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# MARKET STRUCTURE AND TECHNOLOGICAL PERFORMANCE IN THE FOOD MANUFACTURING INDUSTRIES



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# CHAPTER 7. ORIGINS OF IMPORTANT INNOVATIONS INFLUENCING PRODUCTIVITY OF FOOD MANUFACTURERS

## INTRODUCTION

Patents have various shortcomings as indicators of inventive activity, especially the failure to discriminate among inventions and innovations of different quality. An alternative method of determining the origins of inventions is to identify those recognized as being most significant.

Jewkes, *et al.*, used this method in identifying the sources of 60 of the most important inventions in the Western World. Hamberg investigated 27 of the most important innovations in the steel industry, and Mueller investigated the 25 most important innovations of the DuPont company. Here, we undertake an examination of important innovations in a single subsector of the economy, food manufacturing.

The first obstacle in applying this research method is identifying significant discoveries on an objective basis. Fortunately, the Putman Food Awards provide a comprehensive compilation of many of the most significant innovations in food manufacturing since 1966.

## THE PUTMAN FOOD AWARDS

The Putman Food Awards were initiated "to recognize major advances which have made significant contributions to more efficient and effective operation of the food processing industries."<sup>1</sup> This awards program is conducted by the editors of *Food Processing*, a leading trade journal in the food-processing industry. The competition is open to "food processors and the companies supplying ingredients, processing systems, instrumentation, packaging, production aids, and aids to maintaining plant equipment in operable and sanitary conditions." The likelihood of bias by company size is reduced because "no limit is placed on the number of entries from a single company."<sup>2</sup>

Approximately 60 awards are given each bienium. Although awards are not ranked by level of importance, they are divided into two categories: "Top Honors" and "Honors," with about 22 percent receiving Top Honors.<sup>3</sup> In addition to identifying the award recipient (or recipients when an award is given to more than a single party), the nature and significance of the recognized product is described.

## PURPOSE AND NATURE OF THE ANALYSIS

The Putman Awards provide a potentially rich source of information concerning the origins of significant discoveries that improve the efficiency of the food-processing system. By obtaining supplemental information from the award recipients, it is possible to gain insights into a number of important matters relevant to the purpose of this study.

Just where do these discoveries originate? What are the characteristics of the recipients, especially their size and the industries from which they originate? Have the products proved to be commercially successful in the years since they were identified as having considerable economic promise? To what extent have these

discoveries been patented in the United States and abroad? Did the recipients view patents as an important stimulus to inventive effort?

To answer these and other questions, questionnaires were sent to all those who received Putman Food Awards in 1971, 1973, 1975 and 1977.<sup>4</sup> These awards covered discoveries for the years 1969 through 1976. To gain additional information, samples of award recipients in 1975 and 1977 were interviewed.

Before turning to our findings, we consider the types of technological advance represented by the products recognized by Putman Food Awards. Studies of technology often differentiate between invention and innovation, though such a distinction may be difficult or even impossible in particular cases. However, here we characterize the products receiving Putman Awards as innovations<sup>5</sup> rather than inventions, though they often involve elements of each: inventions insofar as they are new products, and innovations because they have been carried to, and often over, the threshold of commercial usage. Indeed, to qualify for consideration for a Putman Award a product must "have made significant contributions to more efficient and effective operations of the food processing industries."<sup>6</sup> Thus, they have, to some degree at least, been subjected to the test of the market place, the ultimate arbiter of technological success or failure.

## **CHARACTERISTICS OF INNOVATIONS RECEIVING AWARDS**

As already noted, Putman Awards were given for those innovations that improve the efficiency and effectiveness of food processing and manufacturing. Not surprisingly, therefore, most are for mechanical apparatus, process control systems, plant design, and construction and materials handling. Two major exceptions are awards for ingredients and industry development.

We have classified these awards into five fairly distinct categories with several subcategories.<sup>7</sup> Although *Food Processing* did not follow the same classification system, we believe the categories used herein represent meaningful differences in the functions performed. The nature of the awards reported in each of the five categories are described below and summarized in Table 7.1. These awards are divided between those receiving "honors" and "top honors." About 22 percent were placed in the latter class, reflecting the judges' views that these were the most meritorious products.

### **Category I: Production Machinery and Equipment, etc.**

This category includes equipment, systems, and inputs that are directly related to the plant production line. One large group of these awards went to *processing equipment and machinery*. Among the innovations cited were blenders and mixers that give improved continuous performance, color sorter for rice, dry and wet products, sealed motors and drives with smooth surfaces for easy sanitation, freezing systems, several products that peel and/or pit raw products, and heating systems used in processing. Among the top-honor winners in this area was United States Steel for an aseptic canning system for containers in the 2- to 5-gallon range. Previous systems could produce only larger or smaller containers.

A second group of awards went to *processing systems*. This subcategory is distinguished from the one above in that it pertains to innovations that usually comprise a complete process or subprocess rather than a component in a process. The award-winning processing systems included systems with wide application, such as freezers, extruders, drum fillers, and aseptic bulk storage

systems. Systems with specialized applications were also recognized; among them a continuous dry-popcorn popping system, an onion-ring fabrication system, a palm-oil refining system, and a soy-grits production facility.

