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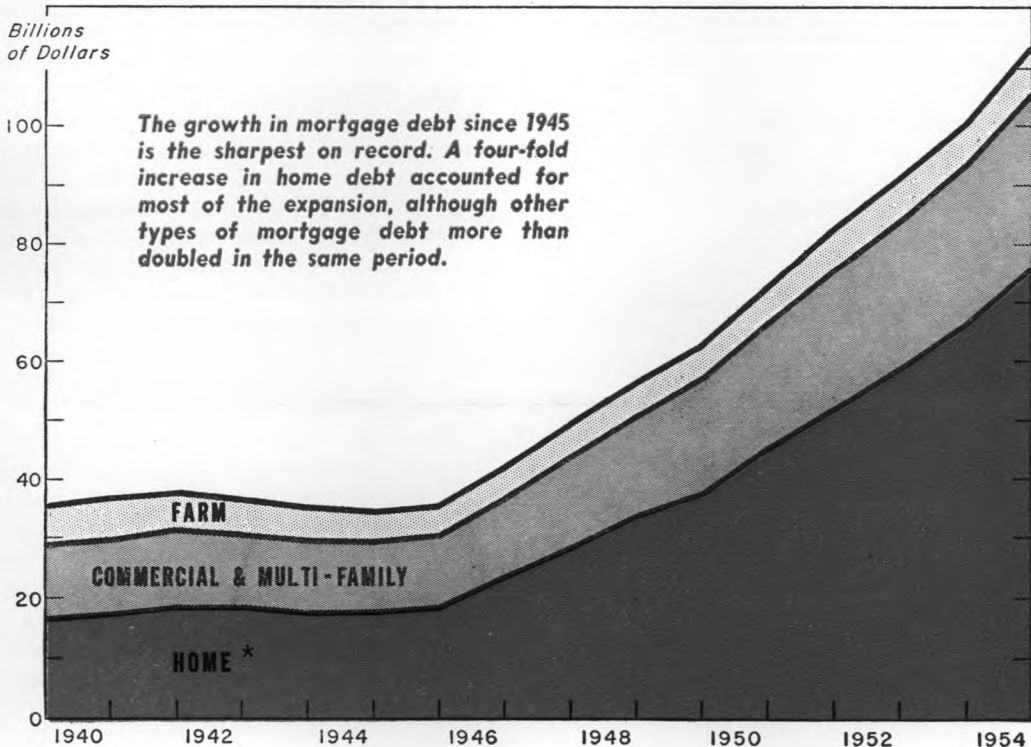
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MORTGAGE DEBT IN U. S.

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Another Look at Mortgage Debt

THE SPECTACULAR expansion of mortgage debt has attracted increasing attention recently as a potential "trouble spot" in our economy. Total real estate debt passed the \$113 billion mark in 1954—a gain of more than 12 percent in a single year. Such debt has more than tripled since the end of World War II, and the pace shows no signs of slackening.

The expansion of mortgage debt has accompanied, and in large part facilitated, the record rate of construction in the postwar period, particularly in home building. Yet questions have been raised about the level, the rate of increase, as well as the quality of real estate credit. Has the burden of mortgage debt become too heavy because of the expansion of such debt in recent years? Are the easy terms of such credit leading to the danger of widespread defaults and foreclosures in case of adverse economic developments? Is there a limit to which mortgage debt can safely rise?

The discussion and charts which follow are designed to throw some light on these important questions, although definitive answers may not be possible. Included are: the outlook for 1955; the factors that produced the past growth of various types of mortgage credit; the relative role of real-estate credit underwritten by the Federal Government; shifts in the sources of mortgage funds; and the significance of expanding mortgage debt and its "burden" on the economy.

The Current Pace

The record increase in home-mortgage debt during 1954 accompanied the high rate of housing construction. Nonfarm home starts

last year rose to over 1.2 million—up 10 percent from 1953, and second only to the 1950 record of 1.4 million. The dollar outlays on new residential construction in 1954 exceeded those of 1950 by nearly 7 percent, reflecting both a higher level of construction costs and a trend toward larger houses. The spurt in housing construction reflected substantial increases in the supply of funds available for home loans on terms very favorable to borrowers. The Housing Act of 1954, which became effective on October 1, also stimulated construction in the closing months of the year. The year 1954 was the sixth straight year in which 1,000,000 or more new homes were put under construction.

