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MODULARIZATION OF DRY GROCERY PACKAGING: ECONOMIC IMPACTS AND IMPLEMENTATION BARRIERS

By

Charles W. Abdalla

Department of Agricultural Economics
MICHIGAN STATE UNIVERSITY
East Lansing

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Charles W. Abdalla
Department of Agricultural Economics and Rural Sociology
The Pennsylvania State University
University Park, Pennsylvania

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Table of Contents

1.0 Introduction 1

2.0 Economic Effects of Modularization of Dry Grocery Packaging . . . 1

2.1 Shipping Container Size Proliferation 1

2.2 A Modular System of Food Packaging 2

2.3 The Probable Effects of Modularizing Dry Grocery Shipping Containers 2
- 2.3.1 Effects Upon Food Manufacturers 3
  - A. Conversion Costs 3
  - B. Benefits 3
  - C. Marketing Effects 6
  - D. Impact Upon Particular Segments of the Manufacturing Sector 6
- 2.3.2 Effects Upon Food Distributors 7
  - A. Conversion Costs 7
  - B. Benefits to Distributors 7
- 2.3.3 Consumer Impacts 13
- 2.3.4 Conclusion: Evidence of Net Benefits 14

3.0 Implementation Barriers: Identification and Analysis 15

3.1 Industry Participants Perception of Barriers to Modular Packaging . 15
- 3.1.1 Manufacturers 15
- 3.1.2 Distributors 16
- 3.1.3 Broadly Identified Barriers 16

3.2 Analysis of Barriers to Modular Packaging Adoption 17
- 3.2.1 Informational Factors 17
  - A. Perceptions of Modularization 17
  - B. Lack of Information about Impacts of Modular Packaging . . 18
- 3.2.2 Institutional Factors: Inter-Industry Coordination 18
  - A. Distributor Procurement Practices 18
  - B. Cost-allocation Practices 19
- 3.2.3 Institutional Barriers: Incentives for Industry-wide Innovations 19
  - A. Distributor Incentives 19
  - B. Manufacturer Incentives 20
- 3.2.4 Barriers to Collective Action At the Industry Level 21
  - A. The Costs of Collective Action 21
  - B. Incidence of Benefits 21
  - C. Historical Factors 22

4.0 Recent Developments with Potential for Affecting Modular Container Adoption 22

4.1 Advances in Distributor Information Systems 22

4.2 An Emerging Systems View: Cooperative Inter-Industry Projects . 23
4.2.1 Joint Industry Shipping Container Design Study. 24
A. Reducing Informational Barriers 25
B. Partial Standardization 25

5.0 Industry Options to Accelerate Modularization 25

5.1 Direct Product Costing Based on Modularization Savings 26
5.1.1 Operationalization and Quantification 26
5.1.2 Development of Comparative Cost Factors 26
5.1.3 Implementation of Direct Product Costing 26

5.2 A System for Monitoring Modular Container Adoption 27

6.0 Public Policy Implications 28

6.1 Public Policy Options to Foster Modularization 28

6.2 Elements of An Appropriate Public Policy Response 29

6.3 Recommendations for Further Research on Modularization 30
6.3.1 Defining and Operationalizing the Modular Concept 30
6.3.2 Identifying and Quantifying the Effects of Alternative Modular Packaging Systems 31
6.3.3 The Threshold Concept 32
6.3.4 Investigation of the Implications of Information System Advances 32

7.0 Conclusions 33

REFERENCES 35

Preface

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Charles W. Abdalla
Assistant Professor of Agricultural Economics
The Pennsylvania State University

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Modularization of Dry Grocery Packaging: Economic Impacts and Implementation Barriers *

Charles W. Abdalla

1.0 Introduction

As marketing activities have expanded in economic importance, greater attention has been focused on the performance of this sector. Studies have found that there are reasons to be concerned about the performance of the marketing system in general and food distribution activities in particular. Productivity and resource utilization have been two of the performance dimensions of concern.

Greater awareness of the performance concerns mentioned above by private and public decision makers has led to a search for ways to improve the functioning of the food distribution system. The standardization of shipping containers (secondary packaging) to form a modular packaging system has been identified as an innovation with a potential for significantly enhancing productivity and reducing food distribution costs. Despite the substantial benefits expected from modular packaging, it has not been adopted for dry grocery products in the U.S.

2.0 Economic Effects of Modularization of Dry Grocery Packaging

2.1 Shipping Container Size Proliferation

Food manufacturers' decisions about retail package shape and size have an impact upon receivers' (wholesale and retail chain distributors) physical distribution operations and ultimately affect consumer food prices. Suppliers design packages to meet the needs of their individual product. A food item's inherent shape and density, its end use, and the portion desired by certain consumer segments determines the item's retail package size. Packages are designed for marketing reasons. The physical dimensions of the package are important product attributes which can be varied to differentiate products. In addition to influencing a consumer's image of a product, package dimensions affect the amount of exposure a product receives on a supermarket shelf.

The diversity in shipping container size is not of critical importance for supplier distribution activities. Suppliers tend to handle in their warehouses and ship large quantities of relatively few items. The impact of shipping container size diversity is markedly different for food distributors. Since distributors ship orders to retail outlets consisting of relatively small quantities of thousands of different items, the basic unit of handling is the shipping container [11]. The full impact of independent supplier package design decisions becomes apparent when the products are intermixed. Each supplier has designed its shipping container without consideration of how it relates to those of other suppliers. The resulting profusion of container sizes prevents distributors from effectively combining different products, thereby causing inefficiency and waste.

* Also published as MSU Experiment Station Research Report 492

2.2 A Modular System of Food Packaging

A proposal to alleviate the problems cited above is to standardize shipping container dimensions into a "modular" packaging system. Sizes of modular shipping containers are a direct multiple of one another and the unit-load size in order to permit maximum flexibility in building mixed product loads [9].

Modular packaging systems have been developed in Switzerland, Sweden and, most recently, in the Netherlands [13]. However, very little progress has been made toward modularization in the U.S. dry grocery industry. In the early 1970's, the topic generated a great deal of interest that culminated in a retail chain sponsored study completed in 1974. This study identified and documented significant savings in distributors' warehousing and transport operations. It proposed further analysis, selection of specific modular sizes and the development of an implementation plan. However, the program was not undertaken by the industry.

2.3 The Probable Effects of Modularizing Dry Grocery Shipping Containers

The term "probable" indicates that there is some uncertainty about the effects of modularization. Two reasons for this uncertainty exist. First, the vast, diverse and complex nature of the dry grocery manufacturing and distribution system make it difficult to precisely predict impacts. Assessing the effect of a major system-wide change upon the system is even more difficult. To reduce the magnitude of this task, emphasis will be placed upon identifying immediate impacts upon manufacturers, distributors, and consumers.

A second reason for the uncertainty surrounding the impacts of modularization concerns the modular concept itself. Modular packaging is presently a hypothetical concept being considered for application in the U.S. food industry. While actual modular systems have been developed in several Western European countries, the modular concept has not been put into operation in a specific system in the U.S. Until specific modular sizes and the number of sizes to be used are chosen, the full ramifications of implementing modular packaging cannot be precisely known. Because of this difficulty, the direction of the effects of modularization will be described, rather than the precise magnitude of these effects.

Both secondary and primary data are used to predict the consequences of implementing modular shipping containers. Relatively little prior research has been conducted on the effects of modularization. The qualitative and quantitative evidence uncovered through an extensive literature search is utilized to assess modularization impacts. The limited prior quantitative work has focused upon the warehousing and transportation functions of distributors. Primary data used in assessing impacts were obtained via personal interviews with managers in manufacturing and distributing firms, packaging and materials handling equipment suppliers and representatives of industry trade associations and academic institutions.

2.3.1 Effects Upon Food Manufacturers

A. Conversion Costs. The food manufacturing industry would bear the cost of implementing modular shipping containers. Such costs include any adjustment, retooling or replacement of production, packaging, and materials handling equipment necessitated by a modularization program. In a search of the literature, no published studies which assessed the magnitude of these effects were found.

While information about conversion costs for manufacturers is not available, several factors affecting the magnitude of these costs have been identified. First, changeover costs are a function of the degree to which retail (primary) packaging requires modification. Costs are thus directly related to the number of products which can be put into modularized secondary containers without adjusting primary containers [6]. One reason for this is that primary package equipment is relatively less flexible than secondary packaging equipment. Second, costs are likely to decrease as the time period allowed for implementation increases and as conversion to modular sizes are made in conjunction with equipment changes for other reasons (e.g., metrication, new product introduction and equipment retirement) [6;12].