**Table 7.1. Putman Awards Received by Various Award Categories, 1971-1977.<sup>a</sup>**

| Award Category                               | Number of Awards |            |            | Percent of Total Awards | Percent of Honor Awards | Percent of Top Honor Awards |
|--|------------------|------------|------------|-------------------------|-------------------------|-----------------------------|
|  | Total            | Honors     | Top Honors |                         |                         |                             |
| <b>Category I</b>                            |                  |            |            |                         |                         |                             |
| Processing Equipment & Machinery             | 52               | 38         | 14         | 21%                     | 20%                     | 25%                         |
| Processing Systems                           | 24               | 16         | 8          | 10                      | 8                       | 15                          |
| Process Control & Laboratory Instrumentation | 30               | 24         | 6          | 12                      | 13                      | 11                          |
| Packaging & Packaging Machinery              | <u>42</u>        | <u>29</u>  | <u>13</u>  | <u>17</u>               | <u>15</u>               | <u>24</u>                   |
| Subtotal                                     | 148              | 107        | 41         | 60                      | 56                      | 75                          |
| <b>Category II</b>                           |                  |            |            |                         |                         |                             |
| Food-Plant Maintenance & Engineering         | 14               | 14         | 0          | 6                       | 7                       | 0                           |
| Food-Plant Construction                      | 9                | 8          | 1          | 4                       | 4                       | 2                           |
| Cleaning/Sanitation                          | <u>19</u>        | <u>17</u>  | <u>2</u>   | <u>8</u>                | <u>9</u>                | <u>4</u>                    |
| Subtotal                                     | 42               | 39         | 3          | 17                      | 20                      | 5                           |
| <b>Category III</b>                          |                  |            |            |                         |                         |                             |
| Materials Handling and Distribution          | 26               | 22         | 4          | 11                      | 12                      | 7                           |
| <b>Category IV</b>                           |                  |            |            |                         |                         |                             |
| Ingredients                                  | 27               | 21         | 6          | 11                      | 11                      | 11                          |
| <b>Category V</b>                            |                  |            |            |                         |                         |                             |
| Industry Development                         | 3                | 2          | 1          | 1                       | 1                       | 2                           |
| <b>TOTAL</b>                                 | <b>246</b>       | <b>191</b> | <b>55</b>  | <b>100</b>              | <b>100</b>              | <b>100</b>                  |

<sup>a</sup> This table reflects the number of innovations winning awards from 1971-1977; awards with more than one recipient have been counted only once. Fourteen different innovations had multiple recipients: nine had two recipients and five had three recipients.

Note: Totals may not add due to rounding.

Two of the innovations that received top honors in the area of processing systems are of special interest. One of these was the Infrared Anti-Pollution Peeling Process developed by the USDA Western Regional Research Laboratory and Magnuson Engineers, Inc. The judges characterized this innovation as "unquestionably the most significant ecological advance in food processing to date." Instead of using the conventional peeling process which uses water sprays to remove skin that has been softened by caustic treatment, this process uses high-temperature infrared irradiation and rotating rubber rolls within flexible fingers to remove the peel which has been treated with a caustic dip. The innovation is significant ecologically because most of the waste from the process is in

solid form that can be used as animal feed, and total waste production is reduced by 75 percent thereby resulting in lower waste-treatment costs.

The second innovation of special interest in this subcategory is the Sterideal system available from Stark Food Machinery, Inc. This system sterilizes and homogenizes milk by exposing it to very high temperatures for short periods. Milk processed with this system, if aseptically canned, has a shelf life of up to six months without refrigeration while its taste, viscosity, and texture does not differ appreciably from that of conventionally processed milk. The widespread use of this system in the United States would have revolutionary effects on the retailing, transportation, and storage of milk products as well as on raw-milk production.

Equipment used in *process control and laboratory instrumentation* represents the third group of award-winning innovations in Category I. Some of the factors measured by equipment in this subcategory are moisture, ammonia, weight, sugar, alcohol, color, flow, and nitrogen. Many of these innovations display information to a monitor and/or have the capability of feeding information to a computer which automatically makes corrections in the processing lines.

*Packaging and packaging-machinery* innovations comprise the fourth subcategory. Among the packaging innovations cited were plastic rings that prevent tampering with products with screw lids, a system for centralized packaging of frozen meat cuts, a new half-pint carton for milk, and several types of packaging that allow for differential heating, either in conventional or microwave ovens, of foods contained in a single package. Award-winning packaging-machinery innovations were primarily improvements in methods of packing cases, applying labels, and readying boxes for the product. Top honors in this category went to Excel Engineering, Inc. for its ExCel-O-Matic automatic packaging machinery. This system was recognized as the first successful mechanical packer for meat patties and other similar fast-food-industry products. The system, it is claimed, reduces labor costs by 70 to 85 percent because it is automated and reduces storage and transportation costs due to the more compact packages used.

Fully 60 percent of all Putman Awards given between 1971 and 1977 were for innovations in Category I (Table 7.1).

## **Category II: Food Plant Maintenance, Construction and Sanitation**

The awards given in this category recognize innovations in the design of plants, materials used in their construction, maintenance of plant equipment, and cleaning and sanitation within the plant. Innovations cited in the area of *food-plant maintenance and engineering* include several tools that can be used to repair valves, lines, and tubes without shutting down the entire piece of equipment, as well as bearing seals, air scrubbers, and heated tape to prevent frozen pipes.

In this area of *food-plant construction*, awards were given for a modular plant design that anticipates and allows for future growth of the plant, two complete designs for processing plants, and several types of insulating panels used in wall and ceiling construction. A major feature of many of these panels is that they retain their insulating value over time because they are impervious to water vapor.

The innovations in the area of *cleaning and sanitation* were in large part systems that deliver either hot or cold cleaning solutions. Also included were vacuuming equipment, a self-cleaning conveyor, and equipment for fly and rodent control. Receiving top honors in the area of cleaning and sanitation were Biocidal

Systems for its electrolytic sanitorizer which turns water and salt into chlorine for disinfecting purposes at a greatly reduced cost, and Birko Chemical for its Contact-It bacteria-sampling device, a sanitary tape that can be laid on a surface and then picked up and tested for the presence of bacteria.

Awards given for innovations in Category II represented 17 percent of the total innovations receiving awards.

### **Category III: Materials Handling and Distribution**

A number of awards given in this category of innovations recognized improvements in finished goods, pallets, cartons, and conveyor systems that move products. Other awards were for innovations that relate to warehousing operations. These innovations included rack systems for pallets, automatic warehousing systems, and warehousing systems for existing facilities. Honeywell, Inc., for example, received a top honors award for the development of the Midas Middleground Warehouse System. This system allows a company to use computer monitoring and record keeping without making the large investment necessary for a completely automatic warehouse system.

Awards were also given for innovations that aid transportation of materials. These innovations included a tri-wheel electric truck, a refrigeration system for delivery trucks, and two-rail cars that handle dry goods such as sugar and starches in bulk. An unusual Category III innovation is an empty-can combining-and-separating system developed by Filper Corporation a subsidiary of DiGiorgio Corp. This equipment consists of a machine used by can manufacturers to place small cans inside larger ones for shipping plus equipment at the user's plant which then separates the cans. This innovation was given top honors in recognition of the resultant savings in handling, shipping, and space requirements.

