to emphasize that a firm considering packaging large particulates such as potatoes in institutional size retort pouches is entering relatively uncharted territory; care must be taken in the planning process to consider such technical details.

Though the type of air evacuation method is an important issue, the selection of the horizontal form/fill/sealing machine for the model plant somewhat limits the choice of features in this regard. The Koch Multivac selected as the filling machine employs a mechanical vacuum system. As noted above, there are problems with the use of brine in a vacuum system. However, some flexibility in processing system design is possible since the Koch machine also has the capability of using a gas flush system.

Retort Method

A retort is a pressurized vessel in which packaged foods are "cooked" (sterilized) by the food processor. Retorts that are used to sterilize pouched foods must have a feature known as overriding air pressure. An informational bulletin from Ludlow Flexible Packaging notes that "This [overriding air pressure] is required so that pressure differentials are minimized between the inside and outside of the pouch during the heating and cooling phase of the retort cycle. The technology has always been used by those packing foods in glass jars. Further, to prevent excessive pressure buildup in the pouch during retorting, the residual air content of the pouch should be less than 10 cc."[10]

Another important distinguishing feature of pouch retorting (versus retorting solid containers - cans and glass) is that pouches must be confined in retort racks. Filled pouches may expand unevenly during the retorting process, but confinement in retort racks ensures a maximum thickness, which facilitates uniform heat penetration. The racks also restrict the pouch from excessive movement during processing. However, the large number of racks required adds significantly to the cost of retorting. Also, the precise manner that pouches are arranged on racks is subject to close scrutiny by the Food and Drug Administration (FDA) and generally cannot be varied without gaining further approval from the FDA. This rigorous approval process and the lack of flexibility also add to the cost of establishing a retort pouch processing facility. The lack of flexibility is due to the fact that pouch racks can officially only be used for one size of pouch.

In selecting the retorting method, there are three main areas in which choices must be made among competing technologies, each of which will be discussed in turn: (1) batch versus continuous retorting, (2) water/air versus steam/air retorting and (3) retorting with rotation versus still retorting

Batch Versus Continuous Retorting

With batch retorts, the food containers are placed in carts and wheeled into the retort chamber, which is then sealed. After the retort cycle is completed, the first batch of containers is removed, another is put in, and the cycle is repeated. With continuous

[10]Continental Flexible Packaging (subsequently Ludlow Flexible Packaging), "Continental Flexible Packaging Answers Your Questions on the Retort Pouch," n.d.

retorts, the containers move continually through the retort, but remain inside the vessel long enough to sterilize the food contents. Continuous retorts generally involve considerably larger capital investments and are appropriate for very large volume food processing operations. Batch retorts are more appropriate for smaller volumes. The initial capital investment is much smaller, and more retorts can be added as needed, expanding plant capacity as sales of the food product increase. Due to the small scale of the model plant for packaging potato products in retort pouches, batch retorts were selected for the model plant. All of the retort pouch facilities currently operating in the U.S. are of the batch type; none have yet achieved the large volumes necessary to justify continuous retorts. A Japanese firm operates the only known system is the world for continuous sterilization of retort pouches; its capacity is claimed to be 105-210 pouches per minute.[11] However, some promoters of retort pouch technology assert that advances in technology and expanding sales of retort pouch foods will make continuous retorting a cost-saving alternative in the foreseeable future.[12]

Water/Air Versus Steam/Air Retorting

Cans are sometimes retorted in 100% steam, but retort pouches cannot be safely retorted in this manner. Cans are sealed mechanically; the metal container and the seals are thus strong enough to withstand this expansion. The use of brine in cans greatly facilitates the removal of air in the canning process. In contrast, pouches are sealed by heat and the seals are less able to withstand such pressures, because internal gas

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[11]K. Yamaguchi, "Current Status of Containers for Thermo-Processed Foods in Japan," Address to the International Packaging, Michigan State University, September 1985.

