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Nº 1

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Economic Intelligence Report

THE ELECTRONICS INDUSTRY OF HUNGARY
1954–65

CIA/RR ER 61–58

December 1961

CENTRAL INTELLIGENCE AGENCY

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FOREWORD

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The purpose of the report is to summarize the progress of the Hungarian electronics industry during 1954-60, to estimate the probable course of the industry during 1961-65, and to provide a general assessment of the capabilities of the industry based on an analysis of aggregate levels of production. Estimates, conclusions, and the derivation of all tables in the body of this report are accompanied by methodologies included under appropriate section headings in Appendix B.

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THE ELECTRONICS INDUSTRY OF HUNGARY*
1954-65

Summary and Conclusions

The electronics industry of Hungary has expanded since World War II from a relatively small production of electron tubes and telephone equipment to a diversified production of a broad range of vacuum tubes and telecommunications products. Although still not large in absolute terms -- the net value of production in 1960 is estimated to have been only 3.7 billion forints** ($185 million) -- this industry has become, after East Germany and Czechoslovakia, the third most important producer of electronic equipment among the European Satellites. The industry has shown a remarkable viability considering the disruptions resulting from the Hungarian revolt and the relatively low level of technology that had prevailed. The Hungarian electronics industry has made notable progress since its earlier stages, in which production of microwave equipment was virtually nonexistent; transistor technology was only beginning to be investigated; production of cathode ray tubes was minor; television receivers were produced only in token numbers; and the main producers such as Beloiannisz, Tungsram, and Orion functioned with obsolete equipment and aging facilities. The industry has assumed a leading role among countries of the Soviet Bloc in production of multichannel microwave radio-relay equipment,*** and production of television receivers is growing rapidly. The application of transistors, germanium diodes, and printed circuitry to the latest export models of radiobroadcast receivers testifies to the advances that have been made in the manufacture of components. Plant efficiency and labor productivity have improved markedly in recent years with the expansion and renovation of plant facilities and production equipment.

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* The estimates and conclusions in this report represent the best judgment of this Office as of 1 December 1961.

** Forint values in this report are given in 1956 forints and may be converted to US dollars at the rate of exchange of 20 forints to US $1. This rate, while appropriate for this report, is not necessarily applicable outside the Hungarian electronics industry.

*** Hungary began production of its GTT 4000/600 equipment (see II, C, 2, p. 21, below) in 1961. East Germany's competitive equipment, the RVG 958, is scheduled to go into production in 1963. Thus Hungary appears to be developing a significant lead over East Germany in a field of telecommunications engineering in which East Germany historically has been considered superior to Hungary.

On the negative side the electronics industry of Hungary has been exceedingly slow in beginning to realize the potential with which it has been endowed by an advanced educational system, the natural aptitudes and energies of the Hungarian people, and a long tradition in the manufacture of certain types of electronic equipment. The following factors have been the principal retarding influences: the Hungarian revolt of 1956, which resulted in heavy losses of engineers and technicians and a condition of widespread lassitude and worker apathy; a lack of originality and initiative in basic and applied research, which sacrificed the long-run benefits from native innovations to short-run gains from the imitation of Western technology; and a lack of native resources of needed raw materials, which necessitated the continuing importation of copper, nickel, ferroalloys, polyethylene, teflon, raw quartz, and other items.

The industry is developing a vigorous export program, and it is estimated that by 1965 three-fifths of all production will be exported. Growing attention is being given to non-Bloc exports of consumer entertainment equipment, particularly television receivers. At the present time the industry exports telephone equipment and consumer entertainment products (radiobroadcast receivers and television receivers) throughout the world, but the USSR continues to be the principal consumer of Hungary's exported electronics products. Electron tubes, radio and television studio equipment, frequency-modulation (FM) transmitting facilities, automatic telephone exchanges, and multichannel microwave radio-relay equipment are among the chief items of export to the USSR. Hungary also exports radio transmitters, telephone equipment, and carrier equipment to Communist China.

A prominent characteristic of the industry in postwar years has been its lack of autonomy. In effect an adjunct to the electronics industry of the USSR, the electronics industry of Hungary lacks flexibility in the use of its production capacity and in the mobility of its finances. Since World War II, Hungary's dependence on the USSR for investment capital and its subordination to Soviet requirements for equipment have contributed substantially to worker apathy and have militated against the organization of a strong base for long-range developments. The electronics industry of Hungary is unlikely to become more independent through 1965. The pattern for the immediate future, as indicated by industry investments, exhibits a threefold orientation, as follows: the development of a strong components base, a greatly increased emphasis on the export of television to non-Bloc countries for the accrual of more foreign exchange, and an intensive effort to expand production of multichannel microwave equipment.

I. General Survey

A. Organization and Structure of Production

The Hungarian electronics industry* consists of eight major producers and a number of minor enterprises subordinate to the Ministry of Heavy and Machine Industry (Koho es Gepipari Miniszterium).** The Directorate of Telecommunications, headed by a deputy minister of the Ministry, is responsible for the coordination and direction of all matters pertaining to telecommunications generally that are outside of the jurisdiction of the Ministry of Communications, which is an important consumer of the Directorate's production.***

These electronics plants are concentrated preponderantly in the Budapest metropolitan area, which already contains 52 percent of the total industrial production of Hungary. A rapidly increasing population has made an overhaul of the Budapest industrial structure increasingly imperative, and plans for the development of small peripheral cities to alleviate the detrimental effects of the burgeoning population reportedly have been integrated into the Second Five Year Plan (1961-65). Nevertheless, with the exceptions of a television picture tube plant which has been built at Vac and an affiliate of Remix being constructed in Szombathely, no major trend toward decentralization or redeployment of the electronics industry to outlying areas is discernible as yet. Rather, the industry today, as before World War II, is oriented around the expansion and modernization of existing plants such as Beloiannisz, Orion, and Tungsram which were built originally with German, UK, and US capital and have long constituted the core of the industry.

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* The electronics industry may be defined as that branch of electrical engineering which produces devices, equipment, or systems in which a flow of electrons is emitted that is amplified, controlled, or directed by the use of vacuum tubes or semiconductor devices. Production includes a wide variety of components and end equipment such as electron tubes; transistors; radiobroadcast transmitting and receiving equipment (including telephone, telegraph, radio, and television); radar; data-processing machines; instruments; and similar items adaptable for consumer, industrial, and military application. Some purely electrical items such as resistors and capacitors are included in the industry, and some vacuum products such as incandescent and fluorescent bulbs are not included.

** Also referred to as the Ministry of Metallurgy and the Machine Industry.

*** For a listing of the major electronics plants in Hungary, the names by which they are usually known, and a general indication of the products manufactured, see Appendix A.

Production of electronic equipment in Hungary may be conveniently divided according to the following commodity groupings: consumer entertainment, industrial electronics, military electronics, and electron tubes. Production of consumer entertainment equipment is mainly concentrated in the following three plants: Orion, the Telephone Plant, and the Hunting Cartridge Plant. Production of industrial electronic equipment is handled principally by the Beloiannisz and EMG plants, which specialize in civil communications equipment and electronic instruments, respectively. Production of military electronic equipment is primarily the responsibility of the Precision Mechanics Enterprise (FMV), with a small contribution being made by the Telephone Plant. In past years, Beloiannisz has engaged in production of military equipment but is not believed to be currently so engaged. Electron tubes are produced by Tungsram and the Hungarian Transmitter Tube Plant.

The largest complex for production of industrial electronic equipment in Hungary is the Beloiannisz plant. This plant is currently undergoing a major expansion which, when completed, will double its size and assure it a prominent place as one of the largest factories for production of telecommunications equipment in Europe. The history of telecommunications development and production in Hungary is, by and large, the history of the Beloiannisz plant. Although the plant suffered no physical damage as a result of the Hungarian revolt of 1956, the loss, through defection, of approximately 10 percent of its personnel (including about 100 engineers and highly trained technicians) temporarily slowed its production during the fourth quarter of 1956 and during 1957. As a consequence, its ambitious program of microwave development was seriously retarded.

At the present time, on the basis of loans from the USSR, Beloiannisz is undergoing a structural and organizational transformation, the objective of which is to provide for intensive concentration on production of microwave equipment. By 1962 the plant will produce this equipment at a rate estimated to be in excess of 1 billion forints per year, which, even granting a high level of organizational competence and technological skill, represents an impressive achievement.

Hungary has long been a producer of radiobroadcast and other transmission equipment, much of which has been delivered to the USSR in postwar years as reparations payments. The early 1950's were characterized by production based on the reproduction of Western patents. Three-channel and 12-channel items of carrier equipment, designated in Hungary as the BBO-3 and the BSOJ-12, respectively, were copied from designs developed by Standard of London, and the turbator (special magnetron) used in Hungary's 24-channel microwave equipment, the PM-24, was reproduced from a Brown-Boveri tube. Such exploitation of Western prototypes, publications, and patents was perhaps inevitable in view of the lack of suitable facilities and an adequate pool of scientifically trained personnel. In 1956,

only 16 percent of the telecommunications workers in Hungary were technically trained, and, even more significantly, only 3 percent were engineers. 1/*

B. Growth and Magnitude of Production

The estimates of the total net value of production of electronic equipment in Hungary in 1954-65 are given in Table 1,** including estimates for the constituent sectors of end use (see also the chart, Figure 1***). The figures for the electron tube sector exclude that portion of its output which is included in the output of other sectors.†

Annual production of the Hungarian electronics industry during 1954-60 is estimated to have grown from 1.2 billion forints to 3.7 billion forints, implying an average annual rate of growth of about 20 percent. Such a relatively high rate of growth would normally be expected in an expanding industry starting from a low base. Nevertheless, considering the dislocations of the 1956 revolt, which caused output in 1956 to drop to about 92 percent of the level of 1955 and in 1957 to 94 percent of the level of 1955, this growth record represents a very substantial achievement. The greatest increase was registered during the period of the Three Year Plan (1958-60), when the labor force of an already labor-intensive industry was augmented by more than one-third, and about 340 million forints were invested in the modernization and expansion of existing facilities. Particular emphasis was placed on production of telecommunications equipment, output of which is estimated to have risen from 1.2 billion forints in 1957 to 3.1 billion forints in 1960. During this period the Beloiannisz plant was expanded and modernized on the basis of an investment of 100 million forints. 2/

The Three Year Plan for the Hungarian electronics industry reflected a growing concern on the part of the Hungarian regime with the balance-of-payments problem generally and gave rise to a heightened emphasis on increased exports of electronic equipment as a realizable method of making that balance more favorable. The plan formally recognized the inherent limitations of a trade program based on the export of heavy industrial products requiring large outlays for expensive raw material and the correlative advantages of an expanded electronics industry which requires a minimum of raw material but a maximum utilization of human technical skills. The plan also reflected an increasing awareness by Hungarian planners of the value of increased telecommunications exports

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** Table 1 follows on p. 6.

*** Following p. 6.

† The gross value and volume of production of electron tubes are shown in Table 3, p. 16, below. For a detailed discussion of production of electron tubes, see II, A, 1, p. 13, below.

Table 1

Estimated Net Value a/ and Indexes of Production of Electronic Equipment in Hungary b/
1954-65

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Consumer entertainment equipment (million 1956 forints)	170	250	260	370	510	640	850	940	1,200	1,550	2,030	2,660
Index (1954 = 100)	100	146	152	212	296	367	488	541	692	895	1,167	1,533
Industrial electronic equipment (million 1956 forints)	740	1,240	1,110	890	1,140	1,990	2,360	2,880	2,950	2,950	2,870	2,650
Index (1954 = 100)	100	166	149	120	153	268	318	387	396	397	386	357
Civil communications equipment	680	1,180	1,060	820	1,050	1,900	2,260	2,760	2,820	2,810	2,710	2,480
Instruments	60	60	50	70	80	100	110	120	130	150	160	180
Military electronic equipment (million 1956 forints)	110	60	40	220	270	270	270	270	270	270	270	270
Index (1954 = 100)	100	50	40	205	247	245	245	245	245	245	245	245
Electron tubes c/ (million 1956 forints)	170	180	170	140	210	240	260	280	300	310	310	300
Index (1954 = 100)	100	103	98	82	119	139	150	163	171	176	177	171
Total (million 1956 forints)	1,200	1,730	1,590	1,630	2,130	3,140	3,740	4,370	4,720	5,080	5,470	5,880
Index (1954 = 100)	100	144	132	135	177	261	311	364	392	423	455	489

a. Net value is basically a value-added series, representing values based on factory prices and therefore excluding double counting.
b. Values have been rounded to the nearest 10 million forints to show the actual extent of the computations. Accuracy, however, should not be presumed to extend beyond two significant digits. Because of rounding, components may not add to the totals shown.
c. Consisting of spares and exports of tubes.

