SEAFOOD PLANT DESIGN

some planning considerations for the small processor

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with Robert Palmateer

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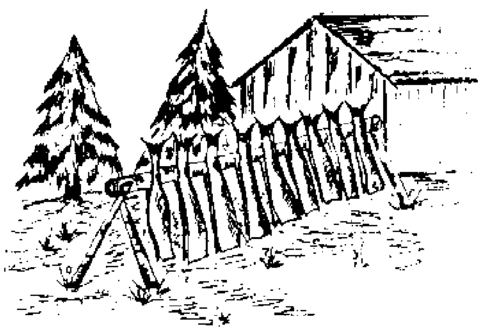
PREFACE

A few years ago, specialists at Washington Sea Grant were concerned with familiarizing small smoked-salmon processors with new regulatory requirements and their impact on plant operations and design. Subsequently, Washington Sea Grant, in conjunction with the Department of Architecture at the University of Washington, became increasingly involved in the more general areas of remodeling small seafood processing plants. This publication summarizes some of the lessons learned during that study. We hope that it will help the novice understand some of the many aspects of facilities operations and design that should be considered before any plant is built or remodeled. The authors do not purport to be processors nor intend to propose processing methods. They wish, rather, to demonstrate, through simplified examples, that the particular processes ultimately used should dictate the design of any facility to house those processes.

From this material, the prospective processor will get an overview that will help him develop a planning method for his particular project. This knowledge should, in turn, enable him to evaluate the feasibility of his starting a small seafood processing plant. Although the material used in the illustrations has proven very useful to the authors in studying proposed facilities, the quantifiers must be used with a great deal of caution since they will vary considerably with time and from one process or processor to another. With these limitations in mind, it is hoped that the prospective processor will identify those areas outside his expertise and seek the help of the proper professionals to support his efforts.



PART I. NEED ASSESSMENT

One of the most critical times for any business is its first few years. In these years it will either become a successful venture or, for a short time at least, become a failure. This success or failure, in large part, is directly related to the degree of intelligent preliminary planning and detail development undertaken by the prospective owner or processor. Few, if any, small businesses can continue operating in the red for any prolonged period, in hopes of riding out the start-up slump. For this reason, it is essential that the prospective owner take as many precautions as possible to insure a successful operation.

This publication is designed to help in this planning stage by raising questions and introducing alternatives and suggestions for enlarging or constructing a seafood processing plant. There are several phases that must be covered, between the conception of the project and the completion of a new or expanded facility. These phases include a planning or feasibility study, arrangement of financing, design and construction, and planned operation of the plant. This publication concentrates on the planning phase of the project and includes the evaluation of products and potential markets, a cost and income projection, the development of a building program, and the selection of a site.

It will be up to the prospective proprietor to carry the project through to completion, and it is a rare individual who will be able to do it alone. In many areas, codes require that any structural changes or design be preceded by drawings prepared and "stamped" by a licensed architect or engineer.

Several professional organizations are available that may save the proprietor the cost of their fees many times over in the course of the project. These sources of help include investment firms, banks and loan agencies, food processing planning firms, architectural and engineering firms, equipment designers and builders, equipment and material suppliers, and other private consultants. The proprietor should weigh the services each of these groups can perform against the time and ability he himself has to devote to the particular areas of the study.

It is almost never too early to hire the professional since the processor can usually spend his time more beneficially in other areas of the planning process. This publication does not purport to answer even a small portion of all of the vital questions essential in finishing a project, but it may well help prospective processors to increase the potential success of their project.

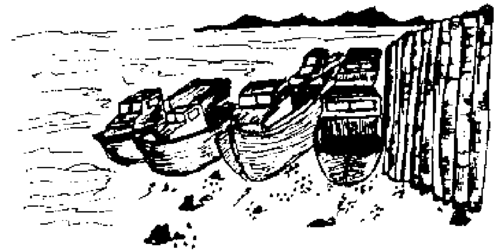
Generally, once the decision to remodel or build a new facility is made, the planning and construction process is done in a great hurry. Because of the magnitude of the consequences that may develop from these hurried decisions, as much time as possible should be taken for construction planning before any actual construction begins.

It is often tempting to expand or to start a new operation on "gut feeling." In the case of fish processing, as in most all business ventures, this is very poor practice. At least three major areas should be carefully studied before the design of any new facilities: 1) availability of raw product, 2) existing and projected markets, and 3) economics of processing to meet those markets.

The following chapter outlines some of the considerations necessary to develop an understanding of these three areas.

1a PRODUCT AVAILABILITY

Three aspects of product availability should be investigated to determine the product's potential as a marketable resource: 1) the quantity available, 2) the time of availability and, 3) the quality of the product. The quality will partially dictate the most [illegible] for the [illegible] capability for the processing operation. [illegible] therefore [illegible] the [illegible] will [illegible] influence the [illegible] processing [illegible].



1 QUANTITY AVAILABILITY

It is essential to locate potential suppliers and attempt to develop reasonable projections of quantity and prices of raw materials. Estimates of the availability of a raw product should not be overly optimistic. High estimates may be beneficial in obtaining financing, but if they fail to materialize, both the business and the banker lose.

2 PERIODS OF AVAILABILITY

When a single species is being processed, availability may dictate long periods between runs and, conversely, periods when all operations must run at their maximum capability simultaneously. It is the goal of management to level out these fluctuations in supply. When more than one species available in cyclical patterns is being processed, it may be possible to develop a schedule allowing for multiple use of equipment or space, thus permitting the most efficient use of capital expenditures. The selection of raw products should take these fluctuations in supply into account.

QUALITY AVAILABILITY

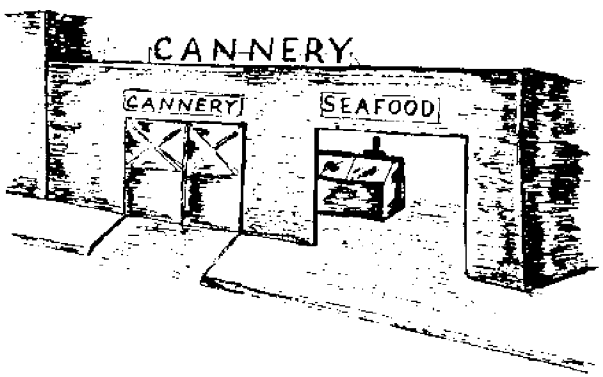
It is possible to receive a product of such quality that it is essentially suited for only a single process method. A "dark" salmon, for example, is suitable for smoking while a high quality "bright" is probably too expensive for smoking in comparison to the prices it will bring on the fresh market. Perhaps a raw product is available of such exceptional quality or type that it would be suited to a specialty market--for example, Alaskan natives selling smoked steelhead.

Regardless of the type of product, the end result may be a financial disaster if strict quality control programs are not implemented. A very high quality product can quickly become worthless through improper handling. Therefore, quality control should be a primary function from the time a product is received until it is delivered to the market.

1b MARKET POTENTIAL

Many feasibility studies fail to give proper attention to potential markets: to the question of who is going to buy the product and to the economic constraints of processing the product to compete in that market successfully.

There is, of course, something to be said for flexibility to meet whatever market demands may develop, but it is highly essential to be positive about a strong market before investing too heavily.



The processor is partially limited in his product choice by his expertise. He is also controlled by economic parameters such as market location, quality of the raw product, and the capital available to produce the market he wishes to reach. Another major area requiring his attention in the determination of potential products is that of regulations governing the intended processes and markets. For example, FDA regulations governing the processing of hot smoked fish or FDA regulations concerning retort operation in all canning processes may drastically affect the design of a building and operating costs of a new business. These regulations often govern more than process methods and may force building design modifications that can break an otherwise profitable venture. These regulations should be considered in planning a facility and all of the groups having applicable jurisdiction should be contacted early in the design process.

1c PROCESS ECONOMICS

A general rule of thumb, often overlooked, is to put a minimum amount of processing into a product to meet a given market. For example, if hot smoked fish accounts for 1% of the net income but requires 12% of the plant and time, it may be necessary to reevaluate the net benefit of retaining this product line.

Although a processor may not be an expert bookkeeper, good record keeping will pay for itself many times over if conscientiously applied. If both direct and indirect costs are amortized over the various products being processed, it will be possible to evaluate which products are profitable. The decision to carry an unprofitable line for its drawing power or advertising strength may be advantageous, but it should be done knowingly. Record keeping will also permit maintenance of product quality and may save many dollars in the event of product seizures or embargoes because of regulatory infractions.

For planning purposes, operation costs should be projected and compared with the income projections on the basis of available market information. Only if the venture appears promising after this exercise, is it time to begin acquiring a facility. The costs of equipment and facility will in turn be considered in the production costs to determine the potential for a return on the required investment.

The following example for a plant smoking silver salmon illustrates the type of economic study that might be developed to evaluate product costs.

A production flow chart similar to that diagrammed in Figure I should be developed. This diagram will involve developing certain assumptions concerning process methods which will, in turn, help outline some of the production cost data necessary to evaluate the feasibility of producing each product. This type of information, developed for each of the alternate products possible, will help determine which products should actually be considered for production. The following cost calculations do not include capital outlay for equipment or structure modifications that may be specifically recognized for any one product, but these costs should be considered.

