PART III

THE STRUCTURE OF CENTRAL-OFFICE GROUPS

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THE SCHEME OF FUNCTIONAL ANALYSIS.

The study of the human body has been divided into two phases anatomy and physiology. Anatomy is the study of the structure of the body's parts; physiology the study of its functions. Up to this point the examination of central-office groups has been purely anatomical, the question asked being: Of what do these groups consist?

These combinations have been surveyed as to their characteristics without analysis of their internal structure. Chapter VII described in detail the source of the data and the various limitations which must be set upon any conclusions drawn from such material. Chapters VIII and IX presented the central-office groups in terms of size and scope. Without such a recognition of the nature and limitations of the data employed, any further physiological examination is valueless. If the last two chapters have succeeded in their purpose, then that more important task may now be attempted—the analysis of these groups in terms of the functions of the establishments which constitute them.

This analysis is based upon the functions of industrial establishments. The word "function" is a dangerous one, because of its universal and varying usage. First employed as a physiological term, it has been extended to other sciences with a corresponding extension of meaning. It is of fundamental importance that the usage here employed be clearly understood.

The function of an establishment is the receiving of raw material, the subjecting of it to certain processes, and the turning out of a certain product. It is therefore the entire process taking place in the establishment, perhaps best synonymized by the phrase,

"the operating of an establishment."

Function is often confused with product. But the function of an organism and its products are two very different things. The function of the iron and steel industry is not its enormous product of iron and steel, but is rather the entire process, including intake of raw materials and output of finished product. The actual functioning may be measured in terms of the final product, it is true, but that is an entirely different matter. It is a natural development in this more or less pragmatic age to emphasize the results, but it must be kept firmly in mind that the function of an industry is the "operating" of the industry. Function is not a matter of product but of process.

One further example to make this usage clear. There are two branches of the iron and steel industry—one which uses charcoal to provide its carbon element and one using coke for the same purpose. These two industries have different functions. Their "operating" is different, and therefore their functions, though similar in many respects, are nevertheless as units different. Only plants which utilize the same raw materials, the same process, and turn out the same product can be said to have the same function.

The problem of physiology proper is the explanation and reconciliation of the various functions of the body parts. The physiological problem of industrial groups is one of the relationship between the various functions of the establishments within the combination. In terms of the above definition the question becomes: How is the producing of a certain product from certain materials by a certain process in one establishment related to the producing of a certain product from certain materials by a certain process in another establishment? Why are the functions combined in a central-office group?

Before discussing the method of analysis one further explanation in regard to data is necessary. How is the function of an establishment determined? Each establishment produces a certain major product. Often this is supplemented by various subsidiary products. It is customary census usage followed in this study to consider that product as the major product which represented the greatest part of the total value of products produced by the establishment during the census year. The function of each establishment has been taken to be the producing of this major product. A consideration of the subsidiary products would have been not only a matter of enormous clerical labor but also of relatively little value. The subsidiary products are considered in toto in Chapter XIV. Let it suffice for the moment to say that they are usually so closely related to the major product and of so little importance in the total combination that they seldom enter into the relationships between separate establishments, but are of significance chiefly in connection with the parent establishment.

Within the combination each establishment may produce the same major product. On the other hand, each establishment may produce a different major product. It is not a matter of chance that these establishments have entered into a single

combination. The determination of the reasons underlying the combination lies in the examination of the relationship between the functions of the various individual establishments.

The possible relationships between functions of establishments appearing in central-office groups have been grouped into five general classifications, two of which have three subheads each. Although each of the nine classes or divisions is discussed separately in a later chapter, it seems only wise to indicate at this point the nature of the classification. The possible relationships are as follows:

- A. Uniform functions.
- B. Divergent functions: (1) Joint products; (2) by-products; (3) like processes.
- C. Converging functions: (1) Complementary products; (2) auxiliary products;
 (3) like markets.
- D. Continuing functions.
- E. Unrelated functions.

Of the five general classifications the first and last need little definition. In the first group are included all those combinations in which many establishments, all similar in regard to materials, process, and products, are combined. These are purely cases of large scale production or centralization—of grouping under a single head a number of like establishments. More prevalent than any other of the relationships it is also the simplest. There is no question of the point of community of the functions; they are all similar.

On the other hand, the last group, and the smallest, is the most perplexing. In it are found all those cases in which establishments are included, having no apparent relationship to the other establishments in the combination. One expects individuals to interest themselves in various unrelated enterprises, on the principle of keeping eggs in different baskets, but when a single central office operates in several quite unrelated fields—that is, a piano factory and a candy factory—it seems less explicable. This group of establishments whose functions are quite unrelated though of little importance economically possesses perhaps more human interest than any other group of industrial combinations considered in this study.

It is in the second, third, and fourth classifications that the significant functional relationships appear. In order to grasp firmly the distinctions made, think of the function of an establishment as a line, starting at a point, the raw materials, and ending at a point, the finished product. Obviously, then, if two estab-

lishments start with the same materials and end with different final products—for example, cotton cloth for the material, one establishment making it into awnings and the other into pajamas, or pig iron, being made into wire and castings—the function lines are divergent. Proceeding together for a distance until the cloth or pig iron is completed they then separate and proceed in different directions. Conversely, consider a central-office group, in which one establishment makes cigars and another cigar boxes, they begin very far apart, yet finish near together, converging in their functions. Such is, of course, a very elementary and incomplete presentation of the classification and will necessarily be enlarged upon as each category is considered separately.

The second group, the diverging functions, is subdivided into three classes. A distinction between the first two subdivisions is desirable yet difficult to make. In both cases joint products and by-products, the manufacture begins with common raw materials, but during the various steps between raw materials and final products, diverges along different paths. The distinction made is one of the point and the voluntariness of the divergence. Joint products diverge from a similar material at a natural break in the industrial process, and whether this divergence shall be present or not is entirely at the option of the operator. The failure to produce either of the products involved will not affect in any way the continuance of the production of the other. Such, for example, have been the cases already mentioned of cotton cloth manufactured into awnings and pajamas and pig iron made into wire and castings. At the end of the production of the cotton cloth the operator wills to diverge along two lines. If he ceases to make pajamas, it does not necessarily affect his awning manufacture.

By-products, on the other hand, diverge in the midst of a process, and this divergence is beyond the control of the operator. To be sure he can disregard one of the elements, but this study is concerned with those who do regard it. In the manufacture of cottonseed oil a substance known as cottonseed cake is produced. Both these products come from the same original material, the cottonseed. But the operator does not manufacture certain cottonseed into cottonseed oil and other into cottonseed cake. The only way to get cottonseed oil necessitates the manufacture of cottonseed cake, and vice versa. To be sure, he may throw the cottonseed cake on the rubbish pile, but it has been produced, nevertheless. This group, the by-product group, includes all

establishments whose divergence from the other establishments in the combination, is the result of such involuntary division of material during some process.

The third class amongst the diverging combinations is very different from the first two. The two already discussed are cases where differing processes applied to the same material result in different products. The third group is that in which different materials applied to the same process result in different products. The same general process applied to wool and cotton yarn results in wool and cotton cloth. Of course in many cases falling within this group, the difference in material necessitates a slight difference in technique, but the fundamentals remain the same. A combination such as a zinc smelter and a lead smelter, fall within this group because the reason for their combination lies mainly in the similarity of the process of the industries involved.

Opposed to the combinations having diverging functions among their establishments are those involving converging functions. Within this classification are also found three groups. The first group consists of those combinations in which the establishments are complementary. Each establishment completes the function of the other. A wood-turning plant and a foundry are combined. and the result of the combination is agricultural implements. As a matter of fact, it is an organization for the fabrication of products. This must be kept clear from the fourth classification, as yet undiscussed, in which occurs the making of products which are in successive steps, rather than parallel. Two establishments. one making tannic acid and the other tanning leather, are not complementary, since the tannic acid is made and then participates in the next step, changing its form there. But the manufacture of shoe findings—that is, parts of shoes other than leather in connection with a leather factory would be a case of complementary products. The considerable number of cases in which establishments manufacture containers to be used by other establishments in the combination, appear also under this class.

Closely allied to this group are the auxiliary products. In these cases the establishments so classed are accessories of the main process of production. A central-office group, consisting chiefly of railroad repair shops, may also have one machine shop. This is accessory to the other repair shops and assists in work beyond their immediate capability. A combination for the canning of fish operates a single ship-repairing plant. Accessory rather than complementary, the function of this establishment converges with that of the other establishments in the combination.

The third group is that in which the functions of the separate establishments finally meet in a single market. Metal beds and felt mattresses have no common material, the processes of manufacture are very unlike, the products themselves are different, yet they converge from the beginning of the process until they finally meet in the market. Dental apparatus and false teeth have little in common within the realm of manufactures, but the convergence occurs in the market. To obtain the convergence in this case, it may appear to be necessary to extend the term function beyond the manufacturing process, but since the selling of its products may be included in the function of a combination the convergence does actually occur within the scope of this study.

The remaining classification is that of continuing functions. In these cases one establishment picks up the function of another establishment within the combination and carries it farther toward the ultimate goal, the final product. This group includes that form of industrial combinations commonly known as vertical integration. Obvious examples are those of central offices operating sawmills, planing mills, and a furniture factory, or iron mines, blast furnaces, rolling mills, and wire mills. In these cases each establishment picks up the product of the previous establishment and advances it one step nearer its final form. The classification is not always as simple as the above. It necessarily includes such cases as the production of tannic acid and the making of leather. Tannic acid is by no means the largest element in the leather-making process, yet it occurs one step prior to the leather-making itself, and therefore the establishments in such a combination must be classed as having continuing functions. A further problem arises in the case of the manufacture of machinery for use in producing products, and the production of those same products. These cases also must be considered in this general classification, for the function lines meet only end to end.

Such, in general, are the five classifications which are made in examining the combinations at hand. Obviously, many cases arise which are difficult to classify. There are many instances in which several different classifications occur among the many establishments in a single central office group. In several cases as many as five of the different classifications occur among the establishments operated by a single office. The extent to which each of these various groups appears in the 4,813 central offices, and further analysis of the characteristics of each, both in terms of extent, industries affected, and the factors determining such combinations, are to be found in the following nine chapters.

XI.

UNIFORM PRODUCTS.

As already said, the most prevalent type of central-office group in industry is that in which the enterprise operates two or more industrial establishments with similar functions. Such a combination may arise in any of three ways. In the first place, firms once competitors may consolidate and form a new enterprise; in the second place, one firm may extend its scope by gaining control of the activity of another concern by purchase; or, finally, the original enterprise may expand by constructing an establishment in another locality.

The purpose of this chapter is to analyze such combinations, attempting to determine the types of industry which seem most favorable to such developments, and the nature and characteristics of the combinations which are of this kind. It is important to keep in mind that this discussion includes those combinations which are active in *only* one industry. If a combination operated 50 sawmills and one machine shop, it would be excluded from discussion in this chapter. As a matter of fact, of the 4,813 central-office combinations studied only 1,784, or 37.1 per cent, had plants in more than one industry classification. The combinations here included have not extended their operations in any direction beyond the single industry in which all their establishments are classified. Such central-office groups will hereafter be called "simple" groups as opposed to "complex" groups in which there is more than one industry represented among the establishments.

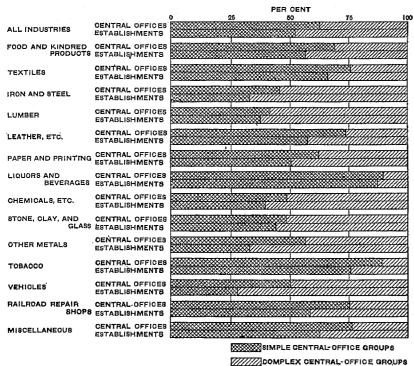
In spite of this rigorous classification the number of central offices in this group is very large. General figures for the development of parallel establishments in central-office groups are given in Table 64. Of the total number of 4,813 central-office groups included in the sample 3,029, or 62.9 per cent, operated establishments with similar functions only. In over five-eighths of all central-office groups, but one type of industry is represented among the establishments. That this group, including over five-eighths of the central offices, includes only a little over one-half of the establishments considered is due to the fact that, in general, these simple central offices are smaller in the number of establishments which they operate than the complex groups. This phase of the problem will be discussed at a later point in the chapter.

Table 64.—Central Offices Operating Establishments All Having Similar Functions, by General Groups of Industries: 1919.

		CHI	NTRAL OF	rces.	establishments.				
Group number.	cenceal group of industry.	Total number.	Number in which all establishments have similar functions.		Total number.	Number in central- office combina- tions in which all establish- ments have similar func- tions.	Per cent.		
	All industries	4, 81 3	3,029	62.9	18, 912	9, 9 1 3	52. 4		
1	Food and kindred products	988	685	69. 3	4, 221	2, 404	57. 0		
2	Textiles and their products	868	658	75.8	2, 702	1, 788	66. a		
3	Iron and steel and their products	422	193	45. 7	1, 519	500	32, 0		
4	Lumber and its remanufactures	414	173	41.8	I, 43I	536	37.5		
5	Leather and its finished products	133	98	73. 7	469	270	57. 6		
6	Paper and printing	237	148	62.4	807	409	50. 7		
7	Liquors and beverages	77	69	89. 6	245	214	87. 3		
8	Chemicals and allied products	557	272	48.8	2, 261	897	39- 7		
9	Stone, clay, and glass products	346	167	48. 3	981	432	44. 0		
ro	Metals and metal products other than								
	iron and steel	95	54	56.8	403	135	33.5		
II	Tobacco manufactures	110	8e	89. r	519	393	75· 7		
12	Vehicles for land transportation	62	31	50.0	281	78	27.8		
13	Railroad repair shops	178	134	. 75-3	I, 788	1, 050	58. 7		
14	Miscellaneous industries	326	249	76.4	1, 285	807	62.8		

The percentage figure is by no means indicative of the situation in the various industrial groups, for it is an average based upon items whose dispersion is great. Comparison of industry groups is simplified by Chart Q. Table 64 demonstrated that the percentages by groups range from 89.6 per cent in the liquor and beverages group, to 41.8 per cent in the lumber and its remanufactures group. Of the four industrial groups in which more than one-half of the central-office groups are engaged in more than one industry, three-iron and steel, chemicals and allied products, and clay, stone and glass products-are industries in which activity in the mining field has classed many of the central offices in the field of sucessive products. Lumber and its remanufactures, the fourth industrial group, has its large percentage of complex combinations because of the number of concerns which manufacture wood products and which operate their own sawmills.

CHART Q.—CENTRAL OFFICES OPERATING ESTABLISHMENTS ALL HAVING SIMILAR FUNCTIONS, BY GENERAL GROUPS OF INDUSTRY.



At the other extreme appear the two industrial groups having the highest percentage of simple central-office groups—liquors and beverages and tobacco manufactures—both of which industries are from their very nature rendered less liable to complex organization than if their materials required more complex processes or could be manufactured into more varied products.

There is another angle, however, from which the figures of the numbers of simple central-office combinations among central-office groups should be examined. How large a percentage of those establishments eligible for such combination are to be found in simple central-office groups? When studied by industrial groups (see Table 65), the percentages are so small as to be of rather slight significance. The 9,913 establishments included in simple central-office groups form but 3.4 of the total manufacturing establishments in the country.

Table 65.—Establishments in Simple Central-Office Combinations, by General Groups of Industries: 1919.

_		M.A	NUFACTUR	Lishments.			
			Number.	Per cent distribution.			
	GENERAL GROUP OF INDUSTRY.		combin which lishmer	ral - office lations in all estab- its have functions.		In central- office com- bina- tions in	
Group number.		Total.	Number.	Per cent of total,	Total.	which all es- tablish- ments have similar func- tions.	
	All industries	1 290, 105	9,913	² 3. 4	100,0	100.0	
ı	Food and kindred products		2, 404	3. 9	21. 1	24. 3	
2	Textiles and their products		1, 788	6. з	9.8	18.0	
3	Iron and steel and their products	20, 120	500	2. 5	6.9	5.0	
4	Lumber and its remanufactures	39, 955	536	1.3	13.8	5, 4	
5	Leather and its finished products	6, 397	270	4. 2	2. 2	2. 7	
6	Paper and printing.	36, 403	409	1, 1	12.6	4.1	
7	Liquors and beverages	6, 354	214	3.4	2. 2	2. 2	
0	Stone, clay, and glass products	12, 224	897	7.3	4, 2	9. t	
10	Metals and metal products other than iron and	12, 529	432	3.4	4.3	4-4	
	steel	10, 667	135	7.0	3. 7		
11	Tobacco manufactures	10, 291	393	3,8	3.7	I. 3 4. 0	
12	Vehicles for land transportation	1 21, 152	78	10.4	7.3	0, 8	
13	Railroad repair shops	2, 368	1,050	44.3	0.8	10.6	
14	Miscellaneous industries	21, 781	807	3.7	7. 5	8. r	

¹ Includes 15,507 automobile repair shops, which industry is not included in central-office data.

The chemicals and allied products industry, with 7.4 per cent, shows the highest percentage of eligibles included. The textile industry, with 1,788 establishments in simple central-office groups, recorded a percentage of 6.3. The lowest percentage is paper and printing, which was also the lowest in total central offices, largely because of the large number of independent job printing establishments in the country.

It should be borne in mind that the percentage of establishments is an inadequate measure of the importance of the central-office groups, because the establishments included in such groups are apt to be the largest in the industry. Consequently, a figure giving the per cent of establishments minimizes the importance of that type of organization.

² If automobile repair shops be omitted, per cent becomes 3.6.

^{*} If automobile repair shops be omitted, per cent becomes 1.4.

This table, however, takes on much greater significance when extended to the specific industry groups. From these it is possible to develop some sort of general analysis of the causes underlying this form of industrial combination.

There are 63 industries of the 354 in the census classification in which more than 10 per cent of all establishments are found in simple central-office groups. Of these 63 industries there are 18 in which the proportion exceeds 20 per cent. These are listed in Table 66.

Table 66.—Eighteen Industries with Largest Proportions of Establishments in Simple Central-Office Combinations: 1919.

		nufactu Ablishm			Manufacturing Establishments.			
industry.	Total.	In 3,029 simple central-office combinations.		industry.	Total.	In 3,029 simple central-office combinations.		
Steam-railroad repair				Condensed milk	401	95	23. 7	
shops	1, 744	924	53. 0	Malt,	55	13	23. 6	
Grindstones	23	12	52. 2	Rice, cleaning and polish-)		
Charcoal	41	. 17	41.5	ing	86	20	23. 3	
Oakum	6	,2	33-3	Peanuts, grading, roast-				
Flax and hemp, dressed	20	6	30.0	ing, cleaning, and shell-				
Explosives	118	33	28.0	ing	78	16	\$0 E	
Printing materials	82	22	26.8	Electric-railroad repair				
Sugar, beet	85	22	25.9	shops	624	126	20. 2	
Gloves and mittens, cloth.	182	47	25.8	Gas, illuminating	I, 022	204	20.0	
Cars, steam-railraod	99	25	25.3	Wood distillation	ırs	. 23	ab. c	
Felt goods	49	12	24. 5					

The three largest industries included among these 18 possess combinations having similar functions because of the varied market factor. Steam-railroad repair shops, electric-railroad repair shops, illuminating-gas manufacture, in each case a single establishment is able to meet the market demands in a single locality entirely and expansion, therefore, requires development in a new locality. The same situation is reflected in the figures for establishments manufacturing ice, which show a figure of 10 per cent of all establishments included in simple central-office groups.

The next generalization suggested by this table, and justified by further examination, is that simple combinations are most likely to occur in the earlier stages of processes and in processes which have but one stage. Most of the industries in Table 66 are industries in which the final product is made directly from the raw material in a single process. Such an industry, of course, does not lend itself to development in other complementary or specialized lines, as does a more complex industry. The fact that single-stage

industries are particularly in evidence hardly needs further discussion—grindstones, oakum, charcoal, beet sugar, condensed milk, peanut grading, wood distillation, etc. This fact is further borne out by an examination of the industries in which the percentages are not so high.

The fact that in complex processes the simple central-office groups are more inclined to appear near the beginning of the process is evidenced in this group by such cases as the dressing of flax and hemp, the malt industry, etc. It is, however, more definitely displayed by examining some industry group in which it is possible to differentiate between early and late stages. In the textile group, for instance, of those establishments which manufacture textile fabrics and materials 12.0 per cent appear in simple central-office groups. Of those which manufacture articles from those textile fabrics but 4.8 per cent appear in simple central-office groups. Since most of the complex developments by-product manufacture, joint product manufacture, complementary product manufacture, etc.—occur in the later stages of industry, it is natural that the central-office groups appearing in the earlier stages of industrial processes should be less apt to overstep the bounds of a single industry than if their activity came later in the process.

The fourth generalization to be made from the data of industries is the influence of scattered sources of raw material on the distribution of plants, particularly when the material involved is subject to deterioration. Among the 18 industries of highest percentages the illustrations of this particular law are the beet-sugar and condensed-milk industries. It is mainly due to this fact that II of the industries found in the food-products industrial group are included in the 63 industries in which more than 10 per cent of the establishments are in simple central-office combinations. The industries in the food-products groups so included are: Fish canning, cheese manufacture, condensed milk, oleomargarine, fruit and vegetable canning, chewing gum, cordials and flavoring sirups. peanuts, rice, beet-sugar, and sugar refining. Special mention should be made of the manufacture of cheese. Exceeded only by the steam-railroad repair industry, cheese manufacture has the greatest number of establishments in simple central-office groups, 551 out of a possible 3,997. The 551 establishments are distributed among 97 central offices, chiefly in New York and Wisconsin.

These simple combinations are of interest, not only in terms of the industries in which they are to be found, but also in regard to the number of establishments in each central-office group. How far do enterprises expand without entering other fields? The summary figures, both in absolute numbers and percentages, are given in Table 67. Of the 303 central offices operating 10 or more establishments, 106, or more than one-third, are active in but one industry. The largest individual case is an enterprise operating 68 similar establishments.

Table 67.—Distribution of Single Central-Office Combinations by Number of Establishments Operated, by General Groups of Industries: 1919.