Innovations receiving awards in this category comprised 11 percent of the total (Table 7.1).

### **Category IV: Ingredients**

Innovations receiving awards in this category were largely made up of new substances developed to replace ingredients that were expensive, in uncertain supply, and/or were of wide variability in quality. For example, Norda, Inc. was honored for developing spice grains, a line of spice replacements which are of uniform strength and color and have a natural appearance. Another award was given to National Starch and Chemical Corp. for Tom-Ex, a line of tomato extenders that could be used to replace between 35 percent and 50 percent of the tomato solids used in processing foods. Other awards went to new dyes, sweeteners, yeasts, and additives which act as product stabilizers and which extend the shelf life of products. One of the most significant innovations in this subcategory is a corn-germ flour developed jointly by Lauhoff Grain Co., USDA-Northern Regional Research Center, and Kansas State University. The flour innovation was given top-honor recognition as the first food ingredient containing high-quality protein processed from dry-milled corn and as a new protein and fiber source.

The Putman Awards granted to innovations involving ingredients represented 11 percent of the total.

## **Category V: Industry Development**

Awards for industry development were given for three innovations that have widespread application for the entire food-processing industry or a particular sector. One award went to the Lamb-Weston Division of Amfac, Inc. and the Olin Water Services Division of the Olin Corporation for a system that uses chlorine dioxide to control bacterial growth in water used for slicing and cooling potatoes. This system, which has applications in many fruit-and-vegetable-processing plants, conserves water and reduces water-treatment costs. A second award went to the Robert Mondavi Winery for the commercial application of centrifuges in the wine-making process. Centrifuges are used to remove grape pulp from juice prior to fermenting white wines and to remove yeast lees from both red and white wine after the first fermentation. A top honors award was given to the U.S. Army Natick Research and Development Command, Innovative Foods, Inc., and Oregon Freeze Dry Foods, Inc. for the joint commercial development of compressed food products. While offering many of the product advantages identified with freeze drying and other dehydration techniques (e.g., long shelf life, light weight), compressed products offer the added advantage of greatly decreased volume. The processing technique can be applied to a wide variety of fruits and vegetables as well as prepared salads and main dishes.

The three awards given for innovations in industry development represented 1 percent of all awards.

### **INDUSTRY OF AWARD RECIPIENTS**

Table 7.2 groups the recipients of Putman Awards according to the primary line of business of their parent firm. This is not a totally accurate representation of the industry origin of award-winning innovations since a firm receiving an award may be outside a parent firm's main line of business. One award recipient, for example, Specialty Foods Company, a machinery-manufacturing firm that is a Beatrice Foods Company subsidiary, appears in the category of food processor. Similarly, Amoco Foods Company, an ingredient supplier, is listed under the "other" category to reflect the primary business involvement of its parent firm, Standard Oil of Indiana.

Considering the nature of most of the award-winning innovations, as discussed above, it is not surprising that firms in four industry groups accounted for more than 60 percent of awards going to U.S. corporations. These four industry groups are: machinery manufacturing (36 percent); plant maintenance, sanitation and design (12 percent); instrumentation and controls (8 percent); and paper and packaging (6 percent). Manufacturers of food and of ingredients used in food received only 13 percent of the awards.<sup>8</sup>

Government-sponsored researchers received top honors for all of their innovations recognized in the competition while only 25 percent of all recipients received top honors. This suggests that government research laboratories were less inclined than those in corporations to submit for competition innovations of lesser importance. The small number of government 1-based recipients (four) also suggests that government researchers devote proportionately more of their time to fundamental research than do researchers in private corporations. As a result, the fruits of government research are more likely to fall in the pre-innovation stage. As discussed previously, government agencies working with private firms were involved developing several of the innovations described as being especially important (see the discussion under category I, Category IV, and Category V).



**Table 7.2. Distribution of Putman Awards by Size and Primary Line of Business of Parent Firm of Recipient, 1971-1977.**

| Recipient's Primary Line of Business        | Size Unknown                                | Under \$1           | \$1-10               | \$11-100<br>(millions of dollars) | \$101-500           | Over \$500           | Total U.S. Firms                  | Government | Total Foreign Firms | Total  |
|---|---|---------------------|----------------------|-----------------------------------|---------------------|----------------------|-----------------------------------|------------|---------------------|--|
| Food Processor and Ingredient Manufacturers | 2 (0) <sup>a</sup>                          | 1 (0)               | 2 (0)                | 7 (5)                             | 11 (3)              | 9 (3)                | 32 (11)<br>13% (19%) <sup>c</sup> | 0          | 2 (1)               | 34 (12)<br>13% <sup>d</sup> (18%) <sup>e</sup> |
| Machinery Manufacturers                     | 5 (1)                                       | 14 (5)              | 42 (19)              | 15 (5)                            | 4 (1)               | 9 (2)                | 89 (23)<br>36% (40%)              | 0          | 4 (1)               | 93 (24)<br>35% (36%)                           |
| Plant Maintenance, Sanitation & Design      | 3 (0)                                       | 7 (1)               | 11 (1)               | 2 (0)                             | 6 (0)               | 1 (0)                | 30 (2)<br>12% (4%)                | 0          | 0 (0)               | 30 (2)<br>11% (3%)                             |
| Instrument & controls Manufacturer          | 0 (0)                                       | 3 (1)               | 7 (1)                | 1 (0)                             | 5 (1)               | 4 (1)                | 20 (4)<br>8% (7%)                 | 0          | 3 (1)               | 23 (5)<br>9% (7%)                              |
| Packaging & Paper                           | 1 (0)                                       | 0 (0)               | 2 (0)                | 2 (1)                             | 6 (1)               | 5 (0)                | 16 (2)<br>6% (4%)                 | 0          | 0 (0)               | 16 (2)<br>6% (8%)                              |
| Chemicals & Paint                           | 1 (0)                                       | 1 (0)               | 2 (1)                | 1 (0)                             | 1 (0)               | 8 (2)                | 14 (3)<br>6% (5%)                 | 0          | 0 (0)               | 14 (3)<br>5% (4%)                              |
| Other <sup>f</sup>                          | 10 (2)                                      | 7 (2)               | 3 (1)                | 2 (0)                             | 3 (1)               | 22 (6)               | 47 (12)<br>19% (21%)              |            | 4 (3)               | 51 (15)<br>19% (22%)                           |
| TOTAL                                       | 22 (3)<br>9% <sup>b</sup> (5%) <sup>c</sup> | 33 (9)<br>13% (16%) | 69 (13)<br>28% (23%) | 30 (11)<br>12% (19%)              | 36 (7)<br>15% (12%) | 58 (14)<br>23% (25%) | 248 (57)<br>100% (100%)           | 4 (4)      | 13 (6)              | 265 (67)<br>100% (100%)                        |