Basic cost of the raw product.

Labor will be a factor throughout the operation and should be estimated at approximately 1.25 times the hourly rate to account for employee benefits paid by the employer. These benefits will include social security, state and federal unemployment, workman's compensation, health insurance, retirement, vacation, sickleave, etc.

Receiving costs for raw product may include transportation, ice, and labor.

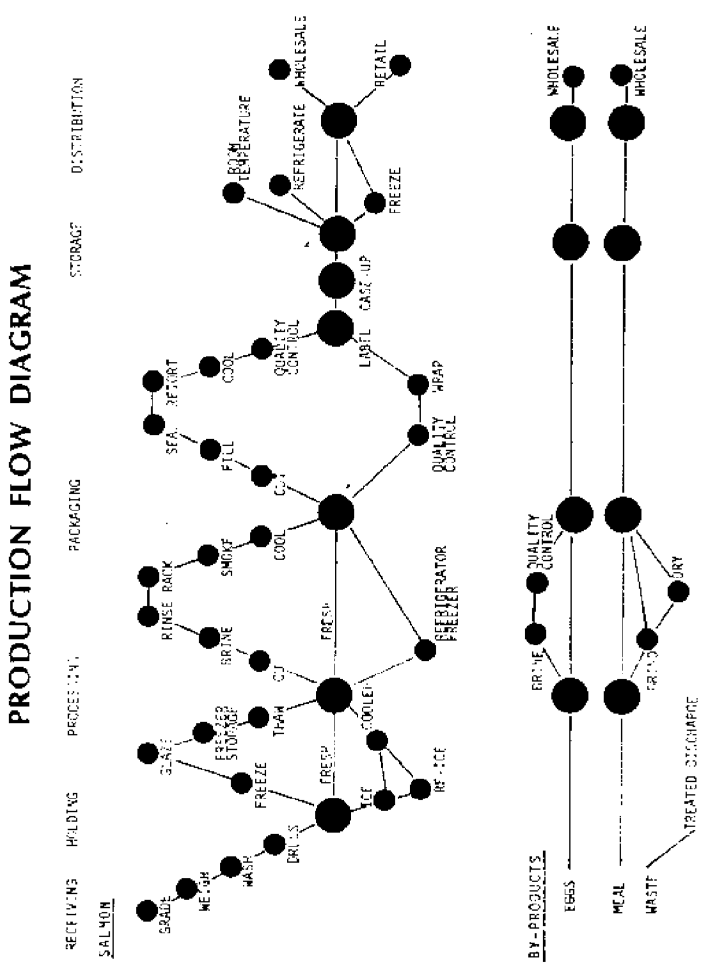
If ice is not purchased outright, icing costs will involve primarily the consumption of water and electricity.

If the holding totes are not equipped with drains, there will be labor costs for repacking if the raw product is held overnight.

Refrigeration costs include the direct costs of operating holding coolers, plate or sharp freezers, and holding freezers. The primary cost is that of electrical power used to reach and maintain required temperatures.

Product weight loss may occur during icing, dressing, smoking, or cold storage. Estimates suggest a 2% loss during icing, 25% loss for dressing, and 40-50% during smoking. Accurate records will indicate the necessity for corrective measures to reduce loss.

Dressing costs are directly related to the dressing rate, which will vary considerably, depending upon species, weight, production line efficiency, and dressing method. Reported rates vary from 0.26 to 1.63 fish/minute/man.



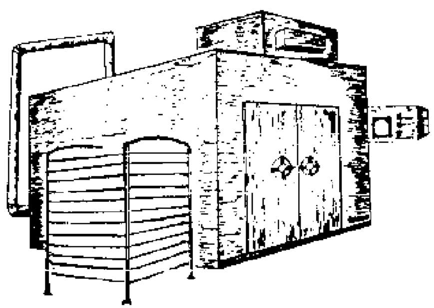
Water costs are difficult to project with any accuracy because of the many variables. However estimates can be made by running flow calculations for specific processes. For example, a crude estimate of water consumption for gutting 8 pounds of silver-salmon should be about 2 pounds finished product/gallon water.

In addition to processing tanks, domestic and sanitation consumption should be estimated as they will affect quality parameters necessary to evaluate waste treatment and disposal charges.

Basic utility charges might be computed during an operational period in an existing plant and values assigned to the various operations. Utility companies and professional consultants may also be contacted for data.

Waste disposal will include both sewer and solid waste disposal charges. Transportation and labor costs must be added in when waste disposal is handled by plant personnel and equipment.

Brining operations will involve salt, water, and labor costs, and should also include refrigeration costs if brining is done in cool rooms. Labor costs may be reduced somewhat by using mechanical agitation and locating the makeup tank to permit gravity feed.



Smoking operation costs should include labor to load and unload racks, monitor temperatures, etc. during the smoke; quality control in the form of checking moisture-phase salt; and clean-up operations. It will also

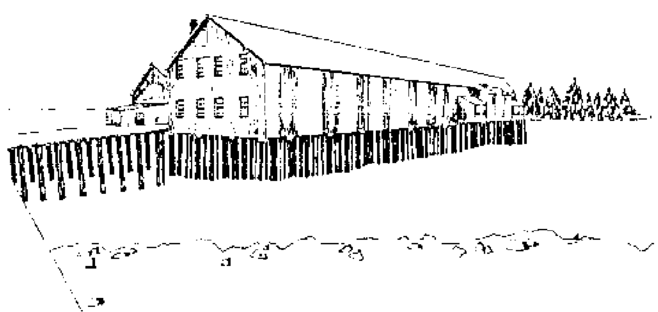
include the cost of wood or sawdust for smoking, and the electricity and/or gas used to dry, heat, and cool the product. When a "hot smoked" product is being processed, refrigeration costs should also be considered to meet federal cooling requirements. An estimation of area and heating and cooling loads can be made for salmon chunks by assuming that a 4' x 6' rack with eleven shelves will hold approximately 500 pounds of salmon chunks.

Packaging costs will include both the packaging materials and the labor required to package the finished product. If the product is to be canned, the cost of cans, labels, and labor must be considered along with the canning equipment requirements for utilities such as electricity and steam. Labor requirements for packaging will include carton makeup, wrapping, filling cartons and cans, and storage.

The actual costs of packaging are very difficult to figure in the preliminary stages. The estimate of costs for containers, liners and fasteners may be simply a cost per unit received from a supplier. On the other hand, if reusable containers are used, shipping costs for returning empties must be considered. The life expectancy of these reusable containers should also be projected in estimating material costs. Although there are usually discounts for buying in large quantities, the cost of the storage space for these large shipments may offset the savings.

Storage costs will vary depending upon the type of storage, i.e., room temperature or refrigeration. Storage is not free simply because the room is there. However, once the space has been purchased through capital construction, storage costs consist primarily of the cost of labor to move products in and out of storage spaces. The cost of space and labor for storing nonfood products such as packaging materials and process ingredients must be added as well.

Shipping rates can be determined by contacting various shipping agencies for rate schedules. It is also essential to determine any restrictions placed on containers carrying fish. The economics of purchasing and operating one's own refrigerated vehicles might be investigated.



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PART II. BUILDING PROGRAM

After evaluating product availability, potential markets, and the projected processing costs to meet those markets, the prospective processor should be in a position to develop a building program. This building program will, in turn, enable him to estimate the cost of acquiring adequate facilities and evaluate the potential for amortizing the project costs in a satisfactory manner.

The establishment of a building program is a cyclical process: while one of the major determinants of building design is the site for that building, the building program and operational requirements may also be major determinants in the selection of a site. For this reason, this chapter could be as easily read forward, backward, or piece by piece and still reflect a good method to evaluate specific needs and develop a design process.

Whether the processor is evaluating potential expansion of an existing facility or construction of a totally new facility, the planning process outlined here will be beneficial in determining what his future requirements will be.

For the processor who already has an existing facility or site, the building program issues are further complicated by his familiarity with existing process methods and any real or imagined physical constraints of the structure. It is important for the processor familiar with an operating facility to divorce himself emotionally from that facility in order to evaluate his needs objectively. At this point, the processor should determine if it may be advantageous to hire a consultant to put the pieces together.

The first section of this chapter will briefly discuss design methods and building design philosophy as they may affect the success of an operation. The second section discusses various methods the processor may use to acquire a facility and some of the planning aspects that may ultimately determine the selection of one of these methods.

The third section addresses the issue of expansion. This aspect of the design should be considered for a minimal remodeling job or construction of a completely new facility. The next two sections discuss some of the considerations necessary to develop a set of design specifications and methods of organizing the space needs. The next section discusses some of the physical characteristics that may influence the cost of a facility, and the last section discusses some sources and ways of contracting for professional services.

2a DESIGN PHILOSOPHY

In preparing to design a facility, consideration should be given to a design method. One approach is to erect a building shell and then place the processes into that shell. Another approach is to develop a building program based on the proposed operations and then design a facility specifically for those processes. Although the second approach is probably the ideal method, it must be tempered by the constraints of site, budget, building schedule, and available construction skills and materials. Probably the greatest disadvantage of the shell approach is the difficulty of separating the various functions within the shell. Circulation is often very poor in the shell approach because of the restrictions imposed by the existing structure.