Figure 1

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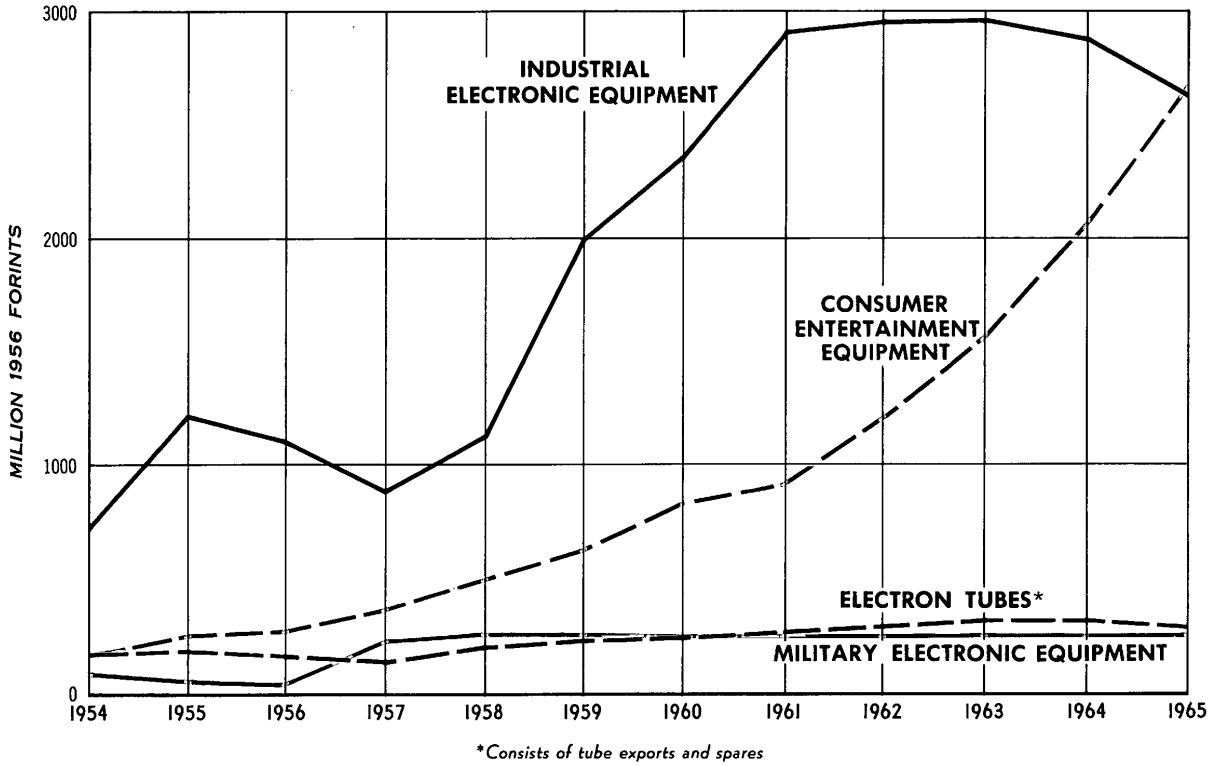
HUNGARY

ESTIMATED NET VALUE OF PRODUCTION OF ELECTRONIC EQUIPMENT BY MAJOR COMMODITY GROUPINGS, 1954-65



*Consists of tube exports and spares

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which, for a given volume of forint expenditure, frequently yield more than three times as much foreign exchange as does the sale of other commodities. 3/ Under the influence of this new policy, Hungary initiated an expanded program for production of household television sets. As a result, production of these items increased 21-fold during 1957-60.

During the Second Five Year Plan (1961-65) the Hungarian electronics industry will continue to grow but at a reduced rate. The industry will achieve a volume of output estimated to be 5.9 billion forints by 1965, implying an annual rate of growth of slightly less than 8 percent. During this period the industry will continue to be dominated by an emphasis on production of telecommunications products, particularly household television sets and multichannel microwave radio-relay equipment. By 1965, production of these two items alone will amount to 3.4 billion forints and will constitute almost 60 percent of the total output of the Hungarian electronics industry.

The simultaneous expansion of television receiver and multichannel microwave production expresses the peculiar ambivalence of the industry. On the one hand, the industry is attempting to become self-supporting through expanded exports of commodities capable of competing effectively on world markets, and, at the same time, it extensively engages in the less profitable enterprise of satisfying Soviet requirements for microwave equipment -- a situation that leads to greater dependence on the USSR and a diminishing likelihood that the objective of effective participation in the world markets will be achieved. The USSR has been and will continue to be the principal source of Hungarian investment capital and the principal consumer of Hungarian production.

C. Research and Development

The most prominent organizations in Hungary conducting research and development in the field of electronics are as follows: the Telecommunications Research Institute (Tavkozlesi Kutato Intezet -- TKI), the Technical Communications Research Institute (Hiradastechnikai Kutato Intezet -- HIKI), and the Military Technical Institute (Haditechnikai Intezet -- HTI). In addition to these organizations, specialized research is carried out by the Central Research Institute for Physics, the Research Group for Cybernetics (both of the Hungarian Academy of Sciences), and the Chair of Special Electronic and Automatic Machinery at the Technical University of Budapest.

Generally speaking, applied research and development of military importance in the field of telecommunications is the primary mission of TKI and HTI, and research efforts on projects of industrial application are the responsibility of HIKI. This dichotomy is not absolute, however, as research by both institutes is likely to have application to both military and nonmilitary end usage.

Before 1950, electronics research and development efforts were small and were largely accomplished in the laboratories and research departments of existing plants, mainly the Telephone Plant, Orion, Tungsram, Beloiannisz, and Remix. This effort was fragmented and lacked centralized direction and coordination. During 1950-51, personnel and equipment of these groups were integrated into the newly formed TKI. As currently organized, this institute is subordinate to the Telecommunications Directorate of the Ministry of Heavy and Machine Industry. During 1951-55, expenditures of this institute are estimated to have amounted to 130 million forints, an average of 26 million forints a year. This sum was equivalent to less than 6 percent of the net production of the Beloiannisz plant alone in 1956 and less than 2 percent of the net value of production for all telecommunications output. Until 1956, TKI worked on the development of electronic components for proximity fuses for antiaircraft shells under the supervision of Soviet technicians and conducted extensive experimentation on microwave systems and special-purpose tubes such as magnetrons, klystrons, traveling wave tubes, and cathode ray tubes. HIKI in 1956 was responsible for research in semiconductors (silicon diodes and transistors), transmitting tubes, electron tube applications, resistors, and capacitors. The activities of both institutes since the revolt may be assumed to have crystallized around the development of microwave components at TKI and intensified semiconductor research at HIKI.

The pace of Hungarian research and development in electronics has been comparatively slow owing principally to the following two factors: first, the pattern of research has been imitative rather than basic and, as a result, has suppressed the best efforts of a number of creative and highly qualified scientists. Second, the revolt of 1956 exacted a very heavy toll of the available scientific and engineering talent. Estimates by defectors of the percent of highly qualified telecommunications engineers who left the country have been as high as 80 percent. 4/ At TKI alone it is estimated that 80 to 85 persons, the majority of whom were engineers and technicians, left Hungary after the abortive revolt.

D. Labor and Productivity

Generally speaking, the Hungarian electronics industry has an adequate labor supply but suffers from a serious shortage of engineers and technically skilled personnel. This industry was particularly hard hit by defections during the 1956 revolt and has functioned throughout 1956-60 with second-line technical and engineering skills. The problem was particularly acute in areas requiring engineering experience and project continuity for the resolution of complicated technical problems such as microwave development, for example, where a commitment to export in quantity to the USSR during 1956-60 had to be greatly reduced. In spite of the disruptive effects on research and development, the defections do not

appear to have greatly undermined the confidence of the USSR in the capabilities of the Hungarian electronics industry or to have precipitated any major reassessment of Soviet requirements on that industry.

The labor force of the electronics industry is estimated to have been in excess of 40,000 in 1959. This figure represented an increase of one-third since 1957. It is likely during the Second Five Year Plan that the labor force will continue to expand in order to satisfy new labor demands generated by the expansion of facilities at the Orion, Tungsram, and Beloiannisz plants as well as at new plants presently under construction. Thus labor intensiveness in the Hungarian electronics industry may be expected to continue as a prominent characteristic of the industry's profile through 1965. At the same time, it is suggested that the new emphasis on procurement of machinery and equipment, as reflected in the multimillion forint allocations for this purpose during 1958-60, 5/ should result in increased mechanization of production technology and a more efficient utilization of labor power. Aside from the television picture tube plant at Vac, which allegedly is highly automated, there are no evidences of such advanced technology in the industry. It may be assumed, however, that Vac gives an indication of future trends.

The average productivity of workers in the electronics industry in Hungary as measured by annual per capita value of output can be reasonably estimated for 1957 and 1959. Productivity in the industry as a whole is estimated to have grown from 54,200 forints per employee in 1957 to 78,500 forints per employee in 1959. Comparing the two main branches of the industry, manufacture of telecommunications equipment and of electron tubes, productivity rates are markedly different. Productivity per employee in 1957 in the telecommunications branch, for example, was approximately 58,000 forints, and the corresponding figure in the electron tube branch for the same year is estimated to have been 40,000 forints.

A number of factors have prevented the achievement of higher rates of labor productivity within the Hungarian electronics industry -- obsolescent equipment; personnel losses owing to the revolt and, in the case of electron tubes, physical damage sustained by the Tungsram plant; worker apathy; and a reject rate of 4 to 8 percent for telecommunications end items and frequently as high as 30 percent for electron tubes.

Productivity also was affected by delays in production resulting from abnormally heavy dependence on imports from other countries of the Soviet Bloc. The latter factor was most noticeably operative in production of telecommunications equipment at the Beloiannisz plant, which imported 70 percent of its specialized instruments and 25 percent of its electron tubes as well as electrolytic capacitors, precision resistors, test instruments, permalloy, nonferrous metals, and other electronic

parts. Owing to the shortage of raw materials, the Beloiannisz plant frequently substituted materials on the production line, necessitating changes in production methods which in turn resulted in production delays. Additional delays were caused by similar shortages at other Hungarian electronics plants that supply Beloiannisz with semifinished products.

By 1959, however, the investment program of the Three Year Plan began to take effect. Labor productivity in the telecommunications branch is estimated to have increased by 60 percent above 1957 and in the electron tube branch by 73 percent. As noted above, average productivity per employee on an industrywide basis in 1959 amounted to 78,500 forints for an over-all increase of approximately 45 percent above 1957.

E. Investment

With the launching of the Three Year Plan (1958-60), a long-term trend toward a more vigorous development of the Hungarian electronics industry was initiated. The Three Year Plan called for investment outlays in the electronics industry in the magnitude of 340 million forints, 6/ a large proportion of which was allocated for the expansion and reequipping of the Beloiannisz telecommunications plant, the construction of the television picture tube plant at Vac, and the modernization of the main Tungsram and Orion plants. Of these outlays, 83 million forints, or 25 percent of the total, were earmarked for the procurement of machinery and equipment. The Second Five Year Plan (1961-65) will accelerate this trend of more vigorous development by providing for an investment nearly three times as large as the Three Year Plan investments, or approximately 1 billion forints. 7/ This sum amounts to almost 12 percent of all investment planned for the Hungarian machine industry during 1961-65. Assuming that the pattern of capital outlays in the electronics industry adheres to that programed for the Hungarian machine industry as a whole, one-third will be allocated for construction and two-thirds for new equipment.

The implied increase in equipment allocations, from one fourth of the total investments in 1958-60 to two thirds in 1961-65, would tend to buttress an earlier observation that the Hungarian electronics industry intends to fulfill its production commitments at least through 1965 by increased productivity from existing facilities rather than by an extension of the industry's base through new construction.

These investments will result in substantially increased mechanization of existing facilities. Moreover, Hungary will achieve a considerably improved capability both in the manufacture of competitive television receivers and in the output of microwave equipment. One highly significant feature of this new orientation will be the development of a much stronger components-manufacturing base, the lack of which in postwar years

has greatly retarded development of the electronics industry. Before World War II the supply of components required by the Hungarian electronics plants was met by parent organizations operating outside Hungary. By nationalizing its plants in 1948, Hungary cut itself off from these traditional sources and was obliged to provide for its own manufacture of components. The Remix plant in Budapest has attempted to fill the vacuum, but its limited experience in this field has resulted in both a low level of technology and inferior products.

The anomaly of an industry capable of producing advanced circuitry but utilizing unreliable components persisted throughout the decade of the 1950's. In 1959, construction of a new plant subdivision of Remix was begun in Szombathely. On completion, the conventional production of the main Remix plant will be transferred to the new facility, leaving the main plant intact with its pool of skilled technicians available for production of technologically sophisticated parts. It is estimated that by 1965 Hungary will have developed a high-quality components-manufacturing sector.