Third, manufacturers' costs would be related to the degree to which they will need to redesign their unit loads to more precisely fit on the standard 48 x 40 inch grocery pallet. Currently, many manufacturers design their unit load to extend over the pallet base by as much as 8 inches. Pallet overhang benefits these manufacturers by increasing space utilization on transport vehicles and, in some cases, by reducing damage. Implementing modular packaging would require that unit loads fit more precisely on pallets and thus would increase costs for manufacturers presently benefitting from pallet overhang. Fourth, the degree to which different retail package dimensions would be affected will influence the level of cost. For example, changing can diameters is likely to be several times more costly than altering the height of these packages [6].

B. Benefits. Evidence on possible beneficial effects of modularization for food manufacturers conflicts. A. D. Little excluded manufacturers' distribution centers from its analysis since researchers believed modularization would have little, if any, impact on these warehouse operations. However, the A. D. Little study did investigate potential benefits of improved space utilization in manufacturers' transport vehicles. They concluded that this opportunity was insignificant since "each unit load is usually made up of only one size secondary carton and there is very little void space in the unit load [6].

Surveys of representatives of manufacturing firms have suggested that, contrary to the above conclusion, some of the benefits of modularization would accrue to the manufacturing sector. In 1978, the General Accounting Office surveyed manufacturing firms in an investigation of container modularization. Eleven of the 19 respondents perceived no benefits or insignificant benefits of modularization for manufacturing firms. Eight respondents indicated that their firms would receive some benefits but the

bulk of the savings would accrue to distributors. The most frequently identified areas of savings to manufacturers were: 1) increased space utilization in warehouses; 2) improved shipping and receiving productivity; and 3) reduced packaging inventories. Several firms indicated they would benefit from reduced investment in package machinery. Also, improved productivity from fewer packaging line changeovers and resulting longer production runs were identified as a potential area of savings [18].

A study conducted in 1978 for the National Center for Productivity and the Quality of Working Life surveyed 144 food industry executives regarding the potential for productivity improvement and the legality of ten cooperative behaviors. The 84 manufacturer respondents in the sample (and the remaining distributor respondents) perceived "cooperation among competitors to standardize package size to improve handling productivity" as having the greatest potential to improve productivity of ten joint industry endeavors [10].

Primary data collected through interviews with 18 manufacturing firms provided information about the potential impacts of modularization upon manufacturers. Fifteen distribution executives were queried about the probable effects of modularization upon their firms. The most common response concerned the cost of retooling equipment to make new sizes. Interviewees also identified possible savings through the internal standardization that would result from a modularization program. The major categories of savings and the frequency with which they were identified are shown in Table 1. Savings in distribution operations were often cited as specific benefit areas. A greater ability to intermix different products within a unit load was cited by several respondents. Such preassembled unit loads are often sent directly to stores and can be used as displays. As Table 1 indicates, possible savings in production, storage and procurement were predicted.

Some additional evidence that standardization of package sizes would result in savings to manufacturers was uncovered through the interviews. One firm in the sample had undertaken a program in which it reduced the number of retail and shipping packages for a major category of products it produced. Significant potential savings were estimated in: 1) plant operations through reduced packaging line changeovers and improved line productivity; 2) savings in areas of reduced package material inventories and improved utilization of package materials;

TABLE 1

Areas of Savings From Shipping Container Standardization in Manufacturing Firms Identified by Supplier Distribution Managers

	Number of Firms Identifying*
A. Distribution Operations	10
1. Warehouse and/or Transport Space Utilization (8)	
2. Damage Reduction (6)	
3. Productivity in Material Handling (4)	
4. Greater Ability to Mix Different Products of a Manufacturers's Product Line (4)	
B. Production and Packaging Operations	8
C. Storage and Inventory Costs	4
D. Procurement of Packaging	3
E. Other	1
1. Productivity in Handling Inputs (1)	

*Fifteen firms were questioned regarding manufacturing impacts. The total exceeds 15 since most firms identified savings in more than one area.

3) warehousing savings from reduced inventories and improved space use; 4) transportation savings from increased loading/unloading productivity and improved utilization of vehicles and 5) reduced damage. As a result of the study, the standardization program was undertaken and many of these savings were realized. However, the respondent indicated that while hard dollars and cents savings accrued to the firm, marketing and sales factors created difficulties in implementing the program. Thus, while this program produced hard savings for the firm, the net effect on its market position may not have been positive.

C. **Marketing Effects.** A modularization program which limits the shapes and sizes of retail packaging could affect manufacturers' marketing efforts. First, a change in retail packaging could alter a product's image (i.e., price-value relationship) or affect the amount of supermarket shelf space and consumer exposure it receives. Some manufacturer's products may be adversely affected and these firms will suffer a decline in sales. Other firms will be beneficially affected
and enjoy sales increases. Thus, as long as the total amount of shelf space devoted to grocery products remains the same, the shifts in sales among manufacturers should cancel one another out and there should be no net impact on the manufacturing sector.

Second, limitations on retail packaging may reduce manufacturers' ability to compete by varying package dimensions to differentiate their products from one another [6]. Greater similarity in retail packages could conceivably allow consumers to compare products on more of a price basis [9]. If competition among food manufacturers shifts from non-price to price attributes, prices will be driven down and manufacturers' profits may decline. Consumers, however, would benefit from lower prices.

A third way in which limiting retail packaging may affect manufacturers is by reducing their options to change packaging as an alternative to changing prices. Package size and contents are marketing variables. Limits on retail packaging resulting from modularization would reduce this marketing flexibility. This would tend to result in greater competition on the basis of price, since cost increases would be reflected in higher retail prices [9]. Again, while such effects are detrimental to manufacturers, the resulting lower prices would benefit consumers.

D. **Impact Upon Particular Segments of the Manufacturing Sector.** Implementing modular packaging could impose relatively higher costs on some sectors than others. Smaller manufacturers may be adversely affected for several reasons. First, smaller firms have less capacity to withstand conversion costs [18]. These firms generally have less market power and thus have less ability to pass conversion costs forward. Second, elimination of odd-sized packages and case packs, which are frequently produced by small manufacturers, would force these firms to compete with larger manufacturers. The long-run result may be that higher cost small manufacturers will fold, reducing firm numbers and competition in food manufacturing [9].

Modularization could impose greater costs on several specific manufacturing segments. Manufacturers of light products (e.g., paper products and cereals) which tend to overhang pallets would incur greater costs in conforming to the 48 x 40 inch pallet than other firms. Also manufacturers using bags for packaging would incur relatively higher costs if they were required to change to corrugated shipping containers.

2.3.2 Effects Upon Food Distributors

A. Conversion Costs. The implementation of modular packaging should not involve any direct costs to distributors provided that the unit load (i.e, pallet) base remains at the standard 48 x 40 inches. If it were changed, distributors would face major costs in modifying their warehouse racking and layout. However, this is an unlikely prospect given the efforts, which have extended over several decades, to standardize the pallet to this size.

B. Benefits to Distributors. The types and magnitude of benefits to distributors is probably much greater than those accruing to manufacturers since the full advantage of modular containers, which can be intermixed to create stable unit loads, is realized in distributor operations. Potential benefits that have been identified through surveys and documented through quantitative studies are reviewed below.

For food distributors, the benefits that have been most frequently identified are: 1) increased labor productivity; 2) reduced product damage; 3) improved use of space in trailers delivering store orders; and 4) greater warehouse mechanization and automation. Nineteen of twenty representatives of distribution firms interviewed by the General Accounting Office in 1978 most frequently cited improvement in warehouse labor productivity and damage reduction as potential modularization savings. Benefits from increased automation potential and improved space use in warehousing and transport were each identified by 60 percent of respondents. Distributors suggested possible additional savings through improved inventory control, retail space use, and the use of pre-priced modules for retail display.

The primary data acquired in this research identified many of these same benefits identified in other studies, as well as several new savings areas. In Table 2, the results of interviews with 37 distributor firms are presented. The most frequently mentioned benefit was that of increased warehouse labor productivity. An executive for a national food distributor estimated that modularization would reduce his firm's labor requirements by about 2 percent. This would amount to annual savings of slightly more than one million dollars for the firm. As illustrated in Table 2, savings in trucking, damage reduction and through increased potential for automation and mechanization were identified by many respondents. Nine firms predicted productivity savings at the retail level, while two firms believed manufacturers would benefit from modularization.

