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ENERGY CONSERVATION IN THE MEAT INDUSTRY

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INTRODUCTION

One of the earliest research efforts concerned with the hot boning of beef was by Ramsbottom and Strandine (1949) and gave impetus to the further research that followed [1]. The work at Oklahoma State University began in 1966 and has continued since that date. In 1976, funds were obtained from the U.S. Department of Energy (DOE) to conduct a comprehensive examination of the effects of the hot boning of beef processing industry. The study concerned itself with only beef processing in the U.S. and distribution of beef to the retailer. The primary concern of DOE was related to the potential energy savings resulting if the beef processing industry adopted hot boning industry-wide. The analysis involved many considerations such as neat quality, yield, marketability, labor costs, equipment and plant requirements, etc., as well as energy factors. One specific and interesting part of the study was determine a procedure and its effect for electrically stimulating beef carcasses. The electrical stimulation proved to have a desirable effect on meat quality. The total study lasted three years in time and had many aspects, but this particular paper is limited to a consideration of hot boning as related to product processing and handling and its effect on plant and equipment. Also, consideration is given to the distribution of the product subsequent to its processing.

As a general overview of the major findings of the research, a summary of results is given as follows:

1. Hot boning showed a 2% higher yield of total meat with an average of 62.4% of the carcass weight.
2. Cooler space would be reduced by 80%.
3. Heat energy required to cool the meat was approximately 68% less.
4. The ratail value per side was increased by $ 17.00 per side.

5. Electrical stimulation was shown to be an effective way to speed glycolysis.

6. Electrical stimulation and hot boning should be used together for graded beef.

7. A square wave pulse of 300 volts with a frequency of 400 cycles per second and a duration of 5 milliseconds for 60 seconds was adequate to reduce the pH and ATP.

8. Shear force measurement confirmed the meat to be tender. Stimulated steaks were more tender than unstimulated.

9. Taste panel preference tests noted the stimulated steaks to be preferred to those unstimulated.

10. Percent cooking loss was less for stimulated steaks.

11. Electrical stimulation and hot boning within 2 hours *post-mortem* provided beef of acceptable tenderness.

12. Hot boned meat was darker in color but on holding provided a brighter colored product.

13. Electrical stimulation permitted the muscle to firm more rapidly thus causing marbling to be evident.

14. Electrical stimulation permitted hot boning within one hour after death.

15. Electrical stimulation and hot boning enhanced retail shelf life.

16. Microbial levels of hot boned meat are lower than in cold boned life.

For a copy of the final report, contact the author of this paper at, Oklahoma State University, Stillwater, Oklahoma, 74078, U.S.A.

Since energy savings were a major consideration in the investigation and are important factors in the design of processing plants, the study results concerning energy are summarized in the following section.

REFRIGERATION ENERGY — HOT VS. COLD PROCESSING

Traditional meat cooling facilities and processes are characterized by long cooling times, inefficient use of space and low equipment efficiency. Available methods for calculating cooling loads and equipment design are handbook oriented and generally poor. It became evident at an early stage during the course of this project that more sophisticated equipment and design procedures would be necessary to take advantage of the benefits of the hot boning method of beef processing.

Conventional chill rooms with hanging carcasses are inefficient in terms of cooling time and cost because the meat is more or less soaking in cold air. Air is a poor heat transfer medium, therefore, heat is slow to transfer from the meat to the air. In order to improve this process, the air temperature is lowered as much as possible and air circulation in the cooler is increased by blasting air into the space. Both of these things lead to high cost operation (low refrigeration efficiency and high fan power). To avoid these conditions, it seemed prudent to develop a cooler which would improve refrigeration efficiency and reduce fan power. Since the hot boned beef is in relatively small pieces and easy to handle, the possibility of a steady flow of meat through some kind of cooler is feasible. This also permits control of the cooling medium (air or possibly a liquid) so that the heat transfer rate can be enhanced. With these things in mind, a counterflow conveyorized cooler was conceived which is quite similar to a counterflow heat exchanger in theory. The cooler can be visualized as a rectangular duct with a conveyor belt travelling along the longitudinal centerline carrying the meat while air flows in the duct in the opposite direction. A conventional refrigeration system cools the air and a blower circulates the air through the duct. The schematic of this final system is shown as Fig. 1.