Although the development of a domestic components base will reduce the dependence of the industry on imports, Hungary nevertheless will continue through 1965 to be dependent on the importation of a wide variety of raw materials, specialized components, and precision instruments. It is not believed, however, that dependence on such imports will be sufficiently disadvantageous to preclude the attainment of a vigorous electronics industry by 1965.

F. Foreign Trade

1. Trading Organizations

Trade in electronic products in Hungary is handled by the following organizations: Budavox, Tungsram, Metrimpex, and Elektroimpex. All four organizations engage in the export of electronic equipment, but only Metrimpex and Elektroimpex are concerned with imports as well.

In terms of the sectors of end use as treated in this report, these trading organizations have export responsibilities as follows: Budavox, industrial electronics (not including instruments); Tungsram, electron tubes; Metrimpex, electronic instruments; and Elektroimpex, consumer entertainment equipment. Before 1956, Elektroimpex was the exclusive agent for the export of all electrical (including electronic) equipment, and it now services all electronics plants engaged in the export of nonmilitary equipment (except Beloiannisz and Tungsram) -- that is, producers, primarily, of consumer entertainment equipment. The former responsibilities of Elektroimpex for nonelectronic export have been assigned to Transelektro and Metrimpex. Transelektro is responsible for marketing high-tension electrical equipment such as generators, motors,

transformers, lighting equipment (except bulbs), cable, and wires. The Beloiannisz and Tungsram plants enjoy a special status not accorded other Hungarian electronics producers in that they are authorized to handle the export of their own products. For this purpose, Beloiannisz established a subsidiary department known as Budavox. Tungsram exports under its own trade name.

2. Imports

In common with the Hungarian economy as a whole, the Hungarian electronics industry is vitally dependent on the import of a wide range of raw materials for successful functioning and is particularly dependent on imports from the USSR. For example, of those raw materials which are important to the electronics industry, Hungary imports from the USSR 30 percent of its copper, 65 percent of its lead, 100 percent of its nickel, 40 percent of its tin, and 98 percent of its ferroalloys. 8/ In addition to this list, the following specialized alloys and components are imported: powder-iron cores from Philips of the Netherlands, permalloy (special laminated magnetic material used for transformers and coils) from West Germany, polyethylene from various countries of Western Europe, teflon (plastic insulating material used primarily for microwave equipment) from Western Europe, and quartz from East Germany and South America. Other imports include specialized types of vacuum tubes; special ceramic capacitors and resistors for use in receivers, transmitters, and carrier equipment; and cobalt, nickel, silver, magnesium, and other nonferrous metals. In addition, Hungary is dependent on outside sources for specialized test and measuring equipment. The total monetary value of these imports for the electronics industry is not believed to be significantly large, but an uninterrupted supply is considered essential.

3. Exports

The Hungarian electronics industry exports a wide variety of telecommunications equipment, electron tubes, and standard electronic instruments to countries of the Soviet Bloc. In the years since World War II the major portion of Hungarian electronic exports has been shipped to the USSR, initially as products of German-owned plants seized by Soviet occupation forces and later, when these were sold to the Hungarian government, as reparations payments. Current trends indicate that the USSR will continue to be the principal beneficiary of Hungarian exports, at least through 1965. Although this trade has proved to be of dubious economic benefit to Hungary over the years, it has nevertheless stimulated the inflow of investment loans from the USSR which may ultimately redound to the greater advantage of the Hungarian electronics industry.

Hungary's exports to the USSR include automatic telephone exchanges; high-power radiobroadcast transmitters; transmitting, receiving,

and special-purpose electron tubes of all types; signal generators; electronic switches; oscillographs; and other electronic instruments. Since 1958, FM broadcast transmitters and multichannel microwave radio-relay equipment have assumed special importance among exports to the USSR. Similar items of electronic equipment are exported to Communist China, with emphasis on 120-kilowatt (kw) radiobroadcast transmitters; the PM-24 and PM-28 microwave equipment; and 3-channel, 12-channel, and 24-channel cable and open-wire carrier equipment. A small percentage of the total exports go to non-Bloc countries in Western Europe, the Middle East, and South America, particularly Argentina. Principal exports to non-Bloc consumers are household radio receivers and television sets, telephone exchanges, and related items of telephony. Estimates of the annual value of the total exports from Hungary during 1954-60 and for 1965 are given in Table 2* (see also the chart, Figure 2**).

In 1954, exports of electronic equipment constituted 46 percent of the total net production of the industry, and approximately the same ratio obtained in 1959. Since the rate of growth of exports is now greater than that of the industry, and, in consideration of the concentrated efforts being expended on production of microwave and television receiving sets for export purposes, it is estimated that by 1965 about three-fifths of net production will be exported. During the period of this estimate it is expected that exports to non-Bloc countries will claim a greater proportion of the total than in the past.

II. Production Trends in Major Branches

A. Electron Tubes and Semiconductor Devices

1. Electron Tubes

Products of the electron tube branch of the Hungarian electronics industry include more than 200 types of radio receiving tubes, cathode ray tubes, special-purpose tubes (klystrons, magnetrons, and transmit-receive tubes), and miniature and subminiature tubes as well as a wide variety of rectifier, X-ray, and gas discharge tubes. The vacuum tube industry is a part of what is officially referred to as the vacuum-technical or vacuum-engineering industry, which includes (in addition to electron tubes and incandescent, fluorescent, and special-purpose lamps) tube and lamp manufacturing machinery and related items. It is concentrated in two major facilities, Tungsram and the Hungarian Transmitter Tube Plant, with a secondary contribution being made by a number of smaller enterprises. The gross value of production of the vacuum-technical industry in 1959 was 832 million forints, 9/ of which the

* Table 2 follows on p. 14.
** Following p. 14.

Table 2

Estimated Value of Exports of Electronic Equipment from Hungary a/
1954-60 and 1965

Million 1956 Forints

	1954	1955	1956	1957	1958	1959	1960	1965
Consumer entertainment equipment	48	56	46	97	150	250	340	1,100
Industrial electronic equipment	360	340	350	370	510	990	1,900	2,200
Civil communications equipment	300	280	300	300	430	890	1,800	2,000
Instruments	61	59	54	71	84	98	110	180
Electron tubes	140	160	120	140	190	210	240	290
Transmitting tubes	36	44	32	28	46	32	36	36
Receiving tubes	110	120	90	120	150	180	200	250
Total	550	560	520	610	850	1,500	2,500	3,500

a. Data are rounded to two significant digits and may not add to the totals shown.

Figure 2

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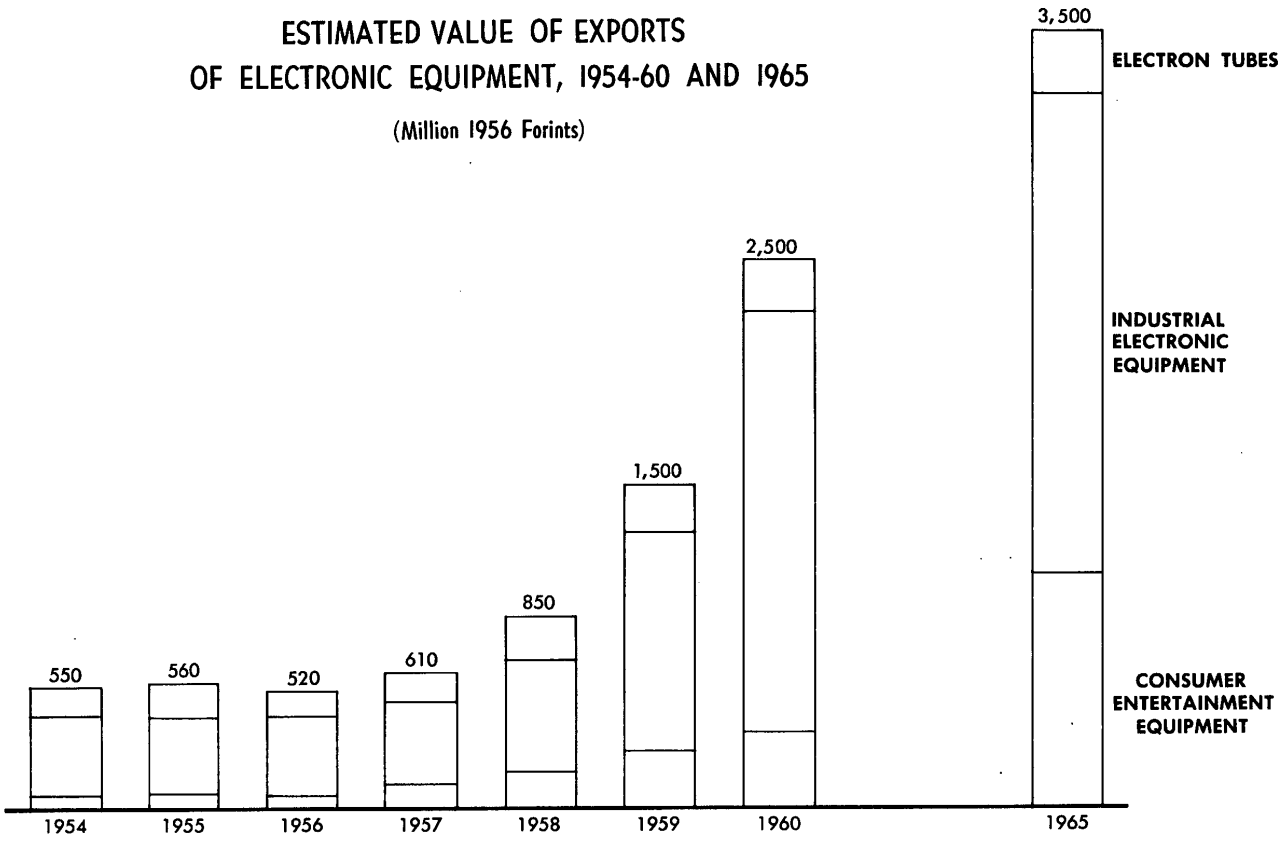
HUNGARY

ESTIMATED VALUE OF EXPORTS OF ELECTRONIC EQUIPMENT, 1954-60 AND 1965

(Million 1956 Forints)



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electron tube sector is estimated to have accounted for 337 million forints, or about 40 percent.

Although most of the machinery and machine parts and some critical raw materials are imported, the industry is in other respects largely self-contained, having its own facilities for the manufacture of all semifabricates necessary for production of its end items, such as glass tubing, glass bulbs, and facilities for processing tungsten and for the regeneration of molybdenum acid. The industry has been chronically hampered in past years by the use of obsolescent equipment, by excessive dependence on the import of critical raw materials, and by the lack of an adequate number of skilled and scientifically trained personnel. The latter deficiency was acutely compounded during the Hungarian revolt through defection of production line workers, as a result of which production in 1957 declined 6 percent below the level of 1954. Nevertheless, the adverse effects of the revolt do not appear to have persisted beyond 1957. Resumption of rapid growth appears to have been achieved in 1958, during which year production reached a level 50 percent greater than in 1957 and 41 percent greater than in 1954. By 1965 it is estimated that output of the electron tube industry will climb to 950 million forints, a level almost 4.5 times as high as in 1954. These figures imply an average annual rate of growth on the order of 14 percent during the decade 1955-65.

Estimates of production of electron tubes in terms of units and values for 1954-65 are given in Table 3* (see also the chart, Figure 3**). The main emphasis of the electron tube industry through 1965 will be on the manufacture of cathode ray tubes. Physical output will grow from the insignificant level of 4,400 units in 1957 to 582,000 units (estimated) by 1965. Table 3 shows that in 1965 production of cathode ray tubes will constitute approximately 40 percent of the total production value of the electron tube industry. This figure represents a significant departure from 1957, when production of such tubes constituted less than 2 percent. The increase is attributable to a new plant, located in Vac, which began the automated production of cathode ray tubes in the latter part of 1959. It is estimated that production of cathode ray tubes will have reached the rate of 200,000 per year by the end of 1961. Although official statistics indicate 1957 as the beginning year of production of cathode ray tubes, information from defector sources indicates that at least small-scale production of these tubes for military application had been started as early as 1955.

* Table 3 follows on p. 16.
** Following p. 16.