TABLE 2

Areas of Savings Identified by Distribution Managers in Wholesale and Retail Firms

	Number of Firms Identifying*
1. Warehouse Labor Productivity	25
2. Improved Utilization of Truck Space	23
3. Reduced Damage in Warehousing and Transportation	22
4. Increased Automation/Mechanization Potential	18
5. Retail Store Level	9
6. Improved Utilization of Warehouse Space	8
7. Reduction in Tape/Stretch Wrap for Unitizing Outbound Loads	7
8. Reduced Training Time for Order Selectors	3
9. Manufacturing Level	2

* Thirty-seven firms were interviewed. The total exceeds 37, since most firms identified more than one savings area.

The effects of modularization upon distributors have been quantitatively estimated by: 1) A. D. Little, Inc. for the National Association of Food Chains in 1974; and 2) the A. T. Kearney Management Consultants in a joint industry study of shipping container design initiated in March, 1984. The A. D. Little study evaluated impacts upon the wholesale/retail chain distribution center and inbound and outbound transportation. The study found several opportunities for improvement that they were unable to quantify. They were: 1) faster training of warehouse workers; 2) increased flexibility of storage space and of automated systems; and 3) direct warehouse to store shelf-stocking and display on pallets. Savings were quantified in the three major areas of warehouse labor, damage and transportation.

The dollar savings in each of the three mentioned above were estimated for several different warehouse types. In Table 3, A. D. Little's estimates (updated to 1983 dollar values) are presented. The greatest saving potential was found for mechanized systems; the second greatest potential was for conventional warehouses using pallets.

The figures in Table 3 can be used to calculate the total benefits of modularization to supermarket distributors. This calculation requires estimates of the annual dry grocery case flow and current warehouse mix. The estimate of 4.52 billion cases was based on available trade literature. This is probably a conservative figure, since other research has estimated the total number of dry grocery cases at 12.9 billion per year [7]. An estimate of the number of cases flowing through three major warehouse types was derived by consulting with the leading materials handling suppliers to the food industry. Table 4 illustrates the range of potential savings for each warehouse type and the savings on an industry-wide basis. Given existing technology and warehouse types, modularization savings to supermarket distributors would range from 106 to 248 million dollars annually. Two limitations of this aggregate savings estimate should be noted: It is based on figures for typical firms, but it does not necessarily reflect industry averages; and it does not include effects upon small, yet important, segments of the distribution industry [6].

A. T. Kearney, in a joint industry-sponsored study of opportunities to improve shipping container design completed in 1986, estimated the savings from container standardization. Through an industry-wide mail survey of manufacturers and distributors, and a limited number of interviews with distributors, the consultants identified 29 different shipping container improvements. These improvements were evaluated for their effect upon labor productivity, space utilization and damage in distributors' warehouse operations. A rough estimate of the savings for 21 shipping container improvements was arrived at by calculating the impact upon the largest and most obvious of these three areas. The gross savings can be found in Table 5. Reducing the number of sizes to form a standardized container system was found to have the greatest savings potential ($116 million per year) of all 29 improvements. Improving bag strength was second in

TABLE 3

Summary of Potential Modularization Savings
by Warehouse Type

($ Per 100 Cases Shipped)

	Manual (Pallets)	Manual (Tow Trucks)	Mechanized (Pallets)	Automated (Carts)
1. Warehouse Labor*	1.99 ± .82	.44 ± .20	2.98 ± 1.35	.08 ± .08
2. Warehouse Damage*	1.26 ± .04	.26 ± .04	.26 ± .04	.26 ± .04
3. Transport to Store**	1.11 ± .49	0	1.11 ± .49	.86 ± .37
4. Store Delivery Damage	.50 ± .18	0	.50 ± .18	.06 ± .06
TOTAL	3.86 ± 1.54	.70 ± .24	4.85 ± 2.06	1.26 ± .55

* Figures converted to 1983 dollar values using an index calculated from wages for workers in the wholesale grocery trade in Employment and Earnings, published by the U.S. Department of Labor - Bureau of Labor Statistics.

** Figures converted to 1983 dollar values using the Producer Price Index for refined petroleum in Producer Prices and Price Indexes, published by the U.S. Department of Labor - Bureau of Labor Statistics.

Source for Table: A. D. Little, Inc., An Examination of the Effect of Modularization Secondary Containers .us on Productivity in Grocery Distribution, Report to the National Association of Food Chains, 1974.

TABLE 4

Estimated Total Savings Potential of Modularization
Per Year With Existing Warehouse Types and Technology

	WAREHOUSE TYPES			
	MANUAL	MECHANIZED	AUTOMATED	TOTAL
Estimated Annual Case Flow (Millions)	4,033.564	410.802[2]	75.636[2]	4,520.000[1]
Percent	89.24%	9.09%	1.67%	100%
Savings Per Year (Millions)				
Lower Bound	93.6	11.5	.5	105.6
Mean	155.7	19.9	1.0	176.6
Upper Bound	217.8	28.4	1.4	247.9

[2]Estimates calculated from data obtained through personal communication with several major materials handling equipment suppliers to the food industry.

[1]Calculated by dividing 68,804.3 million dollars in wholesale dry grocery sales in 1984 by an average wholesale case value of 15 dollars. The wholesale sales figures were estimated by accounting for 21.9% and 19.4% markup on total retial sales of 60,901.5 and 25,103.8 million dollars for food and non-food grocery sales, respectively (Progressive Grocer, p. 42, July 1984). [9]

TABLE 5. Ranking of Shipping Container Improvements by Savings Potential

Rank	Opportunity	Cases Affected (Millions Per Year)	Savings to Distributors (Million Dollars Per Year)*
1	Standardization	11,400	116.0
2	Bag Strength	233	64.4
3	Standard Pallet Height	12,900	23.6
4	Standardized Carton Height	11,400	23.2
5	Standard Case for Similar Retail Package	1,400	14.2
6	Interior Case Dividers	5,400	8.7
7	Minimize Stretch Wrap	2,100	8.7
8	Standardize Code Dating	839	7.2
9	Height Greater Than Length or Width	4,800	5.5
10	Minimize Between Tier Glue	1,000-2,000	3.5
11	Overhang/Underhand	4,800	2.8
12	Chimney Stacking	100	2.6
13	Gluing of Closures	114	2.3
14	Tray Pack Picking	300	1.9
15	Improve Legibility of Markings	12,900	1.6
16	Tray Pack Case Integrity	79	1.3
17	Perforated Display Case	315	1.0
18	Eliminate Kraft Wrap	300	0.5
19	Pallet Integrity for Small Light Cases	3,300	.3
20	Visibility of Marking on Tray Pack	791	.1
21	Improve Brik-Pak Containers	36	.1

*Savings for one area (the largest and most obvious) of distributor warehouse impacts (e.g., labor productivity, space use, or damage). Also savings for each improvement are not additive.

Source: A. T. Kearney, "Executive Summary of Phase I Results of Joint Industry Study of Shipping Container Design," presented at National-American Wholesale Grocers Association Warehouse Operations Seminar, Dallas, TX, December 4, 1984, p. IV.8.

terms of savings ($64 million per year), and three other container size standardization options were among the top five savings opportunities. After the first phase of the joint industry project A. T. Kearney concluded that container standardization and two "partial" standardization measures (i.e., standard pallet height and standard container height) were opportunities in shipping container design having the "best long-term potential." Two other opportunities (i.e., improving bag strength and standardizing containers with similar retail packages), which offered significant savings yet impacted fewer cases, were deemed to be a "good place to start" improving shipping containers [7]. In their final report released in 1986, A. T. Kearney recommended in the intermediate term, the industry should develop joint task forces to implement these two opportunities [8].

A. T. Kearney's calculations of the potential savings of container standardization can be regarded as a conservative estimate for three reasons: First, it would have a potential impact on three areas, and only one of these areas was quantified to arrive at a "rough order of magnitude" savings figure for each improvement. To the extent that a shipping container improvement has significant benefits in the areas that are not included in the calculation, this method will understate its potential savings. Thus, the potential savings of container standardization, which has benefits in several areas of distributors' warehouse operations, is likely to be greater than $116 million per year. Second, potential warehouse savings from the increased automation and mechanization made possible by container standardization are not included. Finally, benefits in transportation, which have been found to be significant in other studies, and the effects at the retail store level were not evaluated.