<u></u>				DISTRI	BUTION	OF CE				JMBER
H C		Num-	Num- ber of	ll .	OF ES	CABLISE	IMENT	S OPER	LATED.	
Group number.	GENERAL GROUP OF INDUSTRY.	ber of central offices	estab-	2	3 to 4	5 to 7	8 to 12	13 to 19	20 to 29	30 and over.
		NUMBER.								
	All industries	3, 029	9,913	1, 924,	733	212	93	32	20	15
1	Food and kindred products	685	2, 404	394	178	63	34	9	4	3
2	Textiles and their products	658	1, 788	429	180	34	12	3		
3	Iron and steel and their products,	193	500	138	42	11	1	ı		
4	Lumber and its remanufactures	173	536	117	39	10	4	[3	I
5	Leather and its finished products	, ,	270	68	21	7	I	r		
6	Paper and printing	148	409	112	27	4	3		2	
7	Liquors and beverages	69	214	40	16	8	5			• • • • •
8	Chemicals and allied products	i '	897	168	68	24	7	2	I	2
9	Stone, clay, and glass products	167	432	126	30	7	4			• • • • • •
10	Metals and metal products other									
	than iron and steel	54	135	42	ıı			I	······	• • • • • •
11	Tobacco manufactures	98	393	48	29	15	3	1	2	1
12	Vehicles for land transportation	31	78	24	5	2				• • • • • •
13	Railroad repair shops	134	1,050	50	32	īб	13	9	7	7
14	Miscellaneous industries	249	807	168	55	II	7	5	2	I
	•	PER CENT DISTRIBUTION.								
			1	1		· ·		1	1	
	All industries	100.0		63. 5	24. 2	7.0	3. I	1. 1	0.7	Q. <u>5</u>
I	Food and kindred products	100.0		57. 5	26. o	9.2	5.0	1,3	0.6	0.4
2	Textiles and their products	100.0		65. 2	27.4	5.2	r. 8	0. 5		• • • • • •
3	Iron and steel and their products	100.0		71.5	21.8	5.7	0.5	0.5		• • • • •
4	Lumber and its remanufactures	100.0		67.6	22.5	5.8	2.3		1.2	0.6
5	Leather and its finished products	100.0		69.4	2T. 4	7. I	1.0	1.0		· · · · · ·
6	Paper and printing	100.0		75.7	18.2	2.7	2.0		1.4	• • • • • •
7	Liquors and beverages	100, 0		58. o	23. 2	11.6	7.2	•••••		
8	Chemicals and allied products	100.0		6r.8	25.0	8.8	2.6	0.7	0.4	0. 7
9	Stone, clay, and glass products	100.0	••••••	75-4	18.0	4.2	2.4		•••••	•••••
to	Metals and metal products other than iron and steel	100.0	li	77.8	20.4			1.9		
,	Tobacco manufactures	100.0		49.0	29.6	15.3	2.0	1.0	2.0	1.0
2	Vehicles for land transportation	100.0		77.4	16. I	6.5	2.0		•. •	1.0
3	Railroad repair shops	100.0		37.3	23.9	11.9	9. 7	6. 7	5. 2	5. 2
14	Miscellaneous industries	100.0		67. 5	22. I	4.4	2.8	2.0	0.8	0.4
		-33.3				7.7				

Upon examining the distribution into size groups in Table 67 it appears that by far the greater number of central-office groups are concentrated in the smaller subdivisions. In general, 87.7 per cent of the simple central-office groups include less than 5 manufacturing establishments. This concentration is exceeded in 9 of the 14 industries, of which 8 report more than 90 per cent of the simple central-office groups as operating less than 5 establishments. The industrial groups showing the greatest relative concentration in the smaller categories are naturally those in which an expanding firm has more opportunities to expand along other related or allied lines and in which industries, therefore, the larger concerns are more apt to be complex in nature. Other metals and metal products; paper and printing; clay, stone, and glass products; and iron and steel show high percentages of concentration in smaller groups. At the other end appears the railroad repair shops group, which has already been mentioned as the industry most prone to expand into simple central-office groups with many establishments. Tobacco manufacture and liquor and beverages. the two groups showing the highest percentage of simple centraloffice groups, report the most extensive development of these central-office groups in terms of size. These two conditions are without doubt interwoven. The industries in which simple central-office development is most prevalent are those in which the developments of relatively larger simple central-office groups will appear. The same underlying causes bring about both conditions.

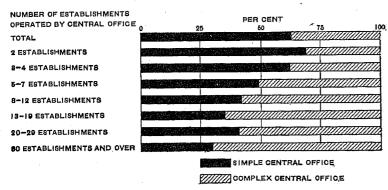
But the problem is not only one of comparison of size of the simple central-office groups within themselves when classified by industrial groups, but also of comparison between the simple and complex central-office groups. The situation is clearly pictured in Chart R. It can be readily seen that as the number of establishments operated increases the proportion of all central-office groups which are simple decreases. Although the simple centraloffice groups compose about five-eighths of the total number of enterprises considered, the number of complex central-office groups operating six establishments exceeds that of the simple groups, and from that point on is, in general, higher. In Table 68 a comparison is made possible in terms of the distribution of the two groups. It is evident that the curve typifying the distribution of the simple central-office groups would be much more peaked, abrupt, and concentrated near the origin than the distribution curve for the complex establishments, which

would be much gentler in its slope and tail out much more than the simpler curve, whereas 12.4 per cent of the simple central-office groups operate five or more establishments 29.4 per cent of the complex central-office groups are in this category.

Table 68.—Percentage Distribution of Simple and Complex Central-Office Combinations, According to Number of Establishments Operated: 1919.

•	PERCENTAGE DISTRIBUTION OF CENTRAL OFFICES BY NUMBER OF ESTABLISHMENTS OPERATED.									
	Total.	2	3 to 4	5 to 7	8 to 12	13 to 19	20 to 29	30 and over.		
Total	100. 0	57.9	24. 5	9.0	4.6	r. 8	1.0	I. T		
Simple central-office combinations Complex central-office combina-	100. 0	бз. 5	24. 2	7. 0	3. I	1.1	0.7	0. 5		
tions	100. 0	42. 9	27. 7	13. 7	8, 0	3. 7	1.8	2. 2		

CHART R.—DISTRIBUTION OF SIMPLE AND COMPLEX CENTRAL-OFFICE GROUPS, BY NUMBER OF ESTABLISHMENTS OPERATED.



The larger the central-office combination may be the more likely it is to have expanded or to expand into allied or related activity. There is a limit to the advantages of large-scale production, which limit has been reached by many of the larger central-office combinations. Instead of doubling its production in a single plant, the enterprise doubles it by duplicating the original plant. In either case the result is a type of large-scale production. In general, the advantages of large-scale production as already described may be divided into (a) economies which result in reducing the cost of production, (b) economies in marketing, (c) economies in management, (d) economies in financial administration. All these economies are desirable because they increase profit and increase the competing strength of the enterprise.

It is probably true that in a great many cases the possible economies do not play an important part in the original formation of the combination, but they are important in continuing its existence. In many cases the combination is merely the result of the possession of surplus capital for investment in the hands of some industrial concern, its ordinary procedure in such a case being to reinvest it in its own industry. This may be done either by expanding those plants which it already operates or by entering a new geographical field.

It is not always convenient, or even possible, for these advantages of large-scale production to be realized by a concern through the enlargement of its original enterprise. For various reasons it may be more desirable to develop an establishment in a new locality. Even in such event, however, the majority of the advantages listed above would accrue. The reasons which may cause a separate development of a new plant to be particularly desirable are as follows:

- 1. Limitation of material in the original locality. It would be foolish to enlarge a dairy, for example, if it were already able to take care of all the milk and cream which that particular community could produce. The same would hold true with regard to most sawmills and the limitation of their supply. In instances where the raw materials are either perishable or of considerable bulk there may be a limit to the expansion in any one locality.
- 2. Location near the market. When commodities are bulky, and therefore any large shipment of goods requires high transportation charges, it is important that not only the location of raw material be considered but also the location and extent of the market. If a brickyard in a certain locality is able to produce all the bricks which are required within a radius of several hundred miles, it would be foolish to develop that particular brickyard further, but logical to expand in a new locality where the market would be much nearer the point of manufacture.
- 3. The presence of such necessities as labor and power in adequate amounts.
- 4. The fact that establishments once built can not be easily moved. Since many of the central-office combinations included in this general category are the products of consolidation of separate firms or of purchase, establishments are less apt to be in the same locality than if they were originally constructed by one firm.

Experience has shown that this simple form of combination is the stepping-stone for larger and more complex organizations. It represents a stage rather than a final form. The larger industrial combinations, almost without exception, have been the outgrowths of simple central-office groups. That a highly developed simple central-office group is particularly eligible for admission to the group of complex combinations is due to many causes. For example, a group of similar establishments may have sufficient demand for a product to justify the operation of such a plant whose product shall be entirely utilized by the group, although no plant alone could utilize its entire product. Or, again, the by-product material of a single establishment may not be sufficient to justify the operation of a separate by-product plant, although a combination of firms might do so with profit. The simple central-office group, therefore, tends constantly toward becoming a complex central-office group, the types of which will be discussed in considerable detail in the following chapters.

XII.

JOINT PRODUCTS.

The varieties of final products which are being made from raw materials and which consumers purchase are being continually increased. New uses for raw materials are constantly being found. Modern chemistry, in particular, has done much to reveal new products. There is, therefore, in industry a continually increasing diversity among the uses of raw materials. If all industry were to be charted in terms of function lines, the lines leading from any raw material to the final products would be considerable in number and in diversity and continually increasing.

This situation, in which a comparatively small and relatively unchanging number of raw materials is used for a much greater and increasing number of final products, has made possible a type of combination which is here termed the manufacture of joint products. Joint products may be defined as different products made from the same material, provided that the divergence is not essential to the manufacture of either product. The first part of this definition indicates merely divergence—the fact that such a combination, by varying the processes used in treating the material, obtains different products. The manufacturer has, for example, produced pig iron in the blast furnace. If his concern takes that pig iron and by using one process in one establishment manufactures steel rails and another process in another establishment produces bolts and rivets, it is thereby producing joint products. In the second part of the definition lies the distinction between joint products and by-products. Both are instances of different products made from a single basic material. But, in the manufacture of joint products, the operator is able to discontinue his activity in either line without affecting his operations in the other, except indirectly. Conversely, it is not required or necessary that he manufacture both products, but it is merely a voluntary expansion on his part. In the case of by-products, however, the divergence is essential to the maintenance of activity; glue can not be made unless the slaughtering establishment continues

operation. The manufacturer may not choose to operate in one of the lines, but the divergence is present, nevertheless. Chapter XIV discusses those cases in which the divergence is involuntary on the part of the operator, termed by-products. It is perhaps necessary to note at this point that each establishment is considered as making one product—its major product. In some instances these products may be different yet fall within a single census category, such as "steam, gas, and water engines" or "knit goods." Consequently, joint products are not merely different products, made from the same basic material, but they must fall within different census categories.

There are 427 instances of the manufacture of joint products among the 4,813 central-office groups. This includes all cases in which the manufacture of joint products appears among the activities of a group, regardless of the presence or importance of other establishments as well. A certain meat-packing house, for example, operates chiefly in meat packing and slaughtering. As a subsidiary business, it operates a butter manufactory and an establishment having condensed milk as its chief product. This central-office group is therefore included among those manufacturing joint products discussed in this chapter, for joint products manufacture is one of the functional relationships present in this organization. This type of combination is the most prevalent form of complex combination next to that producing successive products. That joint products are manufactured to a much larger extent than the above figure would indicate is doubtless true. Many firms manufacture more than one product from some raw material in a single establishment. In fact, comparatively few establishments have a single final product. In nearly 8.9 per cent of the central-office groups, however, joint products are manufactured in separate establishments. Table 69 gives the distribution of instances by industrial groups. Inasmuch as the central offices in the industrial groups are concentrated in certain branches or subdivisions within the groups, it is perhaps wisest to discuss the groups separately before attempting to draw any conclusions from this table. It is of significance to note, however, that more than one-half of all instances are included in the food and kindred products and the textiles and their products groups.

Table 69.—Central-Office Combinations Producing Joint Products, by General, Groups of Industries: 1919.

ber.		Total	Total number			TICE COMBINATIONS JOINT PRODUCTS.		
number.	INDUSTRY GROUP.	number of central offices.	of complex central	Number.	Per cent of-			
Group		Ometai	offices.	Number.	Total.	Complex.		
	All industries	4, 813	1, 784	1 427	8.9	23. 9		
I	Food and kindred products	988	303	114	11.5	37. 6		
,	Textiles and their products	868	210	106	12. 2	50. 5		
3	Iron and steel and their products	422	229	58	13.8	25.3		
4	Lumber and its remanulactures	414	241	33	7.9	13.7		
5	Leather and its finished products	#33	35					
6	Paper and printing	237	89	11	4.6	12.4		
7	Liquors and beverages	77	8	.,				
8	Chemicals and allied products	557	286	14	2.5	4.9		
9	Stone, clay, and glass products	346	179	44	12.7	24. 6		
10	Metals and metal products other than							
	iron and steel	95	40	10	10. 5	25.0		
11	Tobacco manufactures	110	13	9	8. 2	75.0		
12	Vehicles for land transportation	62	31	[
13	Railroad repair shops	178	44					
14	Miscellaneous industries	326	77	9	2.8	11.7		
	Power	• • • • • • • • • • • • • • • • • • • •		23				

¹ There are four central-office combinations manufacturing joint products in two industrial groups. This accounts for the discrepancy between the total and the sum of the instances in the industrial group.

² The category has been added and includes instances from various industrial groups. It is discussed in detail in the text, p. 187.

Food and kindred products.—The manufacture in separate establishments of different products from a single basic food material forms the basis for 114 central-office combinations, a greater number than is recorded by any other industrial group. At first thought it seems very peculiar that such a considerable number of food-product manufacturers should manufacture joint products. As far as the manufacturing process is concerned, the raw material generally offers but little variety of product. The utilizer of sugar beets has little choice but to make beet sugar; the purchaser of tomatoes can only can them; even the flour manufacturer has few supplementary uses for his material-he might perhaps make a breakfast food. Since the most important factor limiting the expansion of such a combination is customarily a limitation of material available, rather than that of market, one of the most natural reasons for the development of jointproduct manufacture—an excess of raw material—is removed.

The relatively high place taken by food products in this classification, however, is due almost entirely to one branch of the

industry—the manufacture of creamery products. Of the 114 central-office groups manufacturing joint food products, 101 are engaged in the manufacture of dairy products, the basic material being, therefore, milk or cream.

The various major products appearing in these combinations—that is, the types of industries in which the establishments fall—are as follows: Butter in 80 combinations, cheese in 55, condensed milk in 42, ice cream in 41, oleomargarine in 2, casein glue in 1, malted milk in 1, and milk chocolate in 1, making a total of 223 major products in 101 combinations.

Of these various instances butter and cheese form the most common combination, and in 35 central-office groups all the establishments in the combination fall in these two industries. The slight extent of wide variation in kind of product, however, is made evident by a recapitulation of the 101 combinations in a slightly different form:

Number of combinations having	2 major	creamery	products	83
Number of combinations having;			-	•
Number of combinations having	4 major	creamery	products	3
Total			•	TOT

More than four-fifths of these enterprises manufacture only 2 major products, although, doubtless, the subsidiary products would include others. The activity of these 101 combinations is not entirely limited to the creamery line. It is, nevertheless, of considerable significance to note that 86 of the 101 central-office groups are not active outside of this field. In the remaining 15 cases 7 operate establishments of a more or less auxiliary nature, such as ice plants, or carriage repair shops; 6 operate establishments manufacturing other food products, chiefly bread and candy; and the remaining 2 are large meat-packing establishments, whose operation in the creamery field is to them a subsidiary interest.

Beyond these many combinations in the dairy field joint-production combinations are few in the food and kindred products group. The remaining 13 combinations show no tendency of sufficient size to compare with that discussed above. One small group is based on the use of apples, and there appear six combinations manufacturing two or more of the following: Cider, vinegar, dried apples, and preserves. The only other type of combination which occurs more than once is that of biscuit and crackers manufactured in certain of the establishments, and of other bakery products, chiefly bread, manufactured in others. The

distinction here made, however, is of little significance, for in the great number of instances the establishments are occupied in the manufacture of both products mentioned.

With regard to the food and kindred products group, therefore, it can be said that the manufacture of joint products is highly developed in the dairy or creamery branch, but elsewhere is present only in very few scattered instances.

Textiles and their products.—The central-office groups which manufacture joint products in the textile industry group may be divided into two groups. The products in this industrial group are naturally classed as follows: First, those products whose essential difference lies in different utilization of the same basic fiber in the manufacture of dissimiliar types of fabrics. An example of this subdivision is a central-office group which produces wool felt and wool cloth. Wool felt is made by matting wool fiber; wool cloth requires the combing, carding, etc., of the fiber and the manufacture of thread or yarn. This central-office group, therefore, manufactures different types of fabrics from a single basic material. Second, those instances in which different final products are made from similar fabrics, such as tents and awnings or men's and women's clothing.

There are 106 instances of joint-product production in the textile industry, 12.2 per cent of all central-office groups manufacturing textile products. Of these 106, 45 are in the first group, in which the joint products are different fabrics, and 61 in the second group manufacturing different final products made from similar fabrics. The first group includes the following: Knit goods and woven goods, 25; rugs and cloth goods, 8; wool and worsted products, 6; woven belting and cloth, 2; lace, embroidery, and millinery, 2; felt and wool cloth, 1; cloth and webbing, 1.

In each of these instances the same basic material is used; that is, one of the various textile fibers, such as wool, cotton, or silk, but the manufacture diverged in or before the fabric-making process.

Although in most cases there is no difficulty in definitely distinguishing between the types of fabric made, the wool and worsted enterprises have been always a source of difficulty in classification. The distinction between these two products, both made from wool fiber, is by no means easy to make. Worsted, a term derived from the city Worsted, in England, is customarily used as the

name for a woolen yarn in which the fibers are combed parallel and lightly twisted. The worsted mills are therefore distinguished from the woolen mills by the initial processes to which the fiber is subjected. In the early days of the wool manufacturer in this country carded-wool products only were produced. This is to be explained by the more simple character of the operations, and also by the fact that the wool of the Merino sheep raised was not well adapted to the combing process as carried on by hand or by early combing machines, which required a long-staple wool to produce the best results. The improvements in the combing machine, which enables it to comb wool of short staple, and the adaptation of American wools to the combing process consequent upon the crossing of the Merino sheep with those of English blood, have resulted in the development of a very large and separate worsted industry. The distinction, however, is one by no means definitely fixed, and the usage of these terms by manufacturers is often inexact.

The 25 concerns which produced knit and woven goods were divided among the fiber groups as follows: Cotton, 11; silk, 6; wool, 3; unknown—gloves, 4; neckwear, 1.

The products made in the knitting mills consisted chiefly of hosiery and underwear. This evident separation by a central office of its weaving and knitting activities is found, in general, among the larger central-office groups.

The 61 concerns which manufactured different textile products from similar fabrics are chiefly grouped in the clothing industries. In these cases, unfortunately, information is not available definitely indicating that the manufacture of men's suits and women's clothing should correctly be grouped under the heading of joint products to the extent that similar fabrics are actually used. However, since all the products here classified are textile products and the manufacture really is based upon a use of fabrics, similar if not identical, it seems wisest to classify them in this group. Many of these concerns, such as those manufacturing collars and cuffs in separate establishments, should be noted as combinations whose basis for organization may be the similarity of market quite as much as the fact that the products are both textiles. Since practically all clothing, except leather products, furs, buttons, hooks and eyes, and other such minor though important items, is made from fabric material, the central offices manufacturing different articles of wearing apparel may well be

grouped either as joint products or as products for the same market. As a matter of fact, the development of the two retailing industries for men's and women's clothing, however, has been quite separate. For example, consider the manufacture of hosiery. If a firm manufactures both stockings and socks, is it manufacturing for one market or for two? At any rate, it is manufacturing joint products, so it seems safest to include such under that classification. There are, then, 52 instances in which more than one major clothing product is made in a central-office group. These products vary from overalls to silk gloves and from millinery to shoe laces. In every instance, however, the type of material used in any one combination must have been quite similar. The products, as stated above, if all found in any single combination, could not have been classed as joint products. As a matter of fact, overalls appear in combination with shirts, silk gloves in combination with neckwear, millinery in connection with embroidery, and shoe laces in combination with corset laces.

There remain nine cases in the textile group which have not as yet been discussed. These are instances of similar fabrics which are used for nonclothing purposes. In this group appear such combinations as cloth bags and tents, awnings and tape, sheets and pillowcases, imitation leather and oilcloth, floor oilcloth and enameled oilcloth, awnings and trunks, and a most interesting combination producing wool cloth, carivas gloves, horse clothing imitation leather, and rubber carriage cloth. It must be explained that oilcloth, linoleum, and imitation leather are classed as textiles because they are manufactured by coating coarse cotton cloth with specially prepared substances.

The data then for central-office groups in the textile industry indicate a much wider spread of joint-product manufacture than was found in the food-product group. In general, this form of organization appears not to be limited to any particular stage of the process or to the manufacture of any particular type of material. In the food-products group there is a multiplicity of kinds of material, but in the textile industry the divergence of function lines is very great, a great multitude of products being manufactured from comparatively few raw materials. This extensive divergence, as found in the textile industry, is especially significant because the early period of production is usually one of paralle operation and the divergence coming later in the process lends itself very favorably to joint-product combinations.

Iron and steel and their products.—The iron and steel industry has perhaps more definite stages in its total process from raw materials to final product than any other industry, save possibly the other metals industry. In lumber manufacture, for instance, there can be only logging, sawing, shaping, and fabricating—four stages as a maximum. The iron and steel industry, however, requires a much longer and more complicated process. Although these stages are to be discussed more fully in the later chapter which deals with the operation of plants having successive functions, it is necessary to give some indication of the later analysis at this point.

From the extraction of raw materials through the blast-furnace stage the iron and steel industry necessarily follows a single track. There are no possible divergences, except perhaps the manufacture of by-products such as coal-tar products, slag cement, slag paving materials, and slag fertilizer. With the completion of the blast-furnace operation, however, the possible lines of manufacture begin to diverge. The Census Bureau recognizes seven separate types of establishment in the next stage in the process with products as follows: Products of steel works and rolling mills; bolts, nuts, washers and rivets; cast-iron pipe; forgings; nails and spikes; springs; structural steelwork. It is true that in many cases the manufacture of these products is done in a single establishment, the rolling mills very often operating separate departments manufacturing various finished products, and thereby being able to practice economy by utilizing the raw material while it is still hot. After this stage, the manufacturing of elementary products of pig iron, comes the stage which includes such intermediate products as tin plate, wire, wrought pipe, and the products of boiler shops, foundries, and machine shops; and, finally, come the complex final products, ranging from hardware, tools, and dynamos, to sewing machines and locomotives.1

Having these, the last three stages in the total iron and steel process clearly in mind—the manufacture of elementary pig-iron products, intermediate products, and the complex final products—let us examine the 58 instances of joint products appearing in this industry. They are distributed as follows: Elementary pig-iron products, 12; intermediate products, 12; complex final products, 33; unclassified, 4. From this total of 61 should be deducted 3 duplications, thus giving a net total of 58.

¹ For more complete discussion of this classification, see p. 243-

The instances noted above as unclassified are cases in which the products are not successive, yet occur in different stages of the arbitrary classification. The "unclassified" include a combination which avowedly manufactures automobile parts in one establishment, nuts and bolts in another, and machineshop products in a third. Another instance of the same sort is a combination having establishments producing, respectively, bathtubs, radiators, and boilers. As can readily be seen, these ought to be classed as joint products, yet, according to the above classification, products of boiler works are in the second group, while radiators appear in the third group. The three duplicating combinations are those in which joint products are produced in more than one stage. An example of this type is a combination operating establishments in the following industries: Mining. coke works, blast furnace, steel works and rolling mill, cast-iron pipe works, forgings works, machine tools factory, steel shipbuilding yard, engine works, and machine shop. Such a combination, as can readily be seen, is active in such varying lines as to make it impossible to classify it as diverging in any single stage of the process.

It is to be expected that the greater number of instances of joint-product combination should appear in the group manufacturing the most diversified final products. An industry begins with but a few function lines, representing raw materials. As the processes continue the inevitable result is to make possible a greater variation of type of establishment. In the iron and steel industry, at one point, there is but one type of establishment. the blast furnace. The blast furnace gives way to several possible lines of development, which then diverge until the number of possible types of establishments to which the raw material may have been taken is very large. Likewise, the expansion in type of establishment means an increase of the number of establishments within that stage in the process. The Census of Manufactures records but 195 establishments operating blast furnaces in 1919. The number of establishments in the next stage is about 2,000. The number in the following stage is difficult of determination, because the census totals include many machine shops which are repair shops in other industries, but the number of establishments manufacturing complex final products is about 8,000. This, therefore, is to a large extent the reason for the greater number of joint-product combinations in the last stage of the production of iron and steel products.

The same general law was present in the textile group, though not so striking as in the iron and steel industry—that jointproduct organization becomes more extensive in the later stages of an industry.

Lumber and its remanufactures.—Perhaps the most surprising figure in the study of joint-product central-office groups is the small number of concerns, using lumber as their basic material, operating establishments producing joint products from lumber. The total number included in this entire industrial group is but 33 central-office combinations. Of this number only 20 represent joint products of lumber.