[12]Reynolds Metals Company, Richmond, Virginia, "Flex-Can Laminate Pouch Comparative Economic Analysis," Unpublished company report, 1 October 1982.

expansion during retorting may strain seals. Internal gas may be either air not removed during processing or dissolved air released during processing.[13]

Many U.S. food processors have considerable experience in sterilizing canned food, but Connor injects a word of caution about transferring this experience to retorting pouched foods: "Processing the retortable pouch or other low-profile containers is certainly more critical and requires more caution than the standard cylindrical can or jar..." Continuing, he notes that "the pouch or tray is obviously not as resilient or rigid as the standard container and, therefore, requires precise overpressure control during sterilization and especially during the cooling phase. Whether a steam flush or vacuum system is employed in the sealing operation, it is impossible to remove all of the residual air in many products, and without proper overpressure control, these gases can expand to the point where seal integrity becomes extremely doubtful."[14] Peterson also notes this factor, that overriding air pressure is required to control this expansion of entrapped gas, and adds that this can be accomplished by using either of two other retort methods: water/air or steam/air.[15] In the United States, processors have generally chosen the water/air method; in Europe and Japan steam/air have generally been favored. Each method has its proponents and detractors; some of their arguments are summarized in the following paragraphs.

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[13]Roger Griffin, Professor, School of Packaging, Michigan State University. Personal communication.

[14] Steven F. Connor, "Sterilization Methodology Applied to Pouches and Trays." See Food Sciences Institute, Purdue University, Proceedings of the Conference: Using the Retort Pouch Worldwide, Focus on the Present With a Look to the Future, 14-15 March 1979, 132.

[15]Peterson, 26.

Peterson notes that a critical issue in retorting is the maintenance of "all parts of the retort at the processing temperatures and......a constant rate of heat transfer during processing..."[16] Milleville concurs: "Uniformity of heating, not rate of transfer is the critical factor in retorting..."[17] In selecting a retort, uniform heating is a key feature to consider; the fact that a particular model saves several minutes of processing time should be a secondary consideration to a food processing firm.

Some of the arguments pro and con revolve around the ease of control and reliability of the different processes. Peterson notes that the water/air process "is generally recognized as being less complicated to control." More specifically, "temperature control of a steam-air process is more difficult...especially during the come up period when there is a large initial heat demand."[18] Stated somewhat differently: "...you can do more things wrong with water and get by with it than you can with steam using superimposed air pressure."[19]

One reason for the greater popularity of the steam/air process in other parts of the world is that government standards are less stringent than those set by the FDA in the U.S. This reliability issue in maintaining heat uniformity is thus a key reason for the skepticism of some food processors toward the steam/air method. Milleville concurs with Peterson: "One reason for the reluctance [to use steam/air] is the...difficulty of control of heat distribution with steam under superimposed air pressure." Milleville goes on, however, to note that for some pouched foods steam/air retorting may be the

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[16]Peterson, 26, emphasis added.

[17]Howard P. Milleville, "Steam/Air Retorting of Pouches: Simpler, Less Expensive Method for Processing with Overriding Pressure, Food Processing, emphasis added.

[18]Peterson, 28.

[19]Irving J. Pflug (University of Minnesota). See Food Sciences Institute, 21.

simpler and less expensive method: "...less equipment, less piping complexity and fewer controls mean simpler and less expensive installation." Peterson adds that "there are a number of commercially available retorts successfully utilizing steam-air as the processing medium." Magic Pantry in Ontario, Canada, uses steam/air retorting; company representatives express great satisfaction with that method and indicate that they are able to achieve excellent temperature uniformity. They agree that a steam/air system takes up less space and requires less pumping equipment.

A marked disadvantage of water/air is that the process leaves the pouches dirty - residue may be left by impurities in the water. This necessitates washing the pouches after retorting which adds an extra step to the processing line, increasing the cost of operation; there may also be a problem of "post-process contamination."[20]

Another disadvantage of water/air retorts is that filling and draining may be time-consuming and may more involve more heat loss than steam/air.[21]

Since more retort pouch food firms today are using the water/air type of retort than steam/air, the water/air type was selected for the model plant. This selection is not an endorsement of the water/air method as the only method appropriate for sterilizing the retort pouch potato product.

The Rotation Controversy in Retorting

If a water/air type of retort is selected, an additional feature can be considered - the ability to rotate the pouches during the sterilizing process. Its main advantage is to shorten the length of the retort cycle due to improved heat transfer. The following

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[20]John A.G. Rees, "Sterilization Methodology Applied to Pouches and Trays." See Food Sciences Institute, 90.

[21]Griffin.

quotes indicate some of the diverging opinions on whether pouches should be rotated during the retort process. One source saw no advantage "in using a rotary process for a pouched product, particularly because of the abuse that the pouch may have to withstand."[22] Stock, a German retort manufacturer firm, takes the opposite view: "Stock has always recommended that rotation be used wherever possible."