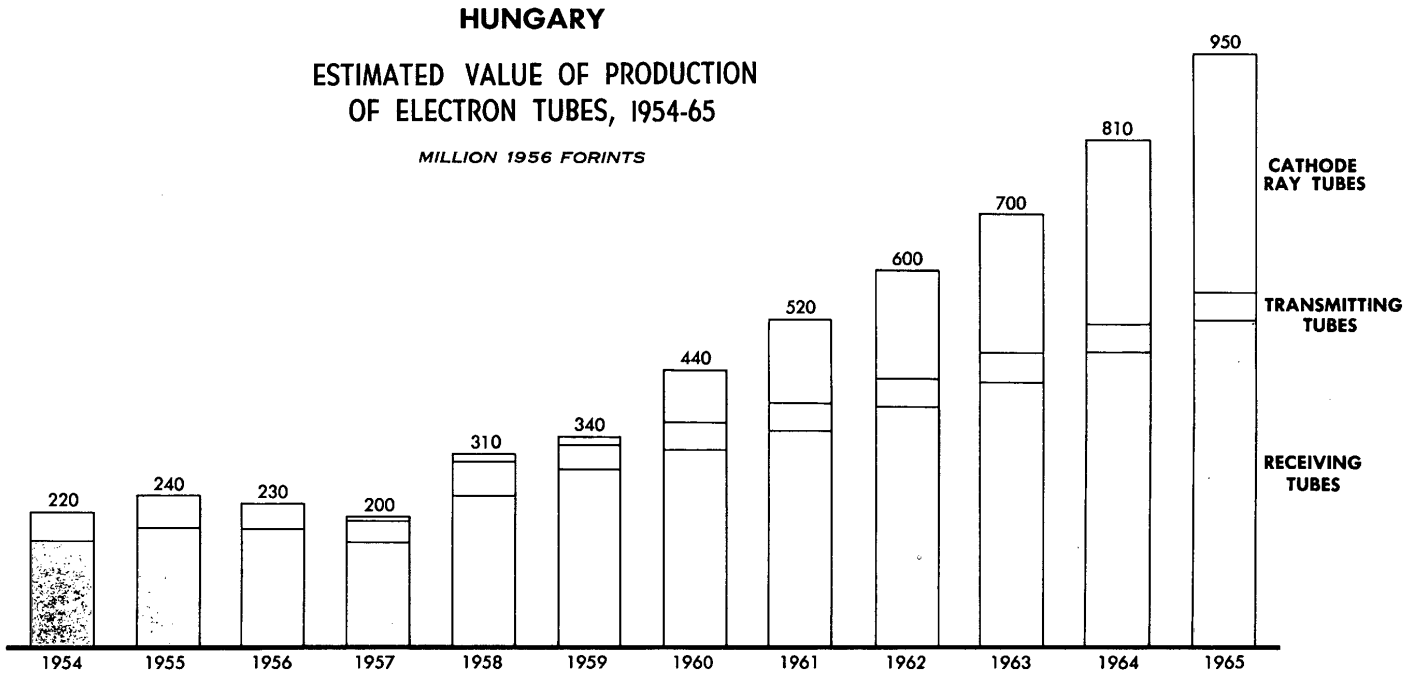
Table 3

Estimated Production of Electron Tubes in Hungary, by Volume and by Value
1954-65

Type of Tube	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
	Production (Million Units)											
Receiving a/	6.3	6.9	6.9	6.1	8.8	10.4	12	13	14	16	17	19
Transmitting b/	0.045	0.054	0.040	0.034	0.056	0.040	0.040	0.040	0.040	0.040	0.040	0.040
Cathode ray b/		Negl.	Negl.	0.004	0.011	0.019	0.120	0.200	0.260	0.340	0.450	0.580
	Gross Value c/ (Million 1956 Forints)											
Receiving	170	190	190	170	240	280	310	350	380	430	470	520
Transmitting	46	55	40	35	57	40	46	46	46	46	46	46
Cathode ray		Negl.	Negl.	3	8	13	81	130	170	220	290	380
Total	220	240	230	200	310	340	440	520	600	700	810	950
	Index (1954 = 100)											
	100	113	106	94	141	156	203	242	278	321	374	439

a. Data for 1960-65 are rounded to the nearest million.
b. Data for 1960-65 are rounded to the nearest 10,000.
c. Components are rounded to two significant digits and may not add to the totals shown. Totals are rounded to the nearest 10 million forints.

Figure 3 50X1



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2. Semiconductor Devices

At the present time, Hungary has only a limited capability in production of semiconductor devices. Initial research in this field, as in other phases of telecommunications, was not original but was based on the duplication of Soviet and Western models. The developmental program in solid-state technology began some time during 1956 at the main Tungsram plant under the aegis of HIKI and consisted in the creation of germanium diode prototypes of the Soviet DGC-16 type and transistor prototypes of the Philips OC-70 and OC-71 types. Work on the development of selenium diodes also was being done. The Hungarian revolt in 1956 arrested these developments, and by 1959 Hungary still had not advanced beyond the laboratory stage in production of transistors and diodes. The absence of a capability in production of germanium base material, the lack of prepared crystals and other raw materials, and the lack of adequate equipment were inhibiting factors. In 1959 the total production of semiconductor devices was 660,000, of which 160,000 were transistors. An increase of three times that amount was planned for 1960. 10/ At the present time, germanium diodes are still considered to be the only semiconductor device produced in quantity in Hungary, and transistor development is believed to be restricted to low-frequency transistors.

As a general appraisal, the state-of-the-art in solid-state technology is not believed to be very advanced at this time. Hungary, however, is intensifying its efforts in the research, development, and production of semiconductors, and it may be anticipated that by 1965 the country will have achieved a capability in production of transistors more nearly compatible with the underlying objectives of the electronics industry -- that is, to make its export items to non-Bloc countries more competitive with Western European products. Production of transistorized radio receivers in 1960 is estimated to have amounted to 20,000 units.

B. Consumer Entertainment Equipment

1. General

Production of consumer entertainment equipment in Hungary is the fastest growing sector of the electronics industry. By 1965 this category of production will have grown by more than 14 times above the level of 1954 and will constitute 45.3 percent of the total output of electronic equipment. Product mix has been expanded to include all the standard items such as radiobroadcast receivers, television receivers, phonographs, and tape recorders. Estimates of annual production of these items, expressed in physical and value terms, are given in Table 4* (see also the chart, Figure 4**).

* Table 4 follows on p. 18.
** Following p. 18.

Table 4

Estimated Production of Consumer Entertainment Equipment in Hungary
by Number of Units and by Value
1954-65

Equipment	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
	Production a/ (Thousand Units)											
Radio receivers	258.3	377.2	352.3	454.2	453.3	263.5	210	200	200	200	200	200
Television receivers			2.2	6.4	37.0	88.1	140	160	220	290	390	530
Phonographs			10.3	15.5	18.3	13.8	18	20	22	24	26	29
Tape recorders			2.5	7.6	8.4	17.0	19	21	23	25	27	30
	Value b/ (Million 1956 Forints)											
Radio receivers	170	250	240	310	300	180	140	130	130	130	130	130
Television receivers			10	29	170	400	640	730	990	1,300	1,800	2,400
Phonographs			10	16	18	14	18	20	22	24	26	29
Tape recorders			6	19	21	42	46	51	56	62	68	75
Total	170	250	260	370	510	640	850	940	1,200	1,550	2,030	2,660
	Index (1954 = 100)											
	100	146	152	212	296	367	488	541	692	895	1,167	1,533

a. Data for 1960-65 are rounded to two significant digits.
b. Components are rounded to two significant digits and may not add to the totals shown. Totals are rounded to the nearest 10 million forints.

Figure 4

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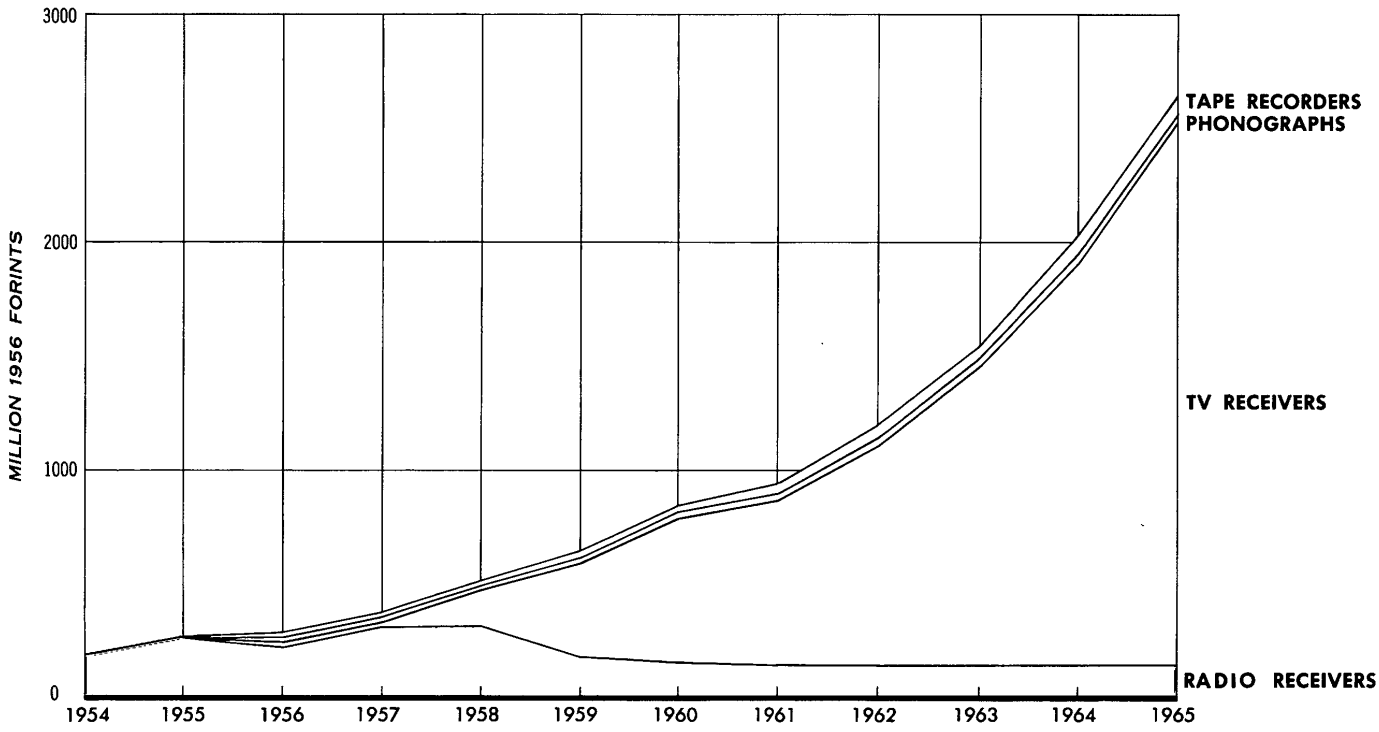
HUNGARY
ESTIMATED VALUE OF PRODUCTION
OF CONSUMER ENTERTAINMENT EQUIPMENT
1954-65



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Since 1957, production of radio receivers has declined rapidly, and, concomitantly, production of television receivers has increased sharply. By 1965, almost 530,000 television units, having an estimated value of 2.4 billion forints, will be produced. Production of radio receivers, on the other hand, probably will remain stabilized at about 200,000 units per year during the Second Five Year Plan -- that is, a level less than 45 percent of that registered in the peak production year of 1957. This decline in production of radios is occasioned primarily by a shifting export market that is increasingly dominated by television. In order to stay abreast of this shift, Hungary's leading producer of household radios, the Orion plant, is being converted into its leading facility for the manufacture of television receivers. Responsibility for production of radio receivers has been transferred to the Telephone Plant in Budapest and the Hunting Cartridge Plant (Vadasztolteny) at Szekesfehervar. During the period of the Three Year Plan, Hungarian exports of radio receivers declined from a high of 116,000 units in 1958 to about 61,000 in 1960. At the same time, exports of television receivers grew from 16,000 in 1958 to 64,200 in 1960, representing an increase of more than 300 percent. Any reversal of the downward trend in production of radio receivers is unlikely in the absence of a transistor technology sufficiently advanced to justify their widespread application to the manufacture of the increasingly popular portable models. Although the period 1961-65 probably will reflect an improved capability to produce radio receivers that are more competitive in the world market, no radical change in the production trend is anticipated.

2. Television Receivers

Hungary has been producing a 43-centimeter (cm) (17-inch) television receiver, the Benczur, which is primarily for domestic consumption, and several 53-cm (21-inch), 12-channel models, such as the AT-505 and the 53T816, for export. In 1960, Orion produced the AT-511 and a more luxurious superheterodyne set, the AT-611, both of which have 12-channel capacity, utilize printed circuitry, and have picture tubes with a 110° deflection angle. Compact assembly and reduced weight and chassis dimensions make these models suitable for export. Hungarian television reportedly is of good quality and will in all probability continue to improve as competition with East Germany for Near Eastern and other markets becomes more intense. Production of television sets suffers from a lack of glass for the domestic manufacture of television tubes, and a considerable volume of glass imports was continuing as of 1960. Efforts are underway, however, to expand the facilities of the Nagykanizsa Glass Factory, which, when fully employed, should reduce substantially or eliminate the necessity for importing glass.