Construction activity in the early months of this year suggests that another large increase in mortgage debt is in prospect for 1955. Housing starts in January and February ran at the seasonally-adjusted annual rate of 1.4 million. Total dollar outlays for new construction in February established a record for the month. Such outlays reached an annual rate of over \$40 billion (after allowance for seasonal factors), compared with \$37 billion in 1954. Exceptional strength was demonstrated not only in residential housing, but in spending for industrial buildings, warehouses, stores, and office-type structures.

Based on construction contracts already awarded, a continued high rate of construction activity seems assured at least until mid-year. Contract awards during February in 37 eastern states set a new high for the month, rising 29 percent over February, 1954. The biggest increase came in the residential category, where contract awards were no less than 46 percent ahead of the high level reached in February last year.

The above indications of prospective growth in construction and mortgage loans this year are reinforced by the preliminary findings of the 1955 Survey of Consumer Finances, conducted under the auspices of the Federal Reserve System. Consumer plans to buy new or existing houses during the year were reported more frequently than last year and slightly more frequently than in 1953. In fact, the percentage of families or other spending units expressing an intention to buy homes in 1955 was higher than in any year since the beginning of the Survey in 1948. The increased availability of credit on attractive terms seems to be an important factor in the upsurge of intentions to purchase homes.

Composition of Mortgage Debt

The cover chart depicts the growth and relative importance of the major types of mortgage debt since 1940. The virtual stability of total mortgage debt during World War II, as a result of wartime controls on private construction, contrasts sharply with the unbroken rise in the postwar period. In 1954, both the amount and rate of increase were larger than those of the previous several years.

Home Mortgage Debt. The driving force behind the growth of total mortgage debt, as shown graphically on the cover chart, was the unprecedented expansion of *home* mortgage debt. In 1954 alone, outstanding mortgage loans on nonfarm 1-to-4 family properties rose by 14 percent and passed the \$75 billion mark by year-end. Such debt was over four times as high as the 1945 level of less than \$19 billion. In contrast, during the twenty years ended in 1945, home mortgage debt had ranged between \$13 billion and \$20 billion.

The unusually sharp postwar rise in home mortgage debt is causing concern in many quarters. Such a rise is not necessarily abnormal, however, when compared with the period of 1930-45, which showed no net expansion. In the latter period, building activity and hence mortgage debt was held down, first by depression and later by war. Thus, the postwar building boom and the related growth

of mortgage credit reflects in part a "catching-up" after 15 years of depressed activity.

Other Mortgage Debt. The postwar increase in outstanding mortgage loans on *multi-family* and *commercial* properties, although dwarfed by home mortgage debt, was nevertheless substantial. After remaining stable in the war years, this type of debt doubled between 1945 and 1954, reaching a level of almost \$30 billion. The record rate of commercial and industrial construction in the postwar period is not fully reflected in mortgage debt, however. External financing of corporate expenditures on new plants, for example, typically takes the form of issuance of stock or bonds, rather than mortgages.

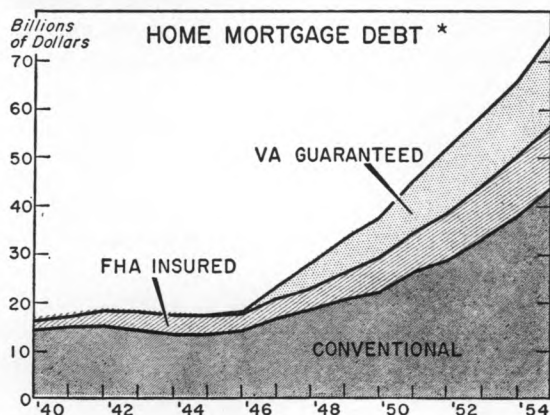
Farm Mortgage Debt, covering both land and buildings, showed the least net expansion in the past fifteen years. After dropping substantially from 1939 to 1945, such debt then nearly doubled by 1954, reaching a level over \$8 billion. Since 1949, farm mortgage debt has been expanding at the rate of about \$500 million per year.