Note: The totals in this table differ from those in Table 7.1 because included here are the total number of recipients rather than awards, i.e., awards with multiple recipients are counted once for each recipient.

<sup>a</sup>Number of top honors awards in parentheses.

<sup>b</sup>Percentage of total U.S. awards.

<sup>c</sup>Percentage of total U.S. top honors awards.

<sup>d</sup>Percentage of total awards.

<sup>e</sup>Percentage of total top honors awards.

<sup>f</sup>The other category includes 14 awards to firms whose primary line was unknown, 12 to large predominately manufacturing conglomerates, seven to firms in basic industries such as steel, oil and aluminum, four to equipment importers and/or distributors, two to independent research firms, and 12 to firms in diverse other fields.

## SIZE OF AWARD-WINNING FIRMS

The corporations that received Putman Awards between 1971 and 1977 represent a broad spectrum of sizes. (All references to size are to the sales of the recipient company in the year it received the award.) The majority of the awards, however, went to very small firms. Fully 40 percent of all awards to U.S. corporations went to firms with sales below \$10 million, not including the 9 percent that were given to firms of undeterminable size (Table 7.2), but the great majority of which can safely be assumed to be small businesses. Small firms also accounted for nearly one-half (44 percent) of all of the awards designated as "top honors."

A significant share (12 percent of the total awards and 19 percent of "top honors") of the remainder of the awards given to U.S. corporations went to modest-sized firms, those with sales of \$11 million to \$100 million (Table 7.2).

At the other extreme, corporations with sales exceeding \$500 million received 23 percent of total awards to U.S. corporations and 25 percent of the "top honors." Corporations in the \$101-\$500 million sales range received 15 percent of all awards to domestic corporations and 12 percent of the top-honors awards.

In addition to the 248 awards granted U.S. business firms of all sizes, four were granted to government researchers and 13 to foreign corporations. As was noted for government research, the Putman Awards probably also understate the contribution of foreign companies because these companies are less likely to participate in the competition than are U.S. companies. Nonetheless, foreign corporations did account for significant food innovations, receiving 5 percent of all awards and 9 percent of the top honors. Although Putman Awards understate the contribution of researchers located in government and foreign-corporation research laboratories, both groups have received important recognition in the Putman Award competition.

## Frequency of Patenting Products Receiving Awards

Patents are often used as an index of inventive activity.<sup>9</sup> While many patented products never achieve commercial significance, some R & D efforts result in important new products or production processes which are not sufficiently unique to be patented. Some insights into these matters may be gained by examining the extent to which products receiving Putman Awards are patented.

Patent information was received from 198 recipients (80 percent of the total) of Putman Awards. Of these, 71 percent received patents (Table 7.3, column 5). The propensity to patent was quite high in all five award categories. The lowest patent ratio is in Category II, especially in the food-plant-construction subcategory. Although this may suggest that it is more difficult to secure a patent for innovations in this subcategory, the sample is too small to draw a reliable inference. Even in this case, however, three of the seven products were patented.

Next, we examine the hypothesis that posits that firms are more likely to patent their most valuable discoveries. To test this hypothesis we compare the frequency of patenting products receiving "honors" with the with the frequency of those receiving "top honors." As shown in columns 6 and 7 of Table 7.3, 76 percent of the products receiving "top honors" were patented compared to 69 percent of those receiving "honors".

A sample of firms receiving awards was also asked how important patent protection was to the development of a new product (Table 7.4). By a margin of about two to one, the respondents indicated they believed patent protection was

**Table 7.3. Number of Patents Applied for or Received by Putman Award Recipients by Award Categories, 1971-1977**

| Award Category                               | Number of Awards <sup>a</sup> | Number with Patent Information Available |                   |              | Percent <sup>b</sup> Patented Domestically |                   |              |
|--|-------------------------------|--|-------------------|--------------|--|-------------------|--------------|
|  |                               | Total Awards                             | Top Honors Awards | Other Awards | Total Awards                               | Top Honors Awards | Other Awards |
| Category I                                   | (1)                           | (2)                                      | (3)               | (4)          | (5)  | (6)               | (7)          |
| Processing Equipment & Machinery             | 52                            | 36                                       | 9                 | 27           | 69%  | 67%               | 70%          |
| Processing Systems                           | 24                            | 20                                       | 6                 | 14           | 65   | 83                | 57           |
| Process Control & Laboratory Instrumentation | 30                            | 26                                       | 6                 | 20           | 65   | 50                | 70           |
| Packaging & Packaging Machinery              | <u>42</u>                     | <u>37</u>                                | <u>13</u>         | <u>24</u>    | <u>81</u>                                  | <u>85</u>         | <u>79</u>    |
| Subtotal                                     | 148                           | 119                                      | 34                | 85           | 71   | 74                | 71           |
| Category II                                  |                               |  |                   |              |  |                   |              |
| Food-Plant Maintenance & Engineering         | 14                            | 10                                       | 0                 | 10           | 80   | 0                 | 80           |
| Food-Plant Construction                      | 9                             | 7  | 1                 | 6            | 43   | 0                 | 50           |
| Cleaning/Sanitation                          | <u>19</u>                     | <u>16</u>                                | <u>2</u>          | <u>14</u>    | <u>63</u>                                  | <u>100</u>        | <u>57</u>    |
| Subtotal                                     | 42                            | 33                                       | 3                 | 30           | 64   | 67                | 63           |
| Category III                                 |                               |  |                   |              |  |                   |              |
| Materials Handling & Distribution            | 26                            | 22                                       | 2                 | 20           | 77   | 100               | 75           |
| Category IV                                  |                               |  |                   |              |  |                   |              |
| Ingredients                                  | 27                            | 22                                       | 6                 | 16           | 68   | 83                | 63           |
| Category V                                   |                               |  |                   |              |  |                   |              |
| Industry Development                         | 3                             | 2  | 1                 | 1            | 100  | 100               | 100          |
| Total  | 246                           | 198                                      | 46                | 152          | 71%  | 76%               | 69%          |