The 13 central-office groups which are included in this industrial group which do not manufacture joint products of lumber are combinations engaged in operating sawmills and in the manufacture of turpentine and rosin. The turpentine and rosin industry is one of peculiar significance, because of the fact that in the 10 years from 1909 to 1919 the number of establishments in this industry decreased about 25 per cent, while the number of wage earners decreased by 29 per cent. The turpentine product of 1919, measured in gallons, was 35 per cent smaller than that of 1914, and 40 per cent less than 1909. In the turpentine and rosin industry timber which is undergoing its first period of working is termed "round timber." After it has been worked four or five years it is allowed to rest for a number of years, usually four, during which time the wounds heal and its vitality is so restored that it is in condition to furnish another yield of gum. The operation of sawmills in connection with this industry is of two types: First, the cutting of pine which has been worked its number of years, and, second, the cutting of other woods which necessarily are included in the purchase of the proper areas for producing of turpentine. An additional incentive for such a combination is the fact that the refuse from the sawmill may be used to provide power for the distillation and manufacture of turpentine and rosin products.

The 20 instances in which lumber products of different types appear in a single combination are so varied as to make any definite discussion impossible. The only type of combination appearing in more than two instances is that of concerns manufacturing paper and other pulp goods, of which five are included. Three concerns manufacture shoe heels of wood pulp.

The remaining 15 instances are thoroughly scattered among the various types of lumber products. Such combinations as railroad ties and barges are included as well as billiard tables and phonographs. In only four instances do central-office groups include more than two different lumber products as major products produced in their various plants.

It is interesting to note, however, that in 10 of these 20 instances of joint-product manufacture noted sawmills are also included in the activity of the central-office group, which usually provide raw material for the various manufacturing establishments in the combination.

Clay, stone, and glass products.—The fact that as many as 44 central offices in this group appear as producing joint products is largely due to the detail with which the Census Bureau classification is made in this particular. The 44 instances are as follows: Brick, tile, terra cotta, fire clay, and earthenware, 31; lime, plaster, and cement, 10; paving materials and building brick, 2; marble and lime, 1.

Practically every combination possible is to be found among the five clay products given in the first group. There are seven instances in which three of the five are included, and three instances in which four types of clay products are represented among the major products of the establishments.

The last three groups need little mention. Perhaps, to understand the classification of the last combination, marble and limestone products, it is necessary to have in mind that marble is merely a form of limestone, usually of much more solidity than that used for the production of slack lime.

Tobacco manufacture.—The tobacco industry showed in its central-office groups less complex combination than any other industrial group. Of the 110 central office groups included in this study but 12 were other than the simple combinations discussed in the previous chapter. Of these 12 complex organizations 9 were engaged in the manufacture of joint products.

The manufacture of tobacco may be divided into two general groups: First, the manufacture of chewing tobacco, smoking tobacco, and snuff, and, second, the manufacture of cigars and cigarettes. The Census Bureau makes use of these two classifications and then subdivides them according to the five headings just given. Of the nine central offices here discussed seven included establishments classed in both of the general groups.

The other two were manufacturers of chewing tobacco and snuff and of cigars and cigarettes in separate establishments.

Of the nine central-office groups one operated establishments in four of the subdivisions, two in three, and the remaining six were active in but two subdivisions, smoking tobacco and cigars appearing three times in combination.

This is practically the only form of complex combination to which an industry of the type of the tobacco industry lends itself. The process is such as not to make specialization in terms of successive products practical, and the only types of convergence possible are with the manufacture of containers and with operation of printing establishments, in which form of combination the remaining complex central-office groups of this industry are to be found.

Power.—One type of combination cuts directly across the lines of industrial groups. However, the function lines of their establishments are not entirely separate, although they may use different raw materials and manufacture quite unlike products. These combinations are based on a particular requirement for the operation of each of the different establishments, adequate power. In certain instances power plays a very important part in the development of an industry, and certain combinations appear as manufacturers of joint products of power. This basis of combination doubtless is an important factor in many a combination and in some instances the determining one.

There are 23 central offices which have been included in this group. These cases are practically all instances in which sawmills, and grist or flour mills are combined. The importance of the power element in the forming of combinations is evidenced by the following two letters received from manufacturers in response to an inquiry into their peculiar industrial combination:

And a report from a concern operating a flour mill and ice plant:

"We are operating an ice plant and flour mill together. We find it a very good combination, as the steam we use to make power and run both mills is again used as distilled water in making ice."

It is probably true that with the more extensive development of electric power plants and of other great power projects, this factor will not be of such great importance in the development of future combinations. There will always remain certain cases, however, in which conditions are such as to make a power combination both economical and efficient.

All other industrial groups.—There remain to be discussed 43 other instances of central-office groups manufacturing joint products. These cases may be grouped industrially as follows: Chemicals and allied products, 14; paper and printing, 11; other metals, 10; miscellaneous, 8.

The group of central-office combinations which produced joint products and are classed as manufacturing chemicals and allied products is largely built around establishments producing patent medicines and druggists' supplies. Three combinations manufactured explosives in connection with other chemical products, two including as well the manufacture of ammunition in separate establishments. The combination of perfumery and patent medicines occurs twice, and in one interesting case, the combination of perfumery and coal-tar products. The manufacture of soap and lard from cottonseed oil, and of oleomargarine and varnish from linseed oil or fish oil, demonstrate the various uses to which the vegetable oils may be put. In general, however, the manufacture of joint products in the chemical industry is most naturally carried on within a single establishment.

The combinations manufacturing joint products in the paper and printing industrial group are engaged in manufacturing various paper and pulp products. Six of the 11 central-office groups manufacture paper boxes as one of their major products, 2 manufacture envelopes, and 6 operate paper mills. The specialization of establishments into the manufacture of products such as blueprint paper and tracing paper is worth noting. One concern operates a paper mill and also separate establishments producing paper cartons and paper mailing tubes. There are no concerns which are classed as manufacturing joint products in the printing industry. The few central-office groups which might be considered eligible have rather been classed as using like processes upon dissimilar materials.

The ro instances in the other metals group are of significance in that they demonstrate that, in this industrial group, the producer is much less apt to carry his material through to its final product form than in the iron and steel industry. Of the instances included four are cases where different kinds of alloys are manufactured. The development as shown in this industrial group is very slight. There are no cases where lead, copper, or zinc is carried to any wider divergence than in the manufacture of bars or ingots, and paint using the oxides as a base.

The nine miscellaneous instances are too scattered to warrant particular discussion. Two central-office groups manufactured products of asbestos, and three, different rubber products.

Conclusion.—Although, throughout the discussion of individual cases, the attempt has been made to indicate the underlying factors entering into joint product manufacture, there are certain elements in this type or organization which deserve special mention.

In the first place, the relation between the amount of raw material available, the extent of the market, and the type of organization must be considered. There can be no doubt but that the most normal method of business expansion is to increase the scale on which the enterprise is already operating. But it may already be operating on a scale such as to meet the demand for its product. In that case, the problem of expansion becomes more complex. Take, for example, a central-office group manufacturing butter. Its market is limited chiefly by the perishability of its product. If it desires to expand, what is more natural than for it to make other dairy products which can be sold in the same market—cheese, condensed milk, etc. Obviously, if all the raw material of one type, such as milk, were made into a single type of product, such as butter, the market would be glutted. Consequently, the joint product organization has developed.

The second factor of importance is in the field of marketing. If a firm operates two factories both making neckties, its salesmen presumably would have to make twice as many visits to sell the products of the firm as he would if one factory made neckties and the other socks. To a certain extent, there is a tendency for the products made by a combination to correspond to the products as sold by types of retail stores. The purchaser for retail trade naturally prefers to buy from as few firms as possible, and, therefore, welcomes such joint product combinations as appear in the food, textile, and tobacco industries. The considerable development of joint products manufacture in these three industries is probably to be explained in large measure by the market factor.

In the third place, the operator is distributing his risk and thereby lessening it. By definition, the joint product establishments are such that if anything happens to one, the other can continue without interruption. Since he is selling in two markets, his risk from market fluctuation is much less than if his entire product went into a single market.

Finally, there are definite advantages which accrue from the utilization of a single basic material. Of course, it makes possible the purchase, or the organization of a means for obtaining the required material on a larger scale than if the two activities were carried on by single concerns. In addition, the knowledge gained through the experiences with the material in one line, may be of considerable value in the parallel activity. The operator, by expanding into a joint product field, is at least capitalizing his knowledge concerning the market for, and the pecularities of, the raw material which he will require.

Joint-product manufacture is a definite example of the relation of specialization and integration. In the textile industry, for example, all kinds of clothing were originally made by single operators. With the development of the machine technique and large-scale production, these various activities were divided. Separate operators began to make specialized products. But the organization of industry in terms of a number of specialized and independent enterprises was not destined to be the final form of economic organization. The development of a great number of specialized enterprises led to an additional step in the development of economic organization, the combining of these various specialized activities into single organizations under a central office. In certain industries, such as the iron and steel industry, such a development has been particularly evident. This tendency, in connection with the marked increase in the size of single establishments, demonstrates a strong development toward greater centralization in industrial operations.

XIII.

BY-PRODUCTS.

A by-product is a product made from the same basic material as the main product, but diverging from the production of the main product during a process in such a way that the suspension of the production of the main product will result in suspending the production of the by-product.

The division of the basic material into that for the main product and that for the by-product is not optional with the manufacturer, but necessarily occurs. Sawdust inevitably results from sawing wood. It is therefore a by-product, and all sawdust products if made in a combination in which sawmills also occur are classed as by-products.

The distinction between a joint product and a by-product is mainly in the point of divergence. Joint products separate at a natural break in its process, so that the cessation of the production of one of the products has no direct bearing on the activity in the other enterprise. But if one of the plants is a by-product plant, its operation is dependent upon the continuance of the main product plant from which it obtains its materials.

Confusion is apt to arise because of the occasional use of the term by-product in reference to all subsidiary or secondary products. One product of a firm being termed its main product, then sometimes all other products which it produces are called by-products. To such products the adjectives secondary or subsidiary are much better applied, since such products often have no functional relationship whatsoever. The relationship between establishments in a combination producing coke and coal-tar products is obviously different from one producing shirts and overalls, and again quite different from one producing tin whistles and toy balloons. According to the use of terms adopted in this study the first instance is one of by-products, the second of joint products, and the third merely one in which the relationship is one of market similarity.

The utilization of waste material was one of the earliest principles of scientific management propounded. The efficiency expert made it the subject of immediate inquiry, and the utilization of waste products has come to be one of the standard measures of economic efficiency. With the aid of modern chemistry

it was soon discovered that few materials are actually waste materials, and various methods have been adopted by enterprising manufacturers to make use of this new source of revenue.

The utilization of by-products is, of course, based upon sound economic reasoning. Two products, which when produced separately, might both result in a net loss, may, on the other hand, if produced together, or if both be utilized, result in a profit. In many cases it is purely a matter of some income versus none. The sawmill produces huge quantities of sawdust. If any income can be gained from this material so much the better. The presence of waste products of this sort is fairly obvious, but in many cases examination has shown that huge values in by-products have been escaping entirely unknown to the producer. In the case of coke ovens especially, vast values in by-products have been lost, with no attempt made until recently to conserve them.

By-products are usually produced in the same establishment as the main products. There are two main reasons for this condition. In the first place, the amount of material available for byproduct manufacture is usually not sufficient to justify the operation of a separate plant to deal with it. Generally, a department within the larger concern is quite sufficient to deal with this subsidiary interest. In the case of large central-office groups, however, the situation becomes quite different. Instead of operating a department in each of a number of establishments, it is often much easier and more economical to centralize the operation, devoting a separate establishment to manufacturing the by-product for the entire group. In the second place, by-product activity is carried on most often in the main plant because of transportation facility and cost. Often the by-product process must be carried on immediately and in the vicinity of the main product process. Particularly in the case of by-products made from furnace fumes, is this situation true. Also, the by-product material is apt to be bulky and of little intrinsic value, so that extensive transportation would offset the gains made by utilizing it. For these reasons the cases of separate by-product plants found in the central-office groups by no means indicate the extent to which by-products are produced. This phase of the question, the production of byproducts in establishments generally, will be discussed later.

In the examination of central-office groups, 125 cases were found in which by-product establishments were operated within such groups. The statement previously made that fairly large groups are necessary in order to make the establishment of by-product plants worth while, seems to be justified by the fact that 87 central offices examined averaged 10 establishments per central office, as compared with the average for all central offices of 3.9 establishments per central office.

As might be expected, the cases appear in a number of different situations. In general, however, separate by-product plants seem to have been most developed in connection with central-office groups, connected either with the production of food products or the type of industry calling for smelters, refineries, ovens, etc.

The food-products group readily falls into two subdivisions, that dealing in meat products and that producing vegetable products. By-product manufacture is most diversified among the meat packers. With eight such central offices represented, the extent of this development can be readily seen. Examining the individual establishments in terms of their principal products, it appears that three of the eight central offices have two industries represented among their establishments, and the remaining five are active in five, six, eight, ten, and twelve industries, respectively. No other industrial group can show as great diversification as this.

It is interesting to note the products which appear in addition to the basic industry of meat packing and slaughtering: Emery paper, fertilizer, glue, greases, lard, oleomargarine, patent medicines, sausage casings, soap, soap stock, sporting goods, tallow, upholstery, and wool pulling.

Each one of these materials has a separate establishment in which it is the principal product, in at least one of the meat-packing central-office groups. Development along lines of parallel products, such as poultry killing and dressing, or creamery products, has not been considered. Into at least 14 different fields the attempt to fully utilize the by-products of a single process has carried these industrial organizations.

The combinations manufacturing vegetable products have also extended into by-product manufacture. The manufacture of various vegetable oils, which are used as lubricants, as solvents, and for many purposes in the chemical and paint industries, yield material for fertilizer, while the various food preparations, such as cereals, have by-products utilized for animal feed.

The main products, and by-products of sufficient importance to warrant the establishment of separate plants for their manufacture in at least one central-office group, are as follows: Main products—

Canning, cereals, cottonseed oil, fish oil, malt and malt liquors, peanut oil, rice cleaning; by-products—Feed, fertilizer, glue, lard.

The single product into which central-office groups of this class seem most prone to convert their waste products is fertilizer. In order to understand the nature of this conversion, it is necessary to examine into the requirements of the industry. A "complete" fertilizer is one which contains elements of nitrogenous substances, phosphates, and potash. The necessary amounts of these three elements differ in accordance with the crop to be raised and the nature of the soil. Usually the industry under consideration provides a part of the necessary mixture, then a by-product, and further treatment is required to complete the commodity. It is, of course, possible to use many of the by-products of mills directly as fertilizers, in which case no separate establishment is required. However, approximately nine-tenths of the fertilizer produced in the country is manufactured in plants classified as fertilizer plants.

A study by W. J. Booker, in "Flour and Feed," based on a report of Prof. E. N. Jenkins, of the Connecticut State Experimental Station, shows the values of certain of the by-products of vegetable products to be:

2,000 pounds wheat bran. Pounds. Pounds. 47.4 60. 2,000 pounds corn meal. 20.0 12.	
	Pounds.
	1
2,000 pounds linseed meal 106.0 38.	1
2,000 pounds cottonseed meal	

Such materials obviously furnish excellent substance for fertilizer manufacture. The 1919 census reported the following materials utilized in the manufacture of fertilizers, which indicates, without discussion, the possibilities for operation of fertilizer establishments in connection with large central-office groups in any of several industries. The materials are listed in order of importance: Tankage and ammoniates; potash salts; superphosphate; phosphate rock; ammonium sulphate; cottonseed oil; nitrate of soda; sulphuric acid; fish; sulphur; pyrites; raw bones; steamed bones; cyanamid or lime nitrogen; kainit; guano; ground bone, raw; bone discard; Thomas or basic slag; and hardwood ashes.

There are several other instances appearing in the food-products group worthy of special mention. A large bakery operates also a feed mill, in this way utilizing the stale and faulty products not sold. The manufacture of fish oil and fish leather, as well as coconut oil in connection with desiccated coconut, are found among the central-office groups. One central office, whose main activity is the canning of fish and oysters, uses the oysters shells to make lime and crushed shell for poultry, and the other refuse is made into fertilizer. In this particular instance the operator modestly remarks that "while we believe the combination is all right, if managed properly, we have not been making very much progress the last several years."

The development of the utilization of by-products in chemical industries is very interesting. The discovery by Le Blanc about 1780 of a practical method for obtaining sulphate of soda, by treating sodium chloride with sulphuric acid, gave the world one of its principal industries. The hydrochloric acid was regarded as a by-product of so little value that it was allowed to pass off into the air, to the great detriment of vegetation in the neighborhood. To remedy this evil, the English government took action against the soda works to compel them to condense the acid, which led indirectly to the discovery that hydrochloric acid could be used as a valuable agent in the bleaching industry.

Chemistry has also opened up the way for the manufacture of many articles synthetically such as perfumes. The fact that establishments producing coal-tar products and perfumes, are found in one central-office combination, indicates this connection. Many of the choicest perfumes placed on the market at the present time are artificially made from bad-smelling elements. The fusel oil obtained in the distillation of spirits has an odor that is peculiarly disagreeable, yet it is used, after treatment with acids and proper oxidizing agents, in making the oil of apples and oil of pears; and the oil of grapes and oil of cognac are little more than fusel oil, diluted.

Oil refining is especially conducive to by-product manufacture. Since the process is one wherein petroleum is made to give up its products in succession, and the obtaining of any one product is conditioned on the previous removal of certain other products, it is in nature a by-product industry. However, these by-products are all produced in one establishment, and unless further treated in some other related establishment, do not appear separately in the central-office combination. The particular cases in which

the refinery products are further utilized or manufactured in the same central office with the oil refining are in the manufacture of lubricating oils and greases, paving material, paint, tar paper, and in the dyeing and cleaning of fabrics. Concerns which operate their own refineries and are engaged in these lines as well are qualified to belong to the by-product utilizing group.

The leading waste material in the iron and steel industry has always been the furnace slag. This material has, until recently, been given little thought, but piled in huge mountains on the dump heaps. Within the last few years, at least three uses for blast-furnace slag have been developed. In the first place, it has been utilized as a paving material. In Europe, Metz, Brussels, and Paris have utilized this material for paving-stones, which are reported to be sufficiently durable to stand heavy traffic. One central office in the blast-furnace group operated a paving material factory. In the second place, slag appears to be a possible ingredient for cement and for brick and artificial stone manufacture, forming a product little affected by high temperature, and after the initial hardening period having greater tensile strength than ordinary cement. A cement factory appears in connection with one of the iron and steel central offices. In the third place, as a basic material for fertilizer, Thomas or basic slag, which is the product of the Bessemerizing of pig iron high in phosphorus and low in sulphur content in a converter lined with calcined dolomite, is used in large quantities in Germany instead of phosphate rock. American manufacturers reported in 1919 the utilization of 11,394 tons of Thomas slag, valued at \$118,768, in the manufacture of fertilizer.

Closely related to the iron and steel industry, is that of copper, lead, and zinc refining. Amongst the central-office groups, four cases appear in which companies operating zinc or copper smelters also operate acid plants. In 1900 there were 2 sulphuric-acid plants out of a total of 127, operated in conjunction with zinc smelters. In 1905 this number had increased to 5, and 1 acid plant in connection with a copper smelter had been added. Rapid development of this branch of the sulphuric-acid industry took place, hastened to some extent by action on the part of the several States and the Supreme Court.

In 1906, the State of Georgia brought a case before the Supreme Court against the Tennessee Copper Co. The Tennessee Copper Co., being located in the State of Tennessee, was therefore beyond the jurisdiction of the State of Georgia, which brought the case to the Federal courts. The decision was handed down May 13, 1907, in which Mr. Justice Holmes said:

"It is not denied that the defendants generate in their works near the Georgia line large quantities of sulphur dioxid which becomes sulphurous acid by its mixture with the air. It is hardly denied and can not be denied with success that this gas often is carried by the wind great distances and over great tracts of Georgia land. On the evidence, the pollution of the air and the magnitude are not open to dispute. * * * We are satisfied by a preponderance of the evidence that the sulphurous fumes cause and threaten damage in a considerable scale to the forests and vegetable life, if not to health, within the sovereign State."—206 U. S., 230.

An injunction was granted by the court restraining the Tennessee Copper Co. from allowing obnoxious fumes to escape from its smelters. This case, in connection with the development of various State laws, has resulted in what is virtually a compulsory by-product industry, which now totals 20 establishments and produces one-fifth of the total product of sulphuric acid annually.

The development of the by-product coke oven has been so widely heralded as an advance in conservation as at once to be recognized as a type of by-product operation. Strangely enough, however, in only one case did a plant producing coal-tar products appear in a central-office combination with a coke plant. Evidently the by-product coke plants carry the materials no further when once produced, but sell to other concerns for further manufacture. The combination of coal-tar products with acids and with chemicals was more frequent. As by-products in the chemical industries must be noted manufactured gas, acids, paving materials, and ice. The last relationship, though perhaps directly due to the production of power, is strengthened by the fact that ammonia is the chief substance used in the manufacture of artificial ice.

There were 37 concerns manufacturing brick and tile and also operating coal mines. There can be no question but that, in many of these instances, the production of clay products is of the type reported by one manufacturer who said:

"The factory producing clay products utilizes a by-product of the shale found in one of our coal mines."

From examining the records of these 37 companies, it would appear that 5 have the production of brick or other clay products

as their primary purpose. These instances have been classed with the concerns who produce fuel as an auxiliary function. The remaining instances must be included with those which produce by-products.

Several other isolated instances of by-products manufacture are to be noted. In two cases, wool shoddy is manufactured in the same central-office combination with woolen and worsted goods. The relationship of cork cutting to linoleum manufacture and to steam packing, in which industries the odd bits of cork are utilized, forms the explanation of one central-office combination. The manufacture of explosives has as by-products celluloid products and imitation leather. Briqueted fuel appears in two central-office combinations in connection with the operation of coal mines. As one operator expressed it: "The purpose of its existence [the plant for the manufacture of briquets and powdered coal] is to effect a more ready means of disposition of a portion of the smaller sizes of coal produced at the mines than to attempt to dispose of them in the form of slack, for which there is but a limited market."

In summary, it seems hardly necessary to remark that the by-product industries are becoming more and more developed, and that the presence of so many and diverse instances among the central-office combinations points toward a better and more complete utilization of waste product in the future.

XIV.

DISSIMILAR PRODUCTS OF SIMILAR PROCESSES.

Up to this point, the discussion of central-office groups in which the functions of the establishments diverge has concerned itself with those groups in which the divergence has been brought about by differing utilizations of the same material. The establishments in both the joint products and by-products groups, although using a single basic material, arrive at dissimilar final products because they apply dissimilar processes to this material.

In this chapter, central-office groups are discussed in which the situation is exactly the opposite. The establishments in this group, although applying the same basic process, arrive at dissimilar final products because they use dissimilar materials with this process. Instead of exploiting a basic material, a basic process is exploited. It is quite natural to expect certain central-office groups to develop along the line of process, just as others have developed in terms of the utilization of a certain material.

Among the central-office combinations, 154 cases are found in which no explanation can be offered for the types of industries represented other than that of a similarity of process. These instances, however, are not scattered through any great variety of industries, but appear only in a few lines of activity. The 154 cases are distributed among the industrial groups as follows:

	Number.	Per cent.
Food and kindred products	99	64. 3
Metal and stone products	15	9.8
Printing and publishing	10	6. 5
Textiles and their products	9	5.8
Chemicals and allied products	9	5.8
Miscellaneous	12	7. 8
Total	T54	100.0

Each of these groups will be given special discussion in the following pages.