Changes in Relative Composition. The divergent rates of increase in the three types of mortgage debt just discussed have brought about major changes in the relative composition, and hence the character, of total mortgage debt. Between 1939 and 1954, home mortgage debt increased from less than half to more than two-thirds of the total. In the same period, debt on multi-family and commercial properties declined from about one-third to about one-fourth of the total. Finally, farm mortgage debt fell from about one-fifth to about one-twelfth of total mortgage debt. As a result of these shifts, the quality and soundness of mortgage debt is much more influenced by developments in the urban housing field than before the war.

Government Underwriting

The emergence of Government-backed loans as a major factor in the home mortgage field is portrayed in an accompanying chart. Insurance of private home loans by the Federal Housing Administration, begun in 1934 at a

Government-underwritten home loans now constitute about 42 percent of the total, as compared with only 11 percent in 1939.



* Outstanding at year-end; nonfarm 1- to 4-family properties.

time when the construction industry needed bolstering, has wrought far-reaching changes in mortgage credit. Largely as a result of practices sponsored by F.H.A., long-term amortized mortgage loans are now commonly employed in the housing field, with much lower downpayments and interest rates than formerly.

Such practices have been widely adopted for conventional home loans as well as those backed by the Federal Government. The scope of real estate credit has been broadened, and the credit facilities of commercial banks and life insurance companies have become more available for home loans. Mortgage credit has become more mobile, liquid, and marketable, and a greater degree of uniformity has been brought about in mortgage terms, lending techniques, and borrower requirements. In short, both the potential supply of and demand for mortgage credit have been greatly increased.

The principal impact of the above changes in home mortgage practices has come in the postwar period; it goes far in explaining the unprecedented rise in home mortgage debt since 1945. By 1939, F.H.A.-insured home loans had reached only 11 percent of the total outstanding. In the postwar period, however, F.H.A. activities expanded rapidly, and the

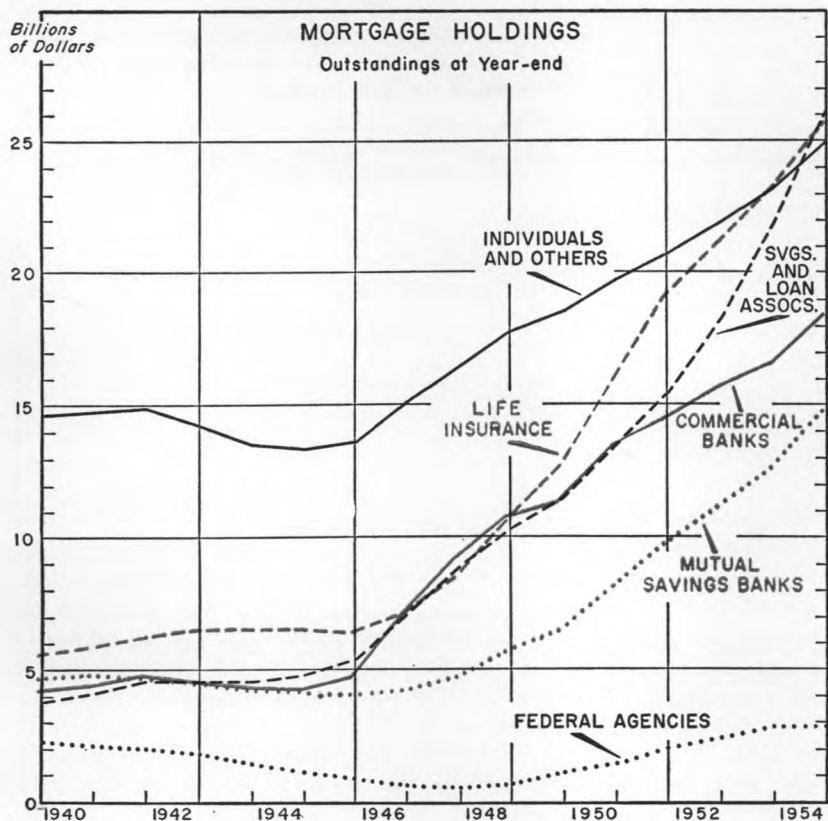
Veterans Administration also began guaranteeing home loans made to veterans by private lenders. As a consequence, by 1951, Government-backed home loans outstanding represented 44 percent of total home debt.