Stock America, Inc. has its headquarters in Milwaukee, Wisconsin. They manufacture both the Automat and Rotomat lines of batch-type water/air process retorts, the latter of which rotates the pouches during the cycle. As the quote above indicates, they remain the chief advocates of rotating. In the retort process, the rate at which the water moves past the pouches makes a difference in how quickly the heat is transferred to the pouch contents. Still-type retorts may use such methods as forcing the water to flow vertically or horizontally past the pouches; they may also use air bubbles to agitate the water, further increasing the rate of heat transfer. Whether to use vertical or horizontal water flow and whether or not to bubble air through the retort are also points to consider when evaluating alternative retort technologies. Stock's philosophy is that heat transfer is superior when pouches move through the water (the rotation method) than when water flows past the pouches (still-type retorting). Peterson states the arguments well and notes that the alleged problem may be even more significant with institutional size retort pouches:

> "There is some question as to whether retort pouches should be rotated to enhance the heat transfer rate. Some manufacturers feel that retort pouches should not be rotated under any conditions...due to possible damage to integrity of the pouch seals. However, others have found no problems with rotation and have found a reduction in process time when pouches were rotated...although rotation during processing did

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[22]Rees, "Sterilization Methodology." <u>See</u> Food Sciences Institute, 89.

> not adversely affect the seal strength after processing, the seal strength was reduced significantly during processing. This reduced seal strength may be more significant with institutional size retort pouches due to the large quantity of product present."[23]

Beverly was with FMC Corporation, a manufacturer of retorts and other food processing equipment, when he made this argument: "We feel strongly that heat sealed containers - pouches and semi-rigid trays - should not be agitated during processing because of the danger of creating leakers...with contamination in the seal area, seal strength (burst pressure) is even lower."[24]

Officials from Stock counter by citing test results from Europe and the U.S. that indicate no adverse effects, "provided that proper holding devices or grid systems are employed." Proper overpressure control is quite important; automatic programming of the retort cycle is suggested as a means of minimizing human error. Shortening the process time can mean more retort cycles per day and can enhance the quality of the product due to reduced cook time.[25]

The purpose of summarizing these arguments on both sides is not to endorse either method, but rather to point out that it is an important point to consider when equipment purchase decisions are being made. Griffin recommends purchasing the rotation type since it will allow for more versatility in processing if the variety of products processed by a firm increases, and if some of those products would benefit from rotation-type retorting.[26] The price of the retorts included in the cost estimate in the

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[23]Peterson, 26, emphasis added.

[24]Robert Beverly, "Sterilization Methodology Applied to Pouches and Trays." See Food Sciences Institute, 104.

[25]Connor, "Sterilization Methodology." See Food Sciences Institute, 133.

[26]Griffin.

next section of this chapter is for a still (non-rotating) retort; since the effects of rotating on large pouches are still unknown, it was decided to "play it safe" and design the model plant with the still retorts. The somewhat longer process time relative to the rotating type of retorts required will provide a more conservative estimate of the plant's output in pouches per day.

Type of Potato Peeler

Three alternative peeling methods are abrasion, caustic (lye) and steam (or combinations of those). Caustic peeling is still used in some vegetable processing plants, but the lye generates a considerable toxic waste disposal problem. It is sometimes argued that abrasion peeling is appropriate for lower volume and steam for larger volumes of raw product. However, the owner of Michigan A cannery argued that even for small-scale operations, the higher quality of potato that results from the extra investment in steam peeling (and the reduced waste relative to just abrasion peeling) is generally worth the investment.

APPENDIX H

TABLE 10 - STRUCTURE OF CAPITAL RECOVERY ANNUITY

End of Year	Capital Not Recovered by End of Year	Interest Due on Unrecovered Capital	Amount of Capital Recovered	Annual Capital Recovery Charge
0	$10,000			
1	$9,342	$900	$658	$1,558
2	$8,624	$841	$717	$1,558
3	$7,842	$776	$782	$1,558
4	$6,990	$706	$852	$1,558
5	$6,061	$629	$929	$1,558
6	$5,048	$545	$1,013	$1,558
7	$3,944	$454	$1,104	$1,558
8	$2,741	$355	$1,203	$1,558
9	$1,430	$247	$1,312	$1,558
10	($0)	$129	$1,430	$1,558
		$5,582	$10,000	$15,582

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