A distinction should be made between the shell approach and prefabricated buildings. The shell approach, as intended here, is the planning concept of taking a given building form and then placing the operation into it. Although the prefabricated building lends itself to this approach, prefabrication in itself need not be utilized in shell approach--i.e., the prefabricated units may be designed to house specific plant needs. The prefabricated units may be large modular panels of concrete, structural steel bays, or combinations of boxes in the fashion of modular trailers which may be stacked. The prefabricated units may be as small as 4' x 8' plywood panels or concrete blocks. In each of these cases the prefabricated units can be assembled to house specific processing operations. The point is that consideration should be given to maximizing the efficiency of what is going on in the facility and letting this dictate form, rather than vice versa.

The primary advantage of prefabricated units is the relatively inexpensive costs of enclosure. This cost advantage is due partially to the decreased labor costs achieved through the quickness with which the building can be erected on the site by skilled laborers. This method is also advantageous when building schedules are extremely tight because of weather or where the cost of keeping skilled workers at a remote site becomes a strong planning factor.

A brief discussion of the relative economics of various building materials is perhaps appropriate here. Although there are apparent cost savings when using the presently popular prefab metal systems rather than conventional wood frame construction, a more in-depth evaluation often dispels these early assumptions. It is true that metal systems provide one of the most economical enclosures available primarily because of the prefab panels, which are quickly assembled on site. However, the nature of the construction of most metal structures tends to require more sophisticated, and consequently more costly, means of finishing a building for sanitary food processing.

Long-term costs such as fire insurance, energy conservation, and maintenance should always be evaluated to determine if this building type is best for the particular circumstances. The actual economic advantages of any one building type over another are not always obvious and should be carefully weighed before one commits himself to a particular structure or building type. The outlining of operations and development of the interrelationships between them are useful planning tools regardless of which method is used to acquire a facility (see site selection discussion, p. 15).

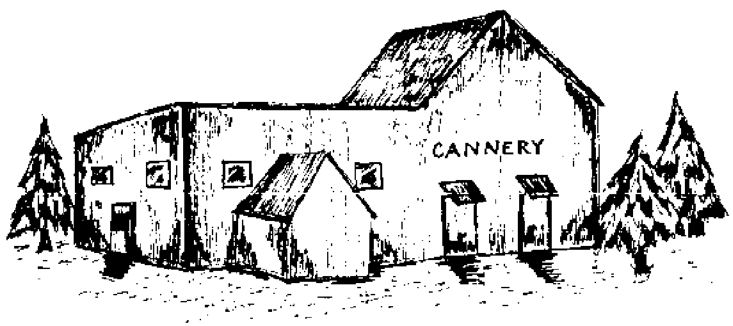
Another philosophical question that should be addressed is the sense of image desired for the facility. It is often a misconception to believe that budget will prohibit the achievement of a particular building character. The character of the physical structure is a frequently overlooked method of potentially increasing employee morale and efficiency as well as customer sales. Furthermore, the character of the structure will greatly influence neighbors, community groups, city councils, and other groups that may have an impact on the development and operation of the business.

The most obvious method of achieving an image is through aesthetics. An Indian smoked-salmon processing plant in Washington will serve as an example. The feasibility study indicated that a prefabricated metal building could be erected to house the processing plant. The reservation site was a heavily wooded lot along a major tourist highway, and it was anticipated that the location would lure a strong retail trade from passing tourists. The metal building, which resembled a highway department storage shed, was not appropriate either to the image the tribe wished to achieve or to the wooded site. The tribe contracted with a design firm which developed a cedar structure that is more in keeping with the tribe's aesthetic traditions, that was within budgetary restrictions, and that has the bonus of more efficient circulation and better sanitation than the building originally designed. This does not mean that metal or concrete construction is not desirable or cannot potentially be as attractive, depending on the specific needs of the processor.

However, the building's visual appeal can only enhance the character and reputation of a business. The cleanliness, quality of product, and personnel rapport with the public will probably overshadow even the best of buildings in determining a business's reputation.

FACILITY ACQUISITION

2b To select the best method to house a particular operation, it is essential to be very careful in the evaluation and selection of a site for the facility. Even if the intent is to remodel existing facilities, several aspects of the site should be reevaluated in regard to the newly projected requirements. There are several methods of getting into new, more efficient building spaces including: 1) remodeling the present facility; 2) purchasing an existing food processing operation and modifying it to meet projected processing needs; 3) converting a nonprocessing facility into a processing facility; and 4) selecting an undeveloped site and designing and constructing a new facility. It is not always obvious from the outset which of these alternatives is the most economically desirable for the particular circumstances.



SITE CONSIDERATIONS

1 Regardless of where a site is, several aspects must be carefully investigated before any property is purchased. These criteria include, but are not limited to, the initial costs of purchase, development costs, fixed operating costs, potential expansion capabilities, length of lease available, future development plans for the area, zoning and other legislative regulations governing development of the site, the site's suitability for food processing, and personal preferences for locations.

Futhermore, the location must be evaluated with respect to receiving as well as shipping of the product. Accessibility is important, not only for transportation of the product and supplies but also for customers, if there is to be a retail sales outlet. Transportation costs either for receiving a raw product or shipping a finished product can be a major expense item in a poorly located plant.

Historically, fish processing plants have been placed on the waterfront. This has been due primarily to the desire to receive the raw product straight from the boats and also for ease of waste disposal. There is also a feeling by some that customers associate better product quality and freshness with a waterfront site and this is used as a sales tool. With the advent of improved transportation methods, new water quality standards, and greater consumer awareness, the criteria seem to have less value than in the past.

When evaluating any site, it is necessary to consider future expansion capabilities with respect to local building code requirements limiting maximum ground cover and total building area for various construction types. Local zoning ordinances may also restrict the kind and size of operation permitted. Many small counties have no building code, but have adopted the National or Uniform Building Codes for projects above a given construction cost.

Waterfront sites are extremely expensive in most cases and often offer very little other than aesthetic value for that increased cost. However, some cities are encouraging port-area development and are very receptive to seafood facilities as a "drawing card." An added consideration for any waterfront site in Washington State is the Shorelines Management Act of 1971, which requires local governments to establish guidelines for the development of waterfront property in the public interest. These guidelines now restrict use of the waterfront within 200 feet of the shoreline, emphasizing "water-dependent," "water-related," and public uses of the waterfront. In considering the lease of any site from the port commission or a private individual, the processor should determine what rights he will have, what utilities and other fixed costs he will be responsible for, and the length of lease available. Many ports have guidelines in addition to normal building codes, within which a facility must be constructed.

An inland area obviously offers a great deal more flexibility in location because of the number of sites available. Taxes and land costs are usually lower than for waterfront sites or sites that are located near the center of the town. However, any evaluation of an inland site requires investigation of the same planning considerations as the waterfront site, with the exception of the Shorelines Management Act.

Several aspects of site selection are not always obvious but are nevertheless important to evaluate in advance of the purchase. These include: development costs for dock, drainage and waste treatment facilities, clearing or fill, piling and bulkheads, utility hookups, access roads, and the availability of financing. It is a good idea to try to visualize potential building orientation to facilitate things like shipping and receiving, weather characteristics such as sun and wind, and employee and customer parking.

Many of the concerns outlined above may seem trivial to the prospective processor, but because of the potential loss of any investment the importance of taking all possible precautions before committing oneself to a single site cannot be overemphasized.

When viewing any real estate, it is a good practice to take photos of the property and properties adjacent to the proposed site. These photos can be invaluable in comparing properties. They can also be useful as a tool in protecting one from any subsequent damage claims that might arise should an adjacent property owner incur property damage after construction has begun.

REMODELING ONE'S OWN EXISTING OPERATION

The owner of an existing operation may feel that he can ignore a discussion concerning site selection because he already owns a piece of property and can obviously "tack" the needed space onto his building where the employee parking lot is now located. This may possibly be true. However, it is still advisable to seek out any constraints that may hinder a remodeling effort at the present site. These restrictions are often difficult to track down because of conflicting regulations carried by state and local agencies, and yet they can often stop projects.

Among the first things to do is to review the legal description of the property and physically locate its boundaries. Then the city or county building department having jurisdiction over the site should be contacted for the zoning and building code regulations for the type of facility. In determining the type of structure permissible, the department will be interested in what products will be processed, whether or not there will be a retail sales outlet, the number of employees, and any negative environmental impacts. The zoning codes will also determine yard setbacks and height limitations for the site. These will in turn determine in which directions the building may be expanded. It is also a good idea to review title reports to evaluate any easements or rights other individuals or groups may have outstanding on the property.

If an increase in the quantity of waste generated, or an increase in consumption of electricity, gas, water, or any other utility is anticipated, the proper agency should be contacted to find out if there are any potential problems in their meeting increased demands. For example, the utility may not have the capacity to meet increased needs, or the company may require a large installation or use fee. The problems can often be minimized with proper design--for example by lowering the peak loads in electrical operation to decrease effective demands. Oftentimes agencies have personnel available free, to help develop a facility to make use of their product most efficiently.

Although the problems can be minimized or avoided entirely, in many cases, with careful planning and design, it is also possible that regulations will be so restrictive or costly that they will effectively prohibit expansion at the existing site. In this case, the proprietor must reevaluate his expansion needs and determine whether or not he can make use of his existing operation or whether he must acquire another facility to meet his increased demands.