Food and kindred products.—Nearly two-thirds of all central offices, whose basis for combination is a similarity of process, are found in the food and kindred products group. There are 99 such central-office combinations. Of this number, 61 central-office groups are engaged in canning or allied activities, 25 central offices in grinding and milling activities, and the remaining 13 organized chiefly about the use of the baker's oven.

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The canning and preserving industries have developed along six main lines. The customary industrial subdivisions are as follows: (1) Establishments whose chief products are canned and dried vegetables; (2) establishments whose chief products are canned and dried fruits; (3) establishments whose chief products are preserves, jellies, etc.; (4) establishments whose chief products are pickles and sauces; (5) establishments whose chief products are cured and canned fish, including pickled, smoked, and dried fish; (6) establishments whose chief products are canned oysters and clams. As can be readily seen, activity in two of these groups by any single concern can be explained only by the similarity in process. The materials used are quite different. The canning of vegetables appears most often in combination with some one of the other groups, all but 9 of the 61 central offices active in the canning industry reporting vegetable canning as one of their activities. Six central-office groups operated fish canneries in connection with vegetable or fruit canneries, while four oyster canneries were combined with vegetable canneries. In three cases, fish and oyster canneries were combined.

Since the materials used in the canning and preserving industry are subject to rapid deterioration, the industry is highly seasonal in nature. The combination of different branches of the canning industry is, to a certain extent, an attempt to offset this condition, by combining canneries whose periods of activity are not similar. Although not eligible for discussion in this chapter, the many combinations of sawmills and canning factories may be mentioned in attempting in another manner to offset the seasonal nature of the canning industry.

There are certain products so closely allied to the canning industry in process, that combinations between their manufacture and any of the above listed groups have been included with combinations solely within the six groups. Among such combinations, are included two cases where canning of vegetables is carried on in the same central-office group with the manufacture of condensed milk; three cases where flavors and sirups are produced by the same central-office group; and also combinations of sirups and cider, and sirups and preserves. In these cases in particular, it is probable that one specific value arising from the nature of the combination is the offsetting to as great an extent as possible of the extremely seasonal nature of the canning industry. However, the similarity of process, from the procuring of raw material through the cooking process and the placing of the product in

air-tight tin or glass containers, has been the chief bond in bringing and keeping the different branches of the industry together in central-office groups.

The second type of central offices among those which produce food and kindred products is that in which the establishments are grouped about the grinding or milling process. In this group, there appear 25 central-office groups whose establishments are active in at least two of the following industries: Flour milling, grist milling, feed milling, rice cleaning and polishing, and coffee grinding. Because of the considerable area devoted to the raising of raw material which must pass thru these mills, and the high transportation cost which would accompany shipment to a central point, the development of central-office groups with establishments in different localities has been natural. From this point, the specialization along the various particular lines of milling was a short step. In fact, a number of single mills operate in several of the classifications given above, being really community establishments. The processes involved are practically identical, and the mills operate in accordance with the raw material available.

The third group of central offices manufacturing food products, and in which the same process predominates, is that in which the process exploited centers about the oven. Bread and confectionery occur in combination six times, while combinations such as bread and preserves, bread and coffee-roasting, and confectionery and condensed milk also come in this group. Such combinations are not difficult to understand. Take for example, the problem of the baker whose business has grown to such an extent that it can handle all the demand in his locality. The operator desires to expand. There are really two possibilities before him. He may either develop the same industry in another locality, or expand along another and presumably allied line in the locality in which his business name and reputation will aid his new activity. The manufacture of confectionery is so closely related in nature to the making of bread that it is most natural for this to be selected as his new field. Examination of the six cases in which confectionery and bread appear in combinations reveals the fact that in five of the six cases the establishments may be considered as being in the same general locality. The sixth instance is of a concern which is national in its scope. One other instance must be noted to complete the total number of food-product central-office groups to be discussed, and that is a central-office group producing cereal liquors and malt liquors.

In general, the more extensive examination reveals a most natural form of combination. As might be expected, manufacturers when desiring to expand, have chosen to expand along lines with which they are familiar. They realize that the knowledge which they have gained in developing a single industry is of value in certain industries and quite useless in others. In certain branches of the food and kindred products field, it is not possible to utilize the same material for the manufacture of any considerable variety of different products. Tomatoes can not be made into many different food products, and a single line, in this case, canning, probably exhausts the raw material available. Expansion of manufacturing groups, therefore, not being able to follow in lines which would utilize the operator's knowledge of materials, has rather made use of his technical knowledge of process learned in the original establishment. Central-office groups, in expanding, have chosen, therefore, to enter other industries which have processes similar to those of the industry in which the central office has already operated.

Metal and stone industries.—Fifteen central offices in the metal and stone industries, appear to have grown about a basic process. In eight of the cases, the process is that whereby the raw material mined is smelted or refined. Among central-office groups in the iron and steel industry, appear in one case a ferro-alloy furnace, and in another case, a zinc smelter in connection with iron and steel blast furnaces. Among the other metal industries, particularly zinc, lead, and copper, smelters operating in at least two of these basic materials are found in combination in five central-office groups. There are also smelters, not engaged in smelting the original ore, which smelt and refine scrap material and resmelt the dross and slag of other smelters. One central-office group produces Babbitt metal in one establishment and in another, manufactures white metal, an alloy used especially in the manufacture of table cutlery.

Beyond the smelting stage, only four central-office groups operate separate establishments working with different metals. Two combinations have establishments which manufacture brass and bronze products and also establishments doing similar work with iron and steel. One central office operates separate establishments in the fields of aluminum and brass and bronze, and another in brass, bronze, and copper. It is surprising that there should be so few concerns in this group. Apparently, it is not as desirable to separate operations into establishments according to the

metal used as to base the separation on processes. It must be remembered that this group includes only concerns whose activity is metal working, and not those making a specific product having a separate industry classification.

Closely allied to the metals, are the concerns manufacturing stone, clay, and glass products. One central office operates establishments classified as manufacturing marble monuments, and other establishments working with other stone materials such as slate. The manufacture of glass appears in two combinations, one with crucible making, and the other with the manufacture of stove lining. In both these cases, the process is fundamentally similar, necessitating the fusion of raw materials, and the shaping, polishing, etc., of the product.

The instances cited above demonstrate the fact that, except in the other metal smelters and in the manufacture of glass and allied products, similarity of process is not an important factor in the formation of central-office combinations within these industry groups.

Chemicals and allied products.—There are only nine central-office groups producing chemicals and allied products in which the bond between establishments is that of similar process. Five of these nine concerns are employed in the manufacture of oils. In each case the process is one of cleaning the raw material, removing extraneous material such as shells, hulls, etc., and crushing by the application of pressure to the material from which the oil is obtained, usually accompanied by heating. Among such combinations were two producing cottonseed and peanut oil and concerns producing cottonseed and coconut oil, cottonseed and fish oil, and linseed oil with fish oil. Cottonseed oil has the greatest variety of uses, being used in the manufacture of soap, in cooking, as an adulterant for other oils, etc. Peanut oil is a food product and a soap material. Coconut oil is used in the manufacture of soap and candles. Linseed oil, made from flax, is chiefly used in manufacture of paints and medicines. A similar combination is that in which tallow is the product of one establishment and grease the product of another.

Three other central-office groups are found in the chemical group which manufacture products from limestone, gypsum, and dolomite, in which the process is one of roasting or calcining the material in order to procure the final product.

As will be noted, all the instances of this classification in the chemical industry are concerned with the preparation of chemicals from the raw material. In those central-office groups operating in the later stage of the chemical industry the emphasis is entirely on material used rather than process.

Printing and publishing.—The central-office groups which operate a number of different printing and publishing plants are most difficult of classification. They have all, however, been included either in the group in which establishments produce successive products, where central offices operating separate printing and publishing plants are classified, or as dissimilar products made by the same process. The reasonableness of this latter classification is made evident by a single example. A single central-office group operates three establishments, one of which does job printing, one prints and publishes books, and one prints and publishes periodicals. Each of these receives a separate industry classification by the Census Bureau. The materials used may be considered either as the implements used in the process, or the manuscript used as the basis for the operation. As a matter of fact, the significant difference between these three establishments is not a matter of process or of implements, but rather a difference in the material used. It is the manuscript which determines the nature of the final product, whether job work, periodical, or book. It seems best, therefore, to classify such a central-office group as one in which the same process, applied to different materials, results in different products. There were nine concerns which fall directly within this group. One additional concern must be allied with these, since its establishments produced periodicals and also society badges.

Textile products.—There are 868 central-office groups which operated in the field of textiles. These utilized cotton, wool, worsted, silk, hemp, flax, jute, and fur-felt as their materials. Among these 868 concerns there were only 9 which had separate establishments utilizing different raw materials. The remaining 859 central offices specialize in a single basic material. It would seem not at all strange for a central-office group to operate establishments some of which produce woolen goods and others cotton goods. As a matter of fact only two central-office groups were so constituted. One additional concern had a worsted mill in connection with cotton mills. There were two central offices which produced silk as well as cotton goods. One concern dealt in woolen cloth and canvas gloves. One concern had an establish-

ment for producing jute goods and another for the dressing of flax and hemp. Finally, one concern manufactured oilcloth and artificial leather. This completes the number.

The above figures for the textile industry, in which it would seem so natural for central offices to organize about a central process, indicate practically no development of this sort. However, these industries, though similar in the fact that they require weaving and dyeing, are nevertheless by no means as parallel as would first appear. In the wool and cotton industries, for example, the raw materials, coming from entirely different sources, both in geographical location and derivation, pass through separate and highly developed independent markets. At the end of the manufacturing process, the markets are again quite distinct. Likewise, during the manufacturing process, various minor differences arise because of the adaption to the raw material. Since these are industries in which it is possible for any concern, when it is desired to expand, to extend in the field in which it is already active, because of the well organized markets for raw materials and the universal requirement for the product, expansion has followed along such lines, rather than extending into one of the other branches of the textile industry. The fact that only nine central offices step beyond the boundaries of a single basic material is an adequate demonstration of this fact.

Miscellaneous.—There remain 13 central-office groups to be discussed which do not properly fall in any of the above groupings. Five of these are concerns which carry on both electric and steam railway repairing, six are cases of steel and wooden shipbuilding, and one, a concern manufacturing rattan and wood furniture. The first two groups are cases by no means easy of classification. However, because similar facilities are required for both—railroad or ship yards—this similarity, being one of process rather than material, has determined their classification. Both types represent, to some extent, an intermediate stage, as the industries involved change the type of product required.

The remaining two instances are worthy of especial note. The first one is a combination manufacturing shoe polish and gas lighters. The explanation given by the operator for the unusual combination is as follows:

"Ordinarily the gas-lighter business and shoe-polish business would be separate, but our salesmen calling on the retail trade can easily carry both lines, the gas-lighter samples not adding materially to the weight the salesmen have to carry.

"Besides this, the presses used in stamping all metal used in the gas-lighter business are also used in stamping screw caps, bottles, and jars used in the shoe-polish business.

"We are making a patented can for ——. These cans are also stamped by the presses used in the gas-lighter business."

The other is a combination of an artificial flower plant and a sawmill. But the product of the sawmill is shipped entirely to the artificial flower factory. In that plant the actual products made are flower stems and wood-turned products—the basis being the same requirements of whirling machinery for winding stems and operating lathes.

In summary, the number of instances in which central-office groups are organized about a basic process is small. In the food and kindred products industry group only has this type of consolidation appeared to any considerable degree. In this instance, the lack of possible variations on the basic material used, and the limitations with regard to the amount of raw material available or product able to be marketed have meant that expansion had to seek some other line of activity. This expansion in many cases has been to those activities in which the experience and technical knowledge gained from the original venture may be of value—namely, those industries whose process of manufacture is similar. Beyond this industry group, except for a few scattered instances, such as smelting and refining and the manufacture of oils, the explanation of industrial combinations must be based on functional relationships other than that of similar process with dissimilar materials.

XV.

COMPLEMENTARY PRODUCTS.

Certain final products are made completely of one material and in one piece, as for example, clothespins or files. For the most part, however, final products require several different basic materials in the process of manufacture, and the more complex products are usually made up of many parts. An apparently simple product, such as a pair of shoes, represents the coming together of a considerable number of subproducts, including leather cut stock, toe caps, staples, counters, pegs, tacks, stains and dressings, eyelets, laces, thread, shoe boxes, etc. When one considers the many different parts in a complex machine such as a typewriter, automobile, locomotive, or electric dynamo, the organization of industry along various lines specializing in the manufacture of particular parts seems almost necessary.

The manufacture of any final product can be broken up into a number of steps. In each step may occur the addition of labor, in human or machine form, such as the polishing of furniture or the weaving of cloth; the addition of some other subproduct to the original, such as tannic acid to hides; or the subtraction of some material, as occurs in the refining of oils. When the operator controls two lines of manufacturing which converge in a single final product, the second of these three cases, his central office is said to manufacture complementary products. It is with such instances that the present chapter is concerned.

The instances which are included in this chapter have been divided into four subdivisions. These subdivisions, with the number of cases appearing in each, are as follows: (1) Complementary materials, 14; (2) complementary parts, 28; (3) complementary products, 78; (4) complementary industries, 39. From this total of 159 should be deducted 2 duplications, giving a net total of 157.

A graphic presentation of this type of converging functions would present the function lines of establishments as being quite separate at their beginnings, but meeting at the ends, like a letter V. The production of tannic acid and of leather, for instance, do not come into the category. They are not complementary but rather

¹ Duplication of two central offices, operating establishments in both groups.

successive. Tannic acid and the preparation of hides for tanning are complementary. Their combination occurs in the tanning and curing of leather. The end of the tannic acid plant function line meets the beginning of the tanning function line, rather than the ends of both meeting, as do those of tannic acid manufacture and hide preparation.

Complementary materials.—There are 14 instances in which separate establishments of a central-office group produce different products which are not themselves in their final material form, but are to be further changed in later stages of the process. The manufacture of parts, on the other hand, is the manufacture of products which are to be joined to other products, but are not themselves to suffer any further integral change. These 14 instances represent the reaching of a convergent point by products in which the following step requires a further change in the form of both—usually the result of their combination.

Five of the central offices in this category manufacture paint or varnish, in connection with the production of other goods. Two agricultural implement and wagon manufacturers produce their own paint; two glass factories and one mirror concern likewise parallel the production of their product by operating paint or varnish mills.

There are two concerns which manufacture paper and also operate establishments which produce coal-tar products. The products of these separate establishments, when combined, form roofing paper. In one instance, a separate third establishment appears whose sole function is the combining of the products of the two establishments mentioned above. In such an instance, the graphic presentation of the combination becomes a Y rather than a V.

Two establishments mine phosphate rock, and also maintain establishments producing the materials with which it is to be treated for the production of fertilizer. In one of the cases the concern is a tallow plant, in the other an acid factory.

The remaining five cases are as follows: A central office engaged in the manufacture of malt liquor maintains separate establishments for the production of malt and of yeast. A central office producing explosives maintains separate establishments producing alcohol, chemicals, and carrying on wood distillation to obtain charcoal. A central office engaged in shipbuilding maintains sawmills and a turpentine and rosin plant. A central-office group manufacturing paper operates a sawmill, and also manufactures

its own line for bleaching purposes. Finally, a concern which manufactures shoes produces its own leather, cut stock, and leather dressing.

It is unfortunate that the data included in this study dealing with the mining activity of manufacturing concerns do not accurately specify the particular types of mining in which the combination is engaged. In a number of the central-office groups of the iron and steel industry the concerns are active in mining more than one mineral product for their own use. The mining of limestone, coal, iron ore, fluorspar, and dolomite are all reported, and at least 32 of the 58 central-office combinations in this group, which did any mining at all, mined more than one of the above-named products.

The few instances in this category indicate the possibility of organization along this line, but likewise the fact that it is by no means extensive. These central offices actually represent double instances of successive functions. In all cases of successive functions, and they are to be discussed in a later chapter, one type of establishment produces the materials for later use in another. The above instances are the cases in which two such materials are produced by the single firm. Although the development of successive functions has been very considerable, it evidently has developed in general along a single line, and the various other commodities required for the process are obtained through purchase, rather than through the operation of parallel establishments producing complementary materials.

Complementary parts.—During the war the manufacture of fabricated ships gave publicity to a method of manufacture which was by no means a new development. The manufacture of parts in separate establishments and their combination at some central point is a method of manufacturing procedure which naturally developed as the division of labor and specialization became more and more prevalent. The manufacture of clothing has always required buttons, etc., which have been manufactured elsewhere, while the manufacture of metal parts, such as nuts and bolts, generally occurs in separate establishments. Perhaps in the automobile industry more than any other this method of manufacture has been most highly developed because of the varied requirements of automobile manufacture. Many concerns in this industry purchase all parts from other concerns and devote their energies to the combination of these parts and to the distribution of the product.

There are six instances in which practically all the parts required for the final product are manufactured within the central-office group. Necessarily, this can be done only when the product is a fairly simple one. An example of this type is that of a central office manufacturing ice-cream freezers, operating a sawmill and a machine shop, which together produce the finished product. Two instances of oil-well machinery are to be noted, in which such activities as sawmills, machine shops, boiler factories, foundries, and establishments making steam packing are to be noted. Two central offices manufacture tool handles and tool metal parts in separate establishments, while another, manufacturing derricks, operates a structural steel plant and a machine shop. One other case is to be noted in this group, and that is an instance of a central office manufacturing watches, which operates one establishment devoted to the manufacture of watchcases, and another to the manufacture of watch movements.

The remaining twenty-two cases which fall within this section are instances in which certain particular parts are manufactured by the central-office group in specialized establishments. Of these cases, six are instances in which shipbuilding concerns manufacture either engines, winches, or electrical apparatus in separate establishments; seven are cases in which carriages and agricultural implement concerns manufacture engines and operate sawmills, four are instances of fabrication in central-office groups manufacturing automobiles. One of these automobile concerns is particularly worthy of note, because of the extent of specialization among its constituent establishments. In this instance, beside the central automobile factories, are establishments producing automobile parts, engines, and electrical apparatus; there are also machine shops, and foundry and a wire mill. One instance of unusual specialization is that of a concern, manufacturing engines, which uses the entire output of a subsidiary establishment which manufactures gauges. One central-office group, manufacturing railway cars, both steam and electric, operates steel works; bolt, nut, washer, and rivet works; engine plant, and a foundry. A central office engaged in manufacturing locomotives manufactures certain parts in a separate foundry. One central-office group, difficult to classify, produces ammunition, and operates separate brass and bronze works, and a felt factory. Finally, one concern, manufacturing arches and rubber clothing, operates a separate buckle factory.

Apparently, this form of development has occurred chiefly in the separate production of engines, or such complex machinery that the central office prefers to have it done in a separate establishment. Of course, in the case of the automobile, the engine is in many cases the most important part of the final product. In practically every instance, however, the subproduct made in the specialized shop is a complex metal product.

Complementary products.—Although the distinction between parts and final products which are combined in the hands of the manufacturer is by no means an easy one to make, it has been attempted in order to make the analysis as logical as possible. An example of the type of combination included in this section is a central-office group which manufactures spools and thread. These two products are separate entities, and converge at the last possible moment before the product reaches the market. They retain to a considerable degree their individuality. There are two instances in which concerns operate plants manufacturing labels in connection with glass containers or carton manufacture. manufacture of sewing machines and sewing-machine tables or cases, and the manufacture of calendars and frames in separate establishments, are further instances of this type of combination. In two cases, glass factories have expanded into complementary activities; one operating a basketry factory and the final product of the central-office group being demijohns; the other being combined with a machine shop and producing fruit jars with metalfastened tops. The manufacture of women's clothing, particularly waists, and also of dress trimming, occurs in separate establishments in one central-office group.

Two central-office groups which seemed from their census classification most peculiar were easily explained by the manufacturers upon inquiry. In one case, the establishments of the central-office group were classified as manufacturing perfumery and leather goods. The explanation was as follows:

"* * * The skins which we are manufacturing in our plant are skins that are used for the capping and decoration of perfume bottles, toilet waters, and other lotions. They are commonly known as baudruche skins and being used extensively by the perfume trade qualifies them as a product kindred to our perfumery and cosmetic plant."

In the other instance, the establishments were classed as manufacturing wire or wood products, and the explanation was as follows: "In the wire goods business, we manufacture sieves and

riddles for the foundry trade. These sieves or riddles are made with a bent wooden rim, and these rims are made in our ——factory, and shipped to us."

By far the greatest development in this group is in the manufacture of containers, using the word to include such varied articles as barrels, tin cans, burlap bags, etc. Many manufacturers have been forced to extend into this field to meet their own requirements. There are two obvious advantages to be derived from manufacturing containers under the same management as the main product—the assurance of supply and the ability to manufacture a container best suited to the peculiar requirements of the industry. In many cases, the manufacture of containers has been an act of self-defense on the part of the operators, because of the difficulty involved in obtaining the needed products in satisfactory quality and amount. A letter from an operator of extensive canning activities in Virginia explains his entrance into the packing-box industry as follows:

"As Europe entered the World's War the price of boxes began to go up. It was hard for us to obtain our required shipments. We began to look around and found that we had quite a lot of box lumber on hand, so bought some machinery and began to make our own boxes."

It is probably true, however, that by far the greatest amount of container manufacture done in this way is carried on in the same establishment in which the main product is produced, and, therefore, does not appear in the central-office data in which the units are industrial establishments.

There are 64 central-office groups which include separate establishments manufacturing containers, and in which containers are not the major product of the group but are manufactured for use in packing or shipping the primary product of the combination. Of these 64 instances, 6 concerns manufacture 2 different forms of containers in 2 separate establishments, and 4 manufacture 3 different types of containers in 3 separate establishments—such as boxes, barrels, and tin cans. Of these 4 instances in which 3 forms of containers are manufactured, 2 are oil-refining concerns, 1 produces tobacco products, and 1 manufactures food products.

Included in the central-office groups, therefore, are 78 distinct developments of container manufacture by operators as complementary to their main activity. The types of container included among these 78 instances are as follows: Boxes, fancy

and paper, 21; barrels and other cooperage, 15; boxes, wooden packing, 15; tin cans, 11; glass containers, 4; tanks and steel packages, 4; bags, other than paper, 3; boxes, cigar, 2; manicure cases, 1; packages, made from pulp, 1; and tin foil, 1.

In certain of these cases, the uses of the container are so limited that no further discussion is necessary. The glass containers are all manufactured in central-office groups producing malt, liquor, cider, or vinegar. The cigar boxes are used only by central-office groups manufacturing tobacco products. The tin-foil establishment is operated in connection with a chewing-gum plant. The manicure cases are made by a firm specializing in manicuring sets.

Of the 21 central-office groups manufacturing fancy and paper boxes, seven are clothing manufacturers, especially producers of socks, and three manufacture shoe boxes for use in their shoe factories. Of the six central-office groups classified as manufacturing food and kindred products which also operate box factories, four are engaged in the manufacture of candy boxes. It is interesting to note that there are three concerns whose main product is glassware, which manufacture their own containers, chiefly of corrugated cardboard.

The manufacture of tin cans is done for the most part in concerns specializing in that industry, and they are bought ready made for use by the concerns desiring them. However, five canning factories, four oil refineries, and two tobacco manufacturing concerns produce their own tin cans for use in connection with their products.

The manufacture of barrels and other cooperage is scattered through a number of industries. Four central offices primarily engaged in oil refining operate separate cooperage establishments, while three flour-milling concerns, two manufacturers of sugar, two concerns producing fertilizer, and various single enterprises are also engaged in the same activity. In several of these instances, the central office also operates a sawmill providing the raw material for the cooperage plant.