3. Radio Receivers

Before 1956 the inexpensive Nepradio (people's radio), in both battery-operated and plug-in models, was more commonly purchased in domestic trade than any other radio. By 1960, however, more versatile household sets costing in excess of 1,500 forints had become highly popular -- in particular, the Terta sets made by the Telephone Plant. The following sets are currently the main export models:

Model	Description
Conventional	
AR-306	Superheterodyne, 6 tubes, 3 AM wave bands, 1 FM wave band
AR-311	Superheterodyne, 4 tubes, 3 wave bands
AR-312	Superheterodyne, 5 tubes, printed circuits, 2 germanium diodes, 2 AM wave bands, 1 FM wave band, short-wave band spread
AR-511	6 tubes, 4 AM wave bands
AR-512	7 tubes, 4 AM wave bands
AR-612	7 tubes, printed circuits, 2 germanium diodes, and 4 AM and 1 FM wave bands, short-wave band spread, 4 loudspeakers
B-858	Battery and AC Morris, superheterodyne, 3 wave bands, magic eye
BR-211	Battery-operated, superheterodyne, 4 tubes, 2 wave bands
R-035F	AC medium superheterodyne, 5 tubes, 3 AM wave bands
R-629	Superheterodyne, 3 tubes for 1 wave band
R-946F	Superheterodyne, 5 tubes, 3 wave bands
R-999F	Superheterodyne, 5 tubes, 2 wave bands
Transistorized	
B-037F	Superheterodyne, 7 transistors, 2 germanium diodes, 3 AM wave bands
Orionette 1004	Portable, 7 transistors, 2 germanium diodes, 3 AM wave bands
Automotive	
Lilliput	Car radio; long, medium, and short waves

As shown above, two export models feature printed circuitry and have germanium diodes, and two others, the Orionette and the B-037F, are fully transistorized. In 1960 these transistorized export models are estimated to have accounted for 10 percent of the total production of radio receivers. This share can be expected to increase significantly in proportion to advances in production of transistors.

C. Industrial Electronic Equipment

1. General

Production of industrial electronic equipment in Hungary is reflected primarily in the manufacture of civil communications equipment and, to a lesser extent, in the manufacture of electronic instruments. Civil communications equipment includes multichannel carrier equipment for use on open-wire and coaxial cable, jamming transmitters, radiobroadcast transmitters, television and FM transmitters, small manual and automatic telephone exchanges with step-by-step and rotary systems, main exchanges with rotary systems, crossbar telephone exchange equipment,* toll dialing equipment, multichannel microwave equipment, and industrial television equipment for closed-circuit monitoring of plant operations.

Production of industrial electronic equipment has always been the largest sector of the electronics industry in terms of value. In 1960 this sector constituted approximately 63 percent of the industry, and it is estimated that it will grow in absolute magnitude from 2.4 billion forints in 1960 to 2.7 billion forints by 1965 but that its percentage share of the total production will drop to 45 percent and will be exceeded for the first time by the consumer entertainment sector in value of production.

Although a projection of trends beyond 1965 is not justified by available evidence, it may be expected that production of industrial electronics will constitute an increasing share of the total production as the developmental efforts of the early 1960's (particularly in respect to microwave and carrier equipments) result in the mass production of a salable end product.

2. Civil Communications Equipment

In respect to production of civil communications equipment the industrial electronic sector of the Hungarian electronics industry is undergoing a structural transformation in favor of a more restricted product mix -- a more narrow specialization of production along a few

* Reportedly, crossbar systems eventually will replace the 7-A2 rotary dial equipment (similar to UK Standard rotary exchanges) that is installed throughout the main Hungarian cities and towns.

selected lines. For example, production of broadcast transmitters is becoming increasingly centered about television and FM, and primary emphasis in the field of telephone equipment is now being focused on production of automatic exchanges. Stimulated by the increasing needs of the USSR and the heightened demand for such equipment in many countries of South America, production of automatic telephone exchanges is scheduled to triple during the Second Five Year Plan. 11/ The level of production of carrier equipment will be lowered to some extent because of the developmental program underway and also because of the uncertainties surrounding the Chinese export market that has been the main consumer of this equipment.

Hungarian anticipations of a rising and lucrative Chinese Communist market have not materialized, and China's own achievements in building a radiotechnical industry suggest that its requirements from the Hungarian electronics industry will decline over time. 12/

The principal Hungarian exports of carrier equipment have been the BBO-3 and the BSO-3, which are 3-channel open-wire carrier systems; the BSOJ-12, a 12-channel open-wire system; the VK-12, a 12-channel cable carrier; and the VT-24, 24-channel voice-frequency telegraph equipment.

Current development efforts are directed toward a new family of equipment designated BKM. The BKM group will eventually include 3-channel, 6-channel, and 12-channel equipment for open-wire systems; 12-channel equipment for use on cable circuits; 60-channel equipment for use on either cable or microwave circuits; and 120-channel, 240-channel, and 600-channel equipment for microwave link circuits. The BKM-60 (60-channel equipment) reportedly is in development at the present time.

Hungary's development and production of carrier equipment has been persistently fettered by a lack of quality crystals for filters, and the inability of the EMG plant to grind crystals to the critical tolerances required has resulted in a high reject rate. Because the crystals often did not meet the required specifications with respect to frequency and drift tolerances, compensatory factors had to be built into filters, causing frequent delays in development.

It is in production of multichannel microwave equipment that the future perspectives of industrial electronics in Hungary are best seen. Although production of microwave equipment is estimated to remain at a constant level between 1962 and 1965, it is likely that, as the needs of the Bloc are more precisely defined and the capability of Hungary to satisfy those needs is more effectively demonstrated, production beyond 1965 will increase significantly.

Microwave research and development was carried on with indifferent success throughout 1950-60. Until 1955 this program was limited, and was oriented around the development of mobile military microwave equipment for the Hungarian armed forces and resulted in a limited production of prototypes of the MH series of equipments -- MH-10, MH-6, and MH-5. In 1956 the Hungarian electronics industry took its first significant step toward acquiring an effective capability in the field of microwave development with the expansion of the Beloiannisz microwave department from 30 to 300 personnel. Moreover, in response to the increasing demands of the USSR, which in 1956 offered to purchase equipment worth 6 billion rubles over a 7-year period, emphasis shifted to production of 24-channel, 2,000-megacycle radio-relay equipment, the PM-24. During the same period, Communist China also evinced interest in obtaining 24-channel equipment from Hungary. Limited development of mobile military microwave equipment continued abreast, and an improved version, the MH-8, was scheduled for production in 1958-59.

Because of its high noise level, the PM-24 was limited to short distances, and although production (estimated to have begun in 1957) continued through 1960, the need for improved equipment to satisfy Soviet and Chinese Communist requirements resulted in the development of the PM-28. The PM-28, which consists of two complete 12-channel systems plus control and synchronizing channels and which uses a proportionately greater number of relays than the PM-24, is designed to operate without excessive signal attenuation at distances up to 2,000 to 3,000 kilometers. Advantages of the PM-28 over the PM-24 include a reduction in crosstalk, a higher signal-to-noise ratio, and the use of long-life components in the multiplexing equipment. The latter feature permits long periods of unattended operation. Although development of the PM-28 began in 1957, it is estimated that serial production was not realized until 1961.

By 1958, Soviet interest in Hungarian 24-channel equipment had become almost marginal and had shifted to broad-band microwave equipment with a capacity of up to 600 channels. A laboratory prototype of the Soviet 600-channel Vesna equipment was made available to the Beloiannisz plant in 1958. It is estimated that Hungary will have its version of this equipment, the GTT 4000/600, in production in 1961, and it is estimated that Hungary between 1962 and 1965 will produce 250 units per year.* The PM-28 will continue in production primarily for export to Communist China.

The history of Hungarian microwave development reflects the strengths and weaknesses of Hungarian electronics generally and provides an insight into Hungary's lingering inability to fully realize its own

* A unit of microwave radio-relay equipment is considered to be one transmitter and one receiver for initiating, relaying, or receiving one radio frequency channel in one direction. 13/

potential. Throughout its development the Hungarian microwave program has been plagued by a persistent shortage of raw material, skilled technical personnel, and specialized test equipment. Hungary's ability to provide the more common types of test equipment, such as vacuum-tube voltmeters, ammeters, and common voltmeters, was overshadowed by its inability to manufacture reliable test equipment such as microwave test benches, wide-band oscilloscopes, and signal and pulse generators. In addition, Hungary's entire program of development has been subordinated to Soviet requirements and has been characterized by the frequent interposition of the Communist Party hierarchy into the affairs of the engineers. Inevitably, this situation has led to apathy, low worker morale, and a slow rate of progress.

These conditions were grievously aggravated by the Hungarian revolt, during and after which a large number of Hungary's most experienced microwave engineers and technicians fled the country. Notwithstanding these factors, under the impetus of large investment (through which the Beloiannisz plant was expanded and reequipped), microwave production is estimated to have increased from 1 million forints in 1956 to 69 million forints in 1960. By 1962, microwave equipment at Beloiannisz will be produced at an estimated annual rate of 1 billion forints.

The value series for civil communications equipment in Hungary during 1954-65, including subseries for microwave production and for telephone, carrier, and transmitter production combined, is given in Table 5,* which indicates a gradual decline in output of this sector after 1963. This decline may be at least partially explained by a changing product mix. Although there will continue to be a rise in production of certain types of civil communications equipments (FM transmitters and BKM carrier equipment), the increasing specialization of production within this sector will lead to an over-all decline in the aggregate value of the sector. Such a narrowing of emphasis is, in any case, inevitable in view of the massive attention being concentrated on the development of microwave technology at Beloiannisz, necessitating a priority allocation of personnel and material resources and a concomitant reduction of efforts along other lines.

3. Electronic Instruments

The EMG plant is the principal Hungarian manufacturer of electronic instruments for export. The major electronics producers, such as Orion and Beloiannisz, manufacture these instruments for their own use. Radiosondes and other measuring instruments (possibly electronic, for use in nuclear research) are produced by another installation known as the

* Table 5 follows on p. 25.

Table 5

Estimated Value of Production of Civil Communications Equipment in Hungary a/
1954-65

Million 1956 Forints

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Telephone, carrier, and transmitter equipment	680	1,200	1,100	810	1,000	1,800	2,200	2,500	1,800	1,800	1,700	1,400
Microwave equipment			1	11	22	69	69	230	1,000	1,000	1,000	1,000
Total	680	1,180	1,060	820	1,050	1,900	2,260	2,760	2,820	2,810	2,710	2,480
Index (1954 = 100)	100	173	155	120	154	278	330	404	412	411	396	362

a. Components are rounded to two significant digits and may not add to the totals shown. Totals are rounded to the nearest 10 million forints.

Electrical Appliance and Measuring Instruments Plant (Elektromos Keszulekek es Meromuszerek Gyara). Production of electronic instruments in 1960 is estimated to have been less than 5 percent of all output of industrial electronic equipment and less than 3 percent of the total net value of production by the electronics industry. Hungary's past and present reliance on the import of a wide variety of electronic instruments for its own research and development program suggests a continuing low level of technology in Hungarian instrument manufacture. In 1959, on the basis of credits extended by the USSR, the instrument industry (including producers of nonelectronic instruments) received a quantity of new machinery sufficient to replace one-third of the existing machine park. An additional stimulus to increased production is the Soviet commitment to purchase 50 to 60 percent of all instruments offered for export by Hungary between 1961 and 1965. 14/ It is anticipated that Hungarian production of electronic instruments during the period of the Second Five Year Plan will reflect significant progress in terms of both quantity and quality.

D. Military Electronics

The military electronics section of the Hungarian electronics industry comprises the following types of production: radar equipment, point-to-point field radio communications equipment, mobile telephone switchboards, field telephones, and mobile microwave equipment for the Hungarian armed forces. The total value of production of military electronics is not large and, as a percent of total output, is generally declining. Production of military electronic equipment constituted 9 percent of the total production of electronic equipment in 1954 and 7 percent in 1960 and (it is estimated) will decrease to 4 to 5 percent by 1965. The estimated value of military electronic equipment in Hungary during 1954-65 is given in Table 6.*

In value terms, production of radar equipment is the most significant component of military electronic equipment. Hungarian experience in production of radar extends back to 1951-52, at which time the Precision Mechanics Enterprise (FMV) was specifically constituted for production of radar for the Hungarian armed forces.**

* Table 6 follows on p. 27.

** FMV now also produces tape recorders in limited quantity and has been conducting extensive experiments with nonmilitary shipborne radar for navigational purposes. This latter type of radar probably will be in series production during the period of the Second Five Year Plan. Recent information suggests that this plant also is participating in the Hungarian program for production of multichannel microwave radio-relay equipment.

Table 6

Estimated Value of Military Electronic Equipment in Hungary a/
1954-65

Million 1956 Forints

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Radar	72	18	12	200	240	240	240	240	240	240	240	240
Radio communications equipment	37	37	32	27	27	27	27	27	27	27	27	27
Total	110	60	40	220	270	270	270	270	270	270	270	270
Index (1954 = 100)	100	50	40	205	247	245	245	245	245	245	245	245

a. Components are rounded to two significant digits and may not add to the totals shown. Totals are rounded to the nearest 10 million forints.