<sup>a</sup> This table reflects the number of innovations given awards from 1971-1977. Innovations with more than one winner (i.e., joint awards) have been counted only once.

<sup>b</sup> Percent of number of awards with patent information available.

important. This leaves unanswered the question of whether these firms would have undertaken the research leading to their innovations in the absence of patent protection.

It is clear, however, that once these firms developed new products with substantial commercial promise, they did make considerable use of the patent laws. Doubtless some, and perhaps many, of the 29 percent of the products that were not patented did not embody sufficient new art to meet the standards of the U.S. Patent Office.

**Table 7.4. Firm's View of the Importance of Patent Protection to the Development of New Products For a Sample of 1975 & 1977 Award Winners.**

| Importance of Patent Protection to the Development of New Products | Number of Firms | Percent of Total Firms |
|--|-----------------|------------------------|
| Important  | 48              | 68 %                   |
| Not Important  | 22              | 31                     |
| Depends on the Product   | 1               | 1                      |
| Total  | 71              | 100 %                  |

Note: For an explanation of this sample of firms see footnote <sup>4</sup>, this chapter. A total of 93 percent of those in the sample responded to this question.

In sum, these findings support the hypothesis that if a product has significant commercial promise, there is a high probability that it will be patented. This hypothesis may be particularly applicable to the kinds of products involved here, since practically all were manufactured for use by others. For such inventions, there is little or no opportunity to rely on trade secrets to protect a new discovery.

### SELECTED CHARACTERISTICS OF AWARD RECIPIENTS

In order to gain additional information about the characteristics of Putman Award recipients, a sample was interviewed by telephone. The sample consisted of firms receiving awards in 1975 and 1977. Most of the sample firms are engaged in machinery manufacturing and related types of operations.<sup>10</sup> The award recipients were asked about the factors stimulating the direction of their research activities, the commercial success of the products receiving Putman Awards, the degree of product specialization within their companies, and the means used to disseminate their new products.

#### Factors Stimulating Direction of Research

The research-and-development efforts of Putman Award recipients are aimed at developing new production techniques and processes and improving existing ones. This raises the question of what factors determine the direction of these firms' applied research. To gain insight into this matter, the recipients were asked to express their views on the subject. Their responses indicate that various influences play a role in the process (Table 7.5).

Nearly 25 percent of those interviewed indicated that they had produced a specific product for which food processors had expressed a need. This need might be communicated in various ways. Sometimes food processors explicitly

indicated a need for a new type of equipment. In other cases a food processor simply expressed dissatisfaction with existing equipment.

Most other explanations as to why a specific product was developed suggest that the award-winning firm believed it could turn out a new or better product. It evidently felt it had the capability to meet an existing demand. Additionally as stated by 43 percent of the respondents, the decision to develop a product was based on a combination of the various other factors, which are listed in Table 7.5.

In only five instances did the company make the product solely to fit its own needs.

### Success of Products Receiving Awards

Putman Awards are given shortly after a product has been introduced commercially. Although an award is granted on the belief the product will make an important contribution to the efficiency and effectiveness of the food industry, obviously it is not possible to predict the ultimate commercial success of the product.

**Table 7.5. Sources of Initiation of New Product Ideas For a Sample of 1975 & 1977 Award Winners.<sup>a</sup>**

| Source of initiation of<br>New Product Ideas                               | Number<br>of<br>Firms | Percent of<br>Total Firms |
|--|-----------------------|---------------------------|
| Expressed Needs of Food-Processing Companies                               | 18                    | 23                        |
| Company Evaluation of Current Product                                      |                       |                           |
| Availability & Prospects For Improved Product                              | 8                     | 10                        |
| Company Developed Product With Intention<br>of Interesting Potential Users | 3                     | 4                         |
| Company Evaluation of its Capabilities                                     | 11                    | 14                        |
| Company's Own Needs  | 5                     | 6                         |
| Combination of the Above Sources   | 34                    | 43                        |
| <b>TOTAL</b>   | <b>79</b>             | <b>100</b>                |

<sup>a</sup>All but three firms interviewed responded to the question.

To determine the extent to which products recognized with Putman Awards achieved commercial success by 1978, each recipient was asked to give its own view as to the product's commercial success.<sup>11</sup> The majority attempted to quantify the degree of success. For example, one said its product had been accepted by 85 percent of the industry. Another said its product was successful because it was profitable one year after introduction and promises to become a multimillion dollar business within five years. Although the question obviously lent itself to self-serving responses, by and large the respondents seemed quite frank in their evaluations of their products.

About two-thirds of the award-winning products were viewed as being commercially successful by 1978, and another 17 percent were characterized as

begin moderately successful (Table 7.6). Only 15 percent were reported as failures. For the other 3 percent of the products, the respondents reported that not enough time had elapsed to determine ultimate success, although several reported they believed the products would ultimately prove successful.

The success rate of products receiving top-honor awards was slightly less than those receiving honors. However, when those products of undeterminable success are excluded from the sample, there was no significant difference in the rate of success of products receiving honors and those receiving top honors (Table 7.6).