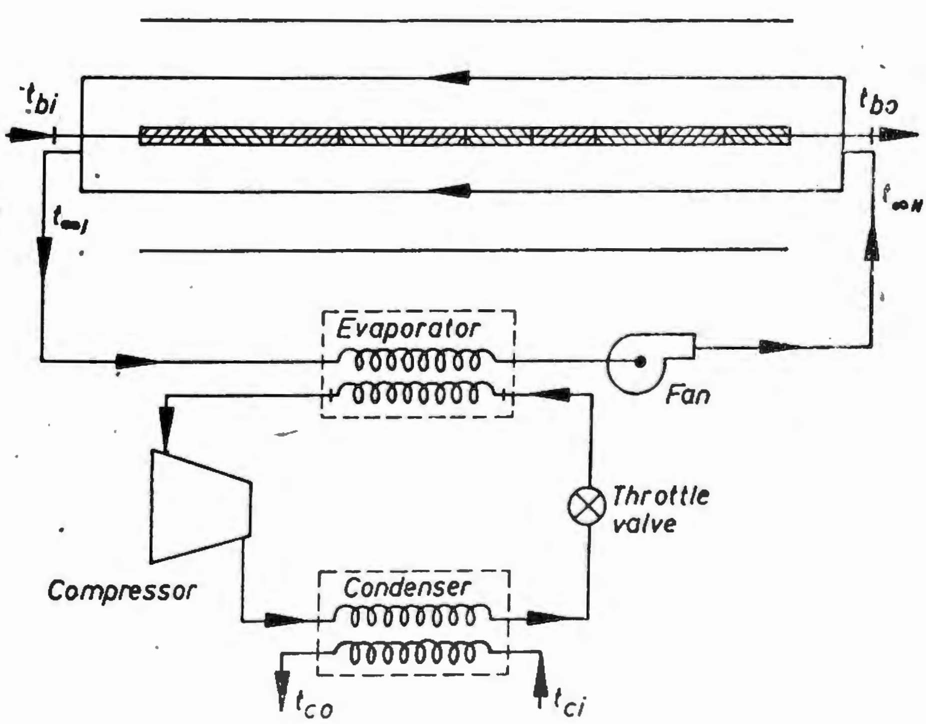

Fig. 1. Schematic of the final system

In a conventional cooler room, the heat transfer process is controlled by heat transfer from the meat surface to the air and the fact that the heat must be transferred from the center of the carcass to the surface by conduction is of little consequence. However, in the case of the conveyorized cooler, the whole process is speeded up to the point where heat conduction in the meat becomes the controlling factor. There is little or no data in the literature for this situation, therefore, a completely new modelling procedure was developed to handle this process. To take full advantage of the benefits of this type of cooling process, it is necessary to optimize the system. That is, for a given situation a particular grouping of components will result in minimum energy consumption. The model was developed so that the optimum may be determined. The model uses actual refrigeration equipment characteristics in conjunction with the new heat transfer theory. The model is practically independent of the actual size of the system.

Results obtained from the modelling program show that cooling time to reduce the average meat temperature from 100 degrees Fahrenheit to 40 degrees Fahrenheit can be reduced from 24 hours to 4 hours or less. By bagging the product moisture removal is all but eliminated. For a typical example involving 520 carcasses, the conveyor cooling system showed a 68 percent reduction in energy based on conventional cooling methods. Peak power demand was also reduced about 30 percent. The reduction in required energy is due to the following factors:

1. About 30 percent of the reduction is due to reduction in mass (fat and bone).
2. There is nearly a 90 percent reduction in fan power.
3. Higher cooling air temperatures may be used which increases refrigeration efficiency.
4. Only about 1/3 the building space is required for the cooling system.

Another important benefit of the cooling process is in reduction of inventory. It is common practice for carcasses to hang in the cooler and holding cooler for 48 hours. Using the conveyorized cooler the product may be cooled, boxed and shipped well within 12 hours time.

Complete details of the modelling, analysis, results, and examples are given in the final report.

MEAT PROCESSING PLANT DESIGN AND LAYOUT RETROFIT

The benefits offered by the hot processing of bovine are available only if the process can be adopted and implemented. The decision to convert to the new procedure requires careful analysis by management of relevant factors as they affect their individual firms. There appears to be sufficient evidence from this research to cause management to give serious consideration to the desirability of hot processing. The benefits to be gained include reduced energy more effective use of existing plant space, a more favorable internal rate of return on investment, and increased yields. However, in order to obtain these benefits, capital funds are required, i.e. and investment cost is involved and temporary problems of process changes are inherent anytime altered operating procedures are introduced into a system. However, the benefits appear to be worth the temporary disadvantages.

PLANT LAYOUT AND DESIGN

The meat industry is greatly concerned with economical processing of bovine. This concern is first and foremost in that survival of the individual firms is at stake. Thus, management will give first consideration to the economic impact resulting from the use of hot boning as a processing alternative. Due to the variability of conductions in processing methods, equipment utilized, etc., the only feasible approach to making cost comparison is to compare plants where processing conditions can be controlled. This desired end was accomplished by developing cost data for three sets of conditions: 1) cost for conventional cold processing, 2) cost for hot processing, new plant, and 3) cost for hot processing, retrofitted plant (conversion from cold to hot boning). In addition, comparisons were made for two levels of throughput — 100 bovine per day and 150 bovine per day. Realistic costs were obtained from an industrial construction and processing equipment firm which has an excellent reputation in the meat processing industry. The data base for costs were from actual plants that were constructed and equipped in the year 1978. Thus data are as current as possible, although it is recognized that inflation has affected 1979 cost figures upward. Likewise, plant equipment and retrofit costs are 1978 figures. Not all costs were included in the economic analysis. For example land, site preparation, etc., were not included because such factors are equal regardless of processing methods. Neither were kill floor costs since hot boning and cold boning procedures, equipment building requirements, and energy consumption are identical. The comparisons did include the following cost factors for each individual plant and its particular processing method.