PURCHASING AND REMODELING ANOTHER EXISTING OPERATION

3

Because of the high mortality rate of new businesses, there is an obvious advantage in buying a successful, going concern. The evaluation of an existing operation should include a financial analysis, a review of its location and its ability to meet particular market requirements, and an evaluation of the physical facilities.

The economic picture may be the most revealing indicator of the desirability of the property. Thousands of pages have been written on methods of going into business and the evaluation of existing operations. (One good source of simplified information is the Small Business Administration booklets.) Some of the characteristics that may furnish indicators of a business's health or areas where it might be possible to increase its value through proper management are outlined below.

Some healthy businesses do come onto the market; the reason for the owner's selling might be transfer, retirement, or boredom. However, it is more likely that some aspect of the business is eating away at the profits, persuading the owner to seek more rewarding employment.

An example of an economic problem with possible physical indicators might be a diminished profit margin. The source of this problem might be poor plant layout contributing to high labor costs; it is also possible that a geographic location might be such as to require high wages to draw employees. Another indicator might be obsolete or inefficient mechanical or processing equipment causing high labor and/or utility costs.

One of the best ways to "see" a plant is to measure it physically. After the plant has been measured and photographed, a roughly scaled floor plan should be drawn to locate existing equipment, utilities, openings, etc. Any site and adjacent property characteristics that may hinder future expansion should be included. Then, with personnel and product circulation as a guide, any additions to equipment or building that are required immediately should be laid out.

As the facility is measured, the quality of construction should be considered, and areas where immediate repairs will be required should be noted. Also areas that will require refurbishing or construction to meet new, more stringent requirements by federal and state regulatory agencies should be indicated.

The company books should obviously be reviewed. In addition, the owner's banker, neighboring businesses, and when practicable, past or potential customers should be contacted to get a feel for the company's reputation. Inevitably, no matter how thoroughly the property has been researched, problems will emerge after the property has been purchased. However, this search will definitely decrease the potential for what could be a fatal surprise.

REMODELING A NONPROCESSING FACILITY

4

The criteria that were used in the evaluation of remodeling an existing processing plant are also applicable in evaluating other facilities for possible conversion into a processing operation. It is also particularly important to consider the suitability of the location in regard to raw product availability and potential markets more carefully because of the lack of historical data.

Conversion will probably be more expensive than the two methods outlined above, primarily because of the need to bring the facility up to an acceptable level for the sanitary production of food. The floors and walls will require an impervious finish. Connection details and base covings at walls and floors will require sanitary finishes for effective cleaning. Lighting fixtures must be sealed against breakage hazards and placed to maximize lighting levels over processing lines. Electrical and plumbing runs must be concealed or wrapped to prevent dust and condensation problems. Drains and sewer capacities will probably need to be increased and updated. Cooling and refrigeration equipment may have to be installed. Most conversion costs will be less in remodeling a facility that has been previously used for food processing. However, because of the probability of very few good processing plants being on the market, conversion is still a viable approach to obtaining a processing facility.

In evaluating the facility, the same measuring and drafting techniques outlined in the discussion concerning remodeling should be used. The construction should be carefully examined and the feasibility of finishing the facility for food handling should be determined. An example will illustrate the kind of exercise to undertake before purchasing a building for conversion.

A building with the following conditions has been located:

> An ideal site with good access for service vehicles, customer and employee parking. The site is on the waterfront and the raw product can be transferred directly into the facility. There is a good deal of land around the existing structure that might permit future expansion.
>
> A sound structure. It is a relatively new wide-span metal structure with steel siding in good shape, previously used as a warehouse. It has a small office area and large access doors for shipping and receiving; the floor is concrete slab-on-grade in good condition. Drawings showing structure and the existing water, sewer, and electrical connections are available from the city.

Given these apparently ideal conditions, it is time to estimate the minimal development costs. The plans of the water and sewer lines reveal that they are inadequate in their existing condition to handle the operation. The water supply line must be replaced and the existing sewer line must be increased for domestic use. An additional line is needed to handle the commercial load. First the concrete floor has to be cut so

that sewer lines can be laid. Then a topping coat of concrete is required to establish sufficient floor slope and then the floor must be treated with a sanitary finish. While the topping coat is being installed, a coving at the floor-wall juncture should be added, and the metal wall structure should be enclosed, after insulating, to get an impervious and sanitary wall finish.

Tests indicate the need for additional lighting in the process area, and new electrical circuits must be installed to handle the lights and power requirements for the additional process equipment anticipated. A new ceiling must be installed that is both cleanable and sanitary.

If a new freezer has to be installed, the cold storage facilities must be placed so that the floors of the freezers do not cause subsequent frost heaving under the slab. This can be facilitated by sub-slab drainage or an insulated floor system set on top of the existing floor. Floor loads in the freezer area to include fork-truck movement must also be considered.

The processor, having gone through a list of development and any other costs like parking, docks, etc., is in a much better position to compare this facility with other conversions or other methods of getting into a facility. It is entirely possible that the savings in purchasing the existing structure will offset the cost of working around the existing constraints.

5 DESIGNING AND CONSTRUCTING A NEW FACILITY

The most flexibility in acquiring a facility is found by purchasing a piece of property and designing a plant to specifically house the particular processing operation. This method is also likely to be the most time-consuming but, if done properly, should ultimately give the most efficient processing plant and one tailored to specific needs.

As in all of the above methods, it is not necessary to limit oneself to properties that are on the market at the time of the search. It is possible to obtain tax records of any property, locate the owner, and make an offer based on the property's assessed value.

In this particular method, there is the added advantage of being able to hire an architect or engineer early in the planning stage to help determine site characteristics most suited for the facility--e.g., access requirements, size of the building, probable utility requirements, best kinds of materials, etc. This consultant can also prove advantageous in advising on such things as pile structures vs. fill or construction types--concrete vs. wood vs. steel. A preliminary soil study should be done for any property to determine its suitability for construction.

In selecting potential sites, the local planning office is useful for finding areas where future developments are likely to enhance the value of an investment.

In buying an existing operation, the processor may have to develop a market only for new products he wishes to produce, as opposed to building a facility in an area without a previous market history, where he will have to develop a market for all products. Brokers and census data may help in reviewing market potential for the area. It is dangerous for a processor to assume automatically that he can sell his product after he gets into operation.

A strong potential market should be developed before any property is purchased. The potential labor market, equipment service availability, insurance rates, local suppliers of raw products, etc. should also be investigated. In this particular method of plant acquisition all of the winning cards are potentially there. By the same token, it is possible to deal oneself out of business in the first month with poor planning.

2c EXPANSION

Consideration is not often given to expansion until the plant has already become extremely overcrowded or an economic liability. The neophyte processor may not believe that he will need to expand in the near future and yet he will probably feel that need for increased space in only a few years' time if he does a good job of planning and operating his business or immediately if he does a less thorough job. Therefore, the need for expansion should be considered in the original plans.

Providing excess land around a building is not in itself an adequate method of planning for future expansion but must be done if future expansion is to be successful. Integration of existing facilities with some as yet undetermined future requirements is difficult to anticipate in early design. The best procedure is to plan the facility at its maximum level of development and develop intermediate phases of construction to reach that goal. The long-range plan must remain flexible and responsive to changes in needs and should be periodically updated to reflect any new needs. Phasing construction is beneficial in keeping immediate cash outlay to a minimum, allowing the proprietor to let the building grow with the business for a small penalty in construction costs.

When designing for expansion, one should determine which areas of the plant are most likely to require more space first. The process-flow diagrams should be studied to determine which areas are most likely to cause a bottleneck in production as the plant nears its design capacity. Perhaps production can be increased through more personnel, more sophisticated equipment or longer work shifts more economically than through construction changes, which tend to be the most expensive method of acquiring increased capacity.

Those functions anticipated to need increased space should be located away from building elements such as stairways, mechanical equipment, utility runs, and heavy or bulky processing equipment like smokehouses, retorts, and boilers that are difficult or expensive to move. One method of planning involves placing these permanent elements and then generating sets of plans based on these constraints. For example, the permanent mechanical equipment might be located at the center of the structure and the processes placed around it. If the mechanical equipment is then sized for the ultimate building size, all of the processes can expand at the periphery.

However, because mechanical equipment requires periodic maintenance, upgrading, and replacement, it is important to anticipate these requirements when evaluating the location of the mechanical equipment, during each phase of development. In some circumstances it is advantageous to place them along an edge of the property, remembering to leave a service access, and to design future expansion into the rest of the site, avoiding their costly displacement during subsequent development. At each stage of development, shipping, receiving, and employee and customer parking should be accommodated. Ideally each expansion stage will minimize plant disruption.

Designing for expansion by designing the ideal layout and then stepping progressively back to the immediate needs can be especially useful in site selection and can also ensure a long-range building growth plan rather than the more traditional ad hoc addition approach. All of the expansion planning in the world will do no good unless the plan is followed. Of course needs change, but care should be taken during each construction stage to evaluate what long-term effects these changes will have on long-range plans so that they can be modified if necessary.