In the intervening years since 1952, Hungary has produced one type of acquisition/early warning radar and two types of fire-control radar but has not made any significantly original or creative contributions to radar design and technology. The regime has been guided throughout, as in other areas of the industry, by a policy based on duplication of US and Soviet radars. Hungarian radar has been of reasonably satisfactory quality, but the unreliability of certain components (in particular, Hungarian-produced vacuum tubes) has militated against the development of more effective equipment. Earlier production, at least until 1956, was accomplished with technical assistance from Soviet military advisers. It is estimated that Hungary's technological base, engineering skills, and experience in manufacturing techniques are now sufficiently adequate to permit production of satisfactory radar without direct technical assistance. Assuming no expansion of the FMV plant and no sudden change in the trends of the electronics industry, it is estimated that production during 1961-65 will continue at the 1959 rate of 265 million to 270 million forints.

In 1952, FMV produced a few fire-control radars based on the US SCR-584. These were experimental models, later used for training purposes, and were never produced in quantity. Between 1952 and 1955 an acquisition/early warning type of radar, the Duna (comparable to the Soviet Crossfork), was manufactured. In 1955-56, emphasis shifted to production of a fire-control radar, the Drava, based on the Soviet Son-4 design. This model in turn was superseded by the Ipoly, which is comparable to the Soviet Son-9-A. The Ipoly went into series production in 1957 and is estimated to have continued in production until 1959. It is estimated that, in accordance with the general phasing-out of production of antiaircraft artillery, fire-control radar will not be produced in Hungary during 1960-65 but probably will be superseded by production of other military radar equipment for which the Soviet Bloc has a continuing requirement.

Before 1957, Hungary produced R-30, R-40, and R-50 point-to-point radio communications equipment for army inventories, and it is estimated that by 1962 the Hungarian army will be fully equipped with Soviet R-series radio communications equipment. Hungary has been allocated Bloc responsibility for production of the R-104. The Telephone Plant, Orion, and Beloiannisz formerly participated in production of military radios. Future production of R-series equipment probably will be carried out exclusively at the Telephone Plant. It is anticipated that Hungary will continue to produce telephones, telephone switchboards, and mobile microwave equipment both for consumption by the Hungarian army and for export to military forces in Communist China. In the field of mobile microwave equipment, Hungary's program until 1959 was still in the developmental stage, having resulted in only a few unsatisfactory prototypes of MH-10, MH-6, and MH-5 equipment. A further modification, the MH-8, probably will be produced in limited numbers during 1959-65, primarily for export to China.

APPENDIX A

MAJOR PRODUCERS OF ELECTRONIC EQUIPMENT IN HUNGARY

Plant*	Address	Estimated Number of Employees	Major Items of Production
Beloiannisz Hiradas Technikai Gyar (Standard/BHG)	Budapest XI, Fehervari Utca	5,000	Telephone centrals, high-powered radiobroadcast transmitters, carrier equipment, television and FM broadcast stations, and microwave equipment
Egyesult Izzolampa es Villamossagi (Tungsram)	Budapest, Ujpest IV, Vaci Utca	10,000	Incandescent and fluorescent lamps; radio receiving tubes, including miniature and subminiature; special-purpose tubes; semiconductors, including germanium diodes and low-frequency transistors; cathode ray tubes; and tube, lamp, and glass manufacturing machinery
Elektronikus Meromuszerek Gyar (EMG)	Budapest XIV, Cziraki Utca	1,500	Electronic measuring instruments
Finommechanikai Vallalat (FMV)	Budapest X, Feher Utca	2,500	Fire-control radar and nonmilitary navigational radar
Magyar Adocsogyar (Hungarian Transmitter Tube Plant) (HTT)	Budapest XIII, Vaci Utca	1,000	High-powered radio transmitting tubes
Orion Radio es Villamossagi Gyar (Orion)	Budapest X, Jaszberenyi Utca	3,000	Household radio and television receivers
Remix Radio Technikai Vallalat (Remix)	Budapest X, Pataki Istuan Square	1,500	Electrical parts and capacitors, resistors, and potentiometers
Telefon Gyar (Telephone Plant)	Budapest XIV, Hungaria Korut	3,000	Railroad signal equipment, household radio receivers, military transceivers, and civilian/military telephones

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APPENDIX B

METHODOLOGY

1. General

Hungary does not publish statistical data on an "electronics industry," although data on those broad categories of production that comprise the industry are substantially covered in the Hungarian statistical yearbook and other officially released statistics. The main difficulty lies in defining and interpreting these categories. The statistical category covering the major share of "electronics production" as defined in this report is that given in official Hungarian sources as "telecommunications machines and appliances." This category has been interpreted as comprehending production of consumer entertainment equipment, industrial electronic equipment (but not including electronic instruments), and some military point-to-point radio communications equipment. This category serves further as a basis for the derivation of a value series on civil communications equipment as outlined below. Two additional categories, "vacuum-technical" (including electron tubes) and "precision instrument" (including electronic instruments), which generally round out the electronics industry, are considered to include a preponderant percentage of non-electronic data, thus limiting the use of these categories in this report to a corroborative or supporting role. The overwhelming proportion of military production -- that is, military radar -- is not believed to be reflected in published statistics.

2. Consumer Entertainment Equipment

a. Estimates of Physical Production

The Hungarian statistical yearbooks for 1957, 1958, and 1959 provide figures on the physical production of household radio and television receivers, phonographs, and tape recorders for 1955-59. Production for the remaining years between 1954 and 1965 was determined as follows:

(1) Radio Receivers

Production figures for 1954 and 1960 are available from Hungarian periodicals. Production for 1961-65 was estimated to be at a constant rate of 200,000 units per year. A constant rate was selected because, although a rapidly declining output since 1958

suggests a downward trend, this trend is opposed by other countervailing forces within the industry. Such forces are as follows: Hungarian efforts to market new, more competitive models; a developing capability to produce the increasingly popular transistorized receiver; and an improvement in production capabilities through the expansion of existing facilities and the modernization of equipment.

(2) Television Receivers

The official Hungarian estimate that production in 1965 will be six times that of 1959 15/ was accepted as a reasonable projection. On the basis of the figures for these 2 years, production during the intervening years except 1960 (official data) was estimated by applying the implied average rate of growth of 34.8 percent per year.

(3) Phonographs and Tape Recorders

A sudden downturn in production of phonographs in 1959 is shown in Table 4.* This situation probably is explained by the shifting emphasis in production at the Orion plant from radios, phonographs, and other items of consumer entertainment equipment to the almost exclusive production of household television receivers. Nevertheless, the upward trend indicated for 1956-58 in production of phonographs is expected to continue through 1965, although at a reduced rate. Normal production after the 1959 dip is considered to have been resumed in 1960, and the years 1961-65 have been projected at an annual rate of growth of 10 percent. Because the decline in output by Orion will have to be compensated for by an increase in production at the Telephone Plant and the Hunting Cartridge Plant principally, a higher rate of growth would appear to be unjustified.

Production of tape recorders is centered at the Telephone Plant. To a much lesser extent the FMV plant and a number of smaller enterprises also manufacture them. The sudden upsurge in production in 1959 is accounted for by the increasing export market and the development in 1958 of a lightweight model capable of effectively competing in this market. Nevertheless, the assumption of increased responsibility in production of consumer entertainment items occasioned by the production shift at Orion and the absence of any significant and corresponding increase in plant and production facilities make it unlikely that output of tape recorders will grow at an annual rate in excess of 10 percent. Accordingly, a 10-percent rate has been projected for 1960-65.

* P. 18, above.

b. Estimates of Value of Production

Value series were derived by determining average factory prices for the four types of consumer entertainment equipment and applying these coefficients to the physical production series. The average factory prices, as shown in the tabulation that follows, represent selected retail prices deflated by 20 percent,* an estimate of the amount of turnover tax, and distribution costs.

Equipment	Price per Unit (1956 Forints)
Household radio receivers	672
Television receivers	4,583
Phonographs	1,000
Tape recorders	2,475

These estimates were derived as follows:

(1) Radiobroadcast Receivers

The three plants producing virtually all receivers in 1956 were Orion, BHG, and the Telephone Plant. From estimates by defectors it has been possible to select representative receivers produced by each plant, the corresponding retail prices, and the relative weight of these plants in relation to the total production of radio receivers. These factors make it possible to determine an average factory price based on a weighted arithmetic average. Retail prices have been deflated by a factor of 20 percent to cover turnover tax and distribution costs. Thus an average factory price of 672 forints for household radio receivers in 1956 was determined by the following calculations:

	1956 Forints			
Type of Receiver	Retail Price	Estimated Factory Price	Weight Factor	Weighted Factory Price (1956 Forints)
AR 602	3,100	1,000**	1	1,000
Terta (5-tube)	1,600	1,225***	2	2,450
Orion 230	1,340			
Nepradio (plug-in)	800	667	3	2,001
Nepradio (battery-operated)	380	317	4	1,268
Total			10	6,719

* Deflated by dividing the retail price by 120 percent.

** Not derived as above; based on an estimate of factory price by a defector.

*** Estimated; derived from conflicting price information.

(2) Television Receivers

The average retail price of television receivers in 1956 was 5,500 forints.

(3) Phonographs

The estimate used is based on the total unit sales in 1957 and the value of total sales as given in the 1957 Hungarian statistical yearbook. The figure for the average retail price based on this information (rounded to 1,000 forints) is equally applicable to 1956, there having been no appreciable change in the retail prices of consumer electronic items in these 2 years.

(4) Tape Recorders

Primarily an export item, tape recorders are produced in small quantities in a narrow assortment and tend to be expensive in price. The 9-kilogram Terta Magna, retailing at 2,970 forints, has been selected as representative.

3. Industrial Electronics

a. Civil Communications

The Hungarian Central Statistical Office periodically releases production data on a category of electronics variously referred to as "telecommunications," "telecommunications equipment," and "telecommunications machines and appliances." In spite of the variations in terminology, the data comprehended by these categories apply to production of consumer entertainment equipment and civil communications equipment. A value series for civil communications equipment, therefore, is derived as a residual by subtracting the value of consumer entertainment equipment from the "telecommunications" total.

The Hungarian statistical yearbooks provide value figures in factory prices on production of telecommunications equipment for 1957, 1958, and 1959. Figures for the remaining years, except for 1955, were derived from other published data on the basis of yearly percentage increases or planned objectives. For example, the figure for 1957 was planned to be 90 percent of the level of 1956 16/ and 36 percent above 1954, the figure for 1960 increased by 22.2 percent above 1959, 17/ and an increase of 19.1 percent was planned for 1961 18/ [redacted] 50X1 [redacted] 50X1 Value of production for 1962, 1963, and 1964 was interpolated on the basis of an annual rate of growth of 8.5 percent (assuming achievement of the 19-percent increase in 1961) necessary to attain a 65-percent increase by 1965. Considering the

substantial rate of growth in both 1960 and 1961 and the increased investments scheduled under the Five Year Plan, it is suggested that this rate of growth probably is conservative. The year 1955 marked the first major emphasis in Hungary on the heightened production of telecommunications to include as well a more comprehensive product mix. Under these conditions an extrapolated rate of growth which would result in a production figure for 1955 that was below the revolutionary year of 1956 would be unrealistically low and at variance with other available indicators. Accordingly, recourse was made to the index of net production in the electrical engineering industry as given in the 1957 statistical yearbook, 20/ which places production for 1956 at 92 percent of the level of 1955. This figure is believed to be a reasonably realistic reflection of conditions then prevailing.

The civil communications portion of the telecommunications category may be conventionally subdivided into two major classes of equipment, as follows: (1) microwave equipment and (2) telephone, carrier, and transmitter equipment. The estimated value of microwave equipment was determined as outlined below and was subtracted from the civil communications total to derive (2).

The value series for microwave equipment was derived by applying unit price estimates to the physical production series for the three major types of Hungarian microwave equipment, the PM-24, the PM-28, and the GTT 4000/600. Estimates for the physical production of the GTT 4000/600 are based on reported Hungarian offers of Vesna equipment to the USSR for 1961-65. 21/ The designations Vesna and GTT 4000/600 are believed to refer to the same item of Hungarian broad-band microwave equipment.

The PM-24 price was estimated to be 550,000 forints on the basis of defector information, 22/ and the same price was estimated for the PM-28. The unit price for the GTT 4000/600 was arrived at by analogy with East Germany. A comparison of the PM-24 with the East German 24-channel microwave equipment, the RVG-934 (costing 25,500 DME*), yields a forint-DME ratio of 22 to 1. Application of this ratio to the East German 600-channel RVG-958 (costing 180,000 DME) yields a forint price for the GTT 4000/600 of 3.96 million forints. Because both countries are producing 600-channel equipment to be compatible with the Soviet Vesna and because, in addition, East Germany and Hungary have approximately comparable technologies for microwave development and production, this comparison is considered to be valid for pricing purposes.