**Table 7.6. Firm's View of the Commercial Success of Putman Award-Winning Products, 1971-1977.**

| Firm's View of the Commercial Success of Product Given Award | Number of Awards |            |            | Percent of Awards <sup>b</sup> |             |             |
|--|------------------|------------|------------|--------------------------------|-------------|-------------|
|  | Total            | Honors     | Top Honors | Total                          | Honors      | Top Honors  |
| Successful   | 133              | 102        | 31         | 65%                            | 67%         | 58%         |
| Moderate Success   | 35               | 25         | 10         | 17                             | 16          | 19          |
| Not Successful   | 31               | 24         | 7          | 15                             | 16          | 13          |
| Not Commercialized Yet                                       | 6                | 1          | 5          | 3                              | 1           | 9           |
| <b>TOTAL<sup>a</sup></b>                                     | <b>205</b>       | <b>152</b> | <b>53</b>  | <b>100%</b>                    | <b>100%</b> | <b>100%</b> |

<sup>a</sup> Total number of recipients who responded to this question.

<sup>b</sup> Percent of total number of recipients who responded to this questions.

In sum, over 80 percent of the cited products were judged to be either a moderate or an unqualified success by 1978. Although one might expect the success rate to vary with length of time since introduction, no significant differences were found in the success rate of products receiving awards in 1971 and those receiving awards in 1977.

### Degree of Product Specialization

One industrial-organization theory posits that firm diversification promotes R & D (See Chapter 2). While we cannot test rigorously this hypothesis with our data, we did examine the extent to which Putman Award recipients were specialized in the type of product for which they received an award.

A substantial share of the Putman Award recipients were quite highly specialized in manufacturing products for food-manufacturing companies (Table 7.7). Over one-half of all companies or the division which made a cited product did 70 percent of their business with food manufacturers. At the other extreme, 31 percent of the recipients did 30 percent or less of their business with food manufacturers. Examples of large companies with food-machinery operations that represent a small part of their total sales are Beatrice Foods Co. (with total 1976 sales of \$4.7 billion), whose Wells Manufacturing Corp. subsidiary had food-machinery sales of \$8.6 million in 1976, and Emhart Corp. (with total 1976 sales of \$654 million), whose Standard-Knapp machinery division had food-machinery sales of \$11.3 million in 1976.<sup>12</sup>

**Table 7.7. Sales to Food Manufacturers as a Percentage of Total Sales for a Sample of 1975 & 1977 Award Winners.**

| Manufacturing Sector as Percent of Total Sales | For Company | For Division | Total     |
|--|-------------|--------------|-----------|
| 0-10%  | 4           | 4            | 8 (14%)   |
| 11-20%   | 3           | 3            | 6 (10%)   |
| 21-30%   | 2           | 2            | 4 (7%)    |
| 31-40%   | 2           | 1            | 3 (5%)    |
| 41-50%   | 1           | 0            | 1 (2%)    |
| 51-60%   | 1           | 2            | 3 (5%)    |
| 61-70%   | 1           | 0            | 1 (2%)    |
| 71-80%   | 7           | 4            | 11 (19%)  |
| 81-90%   | 4           | 0            | 4 (7%)    |
| 91-100%  | 9           | 8            | 17 (29%)  |
| Total <sup>a</sup>                             | 34          | 24           | 58 (100%) |

<sup>a</sup>Companies responded for either the company as a whole or for the division receiving an award. Therefore, a total of 58 companies are represented, or 71 percent of those interviewed.

The above comparisons overstate by an unknown amount the extent to which the firms in Table 7.7 specialize in selling to food manufacturers. For firms replying on a divisional basis, we cannot determine what proportion of the parent company's sales can be attributed to business with food manufacturers. Therefore, the divisional data should be interpreted as indicating only the degree of specialization by the reporting divisions. It should be noted that 20 of the firms responding for the company as a whole made over 70 percent of their sales to food manufacturers. These 20 companies represent a substantial share (34 Percent) of the total sample of divisions and companies. It does appear that most companies rely quite heavily on food manufacturers.

### **Method of Disseminating Innovation**

The large majority of Putman Award recipients are small businesses (50 Percent had annual sales of \$10 million or less). This raises the question of how firms of this size exploit their innovations, i.e., whether they manufacture the products themselves or permit others to manufacture the products under licenses.

A sample of firms receiving awards in 1975 and 1977 were asked how their award-winning products were put to commercial use. Eighty-one percent of the 80 firms reported that they manufactured the product themselves; another 5 percent manufactured it but did not market it themselves (Table 7.8). Another 10 percent licensed other firms to make the product, including the 4 percent that both manufactured the product and licensed other firms to do so. The remaining three firms (4 percent) were foreign firms that manufactured their products abroad but sold and serviced them in the U.S.

**Table 7.8. Company Involvement in the Introduction of Products for Commercial Use for a Sample of 1975 and 1977 Award Winners.**

| Company Involvement in Introduction of Product for Commercial Use | Number of Firms | Percent of Total Firms |
|---|-----------------|------------------------|
| Manufacture & Marketing   | 65              | 81%                    |
| Manufacture, but do not Market                                    | 4               | 5                      |
| Manufacture & License U.S. firms                                  | 1               | 1                      |
| Manufacture and License Foreign Manufacturers                     | 2               | 3                      |
| License others to Manufacture                                     | 5               | 6                      |
| Import Sales & Service  | 3               | 4                      |
| Total   | 80              | 100%                   |

Nearly all Putman Award recipients, regardless of their size, manufactured the products themselves, reflecting the decentralized nature of the equipment-supply industries. Evidently, formidable barriers to entry do not exist in these industries. However, as will be discussed below, many of these innovative firms have been acquired by larger corporations.

### Acquisitions of Putman Recipients

Public-policy authorities long have been concerned with whether there is a tendency for large corporations to acquire innovative firms. Some economists have reasoned that because large firms are less successful than small ones in discovering new products and processes, they have a strong incentive to acquire small innovative companies. By pursuing such a policy, the large corporation may prevent a deceleration in its growth rate. This was the view of Mr. T.K. Quinn, a former vice president for General Electric, who said, "I know of no original invention . . . made by the giant research laboratories. . . The record of the giants is one of moving in, buying out and absorbing the smaller creators."<sup>13</sup>

Others have argued that large corporations buy out small innovative businesses because the large corporation has the financial resources required to take an idea from the embryonic stage of invention or early stages of innovation to successful large-scale commercial production. Presumably, these are tasks beyond the technical competence or financial resources of the small businessperson.