Despite the importance of Government-backed loans, however, it is of interest to note that in each year since 1951, such loans have decreased slightly as a share of total home loans outstanding. Conventional loans have thus increased their relative share slightly. In part, this development reflects credit restraints during the Korean war, which had a greater impact on Government-backed loans than on conventional loans. The recent upsurge in VA-guaranteed loans may change the picture during this year, however.

Although recognizing the benefits brought about by Government-underwritten home loans, some critics believe that present easy terms on which such loans can be obtained are unsound. Particular reference is usually made to 30-year loans requiring no downpayment. As a result of the progressive increase in maturities and lowering of downpayments, many new home buyers have less equity in their property than at any previous time in our history. This points to the possible danger that in a period of declining income, defaults may seem like an easy escape from monthly payments which have become burdensome. To date, the actual losses of the F.H.A. and VA have been extremely low in relation to the volume of the loan-insurance and guarantee operations, even in years of recession. Neither agency has been put to the test of a severe depression, however.

Who Lends the Money?

The shifts since 1939 in the relative importance of mortgage loans held by the various types of lenders are shown in an accompanying chart. In the fifteen-year period portrayed, all classes of lenders participated in the growth of real estate credit. At the same time, however, significant changes occurred in the relative importance of their participation. One such change has been the increasing institutionalization of mortgage lending. In



Private financial institutions now furnish a much larger share of mortgage credit than in the prewar period. Individual lenders have declined in relative importance.

The most notable gain in the postwar period was made by savings and loan associations, which outstripped life insurance companies during 1954 as the largest group supplier of mortgage credit. Mortgage holdings of commercial banks and mutual saving banks have risen at a slower pace.

the postwar period, commercial and mutual savings banks, life insurance companies, and savings and loan associations all increased their *relative* shares of total mortgage holdings at the expense of individuals and miscellaneous lenders. (During the period, the relative share held by Federal agencies—mainly the Federal National Mortgage Association—remained unchanged). The declining relative importance of individual lenders reflects both the decline of second mortgages as a common financing device, as well as the fact that requirements set for Government backing of mortgage loans have tended to screen out individual lenders.

Although each of the four types of financial institutions gained in absolute as well as relative terms after 1945, the rates of increase were far from uniform. The most noticeable gain in the postwar period was made by sav-

ings and loan associations, which outstripped life insurance companies during 1954 as the largest group supplier of total mortgage credit. At the end of last year, savings and loan associations held 23 percent of all mortgage loans outstanding, compared with only 11 percent in 1939. Of all financial institutions, savings and loan associations have the highest percentage of their assets invested in mortgages. At the same time, these associations have enjoyed a record savings inflow in the post-war period, thus explaining their emergence as the largest supplier of mortgage funds.

Life insurance companies showed the next largest gain since 1939. At the end of 1954, their holdings of mortgages accounted for almost 23 percent of the total, in contrast to 16 percent in 1939. Most of this gain occurred in the postwar period, as life insurance com-

panies began to devote a larger share of their funds to mortgage loans.