2d

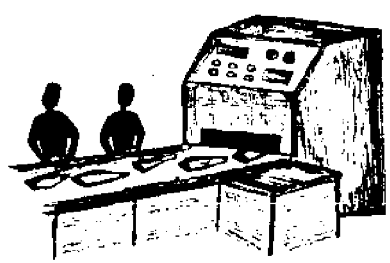
DESIGN CONSIDERATIONS

In the design of any building there are a seemingly infinite number of details that must be evaluated and solved before the first yard of concrete is poured. In the design of a fish processing plant, the planning details can vary from one operation to another to such a degree as to make generalities in preliminary design an exercise in futility. However, a study of the quality of the spaces may in turn help to develop processing methods to a point where the requirements of the project may become much more educated "guesstimates." With this qualified disclaimer in mind, the following design considerations may then be read in the proper perspective--one of generating basic planning considerations upon which to develop processing methods and some general design criteria to help determine the ultimate character and cost of a facility.

FLOORS AND DRAINS

1

Floors should be constructed with an impervious finish. In most cases this is a 6-to 8-inch concrete slab or concrete topping slab 2 to 4 inches thick rough-troweled and perhaps finished with an epoxy coating for increased durability. There are, available on the market, epoxy coatings reported to have sufficient elasticity to hold up on wood decking. This is recommended only if the existing floor system will not allow a topping slab.



Floors should slope to drains in all processing areas. Many guidelines recommend a 1/4-inch slope per foot. However, this slope is rather difficult to work with, if there are wet floors or movable carts. For this reason, a design slope of 1/8-inch per foot is better. The ultimate slope is really incidental; the primary concern is to finish the slab so that there are no "dead spots" where standing water can accumulate.

Floor drains should have a minimum 4-inch diameter. The effective floor area for each drain should not exceed 400 square feet. Floor drains may be equipped with easily cleanable catch screens if the waste flow is primarily liquid with minimal amounts of solids. However, in most processing facilities, the waste flow contains considerable amounts of debris and solid waste which tend to cause considerable problems with plugged catch screens. For these systems the waste lines are tied to grinders that reduce the solids to a slurry. This slurry is passed over tangential screens and stored for reprocessing to by-products or disposed of in accordance with local EPA requirements. Drains in the form of troughs are very useful in facilitating waste and water removal from process areas.

Floor drainage should be designed to minimize the water on the floor, especially in circulation paths and around equipment where employees must stand. In areas where employees are likely to be in water, for example at dressing tables, plastic pallets on the floor will ease the water problems and minimize fatigue and slipping problems.

Thresholds at doors should be detailed to control water from processing and cleaning operations. Floor slope or curb location should be considered with regard to any future remodeling.

Changes in floor elevation can be very useful in keeping processing water out of offices, employee spaces, and packaging areas. However, care must be taken in the design of the facility to follow code requirements for stairs and ramps. Ramps require substantially more horizontal space than stairs and should be carefully located to avoid obstruction of other circulation paths.

WALLS AND OPENINGS

2

Walls should be constructed of impervious materials and have a minimum number of joints and other potential sanitation nightmares. There are materials available in paint form to coat existing plywood walls.

For new construction, there are aluminum and plastic-faced plywoods available for walls. In high traffic areas, however, the aluminum plywood is prone to damage by forklifts, carts, etc. Ideally all construction joints should be sealed to facilitate high pressure cleaning equipment; however, attempts should be made to minimize the number of joints and connection details in any material. At the floor and wall juncture, a concrete curb or sealed coving should be designed to ease cleaning and insure good sanitation. Doors of coolers, shipping, receiving, and packaging areas, and areas of retail displays should be designed to accommodate a loaded forklift.

Swinging and sliding doors should be equipped with self-closing devices.

3 UTILITIES DISTRIBUTION AND LIGHTING

Ceilings should be designed to minimize potential dust collection and to prevent condensation problems. Exposed utility runs should not be located directly over food areas. The lighting system should be designed to minimize glare and spot lighting. Minimum light levels should be approximately 50 foot-candles in detailed work or inspection areas. All fixtures should be equipped with safety glass or safety shields. Fluorescent fixtures mounted in spaces with great temperature and humidity changes, e.g. over retorts or smokehouses, experience longer life with the installation of plastic sleeves. Electrical outlets in processing and other wet areas should be covered and waterproofed. Electrical requirements for all capital equipment should be evaluated.

Access to all service runs should be facilitated. Hydraulic runs should be located below work surfaces and checked regularly for leaks.

Power companies often have customer service people, available at no cost, to estimate projected loads and consumption for a proposed facility. They may also help locate and estimate costs for the installation of the main service line. The service location, although usually a minor concern, may have a significant effect on the potential design of a facility.

Indirect, natural lighting is to be encouraged. However, skylights and/or clearstoreys must be located so as to minimize direct sunlight into processing areas where the heat gain may drastically speed the deterioration of a product. Sunlight into retail displays and receiving areas is also detrimental in that it increases the cooling loads and/or ice consumption.

4 MECHANICAL AND VENTILATING SYSTEMS

Heating of the processing areas should be held to a minimum to help insure product quality.

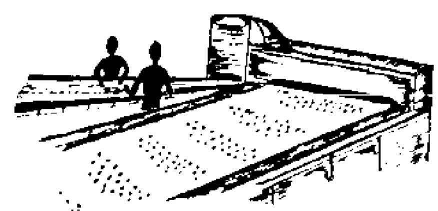
The processing area should be ventilated, and in most cases natural ventilation should be augmented by mechanical venting systems. Air intakes should be located and installed in such a way as to insure minimum contamination by dust, smoke, and odors. Air from processing areas should not be allowed to contaminate packaging and other finished product areas.

Restrooms must be vented by natural or mechanical systems. Care should be taken to insure that these vents do not contaminate processing areas.

It is possible to utilize the heat given off by refrigeration equipment on coolers and freezers to heat portions of the building. However, the mechanical equipment necessary to make use of this heat is often more expensive than exhausting the heat and installing traditional heating systems. In a processing facility, the requirement for heating is extremely limited and can often be accommodated by individual space heaters.

5 WATER SUPPLY

Potable water must be used in almost all processing areas. Potable and nonpotable lines must be separated to avoid contamination through leakage or siphonage. Back flow preventors and antisiphonage devices are generally required by plumbing codes. Lines should be insulated and wrapped where passage through process area is unavoidable.



Water lines should be mounted to minimize dust collection and condensation onto processing areas. Plumbing placed in the wall may be the most sanitary, but poses the problem of service accessibility.

It may be possible to surface-mount the supply lines in the spaces adjacent to the processing area. In seasonal operations, the supply system should be designed to facilitate draining.

6 SEWAGE DISPOSAL

Codes require that domestic sewer lines be separated from processing lines until they are clear of the building. The EPA has established guidelines for waste disposal into natural water systems. The regulations may require in-plant screening and treatment facilities.

City sewer systems, when available, will often have a special increased rate for seafood processors and other establishments that may potentially create added treatment problems. These rates usually depend on Biological Oxygen Demand (B.O.D.) and/or Chemical Oxygen Demand (C.O.D.) readings of the plant effluent.

7 REFRIGERATION EQUIPMENT

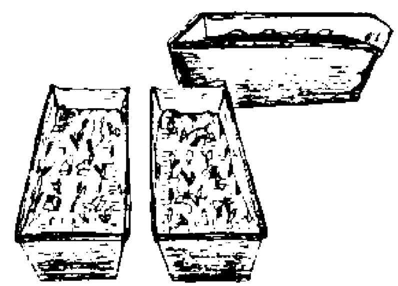
The estimation of refrigeration loads is best done by a professional. However, most refrigeration manufacturers will be happy to estimate cooling loads and quote base prices for equipment. The manufacturer will need certain design information to determine the cooling load. The following information should help in developing the preliminary design he requires.

a) Quantity of fish to be held: approximate number of pounds of fish received daily less anticipated production. Raw product for daily production needs may be held in the process area in iced receiving bins or totes. The remainder must be refrigerated. If adequate separation is available, the holding cooler may be sized to include raw product holdover and "finished" product for the fresh market. Long-term storage should be at freezing temperatures, around 10° to 20° F.

b) Size of refrigeration rooms: The box size is dictated by raw finished product container requirements and available space. In most cases, ten pounds of finished product will occupy about one cubic foot of space when container design is incorporated into the calculations. With proper planning and efficient use of containers, the holding capacity can approximate the density of fish at about 30 lb. per cubic foot. Adequate area for forklift movement should also be included in the calculations for the final load of the cooling box.

In laying out the dimensions of a box, it is necessary to consider the height limitations of forklifts and the stacking and weight capabilities of containers. Standard heights of prefabricated refrigeration units are 7 feet 6 inches and 8 feet 6 inches. The prefabricated panels are generally 4 inches thick and come in various dimensional modules that can be acquired from the manufacturers. Minimizing perimeters decreases heat gain and consequently the refrigeration load; i.e., the more nearly approaching a cube, the more efficient the shape.

c) Temperature of the product going into the cooler: the temperature of the raw product can vary considerably depending on the handling methods. A product that has been properly iced and handled expeditiously should be around 45°-50° F.



d) Internal box temperature: Holding coolers, those designed to hold a fresh or finished product for short periods of time, should have a design temperature around 34° F.