Although no systematic study has examined how the desire to acquire technology may influence mergers, various authors have cited it as an important motive. In 1951, Butters, Linter and Cary, in their study of the motives of mergers, concluded:

In a few acquisitions the primary objective was clearly to acquire a new product as such; in the clearest case, the purchaser's main interest was in patents owned by the acquired company.<sup>14</sup>

Murray Friedman made the first case study of the role technology plays in promoting mergers.<sup>15</sup> Using secondary sources, Friedman examined 16 mergers in which the technological potential of the acquired firm appeared to be at least partially responsible for the merger.

To our knowledge, no study has developed information on the frequency with which innovative companies have been acquired. To gain some insight into this issue, we have examined the number of Putman Award winners that were acquired. We identified, when possible, companies that were acquired before they



received an award on the assumption that they already had a reputation as actual or potential innovators,<sup>16</sup> and we identified those companies acquired after they received awards. Of this sample of acquired firms, 28 were acquired prior to receiving an award<sup>17</sup> and 22 after receiving an award (Appendix Table 7). These 50 companies represent about 25 percent of the 204 firms that received Putman Awards between 1971 and 1977 and account for 73 (28 percent) of the 265 awards given to U.S. firms.

Thirty percent of the acquired companies were machinery manufacturers. The remainder were distributed among various other industries (Table 7.9).

All but nine of the 50 acquired companies had annual sales of less than \$100 million. The greater incidence of acquisitions among firms in the smaller sales categories is only partly explained by the fact that the number of small companies receiving awards greatly exceeded the number of award winners in the largest sales category. Only 14 percent of the award recipients with sales exceeding \$500 million were acquired, which was less than the proportion for each of the other size classes except the smallest (Table 7.10).

Unfortunately, there is no reliable universe of total acquisitions involving small companies, thereby making it impossible to determine whether the acquisition rate among Putman Award winners exceeds that of the entire business population. Available data do strongly suggest, however, that the acquisition rate among Putman Award recipients exceeds that of all businesses.<sup>18</sup>

Large corporations acquired the great majority of the Putman Award recipients that were acquired (Table 7.11). Corporations with sales exceeding \$500 million acquired 25 (50 percent) of these companies and corporations with sales exceeding \$100 million acquired 35 (70 percent). These data suggest that acquisitions served as a vehicle for transferring a substantial amount of technology from small to large corporations.

**Table 7.9. Acquired Putman Award Recipient Firms by Primary Line of Business and Sales.**

| Acquired Company's<br>Primary Line of Business | Size<br>Unknown | Under \$1 | \$1-10<br>(Millions of dollars) <sup>a</sup> | \$11-100 | \$101-500 | Over \$500 | Total<br>U.S. Firms |
|--|-----------------|-----------|--|----------|-----------|------------|---------------------|
| Food Processor, Ingredient Manufacturers       | 2               | 1         | 0  | 2        | 5         | 1          | 11                  |
| Packaging & Paper                              | 0               | 0         | 1  | 1        | 1         | 1          | 4                   |
| Chemicals & Paints                             | 0               | 0         | 1  | 1        | 0         | 0          | 2                   |
| Instrument and Controls Manufacturer           | 1               | 1         | 2  | 1        | 0         | 0          | 5                   |
| Plant Maintenance, Sanitation & Design         | 6               | 0         | 2  | 1        | 0         | 0          | 10                  |
| Machinery Manufacturers                        | 4               | 2         | 5  | 4        | 0         | 0          | 15                  |
| Other <sup>b</sup>                             | 0               | 0         | 1  | 1        | 0         | 1          | 3                   |
| Total  | 13              | 4         | 12   | 12       | 6         | 3          | 50                  |

<sup>a</sup> Sales size in year of award or year of acquisition.

<sup>b</sup> The other category includes a conglomerate, a fiberglass manufacturing firm, and a railroad car leasing corporation.

**Table 7.10. Domestic Firms or Divisions Receiving Putman Awards (1971-77) and Number Acquired, By Primary Line of Business and Sales Size Class.**

| Recipient's Primary Line of Business <sup>D</sup> | Size Unknown                | Under \$1     | \$1-10<br>(Millions of dollars) <sup>b</sup> | \$11-100       | \$101-500     | Over \$500    | Total U.S. Firms            |
|---|-----------------------------|---------------|--|----------------|---------------|---------------|-----------------------------|
| Food Processor, Ingredient Manufacturer           | 5 (2) <sup>a</sup>          | 2 (1)         | 2 (0)  | 9 (2)          | 6 (5)         | 6 (1)         | 30 (11)<br>37% <sup>d</sup> |
| Packaging & Paper                                 | 1 (0)                       | 0 (0)         | 3 (1)  | 1 (1)          | 4 (1)         | 3 (1)         | 12 (4)<br>33%               |
| Chemicals & Paints                                | 1 (0)                       | 1 (0)         | 2 (1)  | 1 (1)          | 1 (0)         | 4 (0)         | 10 (2)<br>20%               |
| Instrument and Controls Manufacturer              | 1 (1)                       | 3 (1)         | 6 (2)  | 1 (1)          | 2 (0)         | 1 (0)         | 14 (5)<br>36%               |
| Plant Maintenance, Sanitation, & Design           | 8 (6)                       | 5 (0)         | 7 (2)  | 5 (2)          | 2 (0)         | 1 (0)         | 28 (10)<br>36%              |
| Machinery Manufacturers                           | 10 (4)                      | 15 (2)        | 36 (5)                                       | 13 (4)         | 1 (0)         | 3 (0)         | 78 (15)<br>19%              |
| Other <sup>C</sup>                                | 8 (0)                       | 6 (0)         | 5 (1)  | 1 (1)          | 0 (0)         | 4 (1)         | 24 (3)<br>13%               |
| Total   | 34 (13)<br>38% <sup>d</sup> | 32 (4)<br>13% | 61 (12)<br>20%                               | 31 (12)<br>39% | 16 (6)<br>38% | 22 (3)<br>14% | 196 (50)<br>26%             |

<sup>a</sup> Figures in parentheses indicate the number of firms or divisions in each sales class which were acquired either before or after their award. Other figures indicate the number of firms or divisions in category.