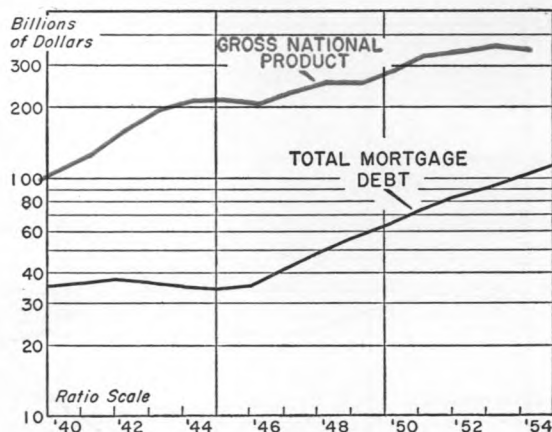
In terms of relative growth of mortgage holdings, *commercial banks* fell substantially behind life insurance companies and savings and loan associations in the postwar period. This development reflects both banking policy and banking regulations. Although total resources of commercial banks grew rapidly after 1945, only about 8 percent of their assets are now in the form of mortgage loans. Even though mortgage loans now represent a larger share of bank assets than in 1945, the dollar growth of mortgage loans made by banks in the postwar period has been smaller than that of the other major lending institutions. Since 1948, the relative share of commercial banks in total mortgage credit has declined, following a substantial increase prior to 1948.

During World War II, almost the entire expansion in assets of *mutual savings banks* took the form of U. S. securities. Since 1945, these institutions have devoted the bulk of new savings deposits to mortgage investments, which reached 50 percent of total assets in 1954. Thus, by the end of the year, mutual savings banks held over 13 percent of total mortgage credit outstanding—about the same position occupied in 1939.

The flow of mortgage credit in the future will be influenced in several important respects by the shifts in the sources of funds as well as by the changes in mortgage practices which have already occurred. The widespread adoption of long-term amortized mortgages has produced a permanent reinvestment problem for institutional lenders, as monthly repayments of principal and interest have mounted. In 1954, for example, new home loans¹ were about 2½ times as large as the net increase in home loans outstanding. The difference between the two amounts was accounted for by repayments on old loans. Lending institutions must not only find outlets for new savings but for the proceeds of repayments on existing debt as well.

¹ New mortgage recordings of \$20,000 or less on nonfarm properties, representing chiefly loans on small homes.

Total mortgage debt is not as high now in relation to Gross National Product as it was in 1939. Since 1945, however, such debt has risen slightly faster than Gross National Product.



NOTE: GNP, annual totals; debt, outstandings at year-end.

The increasing institutionalization of mortgage lending in the past fifteen years stems largely from changes in the forms of savings as well as from the increasing importance of small savers. The latter group tends to hold savings in the form of bank deposits, life insurance, and savings shares rather than in mortgages or other securities purchased directly.

Mortgage Debt Compared to Income

Although there has been a tremendous increase in the absolute size of mortgage debt in the postwar period, the actual burden of this debt on the economy can better be measured by its size in relation to total income, as well as by the size of scheduled repayments in relation to income.

Total Mortgage Debt and the National Product. The relative growth of Gross National Product and of total mortgage debt is compared in an accompanying ratio chart, which brings out proportionate changes.² Two points of interest may be noted. After 1945, total mortgage debt expanded only at a

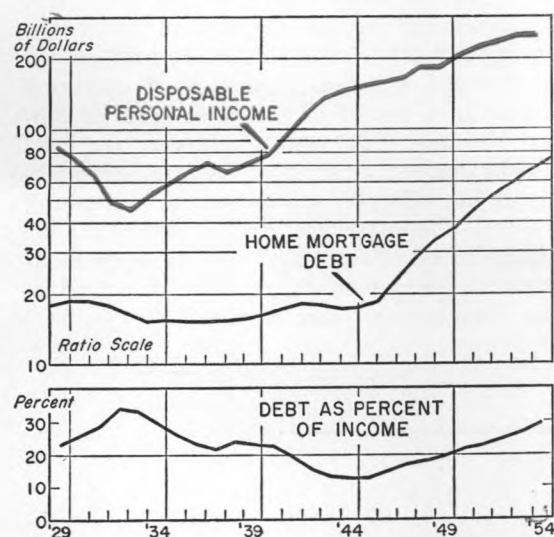
² On a ratio chart, equal vertical distances represent equal percentage changes. Thus, for example, two parallel lines would represent equal rates of change.

slightly faster pace than did the Gross National Product. Furthermore, if the two amounts are compared as between 1939 and 1954, it becomes clear that Gross National Product has risen relatively faster than total mortgage debt over the longer interval. The latter point is accounted for by the lack of debt expansion during the war years. From this standpoint, the level of mortgage debt does not seem to be unduly high.