Holding freezers should have a design temperature about 10° F. For some products plate freezers are very effective for bringing product temperature down very quickly because of direct contact, top and bottom, between the product and refrigeration coils. However, this is an elaborate and therefore expensive cooling system. Because of the coils and racks, the capacity of a given size plate freezer is substantially smaller than that of an equally dimensioned cooler or freezer. Plate freezer size can be estimated roughly at 3-4 pounds per cubic foot. Unlike the design of air cooling systems, the shape of the plate freezer may be determined primarily by rack access and cooling equipment rather than minimization of perimeter dimensions. The design temperature of a plate freezer is about -34° F. Depending upon product thickness, plate freezers can be a very economical unit because of the large quantity of product they can handle in a given time period.

e) Air changes: Generally, the larger the volume of the cooler, the fewer the air changes that occur due to door openings and infiltration. Although the actual number of air changes will vary greatly, depending on the frequency with which the door is opened, the following table will give a rough air-change estimate.

f) Temperature of the adjacent space: The temperature surrounding the cooled space minus the internal box temperature gives the dif-

Table 1. Air changes per 24-hour period per cubic area[1]

Cubic feet	Air changes per 24 hours	Cubic feet	Air changes per 24 hours
200	44.0	6,000	6.5
300	34.5	8,000	5.5
400	29.5	10,000	4.9
500	26.0	15,000	3.9
600	23.0	20,000	3.5
800	20.0	25,000	3.0
1,000	17.5	30,000	2.7
1,500	14.0	40,000	2.3
2,000	12.0	50,000	2.0
3,000	9.5	75,000	1.6
4,000	8.2	100,000	1.4
5,000	7.2		

[1] Source: American Society of Refrigerating Engineers

ferential temperature, which is then used in conjunction with the insulative value of the box to determine the heat gain in BTU's for the cooler. Generally, the higher the temperature in the adjacent space, the greater the heat gain and the greater the refrigeration load.

Besides the air-temperature adjacent to the box, a couple of other design characteristics can influence the heat transfer through the walls of the cooler. A still air surface across the exterior of a wall increases the insulative value of that wall system. On the other hand, refrigerator walls internal to the building will generally have a higher temperature difference, increasing the cooling load.

Refrigerated room walls exposed to the exterior should be protected from direct sunlight--for example, by overhangs or placement on the north side of the plant to decrease heat gain. Reflective surfaces will also reduce the potential for heat buildup on the wall and ceiling surfaces.

Care should be taken in the design of freezers to have subsurface soil conditions evaluated for potential frost heave. The design of a proper drainage system under freezer spaces will increase the likelihood of still having a freezer floor a couple years later even in soils carrying a great deal of water.

There are several methods of mounting refrigeration equipment to the prefab box, and they vary in detail from manufacturer to manufacturer. One of the most common is to mount the blower coil in the cooler box and the condensing unit on top of the box. Care must be taken to insure proper support for the condenser either by structural support of the ceiling of the box or by hanging from the building structure itself. Another method of mounting the condenser utilizes the side walls of the box to support the condenser along the side of the refrigerated space. This method requires more floor space or space on the exterior of the building, but it has the advantage of easy maintenance access and it requires no additional structural consideration.

Ice machines can also be mounted over a cooler and the ice can be allowed to collect within a bin inside the cooler. Access to the ice through the cooler will increase the air changes of the cooler, and thereby increase the refrigeration load. If the ice is to be used, as it should, it is probably best set up as an independent storage bin located near the receiving area or other areas of high volume ice consumption.

A crude estimate of machine size for receiving raw product is approximately one pound of ice to five pounds of product. A second packing of ice and the potential of selling to boats might also be considered in sizing the equipment. Ice machines are generally sized by the weight of ice they produce per 24 hours.

The doors to refrigerated spaces should be sized to facilitate a loaded forklift. The way in which carts, pallets, and totes are carried by the forklift should be considered in sizing the doors as they may be carried with the largest dimension across the face of the truck.

On large refrigerated rooms, double door systems that create a vestibule or air seal between the cooled space and the interior of the plant are very effective. The first set of doors may be rubber flaps that will swing open as a vehicle is driven through them, while the second set of doors are the more conventional type with a positive seal. "Air screens" or "air curtains" are an effective means of creating this vestibule on relatively small doors. However, on doors over 10 feet high the screens are much less effective and where there is room, the vestible technique is probably the better system.

INSECT AND VERMIN CONTROL

8

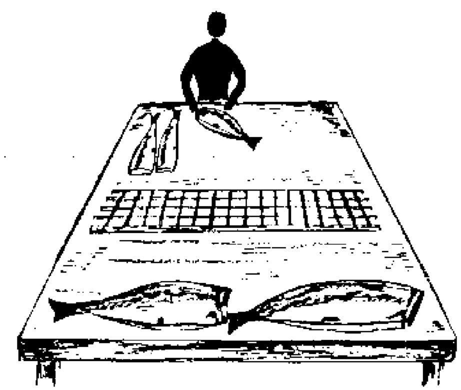
The processing plant must be insect- and vermin-proof. The first step is to select a site that discourages their habitation or infestation--e.g. a site without large open areas of stagnant water or piles of rubbish where insects and vermin can live or breed. A second step is to design a facility that will not permit entry by insects and vermin. This requires screens on all operable windows. Because screens must be closed and tight-fitting to be effective, in areas of very high traffic other means of control, like self-closers on the screens and doors or the vestibule technique described in the refrigeration discussion or air screens should be considered.

Ideally, all plumbing runs will be in a closed system, preventing vermin entry. Drains and water lines should have screens installed at any opening where vermin might enter the system. Where piping or conduit penetrates walls, care should be taken to seal the system so that vermin can not enter through walls into the processing areas.

A third step is to reduce the desire of the insect or vermin to enter a facility. This is accomplished primarily by good sanitation techniques. There should be no sources of food or water to attract vermin. As much of the product as possible should be covered or refrigerated. Storage areas should be neat, and the plant should be cleaned daily with recognized sanitizing chemicals and cleaning agents.

If insects should still get into the plant, a means of getting rid of them is required. Although not a cure-all, insectocutors are an effective means of killing and collecting flying insects once they have entered the plant. These units are most effective in darkened areas and should be placed so that the attraction spheres overlap. They must be cleaned out regularly. It is also essential to maintain a good rodent or crawling insect control program at all times.

All of these precautions, as well as any others available, must be used during the operation of a plant to guarantee a good product, free of possible embargo because of contamination.



ANCILLARY FUNCTIONS

9

The primary emphasis so far has been on the production areas of the plant. In planning future needs, it is necessary also to consider the supporting functions of the plant such as offices, lunchrooms, and restrooms. The supporting areas are a large percentage of the total facility in a small plant; however, this changes dramatically as the plant grows.

In planning the office area, various questions are relevant: Does the office need direct access to the processing room? Can visitors reach the office without passing through the processing areas? How many people will work in the office and what will they need in the way of equipment and storage in order to do their jobs? In preparing for the expansion of this area, storage as well as desk space needs to be included as this function will grow considerably faster than the number of personnel in the office. The office may be expanded or moved vertically as well as horizontally more easily than the processing areas. When expansion into the processing area is planned, it is essential to determine in advance where the displaced process is going and whether drainage systems will be affected. Acoustics may also be difficult to control if expansion into the processing area occurs without proper planning.

Employee facilities will also increase in size as the plant grows and more employees are hired. The lunchroom may not require a great deal more space if meals are eaten in shifts, but the restroom facilities must be increased proportionately. The number of fixtures required will vary from one building regulatory jurisdiction to another but should conform roughly to the figures in Table 2.

Table 2. Required plumbing fixtures

Fixtures	Number employees	Number fixtures required
Toilets[1]	1 - 9	1
	10 - 24	2
	25 - 49	3
	50 - 74	4
	75 - 100	5
Sinks	1 - 100	1 per 10 employees
	More than 100	1 per 15 employees
Showers[2]	15	1
Drinking fountains	75	1

[1]One urinal may be substituted for one toilet as long as there are no fewer than 2/3 the number of toilets required.

[2]Showers required only where there is excessive heat or skin contamination.

Another consideration in the employees' lounge is the storage of personal belongings such as purses, lunches, and clothing. Many plants have installed lockers to hold these items. These lockers, if enclosed, tend to become full of half-eaten lunches, dirty jackets and boots, and other sources of potential sanitation problems. Periodic locker checks or lockers with screen fronts will allow the management to control some of the collection of unsanitary items. The storage of work boots and aprons poses a somewhat different problem because they are usually wet, having just been washed. They are best stored near the processing area in a place where the moisture can be controlled. If possible, it is good to have a small room where there is heat and air circulation to help dry them out. This room should also be equipped with a washer and dryer if a laundry service is not contracted to furnish regular apron cleaning. If storage lockers are furnished, they should be installed above the floor for easy cleaning, and they should be rodent-proof.

If dressing and/or shower rooms are required, the chart above will serve to evaluate the number of showers needed. In the past OSHA has required a "quiet" room where women can lie down, usually placed in conjunction with the women's restroom. With the advent of women's liberation, this facility is no longer mandatory. However, it is still good practice to have an area where employees can get off their feet should they become injured or not feel well.