2.3.3 Consumer Impacts

Consumers may be affected by modularization in two ways. They will be affected by any modifications in retail packaging. Also, modularization could impact consumers through the prices they pay for food.

Legitimate reasons for differences in retail package sizes are to meet consumer preferences for different quantities of a given product, to provide convenience in use, or to create aesthetic appeal. If a container modularization program limits retail package sizes, some retail packages will require modification. The resulting retail packages may be more preferred or less preferred by consumers. If modularization results in retail packages which contain product portions or attributes that are less preferred by some consumers than former sizes, these consumers will be inconvenienced. Thus, it is possible that a modular container system which severely limited retail packaging could make the food marketing system less responsive to consumer preferences.

To the extent that implementation requires major changes in their operations, manufacturers' costs will initially be raised. In this largely oligopolistic industry, most firms should be able to pass on these increased costs to distributors. There are three possible

results for consumers; these results will depend on the degree of competition at the distributor level. First, if distributors possess substantial market power, and can therefore retain modularization savings accruing in their operations and pass manufacturers' product price increases forward, consumer prices will increase. Second, if distributors pass on only enough of their savings to offset the increases in manufacturers' prices, consumer prices will be unchanged. Third, in a competitive environment, market forces will, over the long-term, compel distributors to pass on all or most of their savings, thereby reducing food prices to the consumer.

The most likely outcome for a modular package system with demonstrated net benefits is a reduction in consumer prices, although prices will probably not be reduced by the full amount of the savings accruing to distributors. Manufacturers, who must incur costs to modularize their products, can benefit from expanded sales only if distributors reduce product prices. Therefore, manufacturers would probably only cooperate in a modularization program if enough of the savings accruing to distributors were passed on to offset increased manufacturers' prices. If this occurred, all three parties could benefit from modularization. Consumers would benefit through lower prices. Increased purchases induced by lower prices would increase the volume of manufacturers' sales and, possibly, their revenues and profits. Profits for distributors with sufficient market power to retain at least some of the savings of modularization would be raised. Even in the case where increased profits due to modularization savings are eroded through competition, the result would be a normal return on investment for these firms.

2.3.4 Conclusion: Evidence of Net Benefits

For an innovation to be worth undertaking, it must pass the benefit-cost test. In the case of modular packaging, the benefits must be greater than the conversion costs if total marketing system costs are to be reduced and consumer prices lowered. Only a part of the information (i.e. benefits to distributors) that is needed to make a net benefit comparison has been quantified. No quantitative estimates of the costs and potential benefits for manufacturers are available.

Several investigators have concluded that modularization would produce net systems savings. For example, the General Accounting Office concluded that the "result is likely to be that the food system as a whole will benefit but not all segments" [18]. Furthermore, researchers investigating dry grocery losses indicated that the task of modularizing packaging would be arduous, but the results would appear "certain to be worth the effort" [14].

A review of the primary and secondary data acquired in this research leads to the conclusion that one or more modular packaging systems would produce significant net benefits and thereby lower total food distribution system costs. This conclusion is based on four points. First, a modular container system would have reasonably low conversion costs if it had a sufficient number of sizes so as not to require substantial retail package change; and if there were a

reasonable implementation period, so that manufacturers' operations would not be quickly disrupted, and changes could coincide with the normal cycle of package change. Second, despite the fact that modularization has been a food industry issue for over 15 years, this research uncovered no quantitative evidence demonstrating that conversion costs would be large. Third, some manufacturers would receive benefits from modularization which would at least partially offset conversion costs. Finally, the quantitative estimates of distributor benefits are conservative since a conservative dry grocery case flow figure was used and the benefits in retailing and from technologies stemming from modularization have not yet been estimated.

3.0 Implementation Barriers: Identification and Analysis

Despite the potential for a net reduction in total food distribution system costs and lower consumer food costs, a modular packaging system has not been implemented in the U.S. Barriers to the adoption of this innovation are identified by food industry participants are summarized below. The key informational and institutional barriers to modularization identified through an integrative analysis of information obtained in the research are then presented.

3.1 Industry Participants Perception of Barriers to Modular Packaging

Factors perceived by representatives of key food industry participants as important obstacles to modularization are described in this section. The factors were identified in personal interviews with distribution managers in food manufacturing and wholesale and retail chain firms.

3.1.1 Manufacturers

Distribution managers in manufacturing firms identified numerous impediments to implementing modular packaging. The following seven factors were most frequently cited:

- Potential negative impact on manufacturers' marketing flexibility.
- Subordination of distribution productivity goals to marketing goals in food industry firms and organizations.
- Lack of quantitative estimates of the effects of modularization.
- Uneven incidence of benefits and costs between manufacturing and distribution industries.
- Difficulty of standardizing container sizes, given the inherent diversity of food products.

- Potential constraint on technological innovation in food packaging.

- Diversity of the distributor trade and the resultant lack of agreement on desired package improvements.

3.1.2 Distributors

Interviews with distribution managers in wholesale and retail chain firms resulted in the identification of a number of barriers to modular packaging. The most frequently mentioned factors were:

- Subordination of distribution productivity goals to retail merchandising goals in food industry firms and industry organizations.

- Potential negative impact on manufacturers' marketing flexibility.

- Inability of one firm to affect change.

- Uneven incidence of the benefits and costs between manufacturing and distribution industries.

- Lack of distributor awareness of modularization benefits.

- Short-run focus of the food distribution industry.

- Distributor diversity and the lack of agreement on desired package design changes.

3.1.3 Broadly Identified Barriers

There appears to be considerable agreement among respondents concerning the major barriers to modularization. The following five factors were frequently identified by respondents from both industries:

- Potential negative impact on manufacturers' marketing flexibility.

- Subordination of distribution productivity goals to marketing/merchandising goals.

- Lack of quantitative estimates of the effects of modularization.

- Uneven benefit and cost distribution between industries.

- Distributor diversity and lack of agreement on desired package changes.

3.2 Analysis of Barriers to Modular Packaging Adoption

In Section 2.3.4, it was concluded that one or more modular packaging systems could be developed that would yield significant net benefits and lower total food distribution system costs. Given this conclusion, the key next question is: Why hasn't modular packaging been adopted? If the problem is viewed in an exchange or market transaction framework, this question can be reworded as: Why don't the potential beneficiaries of modularization compensate those who would incur costs so that modularization could be adopted?

If the market system is functioning properly, incentives will be provided in prices for the adoption of innovations, such as a modular packaging, which could reduce total food distribution costs. Initial beneficiaries of the change (primarily distributors) would be expected to compensate those who would incur costs (i.e., manufacturers) to give them an incentive to convert to modular package sizes. Whether an exchange takes place depends upon the availability of information about the "good" to be exchanged and the institutional arrangements for the transaction.

3.2.1 Informational Factors

Parties to a potential exchange require knowledge of the "good" (i.e., modular packaging) to be traded. Several informational problems due to differing perceptions of modularization and the lack of information about the consequences of modular package adoption were identified as significant implementation barriers.

A. Perceptions of Modularization. Distribution managers interviewed in this study were generally quite familiar with the term modularization. However, many respondents were observed to have differing ideas about: 1) what the term meant; and 2) how a modular packaging system would be put into operation. Modularization was often used in a broader way than that specified in the definition given in Section 2.2. For example, the term modular was used by some interviewees to refer to the unitizing of containers of similar products to form a stable load or unit loads that precisely fit on the standard grocery pallet. To other managers interviewed, "modularization" was a means of solving a broad array of interrelated secondary package problems, including package quality and materials, pallet "overhang", and container size proliferation. Some suppliers also used the term "modular" to describe shipping containers of their own products mixed by layer. The existence of diverse interpretations of this term represents a potential barrier to the communication among industry participants needed for implementation.

Differences in views of respondents about how modularization would be put into operation in terms of specific sizes were also noted. Some distribution managers envisaged modular systems containing as few as 15 different sizes, and others believed the number of sizes would be much higher, possibly as many as 300. Obviously the effects of modular systems would differ greatly at either end of this range. Therefore,

participants' perceptions of the modular concept's benefits, costs, and workability are likely to greatly differ.

The differences in perceptions of the modular concept and how it would be put into operation create uncertainties about the "good" to be traded. These uncertainties represent a barrier to communication needed for an exchange that would permit modular packaging to be implemented.