Total building cost
Process room area
Chill room area
Freezer area
Chill tunnel area
Other area
Building retrofit costs
Refrigeration systems cost
Processing equipment costs
Electric power
Labor
Working capital

The intent was to make cash flow comparisons that made realistic evaluations possible. The cash flow model is deterministic *). There are

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*) Should the reader desire to obtain a copy of the CASHFLO computer program, contact the School of Industrial Engineering and Management, Oklahoma State University, Stillwater, Oklahoma 74078.

many other economic models useful for making comparisons that are equivalent to the one utilized in this analysis.

In this example, input information is believed to be close to reality; nevertheless, the accuracy of the data might still be questionable. There are 18 departments considered in this hypothetical plant with estimated area requirements relative to each. These departments and their area requirements are:

Department	Description	Area requirement (square ft)
1	Knocking and bleeding	340
2	Hide removal	410
3	Carcass splitting-inspection washing	540
4	Holding area	300
5	Hot boning	360
6	Packaging	350
7	Chilling	900
8	Processing	840
9	Packaging and boxing	770
10	Finished product cooler	550
11	Shipping	320
12	Dry storage	350
13	Freezer storage	720
14	Shipping office	80
15	Offal room	790
16	Utility area	390
17	Office	530
18	Comfort rooms	110

A single story building with a total area of 9,000 sq. ft. and 36 10 ft. by 25 10 ft. in size is considered for this plant. Also, approximately 350 sq. ft. of floor space is to be reserved for expansion.

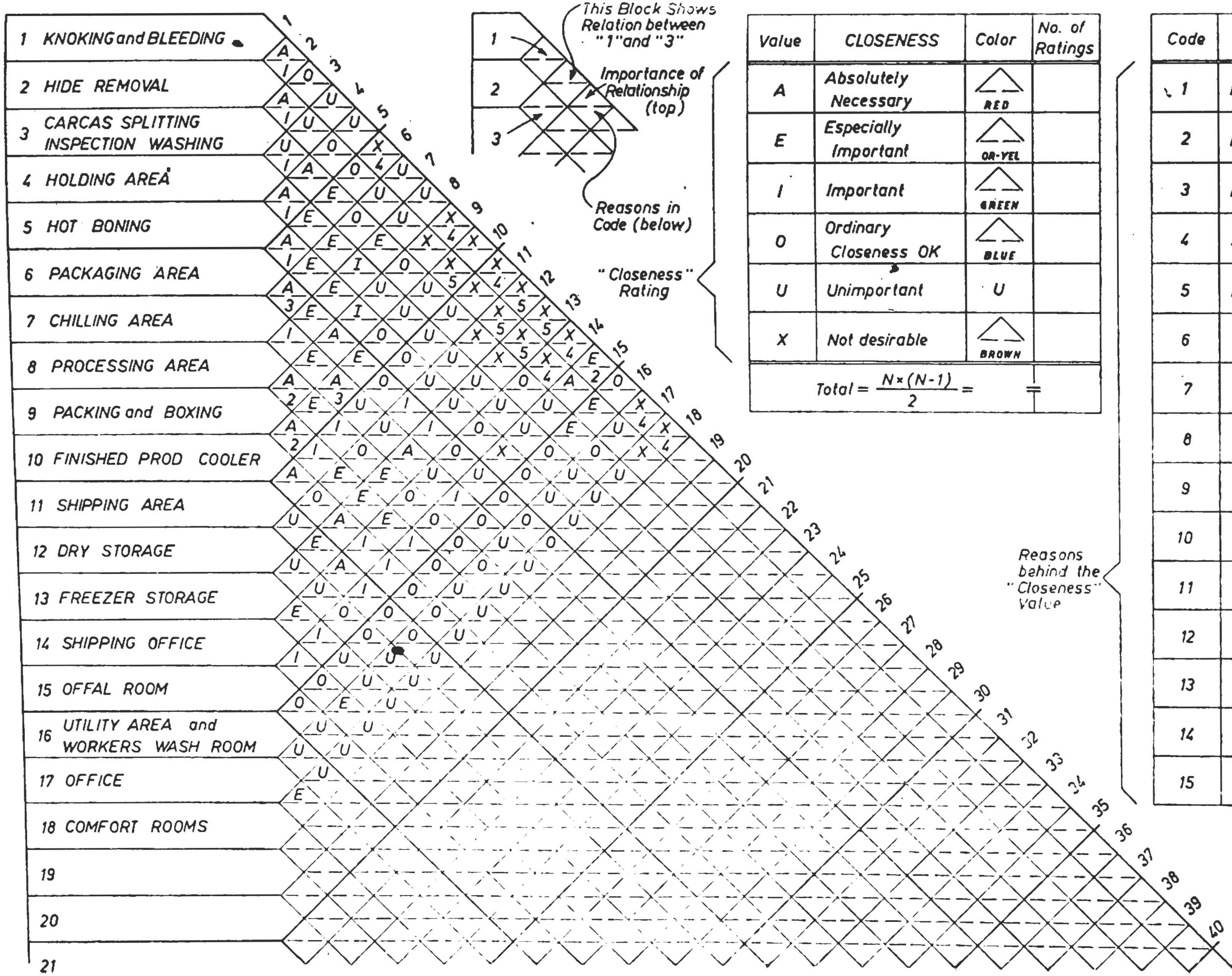
The departmental relationship chart (REL Chart) is illustrated in Fig. 2.