* Deutsche Mark East (East German marks).

b. Electronic Instruments

An estimate by a defector of 4 million to 5 million forints per month as the value of production of the EMG plant in 1956 was used as a benchmark. 23/ Assuming a mean figure of 4.5 million forints per month, the total value of production in 1956 was on the order of 54 million forints. As a check on the reasonableness of this figure, an effort was made to relate the wage bill of the EMG plant in 1956 to the estimated value of production of electronic instruments in that year. The estimated number of employees in 1956 was 1,000, and the average monthly wage for the precision instrument industry was 1,467 forints, yielding a total plant wage bill for 1956 of 17.6 million forints. Thus wages are seen to be approximately 33 percent of the value of production, which is a reasonable figure and is consistent with a similar percentage relationship for the instrument industry as a whole. The 1959 statistical yearbook provides an index of production for the instrument industry as a whole for 1954-59. 24/ A value series for EMG for these years was derived by applying this index to the 1956 benchmark. An implied rate of growth of 10.2 percent was projected for 1961-65.

4. Military Electronic Equipment

The estimated value of production of military electronic equipment is a summation of the value of production of radar and production of military field radio equipment. Other military items such as field telephones, switchboards, and microwave equipment have not been included, because of the paucity of information and the practical difficulties involved in making even physical estimates. In any case, the value of this production is not believed to be sufficiently great to impair seriously the estimate which has been made.

a. Radar

A large number of reports by refugees on activities at the FMV plant, the only known radar-producing facility in Hungary, permit a physical estimate of production of radar during 1954-59. Moreover, estimates by defectors of factory prices on the Duna (1 million forints) 25/ and Drava radars (2 million forints) 26/ greatly facilitate the construction of a value series. The Ipoly, which was a modification of the Drava, was assumed to have the same factory price. [redacted] 50X1
[redacted] The figures for 1957-59 are 50X1
planned production figures 27/ and are assumed to have been implemented. The chief difficulty in the series is the projection

through 1965, for which no information is available. Nevertheless, an annual production value equal to that of 1959 has been estimated for each of the years 1960-65 in the belief that an organization such as FMV, possessing adequate plant and equipment facilities and personnel experienced in the technology of production of radar, would not cease production in the face of a continuing need for military radar equipment by the Hungarian armed forces and other armed forces of the Soviet Bloc. Following is a tabulation of the estimated production of radar during 1954-59:

Type of Equipment	Units					
	1954	1955	1956	1957	1958	1959
Duna	72	8	0	0	0	0
Drava	0	5	6	0	0	0
Ipoly*	0	0	0	98	121	120

b. Radio Communications Equipment

The construction of a value series for field radio communications equipment is based on a determination of the factory prices of the R-30, R-40, R-50, and R-104 radios and estimates of the number of each produced. Production and value series for this equipment during 1954-59** are shown in the following tabulation:

Type of Equipment	Production (Units)						Value of Production (Million 1956 Forints)					
	1954	1955	1956	1957	1958	1959	1954	1955	1956	1957	1958	1959
R-30	180	180	150				3.0	3.0	2.5			
R-40	280	280	250				18.7	18.7	16.7			
R-50	60	60	50				15.0	15.0	12.5			
R-104***				1,000	1,000	1,000				27.0	27.0	27.0
Total†							36.7	36.7	31.7	27.0	27.0	27.0

* Planned production. Although additional plant facilities were being constructed for production of this equipment in 1956-57 and two Soviet Son 9-A radars were being assembled at this plant as late as January 1957, there is no confirmatory evidence of the actual implementation of this planned production.

** Before 1954, Hungary produced other R-series equipment, including R-3, R-5, R-7, R-10, R-12, R-14, R-20, and R-51.

*** This is Soviet R-series equipment. Hungary has been delegated responsibility for production of the R-104 transceiver for use by all Warsaw Pact armies. Initial production was scheduled for 1957.

† Figures for 1957-59 are strict arithmetic calculations based on purported plan figures in an estimate by a defector for which no corroborative evidence is available. As such, they should be accepted only as an indication of the general order of magnitude.

Production for 1960-65 has been carried at the 1959 level (see Table 6*).

The chief obstacle to deriving factory prices for each of these types of equipment was the inadequacy of technical data contained in reports by defectors to permit close comparison with Soviet equipment, for which factory price estimates already exist. By making the most reasonable comparisons, however, it may be inferred that the R-40 price is approximately four times as much as the R-30 and that the R-50 price is 15 times as much as the R-30. Applying these ratios to an estimate of the physical production of these types of equipment at BHG in 1955 and an estimate by a defector of the total value of production of military radios at BHG in 1955, the respective factory prices were determined. The following tabulation shows these prices and those of comparable Soviet types of equipment:

Hungary		USSR**	
Type of Equipment	Factory Price (1956 Forints)	Type of Equipment	Factory Price (1956 Forints)
R-30	16,700	R-104	27,000
R-40	66,800	R-118	119,000
R-50	250,500	R-102	398,000

5. Electron Tube Industry

a. Physical Production

Production of electron tubes in Hungary consists of receiving tubes, transmitting tubes, and cathode ray tubes. Statistical data on the physical production of these items for 1955-59 are contained in the Hungarian statistical yearbooks. Production of receiving tubes was extrapolated for 1954 and for 1960-65 at the annual rate of growth of 10.7 percent that is reflected in the published data. Production of transmitting tubes, on the other hand, fluctuated unevenly during 1955-59, frustrating any determination of trends and dictating the use of a mean average for projection purposes. A mean average of 45,000 units was predicated for 1954 and 1960-65. Production of cathode ray tubes was estimated for 1965, and production for 1961-65 was computed from an implied annual rate of growth of 30.6 percent

* P. 27, above.

** Computed from the US dollar price by applying a forint-dollar ratio of 20 to 1.

over this period. Production of cathode ray tubes in 1965 was estimated on the assumption that the electron tube industry will be self-sufficient by 1965 in its ability to satisfy requirements for picture tubes dictated by increased production of television receivers. A replacement factor of 10 percent was allowed for in computations.

b. Value of Production

(1) Receiving Tubes

Production of receiving tubes in 1956 was calculated to be 83.6 percent of normal production if there had been no revolt. This percentage was applied to an estimate by a defector of the forint value of the annual rate of production for 1956 28/ before the revolt in order to derive an actual production value of 188.2 million forints. Because actual physical production for 1956 was 6,895,000 units, 29/ an average receiving tube factory price of 27.3 forints was determined. The physical totals for all other years were multiplied by this factor in order to derive the value series.

(2) Transmitting Tubes

Transmitting tubes are manufactured by two plants -- the Hungarian Transmitter Tube Plant (HTT) and the Tungsram plant, the latter a producer of tubes of less than 100-watt capacity. Comparing a defector estimate of the number of tubes manufactured by HTT in 1956 with the total number of tubes produced, as indicated in the statistical yearbooks, it is concluded that HTT produced approximately 30 percent of all transmitting tubes in 1956 and Tungsram 70 percent. These percentages were applied to the series for the total physical production to determine the actual production for each plant. In addition, an average factory price was determined for each plant and was multiplied by the plant production, giving a value series. The average tube price for HTT was determined to be 2,460 forints, and the average tube price for Tungsram was determined to be 388.8 forints. Calculations for 1955-59 are shown in the following tabulations:

	Thousand Units				
Producing Plant	1955	1956	1957	1958	1959
Hungarian Transmitter Tube Plant	16.2	12.0	10.3	16.9	12.0
Tungsram	37.8	28.4	24.1	39.5	28.0
Total	54.1	40.4	34.5	56.4	40.0

	Million 1956 Forints				
Producing Plant	1955	1956	1957	1958	1959
Hungarian Transmitter Tube Plant	39.9	29.5	25.4	41.6	29.5
Tungsram	14.7	11.0	9.4	15.4	10.9
Total	54.6	40.5	34.8	57.0	40.4

(3) Cathode Ray Tubes

The Hungarian 5CP1-A cathode ray tube was used to establish a multiplication factor. This tube's retail price is carried in a Tungsram catalog of 1957 as 787.68 forints, and this price is assumed to have been in effect in 1956 as well. Deflating this price by a factor of 20 percent (turnover tax and miscellaneous distribution costs), an average factory price for cathode ray tubes is estimated to be 656 forints. This figure was applied to the physical production series to derive a value series.

c. Check on the Aggregative Estimate

The aggregate value figure for production of electron tubes (summation of values of receiving tubes, transmitting tubes, and cathode ray tubes) in 1957 is calculated to be 203.4 million forints. An alternate methodology, which follows, was invoked to test the validity of this result.

The 1957 Hungarian statistical yearbook presents the aggregate value of production by the "vacuum-technical industry" in 1957 as 422.0 million forints and also contains information on the total number of light bulbs produced. Bearing in mind that the nonelectron tube sector of the "vacuum-technical industry" includes two major categories of production -- (1) incandescent and fluorescent light bulbs and (2) tube and lamp manufacturing machinery -- an estimate of the value of production of electron tubes can be deduced by factoring these two quantities out of the total.

(1) Incandescent and Fluorescent Light Bulbs

Hungary manufactures the following types of incandescent and fluorescent light bulbs:

(a) Normal -- general lighting; 150 watts and below.
(b) Large -- general lighting; above 150 watts and other large special-purpose incandescent bulbs.

(c) Special and miniature (including automotive, flashlight, and miniatures for medical, dental, and other purposes).
(d) Fluorescent -- below 40 watts.

Price data on these items are lacking, but because Hungary has a long history in the mass production of these items and because the quality of Hungarian light bulbs compares favorably with that of Western counterparts, an f.o.b. price, in dollars, for similar items was determined, a forint-dollar ratio was applied to derive comparable forint prices, and the physical quantity of light bulbs was multiplied by these prices.

A forint-dollar ratio of 20 to 1 is considered to be representative for this purpose. The arithmetic results are shown in the following tabulation of the value of production of incandescent and fluorescent light bulbs for 1957:

Type of Light Bulb	Quantity (Million Units)	Estimated US Factory Price (US Dollars)	Estimated Tungsram Factory Price (1956 Forints)	Value of Production (Million 1956 Forints*)
Normal	29.7	0.09	2	60
Large	2.8	0.28	6	17
Special and miniature	21.5	0.08	2	43
Fluorescent	1.2	0.87	17	20
Total				140

(2) Tube and Lamp Manufacturing Machinery

On the basis of an estimate by a defector, production in 1957 was valued at 65 million forints.

(3) Value of Production of Electron Tubes

The total of categories (1) and (2), above, is 205 million forints. Therefore, by subtracting this sum from the 422 million forints representing the total value of production of the "vacuum-technical industry," the value of production of electron tubes for 1957 is seen to be 217 million forints compared with 203.4 million forints calculated by the first method. Because of the difficulties

* Rounded to the nearest million.

of determination of a forint-dollar ratio and the imprecisions involved in the assumption of comparability in the US and Hungarian price structures, this method is presumed to be less reliable than the former. Assuming 217 million forints to be a maximum figure, the margin of error involved in adopting the first methodology, in any case, will not be greater than 7 percent.

d. Electron Tubes as a Part of Total Net Production

The annual value of electron tubes, either exported or allocated as spares, was incorporated into the value series for the total net production. The values for such tubes were determined as follows:

(1) Transmitting Tubes

It is estimated that 80 percent of the total production of transmitting tubes is exported annually. The methodology of estimating the total production of transmitting tubes was given above under b, (2).*

(2) Receiving Tubes

The value series for receiving tubes is based on the physical series for exports and spares. These physical series were derived as follows:

(a) Exports

Export figures (in physical units) for receiving tubes are given in the Hungarian statistical yearbooks for 1955-59. On the basis of these figures, an average annual rate of growth of 11.4 percent was applied to derive the unknown years through 1962. Exports during 1962-65 were projected as remaining at a stable level because a continued extrapolation would involve a contradiction -- that is, the total production of tubes would be insufficient for domestic needs, thereby necessitating an import of the very tubes which are being exported. Such a situation would be distinctly atypical. Although a small quantity of tubes is imported annually, these are, for the most part, special or high-quality tubes used to fill specific requirements, and any program for increasing exports of tubes that requires increased imports of tubes is considered to be highly unlikely.

(b) Spares

The annual number of spares derives from the excess of production of electron tubes above consumption. The total consumption

* P. 39, above.

of tubes, in turn, is the sum of tubes used in household radio and television receivers, assuming a unit consumption of 5 tubes per radio receiver and 16 tubes per television receiver.