Home Debt and Disposable Income. Since most of the expansion in mortgage debt has been in the housing field, it would also be suggestive to compare home mortgage debt with disposable personal income, i.e. personal income after taxes, which is the part of total national income most closely affected by the debt charges. This is done in an accompanying ratio chart, which also portrays home debt as a percentage of disposable personal income. (See bottom strip).

The relative positions of such debt and income from 1929 to 1954 show three distinct

Since the end of World War II, home mortgage debt has risen at a much faster rate than disposable personal income. Such debt is now higher in relation to income than in 1929, after the building boom of the 1920's.



NOTE: Income, annual totals; debt, outstandings at year-end on nonfarm 1- to 4-family properties.

phases. Although home debt and disposable income both declined from 1929 to 1933, the fall in income was relatively much larger. As a consequence, home mortgage debt rose to 34 percent of disposable income by 1933. This level proved unsustainable and was accompanied by a wave of defaults and foreclosures.

The second phase, from 1933 to 1945, was one in which home construction, and thus home mortgage debt, failed to share in the slow recovery and later wartime boom in personal income. As a consequence, home debt fell to 12 percent of disposable income by 1945.

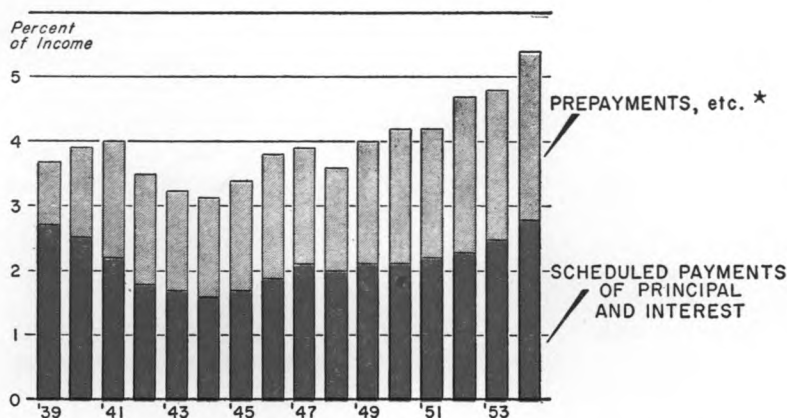
The third phase, from the end of World War II to the present, is one in which home mortgage debt has expanded at a substantially faster rate than personal income. At the end of 1954, this debt-to-income ratio had climbed to 30 percent—not far below the levels reached in the crisis of the 1930's. Moreover, the ratio shows indications of continuing its climb.

Does this indicate that home mortgage debt is getting onto dangerous ground once more? The answer seems to be: "Not necessarily." The reason is that the growth of home mortgage debt has not been accompanied by the same relative growth in amounts of monthly debt payments that must be made from income, as explained below.

Debt Payments and Disposable Income. The final chart depicts the estimated percentage of disposable personal income absorbed by current payments on home mortgage debt, from 1939 to 1954. These payments consist of contractual obligations to pay interest and principal on amortized mortgages, as well as such additional repayments that result from "roll over" and other payments ahead of schedule—i.e., selling one house, paying off the mortgage, and buying another. The latter types of payment are made largely at the option of the borrower, however.

The most striking fact brought out by the chart is that scheduled payments of interest and principal on home mortgage debt rose from 1.7 percent of disposable income in 1945 to only 2.8 percent in 1954. The rise was moderate in the face of the fact that home mortgage debt multiplied by more than four

ESTIMATED PAYMENTS ON HOME MORTGAGE DEBT AS PERCENT OF DISPOSABLE PERSONAL INCOME



Scheduled payments of principal and interest on home mortgage debt are no higher now as a percent of disposable income than in 1939. Total payments, however, have risen in relation to income.