Of the central-office groups which make their own wooden packing boxes in separate establishments, five are in the oil-refining industry, two are meat packers, two in the canning industry, and the remainder produce tobacco products, clothespins, playing cards, glassware, matches, and clothing. As might be expected, most wooden packing boxes are made in the concern and are not considered by the manufacturer as products having a separate value. The primary products are boxed or crated as

produced, and the operator makes no report on the census schedules for boxes manufactured. This fact is demonstrated by the figures from the 1919 Census of Manufactures. Of the total value of boxes produced during that year, 92.2 per cent were reported as produced in establishments in which wooden boxes were the principal product produced. There were only 94 establishments other than box factories which reported box manufacture. These figures alone are sufficient to demonstrate the fact that much of the activity along this line is lost in the general total for industries in which the manufacture of containers is not considered as a separate activity.

That manufacturers are entering more and more into this field is evidenced by the decrease in the number of establishments from 1914 to 1919 in the cigar-box industry, the wooden packing-box industry, and the cooperage industry. In the manufacture of glass containers, the great decrease due to the diminished demand for alcoholic-beverage bottles, makes it impossible to determine the extent of the tendency for manufacturers to make their own containers.

Complementary industries.—There are 39 instances in which the establishments in central-office groups are classified in industries which supplement each other. Of this number, 20, or over one-half, are combinations of foundries and machine shops. In these instances, since the products are not known, it is impossible to determine the exact functional relationship of the establishments concerned. It has been necessary, therefore, to include them in this group, as instances in which the two industries supplement each other.

Practically all the 19 remaining instances are cases in which the industries represented are engaged in the maintenance of transportation activity. In five central-office groups, steam-railway and electric-railway repair shops appear together. These combinations have already been discussed with the central-office groups whose basis of combination is a similar process. However, either combined with these 2 activities or, in 13 additional cases, with steam-railway repair shops alone, appear industries such as the manufacture of gas (Pintsch gas for illumination in trains), sawmills and wood-preserving establishments making railway ties, paint manufacture, ballast mining, etc. In one instance, the concern operates a rolling mill and makes its own steel rails. Perhaps the largest example of this sort is a railroad system including among its establishments steam and electric railway

repair shops, wooden-ship repairing (ferry), Pintsch gas plants, planing mill, paint shop, artificial stone manufacture for bridges, etc., copper and sheet-iron work, and tool factory.

One other instance of complementary industries must be mentioned, and that is a concern which specializes in shipping fruit and which operates ice plants and plants manufacturing refrigerator cars.

Summary.—A total of 159 instances, with other cases in the mining field indicated but not included because of lack of data, is sufficient to demonstrate the considerable extent of central-office organization based on the manufacture of complementary products. It is probably true, however, that in a considerable number of these instances, it was not the original intention of the manufacturer to operate in more than one line. As his knowledge of the exact situation in his industry grew, and perhaps as in the case of the Virginia canner, because "the price of boxes began to go up," when a tempting opportunity appeared, he entered into the new field. In certain cases, the company furnishing the materials or products to the group, being in financial difficulties and therefore threatening the source of supply, was taken over by the central-office group. The advantages of such a combination from the point of view of the operator are: (a) It extends the operator's control one step further, eliminating one more variable in the successful operation of his business—the supply of that commodity; (b) it assures that quality which he desires, no better and no poorer; (c) it makes possible an adaptation to the needs of his final product; (d) it eliminates certain costs, such as selling and advertising, and may reduce the overhead, power, and repair costs; (e) it nets the operator the profit which the original firm was making, and therefore makes his position in competition that much more above the margin.

XVI.

AUXILIARY PRODUCTS.

In discussing complementary products in the previous chapter, those instances were considered in which the articles manufactured by the operator are physically merged into a single product before reaching the final market. There are, however, additional instances of converging functions in which several industries are required for the production of a final product. In the case of complementary products, the industries each made additions to that total of material from which the final product is made. The remaining instances are those in which one of the converging industries merely assists in the process, is presumably essential for the completion of the process, yet remains only an auxiliary or accessory activity, and leaves no material trace in the final product. It assists in the main line of production. It supplements the other establishments.

For convenience in the discussion, the 161 central offices represented in this group have been subdivided into those producing services and those producing commodities. These subdivisions have themselves been further distributed. The totals in the 9 groups are as follows:

Auxiliary service	79
Maintenance—foundries and machine shops	35
Printing. Supplementary shops	14 22 8
Auxiliary commodities	90
Fuel	57 18
Mine timber Fire-brick	9
Other.	3
TotalLess those included twice	169
Net total	 163

There is no question but that the activities suggested in the following pages are actually engaged in by a much larger proportion of industrial concerns than these figures would indicate. In most cases, however, the amount of work of the sort under consideration is not great enough in extent to warrant the opera-

tion of a separate establishment. Every factory does much of its own repair work, but in few cases does this assume proportions such as to justify the operation of a separate repair establishment. The cases here discussed are, therefore, notable as representing the instances where the central-office group found the accessory activity of sufficient importance and extent to warrant the operation of a separate establishment in that field, rather than either to operate it as a division or department in the main plants, or to purchase from some other producer.

Since in no case included in this chapter is the activity of the auxiliary concern the primary interest of the concern, nor does it actually produce a part or a material appearing in the major product, it is to be expected that the central-office groups which find it economically desirable to operate such a subsidiary plant must be of considerable size. The 34 central-office groups which operate machine shops in connection with their other activities average 21.2 establishments per central-office group. This figure, in comparison with the general average of about 4 establishments per central-office group, indicates the correctness of the supposition.

Auxiliary services.—The distinction between services and commodities is purely an arbitrary one, based upon whether the product is a tangible material thing or not. There are 79 central-office groups which include establishments producing auxiliary services. In these cases, therefore, the product of the activity of the auxiliary establishment is not of tangible material but is rather a service product, and the service one required by the central-office group.

The first and largest subdivision in this class is that including foundry and machine shops which do not manufacture parts for the main product, but are active in the maintenance and repair of the other establishments. Of these 35 groups, the case is very clear in all but five, for the main product in these instances is nonmetallic. In the five instances, however, the reports made to the census indicate that the activity of the machine shops or foundries was purely repair work. Doubtless, many machine shops which were grouped in other categories, because they made parts or final products themselves, carry on a considerable amount of repair work; in accordance with the demands of the industry.

Of the 35 instances here discussed, 23 were cases of machine shops, 6 of foundries, and 6 of foundry and machine shop combined. It is interesting to note that in the country as a whole there are more than 6 machine shops for every foundry.

The industries represented in these 35 central offices operating such repair shops in connection with other establishments are quite diversified. The only industry in which any considerable concentration appears to be present is that of railroad repairing. In 10 instances, machine shops or foundries appear in connection with railroad repair shops. In these cases, the machine shop or foundry is in reality a supplementary shop, performing those repairing functions which the regular repair shops are unable to do. In four of these combinations, shipbuilding also appears, as well as the railroad repair shops and the machine shops. It is probably true that the machine shops, in such cases, supplement the activity in both lines.

The groups which show other concentration in this line are the food products and lumber groups, although only four instances are included in each. Others are: Tin cans, two; textiles, two; chemicals, two; paper and envelopes, two; oil refining, two; and the remainder scattering singly among the other industry groups.

The simplest method for presenting the various elements entering into this situation is to quote from a letter from one of the larger lumbering companies in the South.

'This shop (a combined foundry and machine shop) was operated here in --, primarily, of course, as an adjunct to the · Co.'s several sawmills and log camps. We required such a large amount of machine-shop work and foundry work that we considered it possible to operate our own foundry and shop. In this connection, however, we did do a little public work for outside parties. We found after operating this shop over a period of several years that it was not a profitable investment, due to the fact that the machine shop was located so far away from our various plants, and we could buy foundry castings cheaper than we were able to make them. We have, therefore, moved the shop to our largest operation and continue to run the machine shop there, but have abandoned the idea of running a foundry. Had we been able to run our foundry full time and get a full output from this unit, it would have been very profitable."

In a number of instances, the repair shops apparently do custom work, as well as the repair work for which they are intended primarily. This development appears, naturally enough, as the result of a situation in which the maintenance work of the other establishments in the central-office group is not sufficient to provide continual employment. It should also be mentioned that, in several of these cases, the machine shops are active in experimenting and developing improvements in the machinery of the industry.

There are 14 instances of central-office groups active in transportation in which the primary purpose of the group is manufacturing. Since the Census of Manufactures does not record transportation as such, these instances include only those in which the central-office group operated at least one transportation repair shop.

Six of the central offices operate yards for ship repair in combination with other activities. Of these six, two are engaged primarily in the canning of fish, and the other four are engaged in producing riprap stone, coal, lime, and brick. In the first two cases, the shipyards are engaged in repairing seagoing vessels, while the last four instances are central offices which operate barges on rivers or canals for the transportation of their heavy and bulky commodities.

Five of these central-office combinations are of railroad repair shops in connection with other activities, in combinations primarily active in coal mining, in meat packing, in the steel industry, in the production of metals other than iron and steel, and one in a cane-sugar-refining combination. One other instance should be mentioned, although not included in the scope of the study—the case mentioned in Chapter VII in which an American concern operates a railroad in Cuba, supplementing its sugar-refining activities there. Finally, there are three instances of carriage and wagon repairs, two of which are in combinations manufacturing food and creamery products, and one of which is an express company.

These 14 cases by no means indicate the extent to which transportation and manufacturing concerns appear together in industrial combinations. In most instances, however, such combinations are purely financial and the subsidiary companies direct their own operations from their own central offices. A more complete discussion of this problem is included in Chapter X.

The development of printing plants as auxiliary establishments is also worthy of note. A great many products are put on the market in specially printed boxes. Labels and tags are required in great quantities by many concerns. Advertising matter, catalogues, price lists, letterheads, forms—all these things must be printed. In 22 instances, these activities have assumed proportions which warrant the establishment of a private printing plant by the central-office group. In two of these instances the printing plant reported its chief activity to be the printing of a bulletin for employees. The publication of a bulletin or trade sheet has been undertaken by several of the other central-office

groups, but the majority sponsor such an activity rather as a filler in the slack periods than as the primary purpose of the establishment.

The industries operating auxiliary printing plants are decidedly scattered. Six of the 22 central offices appear in the food and allied products group, though within the group displaying wide diversity. They include 2 sugar refineries, 1 meat packing, 1 canning, 1 chocolate products, and 1 coffee-roasting concern. In no other industry are more than 2 instances present—tobacco, textiles, and chemicals each having 2; and tools, glass, street railways, shoes, paint, dental goods, drug supplies, roofing material, plumbers' supplies, and 2 mail-order houses also operating printing shops as accessory to their primary activity.

It should be noted that the average number of establishments in these central offices which operate auxiliary printing plants is to establishments per central office. The general average already noted approximated 4 establishments per central office. This once more substantiates the principle already advanced that only the larger central-office groups are in a position to operate auxiliary establishments.

In completing the discussion of the central-office groups which operate establishments producing auxiliary services, eight combinations must be considered whose relationship to the primary establishments in this group is somewhat different from the instances already discussed. In these cases, the auxiliary shop is one which performs a special part of the general process carried on in the other establishments and are as follows: Glove factories and sewing shop, jewelry and silversmithing, men's clothing and buttonhole shop, publishing and electrotyping, publishing or printing and engraving, sheet-iron work and patterns, shoe factories and stitching shop, and stoves and diesinking. These represent instances of specialization in which a step which was originally but a part of the general process has been separated and is carried on in a separate establishment.

Auxiliary commodities.—At first glance, it would seem evident that any step in an industrial process must be either the addition of some material to the original, or the operation upon the original material of some human or mechanical device. The many constitutent elements, however, are actually much more complex than the above statement would indicate. The previous section has discussed services which have made it possible for the process

to proceed economically and with as little waste as possible. This section is designed to discuss those commodities which, though they do not add to the substance of the primary product, are necessary for the carrying on of the process.

The first and most important auxiliary commodity is fuel. Fifty-seven cases are definitely recorded in which central-office groups produce fuel for their own use. The materials produced and utilized are as follows: Coal, 46; sawmill refuse, 5; gas, 3; coal and gas, 2; and oil, 1.

It is doubtless true that many of these concerns which mine coal furnish it at cost to their employees, and in some cases, sell in the open market. In practically all of these cases, however, the nature of the combination is such as to indicate that any retail or wholesale activity in fuel carried on by the central office is an indication rather of an excess over the requirements of the establishment than of a primary activity.

It must be noted that 36 of the instances of central offices producing coal are active in the manufacture of brick and tile. Clay mines and coal mines apparently form a natural combination, and are found in convenient juxtaposition. It has been suggested in the chapter on by-products that, in at least 5 of these combinations, brick or tile is the primary product. The remaining instances are scattered, including as primary activities such as the production of textiles, cement, lime, acids, tin plate, and wire, and the manufacture of chemicals.

The instances in which coal is mined by companies active in the iron and steel industry are included in the later chapter on successive products. Since coal is an integral material in the blast-furnace process, it is impossible to class it as an auxiliary product in that industry.

The three instances in which the utilization of natural gas was reported were concerns manufacturing sporting goods, distillation of wood, and coal mining. The relatively small number of instances of concerns producing this form of fuel may be explained: First, the necessity for the factory to be located near the wells to make its use economical, and the wells seem to be located with little regard to their use by manufacturers; second, the fact that natural gas is usually a by-product of petroleum production, resulting in the concentration of this activity in another industry; and, third, the comparatively slight extent to which natural gas is used as a manufacturers' fuel.

There were three instances reported in which limekilns were operated with the refuse of sawmills. It is quite probable that the utilization of sawdust and slabs as fuel is becoming more and more extensive. In industries in which a high temperature is required this material has been found to be of particular value.

Two examples of the utilization of sawmill refuse as fuel are particularly interesting. They are quoted from letters written by operators in answer to a special inquiry. The first deals with a combination of an ice plant and sawmill.

"We had an abundance of sawdust and shavings, which cost us money to get rid of, and we built an ice plant near and conveyed this waste to boilers and made ice without any fuel bill. The ice plant was later destroyed by fire."

The second instance is a combination of sawmill and brick-making factory, in which both the seasonal and the fuel problem entered.

"The advantages in operating a sawmill are to receive a better supply of fuel for the brickmaking plant and afford labor for valued employees through the winter months. Otherwise it would necessitate their having employment at other work, and it would be hard for us to obtain the same class of help the following year. The sawmill is of the small, portable type, which can be moved and set up for small lots, sawing the lumber and leaving the tops and small growth for the burning of the bricks. The clay in this locality requires more fuel than in some others. The older brick burners estimate it requires 6 feet of wood per thousand bricks."

There can be little question but that these instances of attempts of manufacturers to control their fuel supply will soon be considerably augmented if the difficulties now present in the procuring of such commodities continue for any considerable period. The recent coal strike and the unusual prices for coal have doubtless brought the problem of fuel to the attention of the producer in a much more forcible way than ever before. As far as the central office is concerned, an extension of its activity to that field seems the surest solution.

The manufacture of ice, naturally enough, appears in combination with the manufacture of products which require cold storage to prevent deterioration. These instances include the manufacture of artificial ice and not the cutting of natural ice practiced in the Northern States. There are 19 instances of the production of ice in industrial combinations as an auxiliary product. Of these 19 central-office groups 7 are engaged in the manufacture of meat products, either poultry killing, meat packing, or fish can-

ning. Ice is an essential in these industries, and the activities of the central-office groups are of sufficient size to warrant the operation of their own ice plant. In addition, there are 6 central-office groups which manufacture creamery products, such as butter, cheese, and condensed milk, and operate their own manufactured-ice establishments. Four establishments producing malt liquors and soft drinks, one transportation system, and one general merchandising concern whose ice plant furnishes cold storage for the store and also furnishes ice for the local trade are also to be included in this category.

The other instances of the manufacture of auxiliary commodities need little discussion. The nine instances in which sawmills are operated in connection with mining activity are worthy of note. One operator explains such a situation as follows:

"The principal activity of this company is the mining and selling of coal. The mine land holdings include timber areas from which the timber is cut which is used in the coal mine operations. We use underground in the mines of —— from 20 to 30 feet board measure of timber for every ton of coal produced. At one of our mine points, there is owned by this company * * * a sawmill constructed for, and the entire output of which is used in, the company's own operations."

There were four of these central-office groups which mined coal and operated sawmills, while one zinc, one zinc and copper, one iron, one clay mine, and one oil-producing company reported sawmills in operation for their own use.

There were three instances noted in which fire brick was manufactured by concerns which required the same for their ovens. These three instances were, respectively, with the iron and steel, coke, and copper industries. Brick so used requires constant renewal, and the larger concerns find it more convenient and economical to produce their own fire brick.

Three other instances are unclassified, one is the production of mill brushes in connection with operation of woolen textile mills. The other two instances are cases in which feed mills are operated and the products used for the stock belonging to other establishments in the central-office group. In one of these cases, the operator reported that the concern "was working from 1,000 to 1,200 head of horses, and by manufacturing our feed in this mill, we know just what feed we grind and mix, and also have a uniform feed for our stock all year round."

Summary.—Since auxiliary products are chiefly used by the other establishments of the central-office group, and usually disappear in the process, it is by no means an easy matter for the operator to determine whether such operation is profitable or not. There are, however, other circumstances which may cause his entrance into the auxiliary field. Probably the desire to avoid the various frictions which develop between separately operated concerns, and to effect a more efficient industrial organization, lies at the bottom of the combination. Although the operation of the auxiliary shop may, as a unit, result in an apparent loss, it may so increase the efficiency of the other establishments as to make such operation profitable to the central-office combination as a whole. In some instances, to be sure, the operation of an auxiliary shop is unavoidable. The central office may be compelled to do its own repair work if no other machine shop is in the vicinity, etc.

Usually, the production of the auxiliary commodity represents a type of activity quite foreign from that in which the original enterprise operates. However, if the demand of the central-office group for the auxiliary commodity is sufficiently great, it is by no means inconceivable, even in these days of industrial specialization, for the central office to embark into the new line of activity. The elimination of the marketing cost and the control both over the type of product and extent of activity of the auxiliary establishment are particularly incentives. Also, it often happens that particular economies result, such as the saving in cutting mine timber from coal lands necessarily owned by the company and providing considerable standing timber, etc., which possible economies may entice the operator to engage in the manufacture of an auxiliary commodity.

XVII.

DISSIMILAR PRODUCTS FOR SAME MARKET.

The two general types of converging functions which have been discussed in the previous chapters are both types in which the functions actually meet before the final product leaves the factory of the manufacturer. Cigar boxes and cigars, although produced in separate establishments, complete their convergence before leaving the control of the operator. There are, however, products made from different materials by different processes, whose function lines converge only beyond the scope of the manufacturing process. This final convergence, occurring either in use or in the market, is in many cases the only explanation for the combination of products produced by the establishments of a central-office group.

For convenience of discussion, the 233 cases which come under this general classification have been grouped into 3 classes and will be discussed under those heads. The first group includes those instances in which the convergence is in the final using of the product. Various products are always used together, yet remain separate products. They may be purchased separately, yet can not be used alone. There are a great number of common instances of this sort, such as pen and ink, collars and collar buttons, paint and brushes, beds and mattresses, etc. There are 32 cases in which convergence in use appears to be the only basis for the combination. The second group contains combinations producing dissimilar articles for a single market. This may be either a wholesale market, in which case the combination might produce such articles as druggists' supplies, building materials, etc., or the products may be those handled by single retail establishments, such as candy and ice cream, pianos and phonographs, etc. There are 139 central-office groups in this class. The third group includes industrial combinations by which more than one type of public utility is operated. The public utilities considered are gas, street railways, power, ice, etc. There are 62 cases in this group.

It must be kept in mind that the cases included in this chapter are by no means all those in which the similarity of market is an element in the explanation of the type of products produced by central-office groups. The manufactures of shirts and of collars by a single concern are obviously intended for the same market. However, they are both produced from the same basic material and, therefore, have been classed as joint products of the same material, rather than as products for the same market. In many cases, markets are not highly organized, and the determination of the presence or absence of the single market factor in such an instance as the production of structural steel and wire nails, would require more knowledge of the activities of the firm than is recorded by the Census Bureau. This chapter, therefore, includes only those central-office groups in which no factor other than the similarity of market can be offered as an explanation for the dissimilar products which the establishments produce. If, in example given above, the products had been cotton shirts and leather belts, then the central-office group would come into this classification, since while neither the materials nor the processes are similar the products are intended for a single market.

Convergent in use.—A great many manufactured products, produced and sold as separate products, can only be used in connection with other manufactured products.

Neither bread nor butter is eaten separately, but they are produced separately; they are brought together in use. There are an enormous number of cases of such a fabrication. Strangely enough, it seldom occurs that two such products, if dissimilar in material and method of production, are produced by a single concern in separate establishments. The smoker uses tobacco produced by one concern in a pipe made by another. The pen manufactured by one concern is used with ink produced by another. The needle made by one concern is used with thread spun by another. The instances in which such supplementary products are actually produced in separate establishments under single central-office direction are few enough to warrant a presentation of them in detail. There are 31 cases falling in this category, representing 22 types of combination. The types are as follows: Automobiles and automobile tools; bread and butter (2); cameras and films; chemicals and gas machines; chemicals and laboratory apparatus; cleansing preparations and cleansing utensils (4); electric-lighting apparatus and electric-light bulbs; filing cases and filing cards; firearms and ammunition; flash-light apparatus and flash-light powder; horse blankets and harness; ice cream and ice-cream cones (2); mattresses and beds (5); paving machinery and paving materials; pianos and music books; prayer books and

religious jewelry; razors and hones; rubbers and shoes; telephone apparatus and telephone books; toilet paper and toilet-paper racks; welding apparatus and oxygen and acetylene gas; window shades window-shade fixtures, and lace curtains.

Of the types of combination listed above, mattresses and beds are found to be the product of five central offices, and cleansing preparations and cleansing utensils occur in four instances. In these cases, however, there is a slight variation, for, although the cleansing preparation in each case is a form of soap, the utensils include scrubbing machinery, toilet brushes, and mops. Bread and butter and ice cream and ice-cream cones appear twice.

Convergent in the market.—There are 139 central-office groups producing dissimilar products, the functions of whose establishments converge in the market. These 139 concerns are central-office combinations in which dissimilar products are produced from dissimilar materials by dissimilar processes, yet are produced by a single concern for a single market. It is true that the group just discussed is convergent in market as well as in use, and should perhaps properly be considered as a special case under the group of central office convergent in the market.

The industry appearing with the largest representation in this group is that producing food and kindred products. The central offices producing for the food market have been discussed at various points in the study. A large number, especially those dealing in creamery products, were classified under joint products of the same material. A considerable number producing canned goods, milled products, and the bakery products appeared under the group entitled dissimilar products by the same process. The meat-packing establishments were included in the discussion of by-products. It remains, however, for 28 concerns to produce dissimilar products in separate establishments, the chief bond between them being that they produce for a single market. Of these 28 central offices, 8 produced the confections—candy and ice cream, candy and smoking tobacco, candy and soft drinks, or ice cream and malt liquor. Perhaps a statement by one of these operators indicating the nature of the development would be apropos:

"We are running an ice-cream, creamery-butter, and softdrink factory. We started in the ice-cream business, and later added the creamery-butter business because it worked in so well with the ice cream. We then added soft drinks because we were doing business in ice cream with most of the soft-drink dealers and could carry this with the same sales force. Also, they worked together in other ways." The remaining cases include the production of such major products as coffee and sugar, bread and jam, both of which might possibly have been classed with materials united in use, depending upon the user, meat packing and butter, cereals, lard, mincemeat, macaroni, etc.

In no other industry is there as great a possibility for economy from producing for a single market as in food-product manufacture. The salesman must visit the retailers, whose variety of supply is necessarily large, and it is as easy for him to deal in several products as in one. The retailer naturally prefers to do business with as small a number of firms as possible and purchases as much as possible from the firms on whom he has learned to rely. In addition, in the manufacture of food products it is not practicable to overdevelop along any one line, because of the dependence of the producer upon factors beyond his control, especially his raw materials.