The figures for the total production, consumption, export, and spares of receiving tubes are shown in Table 7.* The physical series on exports and spares were converted to a value series by applying a unit price of 27.3 forints.** Results of the calculations are as follows***:

	Million 1956 Forints				Million 1956 Forints		
	Exports	Spares	Total		Exports	Spares	Total
1954	110	33	140	1960	200	22	220
1955	120	19	140	1961	230	22	250
1956	90	49	140	1962	250	11	260
1957	120		120	1963	250	19	270
1958	150	14	160	1964	250	22	270
1959	180	30	210	1965	250	11	260

6. Labor Productivity

Measurement of labor productivity for the Hungarian electronics industry is based on the total production of electronics (see Table 1†) and on estimates of the number of employees in the industry. Relying primarily on refugee reports, the most reasonable employment figure for 1957 is considered to be 30,000. Employment figures after 1957 are more difficult to ascertain. Nevertheless, utilizing employment information provided by the Hungarian statistical yearbook for the electrical engineering and precision engineering branches of the economy and making appropriate allowances for the nonelectronic segments of those branches, it is estimated that approximately 40,000 people were employed in the electronics industry in 1959. Although the actual figure may be somewhat higher than this, it will not be lower. The productivity estimate for 1959, therefore, should be considered a maximum figure. Calculations of the average per capita productivity for 1957 and 1959 are shown in the following tabulation:

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* Table 7 follows on p. 45.

** See b, (1), p. 39, above.

*** Data are rounded to two significant digits. Because of rounding, components may not add to the totals shown.

† P. 6, above.

	Number of Employees	Total Value of Production (Million 1956 Forints)	Productivity Per Capita: Thousand 1956 Forints	Productivity Per Capita: Current US Dollars*
1957	30,000	1,626.6	54.2	2,700
1959	40,000	3,141.2	78.5	3,900

Productivity in 1959 shows a rather considerable increase of 45 percent above 1957. This increase is partially, if not wholly, explained by the investment pattern of the Three Year Plan. Because renovation of equipment and facilities was already underway in 1958, positive effects (in terms of increased productivity) could logically be expected to be felt in 1959.

Productivity in the Hungarian electronics industry varies for different subsectors of the industry -- it is highest for telecommunications workers and lowest for those engaged in production of electron tubes. This differential pattern of productivity can be seen in the following tabulations of labor productivity for the telecommunications and the vacuum-technical branches of production of electronics, which are based on the Hungarian statistical yearbooks for 1957, 1958, and 1959:

Telecommunications

	Number of Employees	Value of Production (Million 1956 Forints)	Productivity (Thousand 1956 Forints per Employee per Year)
1957	20,800	1,216.2	58.4
1958	24,000	1,594.0	66.3
1959	27,300	2,560.7	93.7

Vacuum-Technical

	Number of Employees	Value of Production (Million 1956 Forints)	Productivity (Thousand 1956 Forints per Employee per Year)
1957	10,600	422.0	39.8
1958	11,000	507.7	46.3
1959	12,100	832.0	68.7

* Based on a forint-dollar ratio of 20 to 1. Data are rounded.

Table 7

Distribution of Domestically Produced Electron Receiving Tubes in Hungary
1954-65

Million Units

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Total domestic production	6.3	6.9	6.9	6.1	8.8	10.4	11.5	12.7	14.1	15.6	17.3	19.1
Initial equipment	1.3	1.9	1.8	2.3	2.9	2.7	3.3	3.6	4.5	5.7	7.3	9.5
Radio receivers a/	1.3	1.9	1.8	2.2	2.3	1.3	1.1	1.0	1.0	1.0	1.0	1.0
Television receivers b/			0.04	0.1	0.6	1.4	2.2	2.6	3.5	4.7	6.3	8.5
Exports	3.8	4.3	3.3	4.2	5.4	6.6	7.4	8.3	9.2	9.2	9.2	9.2
Total initial equipment and exports	5.1	6.2	5.1	6.5	8.3	9.3	10.7	11.9	13.7	14.9	16.5	18.7
Spares c/	1.2	0.7	1.8	-0.4	0.5	1.1	0.8	0.8	0.4	0.7	0.8	0.4
Spares as a percent of production	19.0	10.1	26.1		5.7	10.6	7.0	6.3	2.8	4.5	4.6	2.1

a. Based on 5 tubes per receiver.
b. Based on 16 tubes per receiver.
c. Derived as a residual by subtracting the allocations to initial equipment and exports from the total production.

It should be noted that these tabulations do not permit a precise comparison of productivity in the telecommunications manufacturing industry with that in the electron tube industry because the category of "vacuum-technical" production does not wholly equate with electron tube production. The category "vacuum-technical" includes a large percentage of nonelectronic production, which probably imparts an upward bias to the productivity figure. In any case, the tabulations adequately illustrate the wide divergence in productivity rates within the two main branches of production of electronics in Hungary.

7. Exports

The value series for exports of industrial electronic equipment and consumer entertainment equipment is based on official Hungarian indexes for Budavox-BHG and Elektroimpex for 1950-58 30/ and is predicated on the assumption that the Budavox index equates to the export of industrial electronic equipment (not including instruments) and that for Elektroimpex equates to consumer entertainment equipment. The value series for exports of electron tubes, previously calculated for the net aggregate, and a value series for instruments were added. The indexes for 1950-58, as given by the source, are as follows:

	1950 = 100								
	1950	1951	1952	1953	1954	1955	1956	1957	1958
Budavox	100	49	95	125	167	158	168	169	238
Elektroimpex	100	129	109	116	181	209	173	362	564

These indexes are somewhat misleading and require clarification. First, Budavox was not established until 1956. Second, Elektroimpex, as explained in the text,* handled the export of electrical as well as telecommunications equipment until 1956, at which time it assumed responsibility for the export of telecommunications equipment exclusively. Therefore, it has been assumed that the Budavox index equates to the exports of BHG both before and after 1956 and that the Elektroimpex index equates to the export of all other items of telecommunications. Because the major items of telecommunications not exported by Budavox are radio and television receivers, Elektroimpex is assumed to represent the consumer entertainment sector of the electronics industry.

* P. 11, above.

In order to apply these indexes, it was necessary to establish base year estimates. In the case of Budavox, a reliable estimate by a defector of the value of exports in 1956, in forints, for the BHG plant was utilized. Estimates for 1954, 1955, 1957, and 1958 were derived by applying the Budavox estimate to the base year estimate for 1956. The figure for 1960 was based on an official Hungarian source stating that 90 percent of BHG production in 1960 was exported. 31/ Because BHG is conservatively estimated to produce at least 90 percent of all industrial electronic equipment (excluding instruments), a value of production of 2 billion forints was estimated for 1960 (see under industrial electronic equipment in Table 1*). The figure for 1959 was derived by straight-line interpolation. The estimate for 1965 was derived in the same manner as the estimate for 1960. The value estimates of exports of industrial electronic equipment were next rounded out by the inclusion of a value series for exports of electronic instruments. This series equates to the annual value of production of the EMG plant (see 3, b, p. 36, above).

The annual value of exports of consumer electronics for 1958-60 was determined by applying known factory prices per unit to the physical volume of exports of household radio and television receivers, the principal components of consumer entertainment equipment. These calculations are shown in the following tabulation of the volume and value of exports of household radio and television receivers during 1958-60:

	Units			Million 1956 Forints**		
	1958	1959	1960	1958	1959	1960
Radio receivers	116,000	78,883	61,150	78.0	53.0	41.1
Television receivers	15,984	42,575	64,197	73.3	195.1	294.2
Total				151.3	248.1	335.3

Estimates of the annual value of exports of consumer electronics for 1954-57 were derived by applying the Elektroimpex index for these years to the base year figure already estimated for 1958.

The estimated value of Elektroimpex exports in 1965 was based on the expectation that the ratio of exports of consumer entertainment equipment to the total production that obtained during 1958-60

* P. 6, above.
** Based on 672 forints per radio receiver and 4,583 forints per television receiver (see Appendix A).

(approximately 40 percent) will continue to be applicable in 1965. Accordingly, the total value of export of electronic equipment in 1965 is estimated to be 3.5 billion forints, representing approximately three-fifths of the estimated value of the total production.

Data provided in an official Hungarian input/output matrix for the year 1957 support the general validity of these estimates. According to the matrix, the value of exports of "communications and vacuum-technical products" in 1957 amounted to 702.1 million forints. This figure must be qualified to exclude the value of incandescent lamps and lamp-manufacturing machinery and to include a value for the export of electronic instruments. Estimating 164 million forints for the former (80 percent of production of incandescent lamps and lamp-manufacturing machinery) and 71 million forints for the latter yields a net export figure for electronics alone on the order of 609 million forints.

Although prices of Hungarian exports are believed to include a tax, as in the case of domestically sold items, deflation of the above figure by a factor of 15 to 20 percent would be unrealistic because of the peculiar nature of the factory price structure in Hungary.* For example, in extra-Bloc trade (and to a certain extent in intra-Bloc trade as well) Hungarian electronics plants have frequently incurred losses in the interest of overcoming other competitors or of achieving an advantageous penetration of markets deemed potentially favorable for the future. In these cases a differential sum has been awarded the producing plant by the Hungarian National Bank from a "price leveling fund" resulting in an over-all return on exported items equal to the prime cost, a 2-percent factory profit, and an excise (turnover) tax of 15 to 20 percent. It is doubtful that this factor is reflected in the "exports" column of the input/output matrix, and the above figure of 609 million is considered to be conservatively low.

8. Estimated Net Value of Production of Electronic Equipment in Hungary, 1954-65

The aggregate figures included in this report, representing the net value of production of electronics** for 1954-65, are a summation

* The Hungarian National Planning Office establishes a "price list" for most commodities that rigidly governs the selling cost regardless of prime cost, factory profit, and taxes. Its purpose is to keep prime costs at a minimum. For goods not listed (primarily new products), plants are permitted to establish prices by adding an increment of 15 to 20 percent to factory cost. There is no tax differential in prices for military, industrial, or consumer goods.

** Electron tubes and other component parts produced in Hungary and incorporated into end items of the electronics industry are not included.

of separate value series for production of telecommunications equipment, exported transmitting and receiving tubes (including a spares factor), electronic instruments, and military radar. These aggregates are based on the following assumptions:

First, it has been assumed that production of military radar is not included in officially released statistics on the value of telecommunications output but that other military end items are included. This assumption is predicated in part on the fact that the only Hungarian plant producing military radar, FMV, is operationally subordinate to the Hungarian Ministry of Defense and responsive to its mandate. Organizationally, FMV is subordinate to the Ministry of Heavy and Machine Industry.

Second, it has been assumed that other items of military electronic equipment -- such as, for example, field radio transmitting and receiving equipment, mobile switchboards, and field telephones -- are minor items of production in the preponderantly civilian output of plants not sharing this dual subordination and are included in the official statistical data on production of electronics.

Third, it has been assumed that the only large-scale producer of electronic instruments for export is the EMG plant and that the total production of this plant is exported.

The aggregates that have been obtained are believed to be accurate within a small margin of error. The accuracy of the derived aggregates is supported by several checks. For example, from a large number of available reports by refugees, it has been possible to assemble individual estimates of the value of production of the main electronics plants that employ two-thirds of the industry's work force. These estimates total 1.2 billion forints for 1956. Furthermore, the interrelationships among the wage structure, the total wage bill, and the derived value of output were examined. Wages in the electronics industry ranged from 700 forints per month for totally unskilled workers and beginning apprentices to more than 3,000 forints for senior engineers and upper-level managerial personnel. Wages were highest in the instrument manufacturing sector, closely followed by telecommunications, and were lowest in the electron tube sector. Making appropriate allowances for the relation that these sectors bear to the aggregate output for weighting purposes, the most reasonable average monthly wage appears to be on the order of 1,350 forints per month in 1957. Assuming an employment level of 30,000, this figure implies a total annual payroll of 486 million forints. Thus labor costs in 1957 were approximately 30 percent of the net aggregate. Because of Hungary's dependence on costly imported raw materials, labor costs can be expected to be relatively low compared with material costs, in spite of the labor

intensiveness of the industry. The figure of 30 percent is therefore considered to be reasonable and tends in some measure to support the accuracy of the aggregate.

A final check on the derived estimates was made possible by the availability of a published input/output matrix covering all major branches of the Hungarian economy in 1957. 32/ This matrix gives a gross aggregate figure of 2,233.5 million forints (including turnover tax) for production of communications equipment and vacuum-technical products in 1957. The industry's consumption of its own output (components and subassembly manufacture) was entered as 340.5 million forints, yielding a figure of 1,893.0 million forints to represent "net" output for 1957. Assuming that this category equates to the electronics industry (the value of nonelectronic vacuum products, estimated to be 250 million forints, which probably is included, is approximately compensated for by the value of electronic instruments and military radar, 267 million forints, which is not included), the difference between the net aggregates of 266.4 million forints, representing approximately 16 percent of the derived aggregate, is accounted for by turnover tax. An estimate by a defector that turnover tax is on the order of 15 to 20 percent 33/ strengthens the reasonableness of the above figure and further validates the derived aggregate.

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