* Includes effects of prepayments, sales and transfers of property, and debt extinguished by foreclosures.

times in the interval, growing at a rate substantially higher than the growth in personal income. How could this occur? The answer lies largely in the stretching out of the repayment period on home mortgages. As maturities have gone from 15 to 25 or 30 years, the amount of income absorbed in current debt charges has not risen nearly as fast as the amount of home mortgage debt. At the end of last year, scheduled payments of interest and principal were no higher in relation to disposable income than in 1939—a year in which mortgage debt was not considered excessive.

If *total* payments on home debt are measured as a percentage of disposable income, the 1954 ratio of 5.4 percent is somewhat higher than the level of 3.7 percent in 1939. Nevertheless, the increase in this ratio is not necessarily a cause for concern. In any event,

it should be kept in mind that with the big increase in home ownership, the increase in home mortgage debt has been offset in part by a reduction in rent payments. To this extent, the growth of mortgage debt has not brought about a net increase in the economic burden of the borrowers.

A final note of caution is in order. Although the current relation of payment on home debt to disposable income appears to be within historically safe limits, this relationship could be changed drastically in case of declining income in a period of severe setback in general business. What now appears to be a level of debt that can be serviced from income without undue difficulty might become a crushing burden. Thus, the "safety" of today's huge volume of home mortgage debt depends heavily on the maintenance of high level production, employment, and income.

What is "Automation" ?

THE TERM "automation" has recently come into the public eye. While proper discount should perhaps be made for the excess of glamor (or dread) which inevitably attaches to a concept of this sort, the underlying facts of the matter are important. Automation has already found application in a considerable number of manufacturing and office processes, and seems likely to prove adaptable to others. The remarks which follow are offered merely as an introduction to the subject, in order to place the concept in perspective and to provide a few illustrations.¹

The term is of comparatively recent origin; few dictionaries include the word in their pages. The meaning of the term varies among individual users, although in general, automation is used in reference to a mechanized process in which machines are subjected to automatic rather than manual control. To some observers, such a concept of automation is satisfied by merely increasing the extent of mechanization in present-day manufacturing operations. To the more technically minded, however, a more rigorous interpretation is given to the concept. According to the latter, in order to qualify as automation, a process must incorporate, in addition to completely automatic operation, a principle of *feedback* control through which the operating machine is fed a continuous stream of information as to the results of its past performance. The feedback principle enables automatic equipment to correct itself, within limits, when

notification of imperfect operations in the past is fed into the machine *via* this system.

Development of Automation

Isolated examples of automatic control as described above can be found in the history of industry dating back more than two centuries. Perhaps one of the earliest devices for the automatic control of machinery was the speed governor which was commonplace on early steam engines. Completely automatic factories for weaving silk and for milling grain were in existence early in the nineteenth century, although such instances of early automation are extremely rare. Automation of industry is largely a development of the past decade.

Military demands resulting from World War II hastened the evolution of automatic control. The ever increasing speed of aircraft, for example, necessitated vastly improved gun-laying techniques to bring down fast-flying enemy planes. Conventional methods of calculating variables and adjusting guns by human efforts were much too slow to be effective against such speedy craft. As a consequence, automatic devices were developed which could perform the necessary computations at speeds far in excess of human capacities. The results of intensive research in this and related problems provided considerable technical knowledge which became available for application to industrial needs during the postwar period.

¹ Debate on the possible impact of automation on the volume of employment or unemployment becomes the last chapter of the well-worn subject of technology's relation to job opportunities. That subject is not treated in this short article.

Degree of Control

Full-fledged automation would provide for completely automatic control of machines in the factory or in the office. Ideally, such automatic control carries through the complete process from the handling and positioning of raw materials, through the actual performance of work on the material, and the checking of results according to predetermined standards. The latter function makes use of the concept of feedback control through which the machine is enabled to adjust its performance to maintain a required standard of quality.

In its present stage of development, automation differs considerably from the popular concept of completely workerless factories into which raw materials are poured in a continuous stream, never to be seen or touched by humans until the finished product rolls out of the plant ready for delivery. Except in the cases of a few industries which are especially adaptable to automation procedures (such as chemicals and oil refining) such a concept of the workerless factory is far from reality.