<sup>b</sup> Sales and primary line are reported for the division or subsidiary which received the award if one was named. If none was named, parent company sales and primary line are reported. Sales size for the 28 firms acquired prior to their award was determined by the sales size reported in the year of the award. (Sales were reported in 16 instances). Sales size for the 21 firms acquired after their award is also determined by sales in the year of the award. (Sales were reported in 21 instances). The remainder of the firms are in the size unknown category.

<sup>c</sup> The other category includes 7 firms whose primary line was unknown, 5 equipment importers and/or distributors, 2 independent research labs, and 10 other firms including steel, aluminum, and railroad car leasing companies.

<sup>d</sup> Acquired companies as percent in size or product class.

**Table 7.11. Putman Award Firms Acquired Since 1950 and Their Acquiring Firms, By Sales Size Classes**

| Size of Acquiring Firm<br>(Millions) | Size of Acquired Firm |           |          |  |           |            | Total Acquired Firms | Percent of Total |
|--------------------------------------|-----------------------|-----------|----------|--|-----------|------------|----------------------|------------------|
|                                      | Size Unknown          | Under \$1 | \$1-10   | \$11-101<br>(millions of dollars) <sup>a</sup> | \$101-500 | Over \$500 |                      |                  |
| Size Unknown                         | 0                     | 0         | 3        | 1  | 1         | 0          | 5                    | 10%              |
| Under \$1                            | 0                     | 0         | 0        | 0  | 0         | 0          | 0                    | 0                |
| \$1-10                               | 2                     | 0         | 1        | 0  | 0         | 0          | 3                    | 6                |
| \$11-100                             | 2                     | 0         | 3        | 2  | 0         | 0          | 7                    | 14               |
| \$101-500                            | 3                     | 1         | 3        | 3  | 0         | 0          | 10                   | 20               |
| Over \$500                           | <u>6</u>              | <u>3</u>  | <u>2</u> | <u>6</u>                                       | <u>5</u>  | <u>3</u>   | <u>25</u>            | <u>50</u>        |
| Total                                | 13                    | 4         | 12       | 12   | 6         | 3          | 50                   | 100%             |

<sup>a</sup>Sales size in year of award or year of acquisition.

## FOOTNOTES

- <sup>1</sup> "The Putman Food Awards," 1971, *Food Processing*, July 1977.
- <sup>2</sup> "The Putman Food Awards," 1971, *Food Processing*, July 1971. However, a change was made in 1977 limiting each company to one entry per category.
- <sup>3</sup> The editors of *Food Processing* described the judging process as follows: "The entries [are] organized into categories and judged by panels of experts in the different categories. The judges represent all segments of the food industry and are well qualified to appraise the different developments as to their value to food processors. Three separate, independent judging periods occurred over a two-month period. The ratings of the entries focused on three considerations: the novelty or innovation factor, the breadth of application in the food industry, and the significance to the industry. *Ibid.*"
- <sup>4</sup> Completed questionnaires were received from 214 (81 percent) of the award recipients. Information on firm and industry characteristics were obtained from secondary sources for another 31 (12 percent) of the recipients. Eighty-two (67 percent) of the recipients of awards in 1975 and 1977 were interviewed by telephone to obtain more detailed information on certain questions, as discussed in the text below. These 82 were chosen from selected categories of the award recipients, particularly mechanical and other innovations most directly relating to productivity. Excluded were all awards for ingredients and industry development.
- <sup>5</sup> This is also the language used by the editors of *Food Processing*.
- <sup>6</sup> "The Putman Awards," 1971, *Food Processing*, July 1971.
- <sup>7</sup> There is no set number of awards given in any specific category in a year. As a result, there have been years when no awards were given in a specific category.
- <sup>8</sup> Of the 32 awards going to food processors and ingredient manufacturers, 20 were for new ingredients, four were for packaging, three were for processing equipment, two each were for processing systems and industry developments, and one each were for process control and laboratory instrumentation, cleaning/sanitation, and materials handling and distribution.
- <sup>9</sup> See Chapter 3.
- <sup>10</sup> A total of 81 percent of 1977 winners in all categories of awards were interviewed. The interviews of 1975 award winners were restricted to machinery manufacturers and related categories, which represented 49 percent of all awards. The total number in the latter categories interviewed in both years represented 67 percent of all award winners in these years and 77 percent of machinery and related categories.

The interviewees were identified by our initial mailed questionnaires, which requested each respondent to provide the name and phone number of the person who filled out the questionnaires. In almost all cases the persons named were the head of the company's research department or, in small companies, the president of the company.

The respondents generally were very cooperative in supplying the information requested.
- <sup>11</sup> The respondents were asked for objective evidence of success or failure. Based on these responses, the product was placed in one of the categories shown in Table 7.6.
- <sup>12</sup> The authors did not receive this information on divisional sales from these companies. Rather the food-machinery sales figures are those reported by Economic Information Systems, Inc., New York City.
- <sup>13</sup> T.K. Quinn, *Giant Business: Threat to Democracy*, 1953, p. 117.
- <sup>14</sup> J.K. Butters, J. Lintner, and W.L. Cary, *Effects of Taxation: Corporate Mergers*, 1951, p. 226.
- <sup>15</sup> Murray N. Friedman, *The Research Development Factor in Mergers and Acquisitions*, Study of Subcommittee on Patents, Trademarks, and Copyrights, Committee on the Judiciary, Committee Print, October 1958.
- <sup>16</sup> It was possible to identify these award recipients because they operated under their original name as a division of the acquiring company.
- <sup>17</sup> Twenty of these 28 were acquired since 1965 and 24 since 1960.
- <sup>18</sup> During 1968-1977 the FTC recorded fewer than 10,000 manufacturing and mining acquisitions; this represented less than 3 percent of all manufacturing and mining corporations. Although the FTC merger series is subject to considerable error, it seems highly unlikely that 26 percent of all businesses were acquired, the acquisition rate among Putman award recipients.