B. Lack of Information about Impacts of Modular Packaging. As the interview results indicated, food industry participants perceived that the lack of quantitative documentation of the effects of modular packaging was a barrier to its implementation. The uncertainty surrounding the benefits and costs of adoption is an important factor inhibiting manufacturers and distributors from taking action. For example, distributors are unlikely to be willing to pay for modular containers until they know the magnitude of the benefits they would receive and at what cost. Similarly, manufacturers are reluctant to offer modular containers until they know what effects this change would have upon them; they are concerned about conversion costs, the impact on marketing and the ultimate effect on their products' prices. Thus, the lack of precise information on the value of modular packaging to each participant inhibits the exchange needed for adoption.

3.2.2 Institutional Factors: Inter-Industry Coordination

In addition to information about a particular good and its value, parties to an exchange require an appropriate institutional arrangement for making a transaction. For the vertically aligned stages of the food distribution system, alternative institutional arrangements for transactions include the market (i.e., interfirm) and internal firm (i.e., intrafirm) organization. Also, firms within the same industry level have developed organizations, such as trade associations, to communicate and represent their collective interests. In some cases, such institutions have been a vehicle for addressing inter-industry problems and opportunities.

Several institutional barriers relating to the internal decision-making of distributors are discussed below. In Section 3.2.3, the limits of the market to generate incentives for system-wide innovations are discussed. In Section 3.2.4, the barriers to action at the collective industry level to address inter-industry problems, such as container size proliferation, are identified.

A. Distributor Procurement Practices. A distributors' internal organization and decision-making practices affect the information and incentives conveyed to food manufacturers. A specific decision-making practice that diminishes manufacturers' incentives for making secondary package improvements is product procurement.

As noted earlier, interviewees perceived the subordination of distribution productivity goals to marketing and merchandising considerations as a barrier to modularization. Clearly, marketing and merchandising forces have a dominant influence on food firm decision making. In manufacturing companies, marketing departments have played a

much greater role in designing retail and shipping packages than have distribution departments. Similarly, buyers in distributor companies have based their decisions primarily on the criteria of effective merchandising, promotional allowances and gross margin. Little consideration has been given to secondary package characteristics that affect costs in the distribution department of the company. Given the basis for buyers' decision-making, no manufacturer has the incentive to undertake container improvements that increase efficiency in distributor operations.

An example will help illustrate this incentive problem. A manufacturing firm which adopted modular sizes for its products would raise its prices to cover conversion costs. Buyers, because they compare products on the basis of gross margin, would be reluctant to purchase the higher-priced products, even though the added costs may be more than offset by savings in the firm's distribution operations. As a result, any manufacturing firm making a shipping container improvement that increased its product's prices would put itself at a competitive disadvantage.

B. Cost-allocation Practices. Available evidence indicates that distributors do not identify and measure the costs of handling individual products. Consequently, information on the actual cost of handling a particular product is not available for use in distributors' procurement, merchandising and pricing decisions.

The implications of distributors' cost allocation methods can be illustrated by analyzing the likely price effects. Since distributors do not know with any precision the handling cost of one item out of the thousands carried, they often average such costs into product prices. Products with very high handling costs and those which can be handled with ease are assessed the same charge. Due to this practice, a manufacturing firm which improved its shipping container and thereby lowered its product's handling cost for distributors would show up as a small reduction in average industry costs. Since the firm would not be directly rewarded by having its product's cost reduced by the full amount of the handling cost savings which the package change generated, the incentive to make the shipping container improvement would be weakened.

3.2.3 Institutional Barriers: Incentives for Industry-wide Innovations

As noted, adoption of a cost-saving innovation depends upon an institutional mechanism to provide incentives to parties to the potential exchange. Individual transactions through the institution of the market are adequate for generating incentives for many cost-saving changes. However, the market's ability to provide incentives for adoption of an industry-wide innovation such as modular packaging can be restricted in several ways.

A. Distributor Incentives. Distributors could attempt to further the implementation of the modular concept through requesting package size changes, refusing to buy non-modular containers or by changing their private label products. The incentives for an individual

distributor to take any one these steps are affected by several factors. First, a distributor's incentive will be affected by the perceived probability of success. Apparently distributors believe this probability is low, since in the interviews many firms identified the inability of one firm to accomplish change as a barrier to modularization. Some distributors feel that they would be in a weak bargaining position if they requested packaging changes from the major national manufacturers with established consumer brands. Another problem is that an individual distributor would need to transact with numerous manufacturers in order to achieve the critical proportion of products in modular containers necessary to produce savings in his operations. This large cost burden for a single distributor weakens the incentive for an individual firm to make efforts to implement modular packaging.

The are few incentives for distributors' for converting their private label products to modular sizes. Since distributors manufacture a relatively small proportion of their products in a limited number of product areas, they would have to significantly expand production to achieve the critical amount needed to yield savings in their distribution operations. Several additional factors reduce the likelihood of modularizaton of private label products which are purchased from manufacturers. First, distributors typically purchase from multiple suppliers and often switch among them in order to obtain a lower price. If a manufacturer changed its operations to produce modular containers for only one distributor, it would become more dependent on that distributor. The manufacturer would need an assurance of continued purchases in order to make these special investments. This condition can reduce the chances that market transactions for modular private label products will occur 19]. Second, private label has not in general been an innovative product area. Third, distributors are reluctant to make changes in private label products that might increase cost and reduce the price differential between private label and the brand product being imitated.

These incentive problems have led many firm managers, industry leaders and researchers to conclude that system-wide changes must be addressed at a collective level. Barriers to collective actions are identified in Section 3.2.4.

B. Manufacturer Incentives. Examining individual market transactions from a manufacturer's perspective provides insight into the problems of implementing system-wide innovations such as modular packaging. Given the substantial evidence that modular containers would reduce distributors handling and shipping costs, the following question arises: Why don't individual manufacturers offer such containers and charge more to cover the costs of conversion? One answer is that distributors are unwilling to pay more for a single manufacturer's products in modular containers since modularizing a small number of the thousands of products stocked would not reduce their handling and shipping costs. A significant reduction in distributors' costs depends upon a "critical mass" of manufacturers' products being packaged in modular sizes. Until this level of adoption is reached, no distributor would be willing to pay an additional amount

a manufacturer that changed its containers. Thus, the inability of manufacturers to obtain benefits (i.e., increased product prices) through market transactions is likely to be an important factor impeding modular containers adoption. The limitations of transactions between individual firms suggest the need for an institution in which manufacturers can collectively offer and distributors can collectively pay for modular containers.

3.2.4 Barriers to Collective Action At the Industry Level

From the discussion in the previous sections, it appears that modular packaging presents some substantial challenges to the market mechanism's ability to facilitate the needed exchange between individual manufacturers and distributors. Possible impediments to distributors collectively expressing their preferences for modularization through trade associations are discussed below.

A. The Costs of Collective Action. Organizing distributor firms to collectively communicate their preferences for modular containers can be inhibited by a number of factors. First, organizing distributors involves the costs of communication and agreement. In an industry with a large number of diverse firms, the costs of getting firms together to discuss modularization is likely to be quite high. Government antitrust policy also affects the cost of collective transactions. The process of standard setting must be pluralistic and open in order to reduce the risk of antitrust prosecution. While few interview respondents perceived antitrust policy as a barrier to modularization, several trade leaders emphasized the problem of private suits.

The heterogeneity of the distribution industry affects the costs of collective decision making. For example, the diversity in the way warehouses are operated affects the perceptions of shipping package problems and solutions. As has been noted, the modular concept is not yet been put into operation. Therefore, firms need to agree on the specific modular sizes and the number to be used. The costs of arriving at a consensus in a diverse industry may be quite high. In sum, these factors, along with antitrust concerns stated above, indicate that the costs of collective action for distributors are quite high.

B. Incidence of Benefits. The incidence of benefits among firms in a diverse industry such as food distributing can be a factor inhibiting factor. If the benefits of modularization are perceived by some firms as being skewed toward other groups, these firms will be less willing to support and incur costs for the collective action needed to implement the innovation. For example, during the interviews, many respondents indicated that the chief beneficiaries of modularization would be distributors with mechanized warehouse operations. Consequently, firms without mechanized warehouses may be reluctant to support collective efforts to implement modularization, since they believe that mechanized distributors would receive undue advantages. Similarly, if some groups of manufacturers perceive that they will bear the brunt of the cost of modularization, they are less likely to participate in collective industry projects.