Twenty layouts were generated and among them the three acceptable layouts were generated. Every digit printed represents 10 square feet of floor area, and the numbers indicate the department codes. Only one of the acceptable layouts is included herein as Fig. 3.

IMPORTANT CONSIDERATIONS

A close look at the proposed layouts indicates the fact that computerized layout programs are only aids and not the final answer to layout problems. The program frequently fails to honor some desired relations-

Source-Reference ____________ Date ____________ Charted by ____________



Value	CLOSENESS	Color	No. of Ratings
A	Absolutely Necessary	RED	
E	Especially Important	OR-YEL	
I	Important	GREEN	
O	Ordinary Closeness OK	BLUE	
U	Unimportant	U	
X	Not desirable	BROWN	
Total = $\frac{N \times (N-1)}{2}$ =			

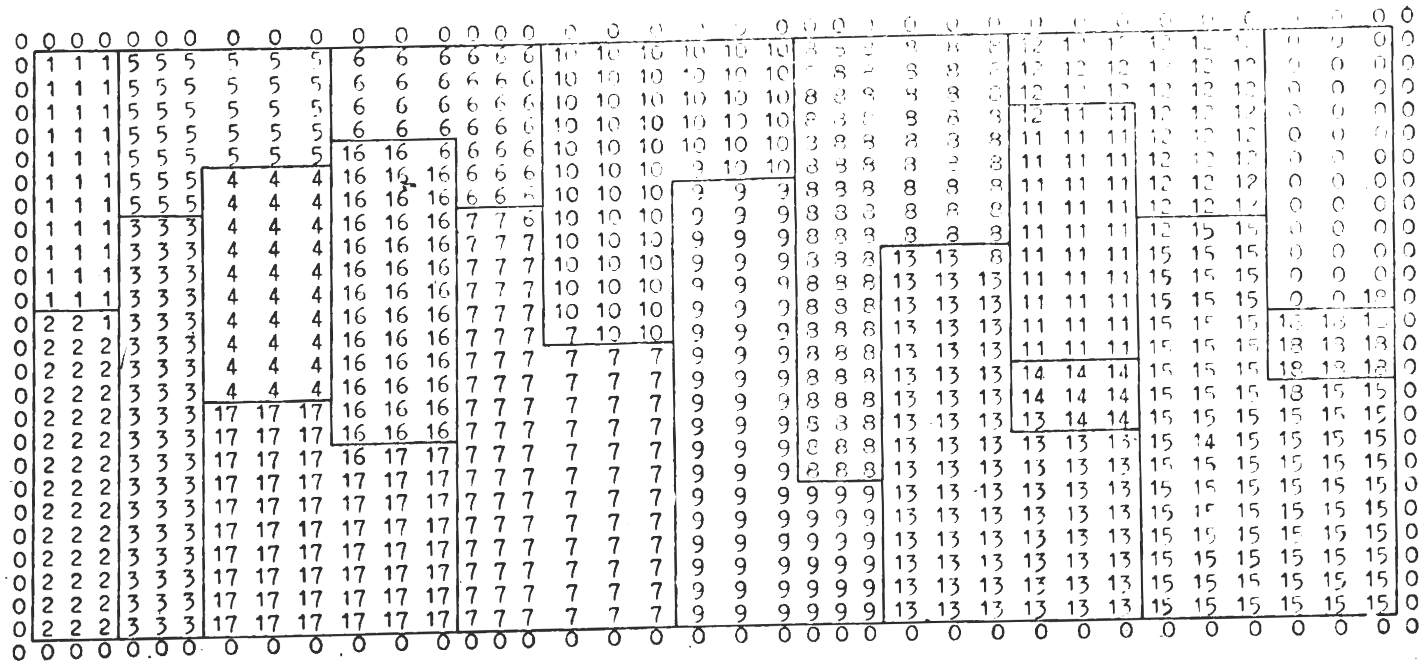
Code	REASON
1	Processing Sequence
2	Material Handling
3	Refrogeration Eff.
4	Sanitation
5	Humidity
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Fig. 2. REL chart for example layout