Plumbing should be located so that the addition of risers or extensions vertically can be done at minimal cost. It is less expensive to rough in all of the plumbing from the outset than to go back in and place it into an existing slab. In wood construction it is probably less important to install all of the plumbing initially if crawl spaces allow sufficient access. Plumbing runs for domestic use must be separated from the processing runs until they are clear of the building.

Regardless of the size of a plant, an area should be set aside for equipment repair and parts storage. As the equipment in any plant always seems to be in need of repairs and periodic maintenance, a workshop area is essential. Having a place to store the grease, oil, tools, paint, and spare parts helps locate them when needed and also helps to maintain a sanitary condition in the rest of the plant. Some separation is required by law and the area may be designed so that the equipment can be brought into the space for repairs, thereby not impeding the processing line. The storage of chemicals, insecticides, and processing materials should also be anticipated.

In most operations there will be a quality control facility. This will include an inspection of the product on the line, but in most cases will also require that products be tested away from the line where the conditions can be controlled with more precision. For example, in smoked-fish processing, tests must be run on the finished product to determine the moisture-phase salt. The area required should have a sink with hot and cold water, a balance scale, heat lamp, blender, hot plate or stove, etc. This process requires a minimum of eight-feet of counter and some storage space. To accommodate this, there should ideally be a separate area built for this purpose. Although much less desirable, in small operations it may be possible to place it in the employees' lunchroom, using it for a coffee and lunch counter when not in use as a testing space. This method is impractical when quality control testing is in process on a regular basis throughout the day.

This exercise should give a basis to evaluate the type of facility needed for specific requirements. These diagrams will be very useful to professional designers later, in evaluating various types of construction and building designs.

2e OPERATIONAL PROGRAMMING

The operational program of the plant has been alluded to in the earlier discussions of site selection and design philosophy. Once the decision has been made about what products to carry and how to process them, it is time to begin the design of the facility to house them.

One of the best techniques for developing a conceptual layout for a plant is to draw diagrams, representative of the various processing phases. The diagrams should be drawn roughly to scale and should include the various supporting functions i.e., office, storage, restrooms, mechanical spaces, etc. Different arrangements of these diagrams will help develop as many viable alternatives as possible. Each scheme should be evaluated with regard to product flow, access, mechanical service, and potential expandability. The diagrams should be read in the most general functional sense. The use of circles helps to decrease the inclination to read the spaces too literally. If the diagrams are interpreted too specifically too early in the process, it will hinder the ability to manipulate functions freely. Only after several viable alternatives have been explored can they be tested against the realities of equipment constraints. Often these constraints will make a scheme impractical; however, at other times, there will be simple ways to modify the equipment to meet a layout that might not have been investigated had a scaled version of existing equipment been used during conceptual design.

After several good layouts have emerged, it is time to begin scaling more accurate drawings to test them. At this point, the specific equipment and internal circulation of each function should be indicated, and physical constraints that will affect product flow and employee access should be noted. After this detailed study, the more general, function diagrams will help to reevaluate potential building configurations. Each arrangement should be evaluated against the site constraints like parking, receiving, site boundaries, utilities, and potential expansion. If a site has not yet been acquired, the internal relationships can help determine site characteristics necessary to meet building requirements.

2f BUILDING COSTS

Estimating the cost of equipment and buildings, which have not been specified in great detail, is very difficult. Even with a full set of architectural working drawings and specifications, a group of very competent professional contractors can vary in their construction bids by as much as 20%. However, there remains some need to project the potential project costs early in the planning process in order to evaluate the likely success of the proposed operation.

ESTIMATING METHODS

1 There are several methods of estimating construction costs. Generally, the easier the method is to apply, the less accurate the estimate. The two simplest methods are "multiple of area" and "multiple of volume." These methods usually do not include items such as site improvements, equipment, architectural fees, and land cost, and they are very dependent on the estimator's ability to compare past projects of similar quality and scale as a basis for his estimate. Because of this limitation, they are very crude estimating methods and should be used with great caution.

Another method is the "unit use" method. In this method the cost of the materials is estimated on a per unit basis. This method is not very useful in that it ignores the costs of placing the materials. For example, a foundation wall with many corners or a large curving section requires a great deal more complex form work system and thus labor that is not reflected directly in the quantity of materials.

A fourth method is the sum of the "in-place unit costs." This method includes not only the basic material cost and the costs of labor to install the material but also the cost of fasteners and the many incidental materials involved in the placement of the major materials. This method is relatively sophisticated and really only useful after the facility has been substantially designed and detailed. It is not a very useful method for estimating during the preliminary design phase and not particularly beneficial to other than a qualified estimator.

SIZES AND SHAPES

Larger buildings tend to cost less per unit than smaller buildings.

2

Compact buildings cost less per unit--i.e., minimum perimeters, as in cooler design, reduce construction and operating costs.

Buildings with unusually high ceilings cost less per cubic foot and more per square foot than buildings with standard height ceilings.

Second story spaces cost less per square foot than comparable areas on the first floor. This is due primarily to the existence of a floor structure, which eliminates the need for additional foundation, roofing, and flooring. Second floor spaces can be roughly estimated at three fourths the cost of an equal area on the first floor; and the cost of covered exterior space can be estimated at one half the cost of interior space.

TYPES OF CONSTRUCTION AND FINISHES OR MATERIALS

3

No estimate of project cost can be made without some assumptions about the type and quality of structure and finish materials. In most cases the designer is dependent on historical data from recent projects costs. Strange as this may seem, in the long run an enclosed structure finished for the sanitary handling of food will cost approximately the same, regardless of the structural materials. This assumes several things including the equal availability of all

products and skilled labor (see section 2a Design Philosophy). This debatable rule of thumb can be blown completely astray by any one of hundreds of factors, including any of those outlined here:

(1) The availability of skilled labor
(2) The ability of the owner to reduce construction costs by furnishing some labor
(3) The length of time available to erect a building
(4) Available financing, fire insurance, and other long-term costs related to construction type
(5) The availability and costs of transporting building products to the site.

Each of these variables must be evaluated in each particular case and therefore make it dangerous to generalize construction costs here.

BID CONSIDERATIONS

4

Place: In remote areas contractor availability may be limited, thus decreasing the amount of competition for the contract. Remote areas may also cost the contractor in transportation and housing. Regional differences in cost of raw products may substantially influence the bid costs.

Time: Cold weather construction often costs the contractor time and may increase bids by about 10%. For example, the contractor faces increased costs to pump concrete to inaccessible foundation forms because of mud or whatever and the cost of time for curing periods and drying times between various applications of materials.

On the other side of the winter construction issue is the possible lowering of a bid to carry a good crew through the traditionally slow building months of winter. If a large contractor has a great deal of overhead in men or equipment, he may attempt to maintain jobs through the winter to meet his financial obligations and hold the men. The smaller contractor, on the other hand, may drop his crew to a minimum and simply do the work himself, avoiding subcontractors where possible. There are also seasonal price trends for raw materials. Lumber prices are such a substantial percentage of the project cost that they have a tremendous effect on the total project cost. Traditionally, lumber prices start to climb in the spring, peak in June or July, and begin a small decline through the rest of the year, then jump again in March or April. By judicious planning the project cost may be substantially affected by these trends.

it is essential to keep these limitations in mind in considering the following guidelines. The figures are intended to be illustrative of a method of projecting costs and are based on the best information available at the present time.

COST-ESTIMATING EXAMPLE 1974 - 1975

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Project costs involve much more than the direct cost of building and land. The total costs of the project must also include the cost of site improvements, planning costs, and the cost of using borrowed money. The following outline is an illustration of a project cost projection process intended to be indicative of the kind of considerations that might be given, during the planning phase of a project, to reevaluate the design assumptions developed during the functional programming against price constraints.

1. Land Cost ________
2. Site development ________
   a. demolition ________
   b. clearing ________
   c. excavation ________
   d. fill ________
   e. utilities ________
   f. well and pumphouse ________
   g. drainage, septic tank, etc. ________
   h. roadways and parking ________
   i. dredging, docks, bulkheads ________
3. Building construction ________
   a. first floor ________
   b. second floor finished ________
   c. second floor unfinished ________
   d. overhangs, decks, etc. ________
   e. coolers ________
   f. freezers ________
4. Equipment ________
5. Planning costs ________
   a. permits and filing ________
   b. legal services ________
   c. design and engineering ________
   d. surveys, soil tests, etc. ________
6. Financing ________
   a. interim financing ________
   b. placement fee ________

TOTAL ________

The following example for a proposed small-scale salmon processing facility will demonstrate how a projection of costs might be developed.

A prospective processor has evaluated his raw product supply and established a market for his fresh product. He has also found a limited interest in smoked and canned products and feels that he can increase that market through distribution to the East Coast.

After viewing as many operations of similar size and function as possible, he then develops a product flow diagram similar to that in Fig. 1, p. 7. He anticipates receiving approximately 40-60,000 pounds of salmon per day and wants to evaluate the potential costs of setting up various processing operations: a) fresh product only, b) fresh product plus some canning, c) fresh and smoked product, d) fresh, smoked, and canned product. To evaluate the space needs of each of these alternatives, the processor draws several alternative plans based on his processing assumptions.

A table of building component cost is developed from rough construction cost data of projects built in the last few years of similar scale and character.