C. Historical Factors. The fact that modular packaging was not a new concept and that an unsuccessful attempt at implementation had occurred appear to be impediments to collective efforts to work toward modular packaging. In the early 1970's, package size proliferation emerged as a problem, interest was sparked in the modular concept, it reached its pinnacle, and then faded when recommendations of a distributor trade association modularization study were not implemented. Due to these events, food system participants developed an image of the modular concept and its workability. The interview results indicated that distributors familiar with the modularization's history were generally less optimistic about the chance for implementation than those that were not familiar. Also, those familiar with the historical context of modularization tended to want to work on smaller shipping container improvements rather than an "ideal" modular packaging system.

4.0 Recent Developments with Potential for Affecting Modular Container Adoption

A number of legal, economic and technological forces impinge upon the food industry. Two recent developments have the potential to accelerate the implementation of shipping package improvements, and possibly, of modular shipping containers.

4.1 Advances in Distributor Information Systems

Food distributors face a daily barrage of decisions concerning buying, merchandising, and pricing products. In the past, the decision making load was eased by employing simple rules of thumb and relying on manufacturers' recommendations. The availability of low cost computer power and the scanning of Universal Product Code (UPC) symbols on retail packages have brought about greater sophistication in these decision-making processes. Recent advances in managing and analyzing information are leading distributors to assess an individual product's performance more accurately. In addition to studying product sales data, some firms are now tracking individual product handling costs. Two specific practices which distributors have developed that may have implications for shipping container improvements are: 1) scanning damaged unsalable products; and 2) direct product cost analysis.

Large supermarket chains in numerous regions of the country have implemented spoils programs. Manufacturers' products which are damaged during distribution and unsalable at the retail level are collected by a distributor at a central location. Here products are scanned, sorted by manufacturer, and reports detailing aggregate damage and incidence by manufacturer are prepared [16]. Return invoices are sent and manufacturers are requested to pick up and purchase back their products. The spoil programs have at least three implications. First, the precise accounting of the aggregate amount and cost of damage has increased distributors' awareness of damage and its causes. Second, firms are able to determine the incidence of damage among different manufacturers brands and sizes [17]. Thus they have better knowledge

of the true costs of carrying different manufacturers' products. Third, since the program shifts a greater amount of the cost of damage back to manufacturers, distributor firms employing the program believe that it gives manufacturers an incentive to change their packaging and shipping practices in order to reduce damage [17].

The growing use of direct product cost analysis is a second development which may affect shipping container improvements. A number of major distributor companies are developing direct product cost computer models for use in their decision making [17]. The basic idea is to identify and measure costs on an individual product basis in order to obtain a more accurate picture of an item's true profitability. A wide variety of cost factors, including the characteristics of product packaging, are considered in direct product cost calculations.

The widespread use of direct product cost analysis by distributors has the potential to dramatically affect food packaging. The use of individual product cost information as a criterion in distributors' decisions should eliminate the interfirm communication obstacles cited earlier. Consequently, the incentive to a manufacturer to undertake package changes which, by this action alone, can produce savings in handling and shipping costs for distributors will be increased. Examples of such changes include strengthening corrugated or reducing the size (i.e., cube) of a shipping container. Buyers using direct product cost data instead of gross margin would be aware of the impact of a product's contribution to the profit of the entire firm. Thus they would be receptive to products which were higher priced (due to better shipping container design) and which generated savings in distribution operations that more than offset the increased price. Similarly, merchandisers could reward manufacturers for making package changes that reduced handling costs by lowering their products' prices or by giving their products more or better shelf exposure in supermarkets. Moreover, the use of individual product cost information by distributor decision makers should enable manufacturers to capture the benefits of some improvements in shipping container design.

While distributors' use of individual product cost data in making decisions should provide manufacturers with incentives to undertake many package improvements, it may not provide incentives for adopting industry-wide changes such as modular containers. As discussed in Section 3.2.3, when one manufacturer converts its containers to modular sizes, it cannot produce savings to distributors. Direct product cost analysis would find no advantage in purchasing suppliers' products in modular containers until a "critical mass" of products is changed and savings are realized. Thus, even when more precise information is used in distributor decisions, it is difficult for the market to generate incentives for the industry-wide adoption of modular packaging.

4.2 An Emerging Systems View: Cooperative Inter-Industry Projects

Food industry observers have increasingly recognized that in an interdependent economy, productivity advances which could lower total industry costs are dependent on system-wide innovations. Adopting such

innovations requires cooperation among food industry sectors. A mechanism developed to foster such cooperation between food manufacturers and distributors is trade associations' joint sponsorship of research. Such research resulted in implementation of the UPC symbol needed for supermarket checkout automation.

In the last few years, many food industry leaders have endorsed a "systems approach" to improving food industry performance. For example, some of the largest U.S. food manufacturers have expressed willingness to support inter-industry projects which would reduce total industry costs, even if it means higher costs for their firms [15;17]. Several jointly sponsored studies aimed at improving total system productivity have been completed. These projects have resulted in a Uniform Communication Standard to permit electronic data transfer between distributors and manufacturers and recommendations for standard coupon formats and sizes to improve handling efficiency. A two-year joint manufacturer-distributor funded study of shipping container design was completed in March 1986.

4.2.1 Joint Industry Shipping Container Design Study.

The major trade associations representing manufacturers and distributors (Grocery Manufacturers of America, Food Marketing Institute, National Grocers Association, and the National-American Wholesale Grocers Association) jointly funded a study of shipping container design in March 1984. This results of the first phase of this study were presented in Section 2.3.2 "Effects Upon Food Distributors". The study was conducted by A.T. Kearney Management Consultants. The recommendations in the final report of this study and possible implications for modularization are discussed below.

The joint study did not address modularization directly. Rather, its goal was to identify barriers to improved efficiency in grocery distribution due to shipping container design, recommend generic guidelines for shipping container design, and evaluate the technical and economic feasibility of proposed changes.

A number of size standardization options were among 29 opportunities to improve shipping container design investigated in the study. As noted in Section 2.3.2, a system of standardized container dimensions (i.e.,modularization) was found to have the potential savings of $116 million dollars per year which was the greatest of all shipping container improvements studied. Improving bag strength, standard pallet heights, standard container heights, and standard case sizes for similar retail packages were the only design changes estimated to save more than $10 million per year [8].

In its final report, A.T. Kearney made recommendations concerning two specific package improvements. Based on the criteria of large savings and relatively small number of cases impacted, the consultant recommended joint task forces be established to work toward: 1) the standardization of shipping containers in like retail packages; and 2) the development of improved containers and unit loads for bagged products. Kearney noted that these two options would "involve a

reasonable number of manufacturers and produce a large immediate positive impact" [8]. The researchers conclude that standardizing products in similar retail packs would produce benefits similar to modular concept without requiring a change in the retail package.

Although the standardization of shipping container dimensions was found to have the greatest savings potential of all improvements studied, no specific recommendations for implementing this alternative were made. The large number of cases and manufacturers that would impacted and likelihood of retail package alterations are likely reasons why this alternative received less emphasis. However, when addressing longer term opportunities, A.T. Kearney urged the grocery industry to develop performance standards to assist container designers and "to continue to study and pursue the standardization of shipping container dimensions to a reasonable number of sizes" [8].

Even though the joint industry study did not fully explore the dimensional standardization or modularization option, the study will have important implications for future shipping container design and the potential for modularization.

A. Reducing Informational Barriers. The joint industry study should remove an important information and communication barrier to modular package adoption described earlier in the report. Given participants' diverse interpretations of the modular concept, there is a clear need to define and clarify shipping container improvements and issues. The joint industry study's broad approach of identifying, classifying and analyzing opportunities to improve shipping container design should go along way toward addressing this need. Since the entire spectrum of package improvements has been defined, the potential exists for a common understanding of the modular concept and, therefore, for more informed discussion among industry participants.

B. Partial Standardization. As noted, the final report of the joint industry study of shipping container design recommended the formation of a joint study committee to implement standard shipping containers for products in like retail packs. The likelihood of implementing this option should be high since marketing resistance would be reduced or eliminated due to the fact that retail packages would be unaffected. Also, a smaller number of manufacturers would need to participate since only 11 percent of dry grocery case volume would be affected. If this "partial standardization" step is accomplished and cost savings are demonstrated, the impetus may be provided for working toward the more substantial savings of a fully standardized or modular container system.

5.0 Industry Options to Accelerate Modularization

Based on the analysis of barriers to modularization, several alternative courses of action for the food industry were developed which should accelerate modularization. Two such innovations are discussed below.