TRIAL LAYOUT ' 1A SCORE = 1552

0 0
0 0

TOP FLOOR



GRUND FLOOR

0 0
0 0

UNDER TASSIGN IN TERRACE LEVEL BUILDING = ' NUMBER OF SQUARES AVAILABLE INE FOLLOWING NECESSARY CLOSE RELATIONSHIPS

112	125	120	123
116	119	121	120
117	123	123	117
119	116	123	120
120	121	125	112

Fig. 3. Trial layout

hip during any given computer run. These relationship often can be honored when solutions are modified manually. Manual adjustments are usually needed before arriving at a practical layout. The computer only gives "food for thought" which the analyst must adjust and modify into workable layout plan.

It should be considered that the layout with highest score is not always the ideal. As a matter of fact, it might not be feasible if some particular properties are desired. As an example, consider Fig. 3 which has a high score, but department number four is surrounded by other departments. This might not be feasible if the flow of incoming materials is to be considered.

Manual adjustments are frequently necessary to modify the shape of departments. Since department adjacency is a very important factor in tabulating the total score, computerized layouts can have very irregularly shaped departments. Such configurations tend to be impractical from an operational viewpoint, as well as expensive to construct if walls are to be used to separate departments.

Thus, management must always consider its unique needs to develop the best possible layout for its specific purposes.

PROCESSING ALTERNATIVES—BUILDING, EQUIPMENT AND ENERGY COMPARISONS

Building and equipment costs were determined for two sizes of plants (100 head and 150 head per day) in order to realistically compare alternative processing decisions. A total of seven processing alternatives for each of the two plant capacity levels were developed for economic comparisons. The costs are based on two actual plants built during the fall of 1978. These costs are presented in Table 1.

Table 1. Capital costs

	100 Head/Day		150 Head/Day	
	Building Cost $	Equipment Cost $	Building Cost $	Equipment Cost $
Conventional Cold Boning, New Plant	315,700	225,488	696,385	272,765
Hot Boning Blast Freezer, New Plant	231,978	205,179	579,125	242,301
Hot Boning Blast Freezer, Retrofit	190,634	172,643	272,240	206,590
Hot Boning Tunnel, New Plant, Waste Heat	238,292	293,179	577,895	372,801
Hot Boning Tunnel, New Plant, No Waste Heat	238,292	290,179	577,895	369,801
Hot Boning Tunnel, Retrofit, Waste Heat	190,634	212,143	272,240	264,340
Hot Boning Tunnel, Retrofit, No Waste Heat	190,634	209,143	272,240	261,340

The cost given for retrofit is the new construction and remodelling necessary for hot boning. After retrofit, some floor space in the old chill room is not utilized, however no value is assigned to this extra space. Also included in the retrofit analysis is 50% of the original, conventional cold boning plant cost which is depreciated over a ten year period.

CASHFLO PROGRAM

The economic analysis was accomplished using the computer program CASHFLO, a deterministic, aggregate effect, after tax economic evaluation program used to analyze financial projects expressed as a set of capitalized items, working capital, incomes and expanses.

Output form CASHFLO consists of a net present worth at a specified, minimum, attractive rate of return (15% was used for this analysis), an internal rate of return for the aggregate at the inputted transactions, and a cash flow diagram for each year's after tax cash flow.

PROGRAM ASSUMPTIONS

CASHFLO assumes the input is dealing with an additional project being considered by a profitable corporation. Therefore, an ordinary income tax is assumed at a 48% rate, investment tax credit at a 10% rate (maximum), and capital gains at a 30% tax rate.

Double declining balance method of depreciation is used for all capitalized items with a switch to straight line depreciation whenever DDB depreciation is less than straight line. A salvage value of zero and a life of 20 years are assumed in all cases, except an original building that is retrofitted.

Electricity is the only form of energy considered with the exception of waste heat from rendering process. Its cost is assumed to be 3.4 ¢/KWH and increasing at a rate of 5% per year.

For ease of interpreting the output, a constant income of $ 200,000 per year was included in the analysis to avoid negative taxes, etc.

CASES CONSIDERED

The following cases were considered for both the 100 head per day and 150 head per day plant size:

1. Conventional cold boning process, new plant.
2. Blast freezer method
   a) new plant,
   b) retrofit of conventional plant

3. Tunnel chilling method
   a) new plant,
   — waste heat available from rendering,
   — electric shrink tunnel,
   b) retrofit of conventional plant,
   — waste heat available from rendering,
   — electric shrink tunnel.