Among the 120 cases included in this classification appear 59 concerns manufacturing dissimilar products going to various wholesale markets and to certain industries as supplies. These 59 concerns are distributed as follows: Building materials, 17; druggists' supplies, 8; plumbers' and pipe-fitters' supplies, 6; shoe-manufacturers' supplies, 6; jewelers' supplies, 4; electrical supplies, 3; dairymen's supplies, 2; dentists' supplies, 2; ship stores, 2; stationers' supplies, 2; bakers' supplies, 1; carpenters' supplies, 1; foundry supplies, 1; paper-makers' supplies, 1; laundry supplies, 1; photographers' supplies, 1; printers' supplies, 1.

It must be kept in mind that this does not include all the concerns manufacturing for these different markets, but merely the cases in which the only apparent reason for the combining of the production of the different products in a single central-office group is the fact that they are bound for the same market.

The combination appearing most frequently among the 17 which produce building materials is that of paint and varnish, which occurs eight times. As a matter of fact, these two products, so often considered as a single industry, are made from different materials and by different processes. Varnish is a solution of gums or rosins. Paint, on the other hand, is made from pigments, zinc, or lead oxide, etc., suspended in linseed oil, turpentine, benzine, or wood alcohol. Other combinations producing builders' supplies manufacture locks, builders' hardware, and wood screws; asbestos shingles and tar paper; paint and structural iron, etc.

Of the other groups listed, space limits specific mention of each. The central-office groups supplying shoe manufacturers are especially interesting because of the various diverse products which are manufactured separately for that industry—the six concerns included, operating separate establishments producing such unlike products as rubber cement, shoe blacking, leather stain, shoe dressing, lasts, shoe patterns, eyelets, pegwood, tacks, and shoe machinery.

There are 52 concerns in the group of central offices whose functions converge in the market which are as yet undiscussed. It is important to note at least the type of industries in which they fall. Six are manufacturers of containers of dissimilar materials. This includes the production of cloth and paper bags, paper and wooden boxes, and glass bottles and tin cans. Nine central offices manufacture products for the farmer, such as agricultural implements, wagons, fertilizer and insecticide, crates. etc. Six more deal in clothing in cases where the materials are of considerable difference, such as leather and cotton coats, straw and fur-felt hats, etc. An additional five produce house furnishings, ranging from candles and lamp shades to oil stoves and coal ranges. Three produce musical instruments made of different materials, in which the wooden instruments are manufactured separately from those of other materials. One combination report concerns manufacturing various articles, such as sponges, hones, polishing preparations—all used by industries where products require highly polished surfaces.

There are seven central-office groups which manufacture strictly for their own retail trade and operate establishments in more than one industry. These cases include mail-order houses, chain stores, and large retail establishments. The lines in which they are active are varied, a partial list being as follows: Lace, thread, underwear, bags, dresses, candy, perfumery, drugs, pianos, bakery products, bluing, canned goods, agricultural implements, tools, cameras, stoves, paint, harness, comforters, window shades, optical goods, flour, and ice.

Special mention must be made of two concerns which publish trade journals in connection with their product. Although this is doubtless carried on to a considerable extent for advertising purposes, the fact that payment is required from the subscriber makes these trade journals appear as separate industries in the central-office group. In both cases, however, the trade journal deals with that trade for which the central office manufactures

supplies. There was one combination of a laundry, printing establishment, and ice plant which, on investigation, proved to be entirely operated in the service of hotels in the locality. The remaining cases were combinations of sporting goods and knit goods, firearms and ordnance, polishers and emery wheels, filters and water softeners, rat traps with other traps, and dyeing machines and blowers.

Since a thorough understanding and knowledge of market conditions is considered one of the necessary adjuncts of a successful business man, there is a definite incentive for a manufacturer to expand along lines which require knowledge of but a single market. If this can be done by utilizing the same material or process, so much the better. The manufacturer of men's garters, in planning for expansion, naturally extends to the manufacture of suspenders. He will be able to sell in the same market and can use his knowledge of webbing in the new activity. Beyoud that, he may expand to silk neckwear. There is little in common between the actual production of neckties and garters. But the manufacturer unites the two in one central-office group because he can sell both in a market with which he is familiar and which is familiar with him. His knowledge lies in the men's furnishing business, and therefore his development is naturally in that one field.

This situation is very similar to that demonstrated in previous chapters. The manufacturer, in expanding, endeavors to utilize whatever knowledge and experience he may have gained from his previous business activity, and, therefore, if he does not expand in a single type of manufacture, expands to lines either similar in materials, process, or market.

Public utilities.—One field in which the development of combinations is of especial interest is that of public utilities. In general, public utilities are those industries providing transportation, light, heat, power, water, telephone and telegraph service, etc. For the purpose of this study, the manufacture of ice has been included as a public utility, although it has no legal standing as such. It is very similar to the other industries mentioned, however, both in the universality and the monopolistic nature of its market. In the data for central-office groups the manufacture of gas and the manufacture of ice are directly reported. Electric railways can be indirectly determined through the records for electric-railway repair shops, but there is no recognition taken of electric power plants or of telephone and telegraph companies in the regular Census of Manufactures. It should be noted.

however, that special quinquennial censuses are made with regard to electric railways, electric light and power plants, and companies active in the telephone and telegraph industries.

On the 4,813 combinations studied, manufactured gas appeared as the major product in at least 1 establishment in 108 central-office groups. Of this number, 46 central offices, or 42.6 per cent, produced gas only, operating 204 establishments. There remain, therefore, 62 combinations in which manufactured gas is produced as a major product in at least one establishment, while at least one other plant in the combination produces some other major product.

Of these 62 cases certain instances are not of the public utility type. In 7 central-office groups, the gas plant appears in connection with steam-railway repair shops, manufacturing Pintsch gas, which is used in illuminating railway trains. There are also 2 instances where the product manufactured is oxygen or acetylene gas and is not distributed for use as cooking and illuminating fuel, but is compressed and sold in tanks. Eliminating these 9 groups, there remain 53 cases in which illuminating gas appears in combination with some other product.

The nature of these combinations is as follows: Gas and electric railways, 32; gas and ice, 9; gas, electric railways, and ice, 7; gas and coke, 3; other, 2.

Since these represent practically one-half of these cases in which manufactured gas appears in the 4,813 central-office combinations, it is evident that the combining of the different public utilities is by no means unusual.

The public utilities form a natural unit of combination. Often conducted under franchise, necessarily of a monopolistic character, operating under conditions quite generally restricted by the oversight of governmental agencies such as public service commissions, producing products which can not be sold at central points but must be distributed intensively over a wide area, and dealing in a market as large as the locality in which the establishments are located, it is natural enough that this form of organization should grow up.

A superficial yet significant demonstration of the nature of these combinations is made by examining the names of the 53 central-office groups. The phrases tabulated below represent those appearing in the actual name of the combination, although the names of individual establishments may be quite different. These

 $^{^{1}}$ The other cases are: Illuminating gas and the mining of manganese ore, r; gas, street railways, and chemicals, r.

phrases are usually preceded by either an adjective such as "National," or "Central," or by the name of the locality. No distinction has been made between the uses of the words, "company" and "corporation" in the title.

Power Co., Light & Power Co., Railway & Power Co 12
Gas & Electric Co., Gas, Electricity & Transportation Co 11
— Utilities Co., — Public Srevice Co 9
—— Railway & Light Co
—— Management Co., —— Securities Co., —— Light & Development Co 5
Railway Co 4
Electric Co 2
Gas Co 1
Other, being named for individuals
Total 53

When it is remembered that these combinations have been selected from all central-office groups because of the fact that they represent the combinations in which illuminating gas appears, these titles have peculiar significance. They indicate centralization about power, and about public service. Although the Census of Manufactures gives no data with regard to electricity, some indication of activity along this line can be obtained, for an examination of the names given above indicates that among the central offices dealing in public utilities the word "electric" appears oftener in their names than the word "gas."

But this method of determining activity can be still further utilized. There were 32 combinations producing manufactured gas and operating street-railway repair shops. From these combinations, the 125 establishments whose major product was gas were selected for particular examination. It is customary, in such combinations, for each establishment to have a separate name, often different from that of the parent concern. An examination of the names of the 125 concerns manufacturing gas as their major product lists them as follows:

Public service, 18; utilities, 9	27
Power, 9; light and power, 7; light, heat and power, 4; gas and	
power, 2; water, light and power, 2; electric light and power, 1;	
light, power, and street railways, 1; railway and power, 1	27
Gas	26
Gas and electric, 16; gas, electric, and heating, 1; gas, electric, and	
power, r	18
Lighting, 5; traction and light, 3; gas, light, and fuel, 2; gas and light,	
ı; light, fuel, and power, ı	12
Electric	7
Gas and fuel	4
Street railways	3
Other	I
	T25

An examination of this table shows that, although these establishments were selected as establishments which are primarily gas companies, their functions are extended much beyond that of merely producing illuminating gas. In only 53 of the 125 names, or 42.4 per cent, the word "gas" appears; in 29 instances, "electric" appears; in 29, "power." The word "traction" or "street railways" appears 8 times. The general phrases, "light," "heat," and "fuel" appear 39 times; while "public utilities" or "public service" appears 27 times. These facts ought to be quite sufficient to demonstrate that the activity of concerns in the public-utility group is by no means limited to a single industry. Apparently, the combination of the production of electricity and gas is extensive, and the operation of street railways is a development from the production of electricity.

The manufacture of ice, though not technically considered as a public utility, has many attributes of such an industry. Because it is much more economical to maintain a freezing point than to reach it from a warmer temperature, the pumps in an artificial ice plant must be kept going all the time. The manufacture of ice, therefore, requires a continual expenditure of power. There is one other relationship to be noted, and that is the fact that ammonia, which is the basis of the ice-manufacture process, is a by-product of gas production. At any rate, in 16 of the instances, ice appeared in combination with gas. In general, these combinations seem to be chiefly present in regions in the Southern States. This coincides with the general distribution of artificial ice plants. since ice can be obtained naturally in the North. It is of interest to note that the location is generally in smaller communities. It must be remembered that there are ice plants operated by publicutility groups. The population of towns in which the 50 ice plants operated by 16 public-utility groups are located is as follows: Under 2,500, 8; 2,500 to 5,000, 24; 5,000 to 10,000, 10; 10,000 to 25,000, 6; Over 25,000, 2.

In practically every case, the town is a smaller southern community. The two over 25,000 are Tulsa, Okla., and Newport News, Va. In most cases, the company operates a street railway or gas plant in the same community.

The problem of the amount of territory supplied by a publicutility group is of interest. Of the 32 central offices manufacturing gas and operating street railways, 21, or approximately two-thirds, operate within the boundaries of a single State. In most of these cases, a gas plant and electric-railway repair shop

are located in a single town, and other gas plants located in various towns in the vicinity. In certain instances, the area of a State appears to have been divided among several large combinations, which operate concerns in the various towns in their particular districts of the State with little overlapping.

In addition to the 21 cases of intrastate operation, there are 4 central-office groups which reach to adjoining States. In the remaining 7 cases, the operation is over a wide area. It is a distinct development of modern times, paralleling the improved methods of transportation, for a single office to be able to operate plants in different regions of the country. One of these larger public utility concerns operates 15 establishments located in 12 States, all included within a triangle bounded by New York. Illinois, and Texas. Another combination, with 19 establishments, operates in 10 States, operating street railways in Florida, Georgia, Texas, and Louisiana in the South, Iowa and Michigan in the North, and Washington in the West, and gas plants in 5 quite widespread States-Iowa, Louisiana, Connecticut, Massachusetts, and Nevada. The remaining cases of interstate operation are similar to the two mentioned. In several instances. central offices operate single gas plants in each of several States.

Conclusion: The problems of marketing were not recognized until long after production engineers had been in the field. Likewise, industrial combinations have long been discussed in terms of production, but marketing combinations have received much less emphasis. The central offices presented in this chapter have demonstrated the wide extent of such a basis for combination. Particularly in the public-utilities field, is this type of combination apparent, though doubtless the importance of franchise and the historical development of this group of industries have been a determining factor. In industries in which selling constitutes a large part of the cost of production, central-office groups can effect great economies.

XVIII.

SUCCESSIVE PRODUCTS.

One classification commonly used in discussing industrial groups is that of horizontal and vertical combinations. A horizontal combination is generally defined as a consolidation or expansion of economic activity at some one stage in the industrial process so that several plants which do the same kind of work are operated as parts of a single enterprise. It is a combination of establishments on the same level of industry, which would otherwise be competitors. A vertical combination, on the other hand, is one which contains within the group, establishments which operate in different stages in the process necessary to prepare the final product for market. The members of such a group, if uncombined, would not be competitors striving against each other for a certain market, but competitors only as are two members in the bargaining process, each endeavoring to best the other. Such a classification is obviously inadequate except for the most general usage, since a third group, which might be termed, diagonal combinations, is necessary to include the cases of converging and diverging functions. It is, however, with those combinations commonly called vertical, those in which the establishments produce successive products, that the present chapter is concerned. The development of this type of industrial organization is often termed "the integration of industry."

Vertical integration as a method of industrial organization is best exemplified by a single industrial establishment. Practically all industrial establishments carry their product through several stages of the entire process within the single plant. The unfinished product is routed from department to department, each subdivision adding its small share to the total process. In many cases, these various steps can only be taken in succession—the brush can not be painted until it has been sandpapered, can not be sandpapered until it has been shaped, etc. The logical extreme of such a consideration is, of course, the recognition that each separate movement made by individuals or by machines represents a separate activity which has been integrated into an industrial process.

In terms of industrial combinations, however, integration has a much more practical application. The advent of the machine technique resulted first in specialization within the shop, and then, because of its corollary, the theory of the advantages of large scale production, in a development of specialization of shops. It was impossible to carry on all the stages in a complex industrial process on a large scale in a single plant. Before the Industrial Revolution, it was expected that the shoemaker would perform in his shop the entire process of turning raw hides into finished shoes. But it is a physical impossibility to do all this in one establishment on a large scale. The natural solution was to break the process at a convenient point, and perform parts of the entire process in separate plants. For a considerable period, each specialized shop was operated by an independent manufacturer. But the very force which caused the first specialization. the attempt to meet the requirements for successful competition. in turn brought these specialized establishments together into industrial combinations, and vertical or integrated combinations are the result.

Vertical integration has not been solely the result of the division of a process into several stages, each carried on in a specialized factory, and the subsequent combination of such establishments. It may also be the combination of processes, always separate, into a single industrial combination—the expansion of an industry into new fields. The mining of coal and the manufacture of coke were never done in a single establishment. Integration in that case represents the desire on the part of the manufacturer to be independent, to control as many as he can of the factors which enter into his industrial operation, to make as many as possible of the variable quantities involved in his enterprise subject to his will. Vertical combinations are the result either of industrial specialization or of the extension of control.

Of the 4,813 central-office groups included in the sample, 903, or 18.8 per cent, include establishments whose functions are successive, working toward the completing of a final product. If, however, all those cases of single central-office groups, in which only a single type of establishment was operated, be eliminated, the successive functions group is represented in 50.7 per cent of the remaining complex groups. It is the most prevalent of the complex forms of organization.

If mining be excluded from the study, and purely manufacturing establishments be considered, there would still remain 602 cases of integration among the central-office groups, a figure still considerably in excess of the other types of complex functional organization. There are two chief reasons for the operation of mines or wells by manufacturers; first, to provide the manufacturing establishments with raw materials for their operation, or second, to obtain power or fuel. All the cases which fall in the first group are instances of integration, while the latter instances were discussed as auxiliary products. The 301 cases which would be eliminated if mining were removed from consideration, however, are not cases of integration solely because they include mining, since many concerns operate establishments in stages beyond that in which the product of the mines is directly utilized, and might be termed instances of double integration.

In Table 70 is given the distribution of the 903 cases among industrial groups, with the percentage which each group bears to the total number of central-office groups. Discussion of each industry group is given later in the chapter, but at this point it is desirable to compare the proportions appearing in the different industrial groups. Lumber and its remanufactures is by far the highest developed along this line, leading both in extent and proportion of central offices which operate establishments performing successive functions. Following this come the industries which utilize the products of mines and wells--stone, clay, and glass products; chemicals and allied products, which includes the production of coke and also oil refineries; iron and steel and their products; other metals and metal products. These are the leading five in order of their importance. They are the five extractive industries. They are industries forming a natural group quite separate from the other industries, and which can be traced back to relatively similar antecedents in raw material. The other industrial groups do not have processes which are as extensive or as naturally broken as in these five groups. The industrial groups dependent upon agriculture for their main material show little tendency toward integration. The remaining industrial groups, which are rather similar in nature in that they emphasize the raw material less than do other industrial groups-paper and printing, vehicles for land transportation, railroad repair shops, and miscellaneous—show percentages between the extractive and agricultural group.

Table 70.—Central-Office Combinations Producing Successive Products, by General Groups of Industries: 1919.

Group number.	INDUSTRY GROUP.	Total. number of central offices.	HAVING		HAVING FU	
Group			Number.	Per cent of total.	Number.	Per cent of total.
	All industries	4,813	903	18. 8	602	12. 5
1	Food and kindred products	988	22	2. 2	18	1.8
2	Textiles and their products	868	78	g. o	78	9.0
3	Iron and steel and their products	422	134	31.8	121	28. 7
4	Lumber and its remanufactures	414	199	48. I	199	48. x
5	Leather and its finished products	133	29	21.8	29	21.8
6	Paper and printing	237	57	24.1	57	24. I
7	Liquors and beverages	77	2	2.6	2	2. 6
8	Chemicals and allied products	557	195	35.0	41	7.4
9	Stone, clay, and glass products	346	126	36.4	5	1.4
10	Metals and metal products other than iron	-				
	and steel	95	27	28.4	18	18. 9
II	Tobacco manufactures	110				
12	Vehicles for land transportation	62	15	24. 2	15	24. 2
13	Railroad repair shops	178	[• • • • • • • • •
¥4	Miscellaneous industries	326	19	5.8	19	5.8

Since this study is one primarily of manufactures, the number of cases in which integration is solely the result of mining and manufacturing combination have been eliminated and the proportions found by such a study included in Table 70. The 602 cases are those in which successive steps occur among purely manufacturing establishments. Lumber still retains its supremacy, becoming even more extensive in comparison. Chemicals, and stone, clay, and glass products, however, drop out and their places are taken by paper and printing and vehicles for land transportation. The process in the chemical and the stone, clay, and glass industries is one which seldom can reach beyond the steps of extraction and manufacture. The result is that, eliminating extraction, but one step in the process is left. The two industries which advance by the elimination of mining are industries which have no mining whatsoever, but are purely manufacturing in their operations.

The more important industrial groups are here discussed in detail. Cases of by-products might conceivably be included as successive products. However, since the two processes do not

meet end to end—for example, the manufacture of soap breaks off in the middle of the slaughtering process—it is not true integration. The distinction between these two categories is not purely arbitrary for the two types of combination rest upon very different bases of justification. The operator is confronted with a very different problem in the two situations. The instances of byproduct manufacture has been discussed separately in Chapter XIV and may be added to the instances in this chapter at the discretion of the reader.

Food and kindred products.—Among central-office groups which produce food and kindred products integration is very uncommon. There were but 22 such cases recorded. As a rule, in the preparation of food products for the market, there is but one manufacturing process required after the agricultural stage before the product is ready for consumption. And this process is such as to make difficult any subdivision into separate stages. Baking, canning, roasting, grinding, milling, cleaning and polishing—in each case the product of agriculture is taken and prepared for the market in a one-stage process. Any considerable development of integration in this industry would have to be one in which two of the four stages of the entire process were combined—production, transportation, manufacture, and marketing. At present, these different functions are, according to the information available, almost exclusively performed by separate operators.

Of the 22 cases 9 were instances in which the first step was the production of a nonfood material later used in making food products. Four beet-sugar plants mine their own limestone for use in bleaching their products; three ice-cream plants produce their own ice; one combination of chemicals and baking powder occurs; and one instance in which the same concern produces creamery machinery and butter.

Eight cases are those in which certain food products are used to make other food products. Three combinations appear manufacturing vinegar and pickles; two which operate plants for grading, roasting, cleaning, and shelling peanuts in connection with establishments producing peanut candy products; and there are single cases of the combination of plants manufacturing glucose and starch, baking powder and bread, and yeast and vinegar. The remaining five instances occur in meat-packing groups, where separate plants are maintained for slaughtering and meat packing, or in which successive products such as glue and sandpaper, cotton-seed oil and lard, or tallow and fertilizer, are produced.

These few cases are sufficient to demonstrate the fact that the processes of manufacture of food products are not readily adaptable to specialization and therefore to integration. Of the 22 instances given, less than half can be considered as purely in this industry group. The markets are so standardized, the raw material so scattered, and the length of the process so short that the development of combinations in this industry has followed other lines, rather than the manufacture of successive products.

Textiles and their products.—The census of 1900 was the last enumeration to include cotton ginning as a manufacturing industry. Since that time, the textile industry proper has been considered as beginning its manufacturing process with the textile establishment, in which yarn, thread, etc., are the first products.

The various industries which are included among the textiles are those utilizing cotton, wool, worsted, silk, hemp, flax, and jute as their basic materials. These commodities are made directly into yarns, thread, felt, etc., and then into fabrics, knit goods, imitation leathers, oilcloth, and similar products. products in turn often require further manufacture before they take their final form. There is usally an intermediate step known as dyeing and finishing. A considerable proportion of this particular operation is done in the establishments manufacturing the fabric, nevertheless, a number of central-office combinations maintain separate establishments which perform this process for the products of their textile mills. It includes "independent bleacheries, print works, and dye works, chiefly engaged in dyeing, printing, bleaching, and mercerizing cotton, woolen, worsted, silk yarns, and piece goods, printing cotton piece goods, and in spooling cotton, winding yarn, etc." 1

There were 78 instances of integration among the central offices active in the textile fields. These were varied in nature, but can be subdivided as follows:

Twenty-two central-office combinations operated establishments whose part in the industrial process came before that of making the fabric, and with the making of the fabric itself. Of these instances, 18 occur in the silk industry, in which the manufacturing process is divided into two stages, isolated into separate establishments. The first step is known as throwing and winding the silk, which includes the twisting and other operations involved in making silk thread. The second step is that of weaving, man-

¹ Census of Manufactures; classification by industries; 1919

ufacturing ribbons, broad silks, etc. Approximately 80 per cent of the silk thrown in establishments which specialize in that one activity is done under contract, so that the relationship between these two activities is even greater and more intimate than the above considerable number of central-office combinations would indicate.

Similar in type to the central-office groups just discussed is a central office which is active in wool scouring and the manufacture of woolen cloth. Wool as it comes from the sheep is in an exceedingly dirty condition, full of grease or suint. Before it can be worked, it is necessary to burr, wash, scour, and dust the wool. Customarily, this operation is carried on near the point of shearing, since the wool loses from 20 to 85 per cent of its weight during the process, and therefore transportation costs can be decreased. That this combination appears only once is perhaps due to the fact that the scouring of wool actually occurs before the market transaction, in which the wool is transferred from the agricultural to the manufacturing field, and therefore the manufacturer purchases his wool already scoured. The remaining three cases occurring in this classification are worthy of note, being central-office groups in which separate establishments are engaged in the dressing of furs and manufacture of fur-felt hats, the manufacture of hemp-dressing machinery and the dressing of hemp, and the manufacture of wire and corset manufacture.