5.1 Direct Product Costing Based on Modularization Savings

This innovation attempts to incorporate the more widespread, longer-run benefits of modular packaging into distributor decisions. This innovation would involve three steps: 1) operationalizing the modular concept into a series of sizes and quantifying the savings of this system; 2) development of comparative factors for all existing container sizes; and 3) implementing direct product cost factors reflecting modularization savings in distributor decisions.

5.1.1 Operationalization and Quantification

The modular concept needs to be taken from a concept to a specific series of modular sizes. Once this is done, it would be possible to precisely calculate the savings for each warehouse type. The objective would be to calculate the cost of distributing products as if they were all, or a substantial portion, were in modular containers.

5.1.2 Development of Comparative Cost Factors

Once the savings for a selected modular package system were known, the next step would be the development of cost factors for all existing container sizes. For example, a cost factor could be based on the degree to which a particular container deviated from a modular size. These cost factors could then be utilized in a direct product cost model which would calculate the individualized cost of handling an item.

The purpose of the model is to provide incentives to manufacturers to make changes in package sizes which lead toward a modular package system. As noted, a fundamental problem for creating incentives for modularization is that no one manufacturer can produce any benefit for a distributor until a threshold is reached. Thus, no supplier can capture the benefits of its efforts toward the development of a modular system. This innovation is designed to circumvent this incentive problem by offering a reward of a reduced cost factor assigned to a modularized product. The reduced cost factor represents the benefits which would accrue in the longer-run after the threshold is reached. In essence, the innovation attempts to reflect benefits which will accrue in the future from the contribution of a manufacturers' conversion of a container to a modular size into present costs (prices).

5.1.3 Implementation of Direct Product Costing

This institutional innovation would depend upon the widespread use of direct product cost data by distributors. The generation of individual product cost data would not be enough. Some mechanism needs to be developed to ensure that this information in used by decision makers. For example, for buyers to use direct product cost as a criterion in their decisions, a reinforcement mechanism must be devised to assure its continued use. The point is that direct product cost

information may be generated but its use depends upon the incentives firm decision-makers face.

A second problem for implementation concerns industry-wide adoption. Interviewees felt direct product costing would not be important because it was at odds with competitive factors which drove decision making, particularly in pricing. Respondents concluded that use of direct product cost information in pricing would only work if all distributors used it.

The use of direct product cost information in distributor decisions could improve vertical coordination and produce incentives for modular packaging if the cost factors discussed above are incorporated. The impact on sales should provide the necessary information and incentives to manufacturers. However, the information content of the economic signal would be increased if manufacturers were aware of cost factors being applied to their products. Thus, a complementary practice would be to send each manufacturer a product cost profile of their products.

5.2 A System for Monitoring Modular Container Adoption

A modular packaging system could be operationalized, its net benefits documented, and trade association guidelines developed, yet the implementation of the system would be up to individual firms. A implementation monitoring system could be developed to encourage manufacturer adoption.

A monitoring system would keep track of the degree of adoption of modular containers by individual manufacturers and the aggregate level of industry adoption. It could be established and supported by distributors through their trade associations. The primary function of this monitoring system would be to survey manufacturers' products and compile information through time about adoption. This information would then be disseminated on a regular basis to key decision-makers in food manufacturing and distributing companies.

The monitoring program could promote the adoption of voluntary guidelines for modular containers in four ways. First, the favorable publicity given to firms that take the initiative to implement modular containers could serve as positive reinforcement needed to encourage participation of such firms. Second, a monitoring system would increase peer pressure to move firms toward the adoption of modular containers. If enough manufacturers begin to convert their packaging, the program increases the visibility of firms that are unwilling or slow to adopt. Third, distributors could use information on the adoption rates of various manufacturers as a criterion in their decision making. For example, buyers and merchandisers may consider the level of adoption of modular containers as a qualitative factor in their decisions. Fourth, a monitoring system would keep focus on the modularization issue after research was completed. It would provide the measuring stick to indicate progress being made and help sustain interest in achieving system-wide innovations that take a long time to accomplish.

6.0 Public Policy Implications

Available evidence indicates that modularization of shipping containers has a significant potential to improve performance of the food distribution system. However, this study found a wide array of factors acting as barriers to adoption of this innovation.

Food system participants' failure to adopt an innovation with considerable savings potential raises some important issues for public and private decision-makers. Existing institutions appear incapable of generating incentives for food industry firms to adopt modular containers. These institutional barriers suggest that modularization will not occur unless: 1) a participant is willing to assume a leadership role and place the interest of the total system and the consumer above its individual interest; or 2) the current institutions are adjusted to change the incentives to participants. With regard to the latter, several institutional innovations which the private sector could implement were described in Section 5.0. The focus here is upon institutional changes public decision makers could affect to foster modular container adoption.

6.1 Public Policy Options to Foster Modularization

The options available to public policy-makers for accelerating modular package adoption can be viewed along a five-part continuum. Located in the first position on this continuum is increased research and development on modularization and the dissemination of the resultant information. Research could be initially focused upon the areas of modularization impacts that are most uncertain. Provision of more quantifiable estimates of benefits and costs to certain groups may provide the impetus for participants to act to implement this innovation.

Second, government could be proactive in implementing modular packaging by reducing barriers related to communication and collective decision-making among and between the various industries. For example, government agencies conducting modularization research could sponsor or support in conjunction with private organizations conferences or symposia on modularization. The cost of collective transactions could also be reduced by having federal antitrust authorities further specify procedures to reduce the risk of public antitrust prosecution and, in particular, private suits. This would help to allay concerns about the risk of persecution and should reduce the cost of collective transactions needed to discuss and agree upon standards having the purpose of improving productivity.

A third option is for government to use its power as an economic agent in the marketplace to create incentives of modularization. Government agencies or firms having government contracts could play a catalytic role in implementation if they only procured food in modular shipping containers. Establishing a stable demand for modular packages would provide assurance that the innovation will be generally adopted and therefore could induce firms to adopt the innovation.

Fourth, government could directly affect participants' incentives to adopt modular containers by changing tax policies or providing subsidies. For example, tax credits could be increased for investments made by manufacturers to change equipment to produce modular package sizes. Subsidies could be utilized to compensate particular segments of the industry that were disadvantaged by modularization to obtain their cooperation.

A final policy at the extreme end of the continuum is to change the property rights to determine shipping container size. These rights could be shifted from manufacturers to a government agency that would regulate container sizes or to another food system participant.

6.2 Elements of An Appropriate Public Policy Response

The type and extent of public policy response to the existence of an unexploited opportunity to improve food system performance should depend on present and likely future private sector initiatives. Several developments, particularly the increasing acceptance by major industry leaders of a "systems approach," will probably increase the potential for reducing food distribution costs through improved shipping container design. The joint industry study recommendation for the "partial standardization" step of standardizing containers with like retail packs may indicate that private sector initiatives may at some future point be extended to include a complete modular packaging system. Therefore, given no major change in present public policies, it is possible that continued private sector initiatives may very well result in the longer term to implementation of a complete modular container system.

The above conclusion, based largely on some positive recent developments, has implications for the appropriate public policy response. If private initiatives will eventually result in modularization, the relevant policy question is: How can changes be made to accelerate this process? Assuming that the trends noted above continue, the most appropriate policy options are the first positions on the continuum described in the previous section. The first option, increased research and development and the dissemination of results, is further discussed below.

There are two additional reasons for focusing on the public policy option of increased research on modular shipping containers. First, a major study finding was that the lack of precise information on the effects of modularization was a barrier to its adoption. Research quantifying the effects of specific modular container systems would clearly contribute to the implementation process. Removing this information barrier is elevated in importance when viewed along with another key research finding. A major theme emerging from the research results was the inherently "system-wide" nature of modular container implementation problem. Many executives in food industry companies believe that one firm can do little individually to move the modular concept toward reality. Consequently, no manufacturing or distributing firm has been willing to take the lead in modularization. Clearly some firms have become large enough to significantly affect the

implementation process. In particular, the trend toward greater consolidation in the food distribution industry and the informational advantages associated with scanning have increased distributors' bargaining power with manufacturers and therefore their ability to affect modular container adoption. While these firms may now have the capacity to affect change, the factor which may be inhibiting action toward modularization is the lack of precise knowledge of the benefits that would accrue to them. Therefore, government research which produced further information on modularization benefits and is likely to accelerate the implementation process.