The results of the economic comparisons are in Table 2. The data indicate a favorable position for hot boning with tunnel chilling being the more favorable. It is believed the analysis is representative of economic conditions in the real world. However, as is always the case, individual plants must develop specific cost comparisons for their own situation.

Table 2. Results of CASHFLO analysis

	100 Head/Day		150 Head/Day	
	PW[1]	IRR[2]	PW	IRR
Cold Boning, New Plant	$ 182,449	20.861%	-$ 184,851	11.448%
Hot, New, Blast Freezer	$ 175,869	22.714%	-$ 198,813	9.978%
Hot, New, Tunnel, Waste Heat	$ 348,033	27.373%	$ 119,324	17.477%
Hot, New, Tunnel, No Waste Heat	$ 345,789	27.371%	$ 115,886	17.459%
Hot, Retrofit, Blast Freezer	$ 118,667	19.512%	-$ 117,003	10.399%
Hot, Retrofit, Tunnel, Waste Heat	$ 330,127	26.198%	$ 191,345	19.333%
Hot, Retrofit, Tunnel, No Waste Heat	$ 327,796	26.206%	$ 111,574	17.343%

LABOR REQUIREMENTS — COLD VS. HOT BONING

Labor costs are the largest single budget item in the meat processing industry. According to U.S.D.A. statistics, labor costs account for 40% of the share of marketing spread. Thus, the altering of meat processing must take into account the effects on labor costs as a primary consideration. Otherwise, industry adoption of hot boning techniques will be impede. Therefore, careful analysis of effects on labor costs are to be considered.

The ability to compare labor requirements accurately is never an easy goal to reach. Variations in methods, equipment, animals, local practices, etc., are factors that must be taken into account when comparing labor requirements. Four different meat processing facilities were studied in the effort that was made to make the necessary labor requirement comparisons. Since there was only one plant in the U.S. which was hot boning bovine on a production basis, this plant provided the data base for hot boning. The data was acceptable and accurate. In order to have a comparable base for cold boning it was finally determined that the O.S.U. Meat Laboratory would be the data base for cold boning. Operators who were skilled but who do not normally function under production type conditions were used. In this respect the conditions were deemed undesirable. This condition was dealt with by video taping cold boning operations at the O.S.U. laboratory that were as close to the industrial hot boning production activity as was possible. The video tapes were then taken to Oklahoma City where experienced industrial engineers viewed them, performed performance rating and assisted in the development of cold boning time standards. Attempts to use standard time study data available in the cold boning operations were deemed to be unsuitable and could not be utilized. Both sets of data, hot and cold boning, were analyzed and prepared suitable for comparing labor requirements. The data resulting from the analysis is shown in Table 3.

In addition to the station by station comparison, it was possible to obtain macro production cold boning work measurement data from an operating plant that was suitable. The cold boning data are as follows in Table 4.

Table 3. Labor comparison — hot vs. cold boning

Station Number	Hot Boning Standard Times	Cold Boning Standard Times
1	.90	.562*)
2	1.015	1.044
3	2.168 (2 operators)	2.113 (2 operators)
4	1.499	1.453
5	1.407	1.418
6	1.307	1.227
7	1.327	1.300
8	1.293	1.300
9	1.201	1.220
10	1.192	1.198
11	1.212	1.169
12	1.191**)	0.0
13	1.403**)	0.0
14	1.279	1.317
	15.800 min/side	15.321 min/side

*) Time reduced for elements not included in cold boning time study.
**) Not included in total time due to steps not being a part of cold boning.

Table 4. Labor data — cold boning

Hindquarter — Full Loin	2.640 minutes
Hindquarter — Rump	2.195 minutes
Forequarter	10.184 minutes
	15.019 minutes/side

Thus, a labor comparison of one hot boning operation can be made with two cold boning operations performing the same tasks. This comparison is shown in Table 5. In all cases the labor requirements were well within the ±5% accuracy limits accepted by industrial engineers in such cases and statistically acceptable. The hot boning production standard is used as the basis for comparison. From these data it is concluded that labor requirements for hot and cold boning are equivalent. Labor costs are greater only for the case of cooling hot boned beef in conventional chill rooms. This process requires extra labor in that handling of meat into and out of basket containers for chilling. Maximum benefits result from tunneling chilling.

Table 5. Macro labor comparison for beef sides

Hot boning	Cold boning — O.S.U	Cold boning — production plant
15.800 min/side	15.321 min/side	15.019 min/side

Note: All labor data is given in man-minutes of work.

MEAT DISTRIBUTION FINDINGS AS RELATED TO HOT BONING

The main purpose of this study is to evaluate the effect of adopting the hot boning technique on the U.S. beef industry in terms of its effect on the dollar costs and energy requirements, and on the optimum beef distribution system. The adoption of hot boning will affect both the processing and distribution system for the beef industry.