The next group of central offices whose establishments perform successive functions includes those which operate textile mills in connection with dyeing and finishing establishments. The development of separate establishments for dyeing and finishing is one of the outstanding examples of industrial specialization on a considerable scale. This development is illustrated by Chart D, in Chapter IV. As can be readily seen, in 1879, practically all dyeing and finishing was done in the textile factory. Since that time, in every intercensal period, the number of dyeing and finishing establishments has increased at a rate faster than the number of textile establishments. During the 40 years from 1879 to 1919, the number of establishments manufacturing textiles increased 41.9 per cent, while the number of establishments engaged in dyeing and finishing increased 228.8 per cent. A new and separate industry has grown up, as indicated by the presence of 16 central offices in the sample, operating 37 establishments, doing nothing else but dyeing and finishing. Twice as many

central offices, 32 to be exact, include dyeing and finishing establishments in connection with the operation of textile mills or the manufacture of textile products. Generally, one dyeing and finishing establishment will take care of the products of several textile mills operated by the same central office. There are 27 central offices producing cotton, worsted, silk fabrics, and knit goods, and operating their own dyeing and finishing establishments which purchase fabrics undyed, and there are 5 central offices whose operations, therefore, begin with the dyeing and finishing stage and continue to the manufacture of products from the dyed material. These are cases in which the dyeing required is unusual and where the step is particularly important. Two cases of manufacture of oilcloth, one of awnings, one of housefurnishings, and one of shirts are included.

The group in which integration seems perhaps most natural is that of manufacture of fabric, and of the final products. This type of combination occurs in but 20 instances in which wool, cotton, and silk fabrics manufactured in the central-office group are made into men's and women's clothing, awnings, oilcloth, and umbrellas. One instance in which the combination manufactures yarn and baseballs, and two cases where cordage and twine occur in combination with the manufacture of nets and seines, complete this group.

Special mention should be made of the five cases in which three processes occur in the single central-office group. In two of these, the fabric is made, dyeing and finishing done, and final product made in separate establishments. In two cases, silk throwing and winding, silk weaving, and dyeing and finishing are done in separate establishments, and in one case, the preparation of jute, manufacture of cordage and twine, and the manufacture of nets occur in the single central-office group in separate establishments.

Taken as a whole, the development of integration in the textile industry is relatively slight, though apparently much more extensive in this country than in England.² Factors which enter into this condition are the tardy inception of large-scale production in the latter stages of the industrial process, the relatively active competition throughout the industry, and the organization of the market which is largely based on the contract form of disposing of or procuring materials.

² See Carter: Tendency Toward Industrial Combination.

Iron and steel and their products.—Integration is perhaps most extensive in the iron and steel industry. In this industry there are an unusual number of definite steps or processes appearing between the first procuring of the raw material and the turning out of the final product. Wood products require seldom more than the lumbering, sawmill, and finishing mill of some sort, and the entire process is complete. Food products require much the same length of process. The iron and steel industry, however, requires an actual change in the character as well as the shape of the raw material; reworking of the material several times is not unusual. As well as dividing into a number of definite successive stages, the iron and steel industry is also particularly favorable to other types of development, since it converges to the blast furnace and then diverges into many different lines—the diversity increasing with the distance from the original production of pig iron. Although not as numerous as the instances of integration in the lumber industry, the cases occurring in the iron and steel industrial group are perhaps of more significance than those in any other industry. The growth of large corporate combinations, combined with the nature of the industry, have inevitably resulted in integration.

The iron and steel industry in this country is particularly interesting in terms of vertical combinations, because in England careful study seems to indicate that "the vertical development of combination is exhibited mainly in the iron and steel industries and its influence in the other main industries is comparatively of secondary importance." There can be no doubt but that the vertical form of organization is much more widely developed in this country, although it is interesting to note that the industries other than iron and steel, in which integration is most extensive, are industries in which English industry is not active.

Centralization and integration in the iron and steel industry has been particularly developed by improvements in industrial technique. Pig iron was once allowed to grow cold and solidify before it reached the smelting furnace. This situation meant that considerable energy had to be expended in heating the cold pig for the next step in the process. As might be expected, the possibilities for economy were soon realized, and now the tendency, is for such an enterprise to be so organized that the iron is rushed

Carter: Tendency toward Industrial Combinations, p. 64.

to the smelting furnace while still hot, and the steel ingots are even kept hot in sand-pits that they may more easily be brought to the heat necessary for rolling them into blooms, billets, bars, etc. This technical industrial development has resulted in a decided concentration of activity. It is no uncommon thing to find the blast furnaces, rolling mills, and wire or tin-plate mills operating as departments of one establishment. From such an industrial situation the development of vertical combinations was a natural evolution.

There were 134 concerns appearing in this study in the iron and steel industry which operate establishments whose functions are successive. This number would be greatly increased if the manufacturing of coke were included. Although the great part of the product of coke ovens is used in the production of pig iron, and although 82 coke manufacturing concerns operated coal mines in connection with their blast furnaces, therefore placing them in the successive functions group, it has seemed wisest not to include them in the iron and steel industry. In accordance with customary census usage they are included in the chemicals and allied products group. The 134 concerns here discussed represent, therefore, enterprises which deal with iron in some form or other, operating either in the blast-furnace process or later.

Because of the impossibility of individual examination of such a considerable number of instances, it has seemed wisest to divide the iron and steel industry into six steps or processes in order to generalize upon the entire group. It is very difficult, and largely an arbitrary matter, to determine such subdivision. The six steps here utilized are so constructed as to bring out most clearly the successive establishments appearing in the various groups. It is, therefore, a classification nontechnical, based on the breaks in the industrial process as evidenced by the presence of separate establishments. That often a single establishment will operate two groups is a difficulty which unfortunately can not be overcome. For example, a rolling mill may have its tin-plate department and yet would be classified only as a rolling mill by the census and therefore in this study. However, if a tin-plate plant was operated separately, it would appear. The generalizations here made, therefore, are based on the actual separation into establishments of the various steps in the process. The groups used are as follows:

GROUP 1.-PRODUCTION OF RAW MATERIALS:

Mining of lignite, coal, limestone, iron, fluorspar, dolomite; extraction of natural gas; operation of sawmills in connection with charcoal manufacture.

GROUP 2.—PREPARATION OF RAW MATERIALS FOR FURNACES:

Manufacture of charcoal, either directly or by wood distillation; coke manufacture; limestone burning; manufacture of fire brick.

GROUP 3.-PIG-IRON PRODUCTION:

Includes all blast furnaces engaged in manufacture of pig iron from iron ore, also ferroalloy furnaces.

GROUP 4.—ELEMENTARY PRODUCTS FROM PIG IRON:

Products of steel works and rolling mills; cast-iron pipe; bolts, nuts, washers, and rivets; structural ironwork; forgings; and springs.

GROUP 5.—IRON AND STEEL, INTERMEDIATE PRODUCTS:

Tin plate; wire; wrought pipe; work done in boiler shops; foundries; machine shops.

GROUP 6.—IRON AND STEEL, COMPLEX PRODUCTS:

Hardware; tools; steam fittings; models; cars; sewing machines; scales; ship-building; stoves; engines; pumps; electrical apparatus; cream separators; ordnance; radiators; locomotives; tinware; wirework; razors; etc.

Having these 6 groups in mind, a classification of the 134 firms examined gives the following results:

	ENDING WITH—				
beginning with ~	Pig-iron produc- tion,	Elemen- tary products.	Interme- diate products.	Complex products.	Total.
1. Production of raw material	34	13	7	4	58
2. Preparation of raw materials for furnaces	5	6	2		13
3. Pig-iron production			1	1	8
4. Elementary products			1 7	17	24
5. Intermediate products			.	131	31
Total	39	25	17	53	134

¹ In this group, r concern operated coal mines in connection with its other activities.

A recapitulation of this table demonstrates that of the 134 cases, 49, or 36.6 per cent, operated establishments in 2 adjacent groups; 48, or 35.8 per cent, operated establishments covering 3 steps in the total process; while 16 entered into 4 steps, 7 into 5 steps, and 4 into the entire 6 groups.

The four concerns operating in all six stages of the process represent the maximum integration in the iron and steel industry. The details of these cases are as follows:

Case No. 1.—Mines limestone, coal, and iron ore; coke furnaces; blast furnaces; rolling mills; a plant making bolts, nuts, washers, rivets; iron and steel forgings; machine tools; machine shop; steel shipbuilding; engines.

Case No. 2.—Mines limestone and fluorspar; coke furnace; blast furnaces; rolling mills; wire mills; manufacture of wire products.

Case No. 3.—Mines limestone, iron, coal, and dolomite; coke furnaces, both beehive and by product; lime; blast furnace; rolling mills; shipbuilding; railroad repairing.

Case No. 4.—Mines coal; blast furnace; rolling mills; tin mills; manufacture of tinware.

It is unfortunate that material is not available whereby this problem might be extended to include financial control. In this industrial group the presence of large fortunes and large combinations would make such developments of peculiar significance. The extensive development of central-office groups, however, is itself very worthy of note.

The Census of Manufactures of 1919 reported 195 iron and steel blast furnaces in the country. In the sample of 4,813 central offices there were 2 central-office groups operating only blast furnaces, for a total of 5 establishments. There were, however, 75 different central offices which operated establishments whose products were successive, which included at least one blast furnace among its establishments. These 75 central offices account for 145, or 76.3 per cent, of the 190 blast furnaces as yet unaccounted for.

According to the data examined, the extent of integration in this field is striking. The factors which have been largely responsible for this integration are: (1) The nature of the process, (2) the presence of large fortunes and capitalistic combinations in the industry, and (3) the necessities of competition.

Lumber and timber products.—The industrial group in which integration is most prevalent is that of lumber and timber products. Of 414 central offices which fall within this group, 199 operate establishments performing successive functions. This percentage of 47.9 is the highest shown for any group.

Integration, while very extensive in this industry, presents by no means as difficult a problem as in combinations such as iron and steel. Of the 199 cases, only 9 are at all complex, the other 190 being cases where but two types of establishments are operated in which one further manufactures the product of the other.

The extent to which logging is undertaken by these central-office groups is impossible of determination. Logging is not considered a manufacturing industry, and is, therefore, not included in the data on central-office groups. The relationship of manufacturing and logging, however, has already been discussed on page 133, where figures were introduced showing that 70 per cent of all lumber sawed in mills was cut by the same

company that sawed it, and that 21.2 per cent of the lumber used in the wood-pulp and paper industry was cut by the company which later used it as a material for its manufacturing operations. The data for central offices, however, begin with the milling processes.

Of the 199 cases of integration in the lumber and timber products industrial group, the first steps occurring in separate establishments were: Sawmill, 182; planing mill, 12; wood turning, 4; excelsior plant, 1.

As can readily be seen, over 90 per cent of the cases of integration in this industry are combinations of sawmills with other establishments using the sawmill products.

Of these 182, or 91.4 per cent of all cases, 8 are complex, and the remaining are cases in which sawmills are combined with one other industrial activity which utilizes the sawmill product. These 174 can be grouped as follows:

I.	Operations changing the material from the lumber, such as wood distillation,	
	paper and wood-pulp manufacture, and wood preserving	16
2.	Planing-mill and excelsior products	55
3.	Boxes and baskets	32
	Cooperage	23
5.	Wood-turning processes, including lasts, pencils, spokes, wheels, vehicle	
	parts, agricultural implements, spools, handles	3r
6.	Furniture, including store fixtures, piano materials, and sewing-machine	
	cases	12
7.	Miscellaneous, consisting of sporting goods, scales, ships, fence posts, and	
	matches	5
	Total	

It is a natural step for a firm whose principal material is lumber to expand backward in the direction of sawmill ownership. It is then possible to cut and treat the lumber according to the particular product which they intend to make, and, in that way to make the entire process one which is more efficient and less wasteful. Another distinct advantage is that of relatively greater assurance of supply.

The eight more complex groups mentioned above are in four cases instances where the sawmills operated by the central office provided material for two different lines of operation, making more than one final lumber product, and four are cases where there were three steps present among the establishments. In these latter instances, two were combinations of sawmills, planing mills, and final products, and two groups of sawmills, pulp mills, and final paper or pulp products.

The instances in which the primary activity is other than the operation of a sawmill are few in number and not particularly significant. All but one are simple instances of mill and final product. These final products vary from artificial limbs to coffins. It is of interest to note one combination producing excelsion and mattresses.

In the lumber and timber products group, one case occurs of machinery and product. This firm produces match-splint machinery and matches. It is quite possible, however, that in the four instances included in the chapter on Auxiliary Products in which machine shops were reported in connection with sawmills, the machine shops are engaged in other than repair work.

The presence of integration in this industry is apt to be considered as overemphasized because of the fact that in Chapter XII it was stated that 33 central offices, operating 129 establishments, were active in sawmill activity only. Such a development, however, is to be expected when it is realized that much of the lumber used does not go to the manufacturing establishments for use in making lumber products, but rather to such activities as railroads, for ties, fence working, etc., and construction industry. The sawmills producing for such a market, of course, have little opportunity for integration with manufacturing establishments. It is, however, true, that the development of "backward" integration in the case of manufacturing establishments requiring lumber in considerable commodities is an outstanding feature of any discussion of integration in this country.

Leather and its finished products.—Integration in the leather industry centers about the tanning operation. The tanning, currying, and finishing of leather as an industry has undergone very startling changes in the last 50 years. The examination of this industry in Chapter IV gave some indication of the development. During the 50 years, 1869 to 1919, the introduction of machine technique resulted in putting the industry upon an entirely new basis. Although 1919 recorded but one-eleventh as many establishments as did 1869, it reported more than twice as many wage earners. This development, through expansion and consolidation, has brought the establishments in the industry into much closer connection and touch with their sources of material and with those manufacturers to whom their product goes for further manufacture. In 6 cases, in which the tanning operation is combined with the manufacture of tannic acid, it appears as the final step occurring under the supervision of the central office. In 14 cases, it occurs as the first step.

The 29 establishments which occur earlier in the industrial process in this industrial group are: Tannic acid, 6; leather, tanned, curried, and finished, 14; boot and shoe findings or cut stock, 9.

The leather industry consists of very few different types of industrial establishments. There are three central offices which perform more than two steps in the process, in each case the combination being the tanning of leather, the manufacturing of boot and shoe cut stock, and the manufacture of boots and shoes. The manufacture of boot and shoe cut stock includes soles, tips, heels, top lifts, inner soles, etc. The remaining combinations include but two stages in the industrial process.

The 29 establishments which culminate the process in each of the central offices in this group are: Leather, tanned, curried, and finished, 6; boots and shoes, 16; belting, leather, 5; leather goods, not elsewhere specified, 1; hat and cap materials, 1.

The fact that there are 98 central offices in this industrial group which operate establishments—all similar—indicates that the general form of organization to date has been horizontal rather than vertical.

Paper and printing.—Mention has already been made at several points in this study of the relationship between the paper industry and logging. The figures presented indicate that 22.3 per cent of the lumber used by the paper and wood-pulp mills was cut by the establishment which manufactured it.

The paper-working process has been broken in a number of instances by the separation of pulp mills from paper mills. In 1919, out of a total production of 3,517,952 tons of wood pulp, 2,417,649 tons, or 68.7 per cent, were produced and consumed in different establishments. In 1914, 14.6 per cent of the wood pulp consumed was imported from Canada. This separate development of pulp and paper mills is recognized in the central-office organization. In 13 central-office groups, separate establishments produce pulp and paper. Because of transportation cost, the large paper mills find it worth their while to make their pulp at some convenient point near the field of logging operations, rather than ship the lumber in the form of logs. Because of the desire to control their raw material, the concerns whose original function was merely the manufacture of paper from wood pulp have extended back into pulp manufacture and finally into logging operations.

The extension of central-office organization from paper making has been also in the other direction. In 27 cases, paper mills are associated with factories manufacturing paper goods. These products included paper bags, envelopes, playing cards, paper boxes, cartons, mailing tubes, paper novelties, tags, roofing material, etc. Apparently, however, the integration seldom extends in both directions from the paper-making establishment. No cases of more than two successive stages were reported in the industrial group.

The combination of paper manufacturing with printing and lithographing establishments occurs in three central-office groups. The lithographing concern using a particular form of paper for checks, etc., is best able to make a final product which meets the demand by operating its own paper mill. The two other instances are those of large printing establishments which are capable of utilizing the product of an entire paper establishment, one being classified as engaged in job printing, the other in newspaper and periodical publishing. In general, the requirements of printing establishments are for such varied and relatively small quantities of paper that the operation of a paper mill would provide a product not of the proper quality and in too much quantity.

In the printing and publishing field there are 13 combinations to be found which can be classed under integration—12 being cases where the binding or printing are separate from the publishing and, therefore, in accordance with the discussion on page 204, are classified as producing successive products, and one an instance where school supplies are made in one establishment and job printing done in another.

Chemicals and allied products.—The 195 instances of successive products in the chemicals and allied products industrial group are chiefly the result of mining and oil activities. Although the industrial classification used by the Census Bureau is as a whole satisfactory, it must be kept in mind that certain activities do not classify easily. The general title given this group is apt to mislead, unless it is realized that both coke production and oil refining are included in it. It is these two groups which largely make up the considerable number of cases of integration here appearing.

Of the 195 cases, 154, or nearly 80 per cent, are instances in which the combination is one of extraction of raw materials with a single type of manufacturing establishment. Of these, 82, or more than one-half, are combinations of coal mining and coke manufacture, and 44 of oil wells and petroleum refining. There

are five instances in which the extraction is followed by two steps in the manufacturing branches, such as oil wells, oil refining, and dyeing and finishing textiles, or the manufacture of boracic soap.

Except for two large drug-supply companies, which defy classification successfully, due to inadequate data, nearly all the remaining cases are based on the exploitation of a single material which has itself been through one stage in some establishment within the central-office group. These materials, and the number of central offices which manufacture them and also succeeding products, are as follows: Oils, II; chemicals, 7; grease, 4; carbon black, 2; tar, 2; alcohol, I; charcoal, I; casein and albumen, I; glue, I.

These are the instances which are generally considered as more definitely belonging to the chemicals group.

One other instance to be particularly noted is that of an oil-refining company which operates a fuller's earth mine. This case is a particularly interesting instance of the "conquest of distance," since the refineries of the company are in Pennsylvania and the mine in Florida. The operator's reply to an inquiry was as follows:

"* * * and promptly commenced mining and milling this fuller's earth for use in its (this company's) petroleum refineries in the classification of petroleum oils by percolation or agitation. The undertaking was conceived principally for the purpose of providing our own refineries and our associates in the refining industry with their requirements of fuller's earth, and for a long time such refineries consumed practically all the output of the mill."

The element of convenience is very important in this industry. Usually, the intermediate products are in a form where the economical procedure is not to ship, but to proceed in the same establishment. Such a definite break as is required for a vertical combination is often an impossibility. The considerable number of cases in this group, however, is of significance.

Clay, stone, and glass products.—Integration in the clay, stone, and glass products industrial group is almost entirely the result of combinations of mining with manufacturing establishments. Of the 126 instances noted, only 5 would remain if mining were eliminated from consideration. The mining of the materials which are used in this industry results in a product of such bulk and weight that the limitations set by transportation costs necessitate the manufacture of the product at a point near the point of extraction. Propinquity, a relatively low value for the unworked raw material, and the necessary coordination between the two activities result in the considerable number of vertical combina-

tions found. The products of the mines, in many instances, would have no market as raw material, but are of value only if manufactured.

The 120 cases in which manufacturing and mining are united in single central-office groups are: Single product (113)—brick, 61; cement, 15; lime, 12; marble, 7; plaster, 7; earths, mineral, 4; grindstones, hones, and whetstones, 3; paving material, 2; pottery, 2; more than one product (7)—cement and lime, 3; cement and plaster, 1; lime and brick, 1; lime and marble, 1; paving material and brick, 1.

The five instances in which mining is not an essential to the classification as successive functions are as follows: Glass and glass cutting, staining, and ornamenting (twice); tile and refrigerators; mineral earths, and acids, and one concern, the only instance of more than two stages in this group, mining silica, making glass and stove lining, and also cutting and staining glass.

The manufacturing processes in this industrial group are usually of but one stage. The making of bricks will never become a matter of integration with several establishments all participating. Integration has developed backward to a considerable degree from the manufacturing stage into the production of raw material. It is probably true, for instance, that those mining concerns manufacturing bricks, which failed to report the operation of a clay mine, did so because they utilize all of its product and do not conceive of it as mining activity.

Integration, however, has apparently not advanced to the same degree between the manufacture of these products and their utilization in building construction. The manufacturers of brick, cement, marble, plaster, and such products all sell their products to the builders, and reserve all their own energies for the business of manufacturing. If integration ever appears between these two industrial groups, it will arise from the building contractor's desire to make his own material. At present there are few contractors with a business large enough to make the production of their own building materials an economy.

Other metals and metal products.—There are 27 instances of integration among the metal and metal-products industries, other than iron and steel, called for convenience the other metal industries. Of these central-office groups, 14 were active in mining and the remaining 13 began operations at a point later in the process. Six central offices reported no mining, but operated smelters. In 9 instances, the organization was one of mining and smelter only.

Of the metals represented, copper occurs in the greatest number of cases, although zinc, lead, aluminum, silver, and metal alloys are all major materials in at least one of the establishments in these 27 central offices. In several instances, establishments which smelt different ores are operated by one central office.

A peculiar type of activity found in several central-office groups is that in which a smelter roasting material other than ore appears in conjunction with an ore smelter. In these cases, the secondary smelter uses the dross from the first smelting and procures other metals from it. This might be considered a by-product activity. Two concerns operate establishments which produce brass and bronze products, one in conjunction with a cash register plant, and the other with watch movements and watchcases. The manufacture of Babbitt metal and automobile clutches, and the manufacture of white metal and tableware, illustrate the form of integration appearing among the alloys.

The other metal industry is by no means as extensive as the iron and steel industry, but it also affords development along lines of several consecutive establishments in vertical combinations. The other metal concerns, however, are more prone to sell their product in the form of bars or ingots for further manufacture into a final product by some other manufacturer, rather than to carry it through themselves to the final product state, as so many of the iron and steel concerns do. Most of the other metal establishments produce as final products, paint and acids, but their own major product appears in the form of lead bar or pipe, copper wire, etc.

Vehicles for land transportation.—The 15 central offices manufacturing vehicles for land transportation, and which operate establishments performing successive functions are all engaged either in automobile or carriage manufacture.

Nine of the 15 central offices manufacture automobiles as their final product, preceding the final production by manufacturing automobile parts, engines, wire, or by foundry and machine-shop operation. Much of the automobile production, as such, is purely fabrication, the parts being made in separate factories and brought together for assembling. In cases where more than one type of establishment was engaged in making parts, the central office would be classed as "complementary."

There are four central offices which go only as far as producing automobile parts, having prefaced this production by manufacture of brass and bronze products, machine-shop operation, or manufacture of forgings. Two plants manufacture wagons, one prefacing this manufacture by manufacturing wagon materials in a separate plant, the other by operating separately a foundry and machine shop not engaged primarily in repair work.

Vehicles for land transportation are such complex products that it is well nigh impossible for the manufacturer to manufacture all the parts which he must utilize. Expansion is apt to take the form of relieving the pressure at the point where it seems most profitable to do so and therefore to produce parts which are particularly important, unnecessarily expensive, or difficult to obtain in desirable quantity or quality. In this chapter, 15 central offices are reported as active in manufacturing a single line of successive products. To these must be added the 11 instances of Chapter XVI, in which complementary products were produced, and in which therefore 2 converging lines of products appear.

Miscellaneous.—Certain of the 19 instances of integration which are classified as miscellaneous are worthy of mention. Five of these cases involve the manufacture of musical instrument parts, chiefly piano parts, and the manufacture of musical instruments themselves.

One additional case of machinery combined with product appears in a firm which makes buttons and also machinery for making buttons. In this instance, because the demand for such machines is so slight as to make a separate general industry for their manufacture unnecessary, this particular plant, having determined to improve or change its machine, was compelled to enter that field in order to do so.

The manufacture of electrical apparatus, prefaced by manufacture of chemicals in the case of storage batteries, and in other cases, by manufacture of glass, or of machine-shop operation, also appears in several central-office groups.