Table 3. Comparative Building Costs*

	1973	1974	1975	1976	1977
Architectural	$ 12.65	$ 14.50	$ 15.85	$ 17.10	$ 18.30
Structural	7.55	8.70	9.45	10.20	10.93
Electrical	4.40	5.05	5.50	5.95	6.35
Plumbing	2.95	3.40	3.70	4.00	4.25
Heating, Vent.	2.80	3.20	3.50	3.75	4.05
Air Conditioning	30.35	34.85	38.00	41.00	43.90
Refrigeration	49.85	57.25	62.45	68.05	72.85
TOTAL	$ 110.55	$ 126.95	$ 138.45	$ 150.05	$ 160.63

*Estimated rate of inflation 1974 - 14.9%; 1975 - 9.0%; 1976 - 8.0%; 1977 - 7.0%.

Using these crude tools, the author made cost estimates for constructing processing lines for: fresh product only; fresh and canned product; fresh and smoked product; fresh, canned and smoked product.

See Tables 4-7, pp. 42-45.

Table 4. FRESH PRODUCT ONLY (E X A M P L E)

(1)	Land cost				$ 30,000
(2)	Site development	3,300 sq. ft.	@ $ 3		9,900
(3)	Building costs				
	processing area	1,000 sq. ft.	@ $41	$41,000	
	packaging area	300	@ 41	12,300	
	office and employee	500	@ 32	16,000	
	storage	300	@ 21	6,300	
	service, mechanical	200	@ 21	4,200	
	dock area	500	@ 21	10,500	
				$90,300	
	sharp freezer	250	@ $85	$21,250	
	holding freezer	500	@ 80	40,000	
	holding cooler	500	@ 65	32,500	
				$93,750	
	Total building costs				184,050
(4)	Equipment				
	platform scale			$ 3,000	
	hanging scale			550	
	fork lift			5,500	
	electric hoist			600	
	glaze tank			250	
	ice machine			3,500	
	cutting tables			3,000	
	sinks, miscellaneous tables			3,000	
	carts			2,500	
	waste containers			350	
	cleaning equipment			1,000	
	packaging equipment			1,500	
	miscellaneous knives, aprons, etc.			1,500	
				$36,250	
	screening system			$ 4,500	
	office supplies			2,500	
				$ 7,000	
	Total equipment costs				43,250
(5)	Planning costs				
	permits and filing	$184,050 x .01		$ 1,840	
	legal services	184,050 x .01		1,840	
	design and engineering	184,050 x .08		14,724	
	survey			1,000	
	Total planning costs				19,404
(6)	Financing				
	site development	$ 9,900			
	building costs	184,050			
	equipment	43,250			
	planning costs	19,404			
	6 mos. interim at 14%	$256,604 x .14 x .50		$17,962	
	placement fee	$256,604 x .025		6,415	
	Total financing costs				24,377
	TOTAL PROJECT COST				$310,981

Table 5. FRESH AND CANNED PRODUCT (E X A M P L E)

(1)	Land cost				$ 30,000
(2)	Site development	3,300 sq. ft.	@ $ 3		9,900
(3)	Building costs				
	processing area	1,000 sq. ft.	@ $41	$ 41,000	
	packaging area	300	@ 41	[illegible]	
	can line	500	@ 41	20,500	
	controlled inventory storage	300	@ 21	6,300	
	office and employee	500	@ 32	16,000	
	[illegible]	300	@ 21	6,300	
	[illegible]	[illegible]	@ [illegible]	[illegible]	
	service, mechanical	200	@ 21	4,200	
	dock area	500	@ 21	10,500	
				$129,700	
	sharp freezer	250	@ $85	$ 21,250	
	holding freezer	500	@ 80	40,000	
	holding cooler	500	@ 65	32,500	
				$ 93,750	
	Total building costs				223,450
(4)	Equipment				
	fresh processing			$ 43,250	
	retorts	2	@ $ 850	1,700	
	retort controls	2	@ 1,000	2,000	
	seamer			4,800	
	boiler			7,000	
	Total equipment costs				58,750
(5)	Planning costs				
	permits and filing	$223,240 x .01		$ 2,234	
	legal services	223,450 x .01		2,234	
	design and engineering	223,450 x .08		17,876	
	survey			1,000	
	Total planning costs				23,344
(6)	Financing				
	site development	$ 9,900			
	building costs	223,450			
	equipment	58,750			
	planning costs	23,344			
	6 mos. interim at 14%	$315,444 x .14 x .50		$ 22,08	
	placement	$315,444 x .025		7,886	
	Total financing costs				29,967
	TOTAL PROJECT COST				$375,411

Table 6. FRESH AND SMOKED (EXAMPLE)

(1)	Land cost				$ 30,000
(2)	Site development	3,300 sq. ft.	@ $ 3		9,900
(3)	Building costs				
	processing area	1,000 sq. ft.	@ $41	$ 41,000	
	packaging area	300	@ 41	12,300	
	office and employee	500	@ 32	16,000	
	smoking line	300	@ 41	12,300	
	storage	300	@ 21	6,300	
	dock area	500	@ [illegible]	[illegible]	
	service, mechanical	[illegible]	@ [illegible]	[illegible]	
				$102,600	
	sharp freezer	250	@ $85	$ 21,250	
	holding freezer	500	@ 80	40,000	
	holding cooler	500	@ 65	32,500	
	post-smoke cooler	100	@ 65	6,500	
				$100,250	
	Total building costs				202,850
(4)	Equipment				
	fresh processing			$ 43,250	
	smoke-house with controls			12,000	
	racks			2,000	
	brine tank with mixer			500	
	smoke generator			1,500	
	test equipment			500	
	Total equipment costs				59,750
(5)	Planning costs				
	permits and filing	$202,850 x .01		$ 2,028	
	legal services	202,850 x .01		2,028	
	design and engineering	202,850 x .08		16,228	
	survey			1,000	
	Total planning costs				21,284
(6)	Financing				
	site development	$ 9,900			
	building costs	202,850			
	equipment	59,750			
	planning costs	21,284			
	6 mos. interim at 14%	$293,784 x .14 x .50		$ 20,564	
	placement	$293,784 x .025		7,344	
	Total financing costs				27,908
	TOTAL PROJECT COST				$351,692

Table 7. FRESH, CANNED AND SMOKED PRODUCT (EXAMPLE)

(1)	Land cost				$ [illegible]
(2)	Site development	3,300 sq. ft.	@ $ 3		9,900
(3)	Building costs				
	processing area	1,000 sq. ft.	@ $4[illegible]	$ 4[illegible],000	
	can line	500	@ 41	20,500	
	smoking line	300	@ 41	12,300	
	canned inventory	300	@ 41	12,300	
	can storage	600	@ 21	12,600	
	[illegible]	[illegible]	@ [illegible]	[illegible]	
	[illegible]	500	@ [illegible]	[illegible]	
	[illegible]	500	@ 21	[illegible]	
	service, mechanical	200	@ 21	4,200	
	packaging area	300	@ 41	12,300	
				$1[illegible],000	
	sharp freezer	250	@ $85	$ 21,250	
	holding freezer	500	@ 80	40,000	
	holding cooler	500	@ 65	32,500	
	post-smoke cooler	100	@ 65	6,500	
				$100,250	
	Total building costs				248,250
(4)	Equipment				
	fresh, Table 4 (4)			$ 43,250	
	canned, Table 5 (4)			15,500	
	smoked, Table 6 (4)			16,500	
	Total equipment costs				75,250
(5)	Planning costs				
	permits and filing	$248,250 x .01		$ 2,482	
	legal services	248,250 x .01		2,482	
	design and engineering	248,250 x .08		19,860	
	survey			1,000	
	Total planning costs				25,824
(6)	Financing				
	site development	$ 9,900			
	building costs	248,250			
	equipment	75,250			
	planning costs	25,824			
	6 mos. interim at 14%	$359,224 x .14 x .50		$ 25,145	
	placement	$359,224 x .025		8,980	
	Total financing costs				34,125
	TOTAL PROJECT COST				$423,349

The costs related to capital construction must finally be viewed in light of the projected operating costs to determine the prospective processor's ability to amortize his investment.

It should be reemphasized that these price projections are very crude and may not reflect the actual costs of the future operation. However, having gone through this planning process, regardless of its accuracy, the prospective processor will have developed a much better understanding of his project and the process he must ultimately go through to determine the potential for a successful seafood processing design.

SUMMARY

Although there are many variables in preparing new facilities, the procedure outlined in this book should enable the prospective processor to develop some understanding of the physical aspects of his proposed project. With the use of both the information generated by the processor through this exercise and also the information generated by any professionals consulted, the project should be well along its way to becoming a successful venture.

This physical information should serve as a sound base from which to formulate financial projections. These, in turn, will prepare the processor to seek financing or to manipulate portions of his proposal to reflect the type of operation he desires.

The planning process is a cyclical process, and the product of this process should be adjusted and refined until the best possible representation of the intended project is achieved. This product should be regarded as a working tool that will respond to any changes caused by new information throughout implementation of the proposal. Making a change on paper is, obviously, easier and cheaper than making a change to a physical reality cast in concrete.

The exercise described in this book is specifically devised to organize this process of evaluation and should not be considered a final solution. It is, rather, a beginning. And with that final word, we wish you good luck!