There were six separate models developed in this study. The first three deal with interregional distribution and the last three include both intra and interregional distribution. About 50% of the annual beef consumption of the United States is consumed outside the region in which it is produced. Since interregional beef shipments are transported over greater distances than most intraregional shipments, the former account for more than 70% of the total beef shipment costs for the United States.

In general, the major findings form the study can be outlined as follows:

1. For the U.S. beef industry, though total processing costs are greater than distribution costs, the adoption of the hot boning technique will have a greater absolute impact on the latter. Using 1976 as an example, the total processing and distribution costs are estimate at $ 1,040,000,109 of which the total distribution cost is projected to be $ 419,024,689. However, since beef processing is labor intensive and beef distribution is energy intensive, the 30% reduction in shipping and storage weight

Table 6. Sources of annual savings in U.S. beef industry resulting from hot-boning processing

Source	Item	Energy Savings BTU	Energy Savings %	Dollar Cost Savings ($)	Dollar Cost Savings (%)
1976	Distribution	2.9184622×10^{12} BTU	75.32%	$ 125,707,407	91.38%
1976	Processing	0.9561898×10^{12} BTU	24.68%	$ 11,860,780	8.62%
1976	Distribution and Processing	3.874652×10^{12} BTU	100%	$ 137,568,187	100%
1980	Distribution	3.2604988×10^{12} BTU	75.61%	$ 139,595,554	91.44%
1980	Processing	1.0518295×10^{2} BTU	24.39%	$ 13,074,875	8.56%
1980	Distribution and Processing	4.3123283×10^{2} BTU	100%	$ 152,670,429	100%

of processed beef due to the use of the hot boning technique will clearly have a greater impact on distribution. It is not surprising that the study found about 91% of the dollar cost savings for the hot boning technique arose from distribution as opposed to processing.

2. For energy usage in the processing of beef, this study only considers two stages in which processing changes will result from the adoption of the hot boning technique — the initial chilling and storage cooling stages. Since the total cost of energy usage in processing is a small proportion of energy usage is greater than percentage savings in terms of dollar costs. The source of annual savings in U.S. beef industry for the hot boning technique are outlined in Table 6.

3. The cost of distribution is, by far, the most important factor in determining optimum geographical flow of beef. The hot boning processing technique will not affect the optimum transportation pattern but the savings in terms of dollars and energy are substantial. The results indicate that a saving of $ 137,568,187 and 3.874652×10^{12} BTU for 1976 and $ 152,670,429 and 4.312383×10^{12} BTU for 1980 will accrue from the adoption of the new technique.

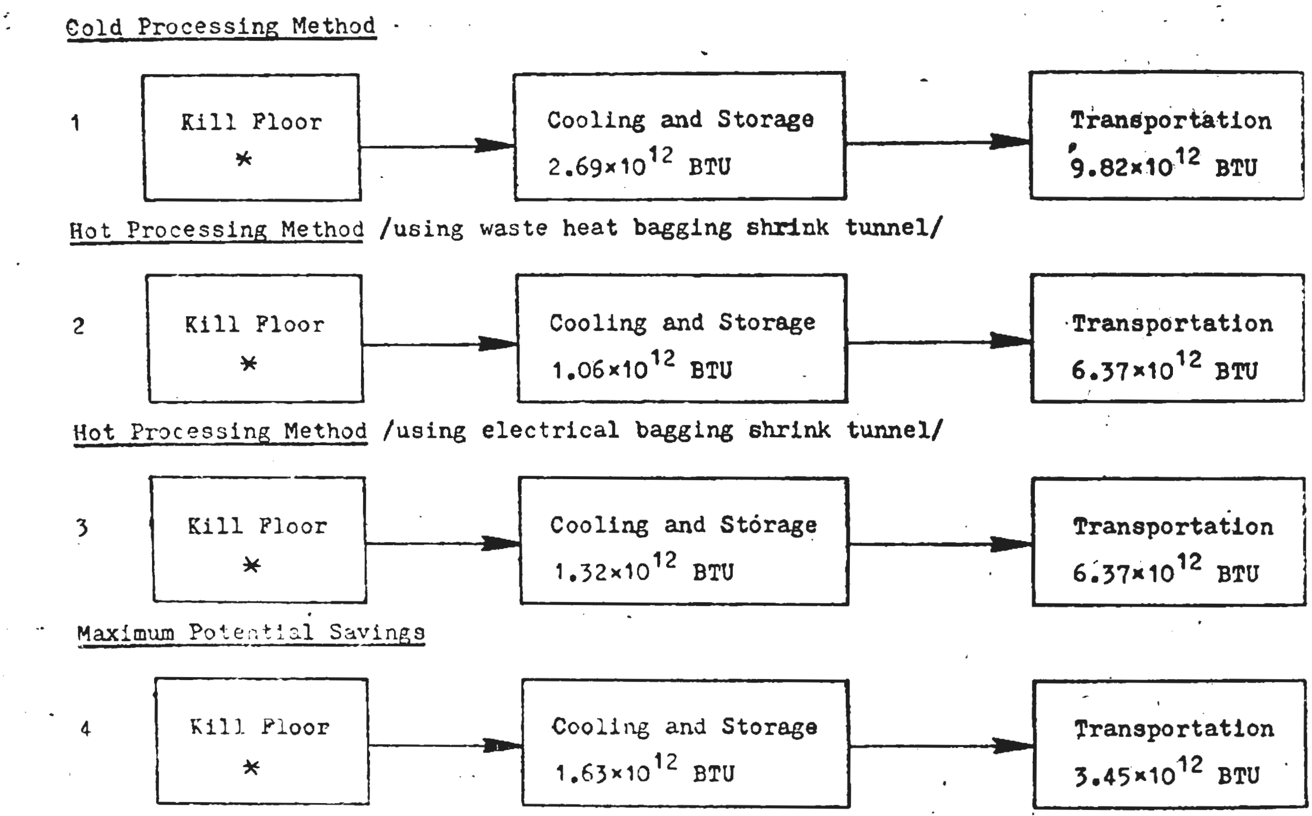
4. The hot boning technique will provide the greatest cost savings for beef processed for interregional shipment — as opposed to beef processed for intraregional shipment. In other words, the per mile cost savings which accrue from shipping hot boned beef will obviously benefit long hauls more than short hauls.