A second rationale for greater government research concerns the scope of private sector research efforts. There is presently a lack of information about modularization effects. Given the relegation of container standardization or modularization to a long-run industry priority in the A. T. Kearney study recommendations, this information void will continue to exist. The tendency for industry-sponsored research to focus on high-probability short-run improvements which effect few manufacturers suggests a role for government to fill this void by supporting research on broader opportunities with larger long-run payoffs, such as modularization. By increasing government research on this impacts of this innovation, an important category of barriers to implementation could be reduced or eliminated.

6.3 Recommendations for Further Research on Modularization

As noted, greater knowledge of modularization and its effects could be the critical ingredient needed to spur implementation. Four promising research areas are proposed below.

6.3.1 Defining and Operationalizing the Modular Concept

Participants' diverse interpretations of the modular concept has contributed to communication problems which impede implementation of modular packaging. Some of these problems have been or will be solved by the joint industry study of shipping container design. However, the modular concept has not yet been put into operation. While many participants hold beliefs about the nature and extent of the effects of the general term "modularization," the effects are very likely to differ depending on the specific modular sizes chosen and the implementation period.

Operationalizing the modular concept into one or more specific systems would likely have several positive impacts upon implementation. First, it would allow discussion to focus on specific alternatives thereby reducing the chance of miscommunication. Second, it would allow precise identification and measurement of impacts. Third, operationalization would take modularization from the category of "ideal" innovations to a concrete alternative. For example, a possible approach is to devise several alternative modular systems, each having a different total number of and specific sizes. Options for study would include practical "partial modularization" systems, which could be the first step toward the implementation of a full modular program. A system of modular container heights is described in the next section.

6.3.2 Identifying and Quantifying the Effects of Alternative Modular Packaging Systems

As noted above the exact nature and magnitude of impacts depend upon the specific modular system developed. Benefits and costs should be estimated and compared for each alternative that is operationalized. Thus, the general question of whether modularization is worthwhile (i.e., produces net benefits) should be refined into: 1) which specific alternatives have positive net benefits?; and 2) which alternatives produce the greatest net benefits?

One of the alternatives which should receive further in-depth study is a system of modular container heights. The height dimension is critical to increasing the potential for further distributor warehouse automation and to increasing container stackability in warehouse operations. Also, conversion costs may be lower for this option. Research is needed to quantify the benefits and costs of this promising alternative.

The effects of each alternative modular system should be assessed for at least four levels: distributor warehousing and transportation, retailing, manufacturing, and the consumer. While currently the most is known about distributor level impacts, much additional work needs to be done. Benefits which have been identified (e.g., warehouse space use, worker training) need to be quantified. Categories of benefits which would not immediately occur but which would stem from the adoption of modular containers (e.g., warehouse automation, development of alternative distribution channels) should be further explored and quantified.

A second recommended research area is at the retail store level. A number of potential benefits (e.g., cartridge shelf leading, modular display units, and reduced damage) have been identified 12;18] but have not been quantitatively assessed. The benefits of the "partial" step of modularizing case heights to fit standardized store shelving systems at the retail level may be a fruitful area of study. The potential benefits of modular containers in various store formats have thus far only been speculated about and therefore deserve further investigation.

Third, the possible benefits and costs of modularization for manufacturing firms need to be identified and quantified. The diverse nature of the grocery manufacturing industry will make this a difficult task. However, it should be possible to identify common classes of effects and aggregate costs for the industry.

Conversion costs are a particularly important area of study. Each alternative modular system would need to be evaluated for the degree of retail package impact. The technical relationships between retail packaging, case counts, and shipping containers must be understood before such costs can be accurately known. Conversion costs will be very sensitive to the period of implementation.

The effects of implementing each modular system upon consumers is a fourth level of impact worthy of further study. This effect would be correlated with the degree of retail package limitation. However, it is possible that a change in case pack could affect consumers through changing the amount of product displayed on supermarket shelves.

6.3.3 The Threshold Concept

This research hypothesized that modularization was one of a class of innovations for which a threshold level of adoption was needed to produce savings. Some limited evidence was found to support the hypothesis in the study. An important research need is to further document the threshold's existence and, more importantly, to determine its characteristics.

Knowledge of the level at which adoption of modular containers will actually yield savings is critical for several reasons. First, knowledge of the threshold is need to place estimates of the benefits of modularization in context. The benefits of any "partial modularization" steps will depend upon the nature of this threshold. For example, A. T. Kearney's recommended that the industry pursue standardizing shipping containers with the same retail package. A key question is whether this partial step of standardization affecting 11 percent of products would achieve benefits similar to modularization. Whether this or other piecemeal approaches can produce benefits similar to modularization depends upon the characteristics of this threshold.

Second, the threshold's characteristics should be specified in order to precisely calculate savings. If and when modularization is implemented, the change will take place gradually. To know the precise benefits of a specific implementation plan, it is necessary to know when benefits will begin to accrue. The time period in which the benefits accrue will affect their value to food industry participants.

6.3.4 Investigation of the Implications of Information System Advances

Information system advances were identified as a development with the potential to affect shipping container design improvements and possibly modularization. This development warrants considerable further study for several reasons. First, the extent to which vertical coordination barriers (e.g., ineffective internal communication within a firm) will be reduced depends on whether individual product cost information is used by distributors on a widespread basis. Numerous other shipping containers improvements will probably not be made unless these vertical coordination barriers are removed. Second, direct product cost analyses' ability to create incentives for industry-wide innovations deserves further study. This study suggested that such information alone may be insufficient to create incentives for change because of the existence of an adoption threshold. Further study of this problem and the potential of the institutional innovation proposed in Section 5.1 to deal with it is warranted.

7.0 Conclusions

Primary and secondary data acquired in this research project indicate that standardizing shipping containers for dry grocery products into a modular packaging system can significantly improve productivity and reduce costs in the food system. It was concluded that one or more modular container systems could be developed that would be capable of producing net system savings and reducing food prices. However, food industry participants have not successfully developed and implemented a modular packaging system.

The interview results indicated that participants perceive a number of diverse factors as obstacles to modularization. Analyzing modular container adoption incentives led to the identification of implementation barriers. Several distributor internal decision making practices were found to weaken and possibly eliminate the incentive for manufacturers to make shipping container improvements which would lower distributors' costs. This research also identified a number of factors which diminish the incentives to individual manufacturing and distributing firms to implement industry-wide innovations such as modular packaging.

Two recent developments with the potential to affect modularization were described: first, the use of individual product cost data in distributor decision making was shown to have the potential for creating incentives for a manufacturer to implement shipping container improvements which, by its action alone, would produce savings to distributors. Because of the industry-wide adoption needed for modularization, these developments alone are unlikely to generate incentives to manufacturers to modularize their products. Second, the objectives, scope and preliminary results of a joint industry study of shipping container design were reviewed. The study's identification of the many possible shipping container improvements should reduce certain informational barriers to modularization. It was also predicted that the in-depth analyses of a "partial" standardization option and its possible implementation may lead to achieving the much greater savings available through modularization.

The lack of adoption of an innovation having significant savings potential raises several questions for public policy. A key question is: what changes in present policies might be made that would accelerate the adoption of modular packaging? Options were outlined for affecting key categories of implementation barriers. Given continued private sector initiatives, a governmental role emphasizing the removal of informational barriers through research on modularization and public actions to reduce the cost of collective transactions among food industry participants was recommended. A number of specific topics for future research were identified.

A common thread in the research findings is the "system-wide" nature of the problem of implementing modular packaging. Many executives in food industry companies believe that a single firm can do little <u>individually</u> to move the modular concept toward reality. Since savings depend on a significant proportion of products being packaged

in modular containers, the economic incentive to an individual firm to work toward implementation of modular packaging is weakened. The expanded use of individual product cost data by distributors is unlikely to overcome this threshold problem. However, many companies in both the manufacturing and distributing sectors are clearly large enough to significantly affect the implementation process. The critical problem appears to be that none of these firms has yet taken a leadership position in the area of secondary container standardization and modularization. Therefore, if no significant changes are made in public policies, the rate at which modularization savings are realized will depend on how quickly a major firm or firms assume a leadership role.

The joint industry sponsored study of shipping container design, a problem area recognized for over a decade, indicates that some industry participants are willing to take the lead in this general area. If support for a "systems approach" to lowering total food industry costs continues, these efforts may eventually be directed toward the area which appears to offer the greatest savings -- standardization and modularization of shipping container dimensions.

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