Lenses and optical goods, feathers and neckwear, asbestos and roofing material, refrigerating appliances and ice—all such are here classified and further illustrate the development of integration as a basis for the formation of industrial combinations.

Conclusion.—The examination of cases only serves to emphasize the extent to which integration has developed as a form of industrial organization. The fact that the manufacture of successive products occurs in central-office groups in more than twice as many instances as does any of the other complex forms of functional relationship indicates that very decided advantages must accrue from such a type of combination.

Vertical combinations are entered into for various reasons but they resolve themselves chiefly to but two, either as a more or less fortuitous way of investing surplus capital, or as a means of increasing the competitive strength of the operator. An increase in competitive strength is inclusive of the more notorious motive, to make more profits. There are six elements in this increase in competitive strength, each of which deserves separate comment.

- A. Economies in production.—In addition to the various economies which are generally considered as the result of increasing the scale of any industrial operation, there are certain economies which quite definitely belong to the vertical combination. It is probable that in particular instances many different variations might be found, but in general, there are four.
- I. Elimination of the middleman and marketing costs. In certain industries, the activities of middlemen are so extensive as to add a considerable increment to the necessary costs of uncombined establishments. In industries in which sales are made directly from certain establishments to others, the similar cost of marketing will be eliminated from at least one of the establishments in case of a vertical combination. All costs involved on either side in the making of the bargain no longer appear.
- 2. A better adapted product. The combination avowedly changes its emphasis from an attempt to make the highest profit in each concern into an attempt to make the highest profit from the sum total of concerns. The factory manufacturing steel plates for the shipbuilder will do so with quite a different point of view if it is independent than if it is operated by the same central office. The assurance of a market having certain definite requirements makes it possible to organize the earlier stages of the activity in a more specialized way than would be possible if there were always the possibility of having to shift manufacture to meet the specifications of another customer.
- 3. A better coordinated process. In the discussion of iron and steel, the economy arising from integration in that particular instance was noted. An illustration of this same thing from another field is the continual difficulty of nonrailroad-owned coal mines to procure necessary cars, when railroad-owned mines appear to have a surplus. The possibilities of economy in this way are particularly present in those cases in which successive industries are combined, rather than successive stages within one industry.

4. An assured supply. The most efficient plant is the plant which is run at a steady and regular rate. Wide fluctuations in output represent additional costs in terms of unused equipment, idle employees, etc. There can be little doubt but that a single operator can organize his enterprises so that the constituent parts will dovetail in a much more harmonious fashion than is done by the traditional forces of supply and demand. He is able to plan further ahead because of his wider range of activity. He is undisturbed by market fluctuations which would otherwise have affected his supply of raw material.

These four elements of economy represent the first advantage of the vertical group in competition, for cheaper production is always a producer of increased profit and competitive strength.

B. Independence of operation.—The tendency for integration is generally backward. The manufacturer usually does not add a factory which will utilize the products of his original enterprise, but rather enters into the industry from which he buys his material. If the market for his original product be good, he does not need to extend to processes beyond that field but would naturally attempt to increase the amount of his product for that market; if it be bad, he does not care to enter that field. If he expands forward, his original enterprise will guarantee him materials; if he expands backward, it can guarantee him a market. Of the two, the market is the more difficult to obtain. Finally, the fact that any disturbance in the source of his supply of materials upsets the operation of his plant far more than a disturbance of the market results in making integration more prevalent toward raw materials. It is definitely to the advantage of the operator to be independent, to rely on the activities of as few other operators as possible. The combination which is self-contained is in a much better competitive position because of its independence and freedom from various otherwise disturbing factors.

C. Distribution of risk.—The vertical combination is, in a sense, an illustration of the old adage, "Don't carry all your eggs in one basket." In such a combination there is a pooling of profit and loss. This has a decided advantage in several ways. It reduces to some extent the speculative element in industry. It likewise prevents the necessity for shutting down factories for short periods, which would in many cases involve a cost greater than the loss from running them for the intermediate period. If, for example, a combination only mined coal, a sudden drop in the market might necessitate the closing of its mines, which is a very expensive

operation. If, however, it also operated a number of coke plants, it is quite conceivable that the coal mines would be operated, even though coal might be purchased more cheaply on the market.

D. Greater resources.—This element must be particularly mentioned, although it is usually an element of advantage to any combination. In a vertical combination, however, the fact that these resources of the company are not centered about a single industrial process, but are distributed throughout several different industrial activities, lends additional value. This is of great advantage, particularly for purposes of borrowing money in times of depression.

E. Wide range of products and processes.—The distribution of the activities of a combination through several different levels of industry gives it a number of possible outlets for its products. It opens up more opportunities, and, in general, makes it more difficult to upset the concern through competition in any particular market.

F. Increased profit per unit of product.—The last element entering into the increase in competitive strength which arises from vertical combination is the increased profit per unit of product. In such a combination, the final product as put on the market has a much lower minimum cost than if produced by a series of independent operators. The profits which ordinarily appear in each market along the way are summed up in the final market, and the operator has a much greater possible reduction in price before he must go out of business than his less integrated competitors. In illustration of this point, "Where the steel manufacturer controls both his raw materials and his pig-iron supplies in the same way, his position is theoretically ideal * * *. No longer must the blast furnace owner pay a profit to the mine owner, the colliery owner to the coke manufacturers; nor must the steel producer pay a profit to the maker of pig iron, nor the rolling-mill proprietor pay a profit to the steel producer who supplies his billets, bars, ingots, etc. Under the newest arrangements which regulate and control modern practice, the intermediate profits are treated as a final profit on the finished product * * and the producer is thereby left in a better competitive position and can produce more cheaply in times of stress, from whatever cause it may arise." The situation is true not only

⁸ Adapted from Journal of the Iron and Steel Institute, 1903, p. 34, and the Iron Trade (Jeans), pp. 174-177, by George R. Carter.

in this industry but in every other case of vertical combination, that the operator is in a better position to meet a price war. And, likewise, a fluctuation in the price of the final product has a much smaller relative effect upon his total profit, if his combination is vertical.

These various elements which enter into the competitive strength of the operator of a vertical combination give clear evidence of the underlying basis for this type of combination. It also introduces a very interesting comparison between vertical and horizontal combinations. The manufacturer of coke who operates one coke furnace and adds another one, thereby increases his profit, although the profit per unit remains approximately the same. If, however, his expansion had been vertical instead of horizontal, i. e., if he had added a coal mine instead of a coke plant, his profit would have similarly increased, but solely because of the increase in profit per unit. There can be no absolute judgment as to which form of increasing his profit is wisest. In an industry of widely fluctuating prices, however, the vertical combination represents perhaps the more conservative form of organization. A drop of price in coke, returning to the original example, supposing it to be equal to the original profit per unit in the original plant, would wipe out all profit entirely in a horizontal combination. In the vertical combination, however, the profit from coal would still remain. If such fluctuations are wide and often occur, it is apt to strain in the horizontal combination much more than the vertical.

There are three additional conditions which may explain why vertical combinations are sometimes developed rather than horizontal combinations. The first is purely a psychological truth—that it is much easier to bring together men who have been bargaining together and reaching compromises, than men who have been bitter competitors. The second is the fact that manufacturers of successive products must have monetary dealings with each other. Consequently, there is a possible development of debts such as to make the taking over of such a firm by another a necessary way of obtaining payment for credit advanced. The third deals with the problem of the law. At present, a horizontal combination is much more apt to run into legal difficulties than a vertical one, since its operations are concentrated in a single market, while the vertical combination is active in many different lines.

It is significant to note that, in very few cases outside the iron and steel industry, is the process of the enterprise divided into more than two stages. This is largely due to the nature of the processes involved. Any break necessitates a transfer of goods, which is sometimes inconvenient and always expensive. Specialization does not always mean economy, and there is no question but that a development of separate establishments for a considerable number of the stages in a single process is impractical.

It was noted at the beginning of the chapter that integration developed in two ways, either through the breaking up of a hitherto single process into several stages, or the bringing into a single enterprise of two stages recognized as separate, perhaps even to the extent of being classed as different industries. Instances of the first type are relatively few in number and little development along that line is to be expected. Examples are found in the silk industry and in the manufacture of paper. The second type of integration, however, presents a type of organization already developed in many fields, and which would doubtless appear in much greater proportions if this study dealt with financial and the less direct affiliations. It is along such lines that the further extension of integration must come.

XIX.

UNRELATED PRODUCTS.

There are a small number of combinations which do not fall within the categories of various related functions which have been used. It is possible that many of the combinations previously discussed were not rationally formed because of the functional relationship, although that must have indirectly influenced both the formation and the continuation of the combination. But these combinations, of which at least one establishment refuses to enter into such a classification, are worth examination because they give some indication of the various other factors which may enter into the formation of industrial combination.

There were 83 enterprises which seemed to require explanation other than that offered by a functional relationship. A letter was sent to each of these concerns asking for an explanation of the peculiar industries which it embodied, and asking whether there seemed to be any particular advantage from such a combination. Replies were received from about three-fourths of the enterprises, and, with regard to the others, the schedules have been carefully examined to see if any possible connection can be found. Many of the replies, of course, indicated that the combination should have been classified elsewhere, and the various quotations which have appeared throughout the monograph from these letters indicate the presence of such cases. After a careful study, there still remain 47 combinations in which the functions are quite unrelated.

There are eight combinations in which enterprises are carried on in the interest of the employees. In many cases, in order to maintain its force in a community in which the activity of the company must be located, it is necessary to supplement the activities of the community somewhat. A letter from the vice president of one of the large cotton-manufacturing concerns indicates this situation very clearly:

"We are operating eight separate mill plants. Our largest operations are at ———. This town is entirely one of mill workers, incorporated, and a municipality to itself. The company has found it to its advantage to organize and run in the interest of a better community a dairy farm, a chicken farm, an ice plant, a laundry, a gristmill, a drug store, a meat market, a hospital, and a swimming pool.

"At some of our other plants we also run laundries, ice plants, and swimming pools, all in the interest of better service at reasonable cost to the operatives. The gristmill manufactures both meal and flour and was put up during the war not only to provide the flour and meal to the employees but to provide a place for the farmers to grind their wheat.

"We have found that these side lines, managed economically and in a businesslike way by our organization, provide conveniences for the operatives which they otherwise could not have

out in the country districts."

There are a number of manufacturing and mining towns throughout the country which are centers of activity of a single company. In many cases, the company owns the business enterprises of the town. The extent to which such enterprises are operated from a central office is, of course, limited. An instance of such a town is given by the following letter from one of the larger coal-mining companies:

" * * * some years ago, the —— Co. acquired a tract of coal lands located in the mountainous regions of ——. In the development of this tract, it induced the railroads to extend their lines into this coal field, and it built a mining town of some four or five thousand inhabitants, consisting chiefly of employees of the company. There were no bakeries, ice plants, or other manufacturing plants in this town to supply the requirements of its inhabitants, and the ——— Co., in order to supply the requirements of its employees, built and operates these plants."

In close connection with these instances of companies which are active in industries in order to maintain their labor force are combinations of seasonal industries. There are seven combinations in which the fundamental reason for combination appears to be the seasonal factor. Of these cases, six are instances of sawmills and canning, while one is of sawmills and brickmaking. The sawmill is always a desirable item in a combination, particularly when the other member requires fuel, and slash, etc., from the sawmill can be utilized.

The easiest way to appreciate the activity of such a combination is to take a single example. In a combination of a sawmill and two vegetable canneries, the operations were as follows: The canneries operated in June, August, September, and October; the sawmill operated in April, May, and July; and the operator carried on operations in timber camps, logging, in November, December, January, and February. No two activities overlap. Every month is busy except March, and that is, in all probability, the period in which the logs are transported to the sawmill.

The treasurer of such a combination explains it as follows:

"It is a fact that we operate a spring clothespin factory and a sawmill in connection with our canning business. We are located in a small town where we do not have very much floating labor. The canning of corn and beans, which is all we pack, is done in about two months. We have some positions where experience counts very much. Only employing a man two months and then letting him go, we are not liable to secure him again. To meet this condition, we started this other industry to keep men the year around and to have the labor we felt sure of."

Many attempts have recently been made within factories to so combine products as to offset the seasonal demand, but in industry in general, certain types of industry, such as canning, can only be regularized by operation in connection with some other separate and inversely seasonal industry.

A peculiar situation arises in the case of certain types of industry, particularly mining, which results in nonrelated operations. Through the purchase of land for use in connection with its major operations, the company may acquire certain enterprises situated thereon, which it must continue. There are five concerns which reported such a situation. One company discussed it in detail as follows:

"I know it is very unusual for a company mining coal and manufacturing pig iron and coke to be running flour mills, and I do not suppose that we would have purchased them had we not been compelled to take them over with the other properties that we bought. We do not find any advantage in operating these mills in connection with our plant, as nearly all the flour we make is sold to outside parties and very little of it shipped to our own operations. I also might say the same in regard to the farm lands. We have been trying to dispose of the farm property for some years, but as they were acquired with the idea that they contained iron ore in large quantities, and were purchased on that basis, we have never been offered anything like what we consider a fair price for them, this being the only reason we still continue the operation of our farms and flour mills."

A different situation is reported by a large marble company:

"In connection with our marble business, we have found it necessary to acquire large tracts of land on account of their containing marble or sand deposits; on account of our flooding lands in the development of our water power, and by the deposit of sand from our mills where marble is sawed. In order to make use of this land, we are operating about 12 farms. And to take care of the cream which is produced thereon, we started a creamery some 20 years ago. In addition to taking care of the milk and cream from our own farms, we received cream from some 40 or 50 other farms which are located near by."

Of the five concerns which are to be noted for this type of combination, two are operating flour and grist mills in connection with coal and iron mining, while the other three operate dairies and creameries, and ice plants, to take care of the requirements of farms which they own. No information is available of the extent to which manufacturing concerns operate farms; it only appearing in these cases because the operation of farms required the operation of manufacturing establishments as well.

There are five combinations which can only be explained by the enterprise of the managements, coupled with a refusal to consider themselves bound to only one industrial activity. These instances are so different in nature as to necessitate particular mention of each.

Three of the combinations are based upon inventions outside the particular realm of the original activity of the concern, and developed, at first, in experimental form. In one case in particular, the combination is built around the inventive genius of a single man, the report from that company being that "their wide dissimilarity is due to the fact that Mr. ----'s thoughts have never been contented with a single channel, and not to any subtle interior connection." In another case, a particular invention by an employee resulted in the manufacture of an artificial stone specialty in addition to the original activity of manufacturing ladders. In the third case, the invention was a direct product of the war. The perfection of the Liberty aeroplane motor by the Government necessitated an improved spark plug to withstand the great heat and compression of this motor for a satisfactory period of time. It was suggested to one of the large jewelry concerns in the country, which had demonstrated its eagerness to assist in any possible manner, that it undertake the problem. Resulting from this, the jewelry concern has built up a considerable business, separately incorporated, manufacturing spark plugs.

But enterprise of management has demonstrated itself in other lines. One interesting instance is that of a concern which operates plants producing fur-felt hats and academic caps and gowns. A letter from this firm is as follows:

"The business was established 90 years ago as a fur and hat store. * * *. From the hat store grew a manufacturing and jobbing business, which 3 years ago discontinued all jobbing and concentrated solely on the output of our own factory.

"The manufacture of college caps and gowns, etc., had no direct relation to the rest of the business * * *, a member of

the firm, now deceased, conceived the idea of adapting for this country the system of academic costume in vogue in England. He accordingly obtained the cooperation of the leading colleges and universities of the country in adopting standards, styles, etc., and from that beginning the idea has continued to spread until caps and gowns are now used by even many of the high schools."

And there is one further instance in this group which must be mentioned. The letter from this concern perhaps best explains the situation:

"There is, of course, a great dissimilarity between trunks and power transmission machinery, such as pulleys, gears, shafting, etc. Such dissimilar commodities, having obviously no molecular affinity, do not represent any natural development of our basic

business, but it is best explained as an accident.

"We have for many years manufactured wood split pulleys. Our initial work in connection with * * * (what is now the trunk factory) was all done with the wood split pulley in mind. After a considerable amount of experimenting, it was found that the veneers as we were producing them had a greater adaptability for trunks than they had for pulleys. We finally segregated the business and drifted completely into trunk manufacture.

"The ——— Co., therefore, had its genesis in a mistake, in that the product was not commercially adapted for the initial purpose we had in mind. But the product was found to have a wonderful adaptability for trunk manufacture. Our original investment was of considerable magnitude, and the prospects in

the trunk line were favorable.

"'Missing the goose and hitting the gander' is probably a reasonable way to explain how we came into the ownership of two plants now producing equipment of an entirely dissimilar nature."

The five instances given above are outstanding instances of enterprise on the part of the management, not restricted too much by traditional boundaries of industry.

One other type of combination must be mentioned. Although it appears only twice, it doubtless is a factor in the formation of many combinations—the taking over by the concern of some investment of individuals who are in a position to direct activities. For example, a concern operating establishments producing electrical apparatus and coal-tar products reports the following explanation:

"There was no direct connection, for technical or commercial reasons, between our chemical plants and our electrical plant. The latter was, and is, our original line of endeavor, and the chemical end was originated due to certain affiliations with persons interested in the chemical line."

Another concern operating plants reworking wool, manufacturing horse blankets, and box toes, reported as follows:

"Our corporation began business * * * manufacturing reworked wool. About 25 years ago, the mill making horse blankets, which was owned individually by one of the stockholders of this company, was purchased and operated as a separate plant. Later on, the factory for box toes was purchased under similar conditions. There is no similarity in the industries, and the principal reasons for having them united has been on account of management."

Such combinations are, of course, closely akin to financial combinations, yet in both of these cases the establishments are all operated from central offices.

There were four concerns which reported that there was no connection—that the combination existed, but for no functional reasons, being really separate enterprises. No explanation was given of the original cause for the combination, so they are here given, without further explanation: Steel pipe for conduits and rubber-surface clothing; canning and a creamery; paper products and glassware; gristmill and salt.

Finally, there are 16 combinations which did not reply to the inquiry and which give no indication of the nature of the combination on the regular census schedules. It is possible to evolve all sorts of hypotheses explaining them, but since they would still be hypotheses, it seems wiser merely to state the nature of the combination: Shears, clippers, etc., and briquets; coke and saw-mills; hemp, hemp brake, and peppermint oil; ferro-alloys and coal-tar products; illuminating gas and mining manganese; planing mills and cement-block factory; lace curtains and leather gloves; meat packing and planing mill; asbestos products, fire extinguishers, and speedometers; bricks and corn meal; feed mill and cement blocks; berry crates and cement blocks; fishing tackle and surgical appliances; carpet sweepers, needles, and motor-cycle spokes; gasoline engines, woven-wire fencing, and barbed wire; animal traps and silverware.

These instances represent the varying fortunes of industrial establishments. Industrial combinations can not always be explained in terms of efficiency. It is perhaps surprising that such a large proportion of central-office groups possessed some functional relationship among their establishments.

SUMMARY AND CONCLUSION.

It has seemed important to present in the last nine chapters, detailed descriptions of the structure of the many central-office groups, since such data have never been accessible before. Only by means of such exact and perhaps tedious presentations, could the intricacy and variety of central-office groups be properly presented. Such an extended inquiry, however, is apt to overwhelm and obscure the general trends of the data, and thereby destroy much of the value in such a study.

This study has dealt with economic organization as represented by the producing unit, the establishment, and by combinations of those units into operating groups. The introduction and rapid development of the factory system into the United States during the nineteenth century resulted in a very rapid growth of manufacturing establishments. The number of wage earners per establishment increased notably and the physical product per establishment was augmented at an even greater rate. The scale of operation was rapidly enlarged and greater and more efficient establishments were constructed. Since the beginning of the twentieth century, however, this tendency toward concentration has been by no means so marked. Certain industries, such as those producing automobiles, beet sugar, etc., have recorded remarkable development, but the activity in other industries has actually declined. The changes in size of establishments have demonstrated even greater variety. The tendency of industry as a whole, so consistent toward concentration in the nineteenth century, has become merely a meaningless product of many conflicting tendencies among the various industries. The development of new types of activity requiring large scale operation is perhaps the predominant feature.

The large-scale operations, though relatively few in number, reached a point in 1919 where 2.2 per cent of all establishments employed 53.5 per cent of all wage earners. This has not been accomplished by eliminating the smaller operators, for there were more small establishments reporting in 1919 than at any previous census. Rather has it come about through the increase and extension of the larger establishments. There is no evident tendency toward eliminating establishments of any particular size—the increase in number of establishments between 1914 and 1919 being so distributed as to record an increase in number of establishments found in each of the nine size groups used by the Census Bureau.

One important factor in the development of these large operations in industry has been the extension of the corporate form of ownership. Large scale production as a rule requires large scale investment. Individual fortunes or even partnerships can only in a few instances meet the financial requirements of these concerns. The corporate form has therefore made possible large scale operation and has been required by it.

But analysis of the concentration of industry is only begun by studying the industrial establishment. Many of these establishments are in turn linked together in industrial combinations. Census data make it possible to study the most apparent form of combination—combinations in which single central offices avowedly control and operate more than one establishment.

The census records indicate that at least 7.8 per cent of all establishments are found in central-office groups. It is probable that more than one-third of all wage earners engaged in manufacturing are employed by them, and that they produce a similar proportion of the total product of American factories. These combinations vary from concerns operating 2 mills to groups of over 100 establishments with activities in foreign countries as well. The distribution among industries is very wide. Nearly all lines of activities are represented, and many combinations extend outside the manufacturing field, particularly into mining operations. The establishments are often widely scattered geographically, a development which has only been made possible by the modern means of rapid communication.

Of these central-office combinations approximately five-eighths are simple in nature, operating establishments all of which are found in a single industry. With the exception of a very few instances, the remaining central-office groups were shown to have a rational functional basis for existence. The greatest number of complex central-office groups were found to operate establishments producing successive products—a type of organization often called "vertical" or "backward integration." Second in number of instances were the combinations which produced joint products—cases of diversification based upon the exploitation of a single material. In the third place were the central-office groups in which different types of establishments are included because they all produce for the same market. In the remaining types of functional organization fewer instances were recorded, yet sufficient in number to justify the existence of separate categories for

manufacture of complementary and auxiliary products, byproducts, and the operation of establishments exploiting a single process.

To indicate more definitely the instances which were presented to illustrate each type, the following tabulation has been prepared:

Uniform products 1	029
Joint products	427
By-products	125
Dissimilar products of similar processes	154
Complementary products	159
Auxiliary products	169
Dissimilar products for same market 1	233
Successive products	903
Unrelated products	47

These are the functional groupings as presented in Part III of this volume. It is probably true that practically all centraloffice groups of any importance have been included in this survey. The diversity of the nature of the combinations demonstrates the untold intricacy of our modern industrial system.

With the analysis of central-office groups, the investigation of industrial concentration by the Bureau of the Census must stop. There still remain the many other still larger though less definite forms of concentration of control which tie establishments and operating combinations together. The direction in which modern industry is tending can not be definitely determined, but it is probably true that the first part of the twentieth century has seen far greater development of concentration in terms of combinations of superstructure, either operating or financial combinations, than it has seen development of the scale of production within single establishments.

There are at least three directions in which this study should be extended. These further studies should be: First, a study of central-office organization in terms of wage earners and value of products determining the importance of such combinations in all industry, and the value of central-office management in terms of regularizing employment, etc. Second, a study of secondary or subsidiary products within establishments, and the relationship of central-office organization to the utilization of waste. Third, the extension of the study of industrial operation to include industrial control, thereby admitting financial and other bonds which unite industrial ownership. If this study has served to present a series of problems and indicate to some extent a method of analysis, it has accomplished its purpose.

¹ Only those cases included in which no other explanation was possible.