SUMMARY OF ENERY SAVINGS — HOT VS. COLD BONING

This final portion of the paper summarizes the potential energy savings that could be available if the meat industry were to adopt hot beef boning throughout the United States. There is evidence that hot beef boning is being received favorably not only in this country, but in other parts of the world as well. One plant in Nashwille, Tennessee, is processing approximately thirty head per hour at present and all of their cold processing has ceased. In the western states of the U.S., an increasing acceptance of hot boning is becoming evident. Therefore, in the not too distant future, substantial and ever increasing quantities of hot boned beef will be available in the market place.

SOURCES OF ENERGY SAVINGS

There are two main sources of energy savings from hot boning. First, energy requirements can be reduced in the cooling and storage stages. Second, the transportation of processed beef requires substantially less energy than does the transportation of sides of beef. For the readers convenience, these data are summarized and extrapolated for the quantity of beef that was processed in the U.S. during the year of 1978. It should be noted that meat production is less for 1978 than for prior years and that energy savings are in direct proportion to the quantity of meat processed. The Source Energy Block Diagram, Fig. 4, summarizes 1978



Grand total = 5.08×10^{12} BTU or 5.08 trillion BTU /source energy/.

* It is assumed that kill floor energy requirements are the same under the hot and cold processing methods.

Fig. 4. Source energy block diagrams

conditions and indicates a maximum energy reduction of 5.08×10^{12} BTU or 5.08 trillion BTU in source energy. Stated in other terms, energy savings are predicted at 1.62×10^{7} BTU/head or 205 BTU/pound of beef processed. Line 1 of the block diagram shows energy requirements for 100% cold processing of the 1978 beef production. Line 2 indicates the energy requirements in Line 3 are for processing the same quantity of hot boned beef but considers the case where waste heat is not available or is not utilized. Line 4 indicates the maximum potential savings for hot boning and compares Line 1 and Line 2 at the most favorable case, i.e. a savings of 5.08×10^{12} BTU annual savings for the 1978 year.

OVERAL CONCLUSION

The advantages offered by hot processing are significant and should be given serious consideration by the meat processing industry. An increasing segment of the industry is already moving toward hot processing and if present trends continue, the rate of change to hot processing will accelerate.

LITERATURE

1. Ramsbottom J. M., Stradine E. J.: Journal of Animal Science 1949, 8, 398.

E. J. Ferguson

OSZCZĘDNOŚĆ ENERGII W PRZEMYŚLE MIĘSNYM

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S t r e s z c z e n i e

Zanalizowano efekt wprowadzenia do praktyki przemysłowej w USA techniki odkostniania mięsa wołowego w stanie ciepłym (bez wychładzania), wyrażony w nakładach kosztów oraz nakładach energii na wyprodukowanie wołowiny oraz jej dystrybucję. Stwierdzono, że wprowadzenie tej techniki wywiera wpływ na obie wymienione dziedziny — jednak wpływ na składowanie i dystrybucję mięsa jest większy. W procesie produkcyjnym największe oszczędności energii dzięki odkostnianiu mięsa na ciepło uzyskuje się przy wstępnym schładzaniu i składowaniu chłodniczym mięsa. Technika odkostniania mięsa na ciepło nie ma wpływu na optymalizację promienia transportu mięsa, jednakże daje wyraźne oszczędności nakładów kosztów i energii na transport. Największe oszczędności dzięki zastosowaniu tej techniki uzyskuje się w odniesieniu do mięsa produkowanego z przeznaczeniem na transportowanie go na większe odległości.