As currently practiced in most industries at the present time, automation is relegated to certain areas of the total production function where the replacement of limited human capacity for speed and accuracy by swifter and surer machine control results in increased and less costly output. A number of processes in the modern assembly line which formerly were handled by machines controlled by human minds have been redesigned to permit the process to be handled by machines controlled automatically by other machines embodying the feedback principle. Where, in the past, human operators acted as the feedback link between the machine and its product, mechanical or electronic devices are now capable of serving this purpose in a number of instances.

The introduction of automation, or automatic control of machines, to American industry as a substitute for human control has often been referred to as a "second industrial revolution." An analogy is drawn between

the industrial revolution of a century and a half ago which replaced human and animal physical effort with machine power, and the current evolution of automation which promises to replace the simpler and repetitive functions of human minds with automatic machinery. Just as the introduction of labor-saving machinery in the past failed to relieve mankind of all necessity for physical exertion, automation cannot promise to relieve human minds of all the essential machine-control functions. However, the more tedious and repetitive types of mental effort associated with the operations of machines in factories and offices can in many cases be assigned to automatic control devices.

Single Purpose and Multipurpose

Although automation machinery provides for non-human control during the actual process of production, such equipment must have a set of "instructions" to follow before it can begin operations. In this respect, machinery in the automatized plant is of two kinds—the single-purpose machines and the multipurpose machines. The single-purpose machine is capable of performing only those operations for which instructions have been built into the apparatus. Once set up, such a machine functions automatically at the task for which it has been built. Since the automatic control devices have been built into the single-purpose machine, the latter cannot easily be adapted to any work other than that for which it has been originally designed. Any change in the type or design of products expected from the single-purpose automatic machine would ordinarily necessitate extensive rebuilding of the equipment and its automatic "nerve center" or, worse, would render the machine obsolete.

The second type of automation equipment, the multipurpose machine, is designed to perform a variety of functions within a general area of the manufacturing process. Such a machine is ordinarily equipped with a mechanical or electronic control center capable of "reading" instructions from punch cards or magnetic tape. Thus, a multipurpose ma-

chine can be made to perform a number of different tasks from time to time by merely changing the recorded instructions.

Although the versatility of the multi-purpose type of automatic machine is a distinct advantage, the programming of the functions required of the machine for each operation, and the translation of the program into punch-card or taped instructions, present a number of problems. Every minute step in the operation of such a machine must be thoroughly planned in advance, a project which sometimes requires actual manual performance of the task. Once the operation has been recorded in a way which can subsequently be interpreted by the machine, it is usually a comparatively simple matter to feed the machine the appropriate instructions for the task at hand. The flexibility of such automatic equipment and the relative ease with which instructions can be changed, make this type of device particularly valuable when a number of short runs of different products are required.

Adjusting to Automation

Only in extremely rare cases is it possible for a particular manufacturing plant to apply automation techniques to existing procedures. Automation involves considerably more than the mere adaptation of present day equipment to automatic control by a simple process of increasing mechanization. Automatic devices are, as a rule, incapable of reproducing very closely the motions and mental processes of human workers. For this reason, the conversion of existing manufacturing plants to automation necessitates, more frequently than not, a thorough redesign of the manufacturing process. In some cases, even the product itself must be redesigned to permit the application of automation to its production.

Automation is likely to be more successful in a continuous-process type of operation than in the manufacture of products in batches. Thus, the chemical and oil refining industries have been pointed to as examples of automation, primarily as a result of the ease with which liquid products can be processed in a

continuous stream.² It should be pointed out, in this connection, that petroleum refining also offers an example of the need for redesign in processes before automation can be applied successfully. Prior to the automatic refining plant, petroleum was customarily refined in batches, and the shift to automation was accomplished only after redesigning the process into a continuous-flow method.

Automation in Specific Industries

As mentioned earlier, the petroleum and chemical industries have perhaps made the most significant advances in automation. These industries come nearest to fulfilling the popular concept of workerless factories, where the entire process is machine controlled from the entrance of raw materials into the plant through quality control of the finished product. Although little manpower is required in actual production by these plants, the problem of maintenance in such a highly automated industry requires a considerable number of skilled maintenance workers.

An example of automation in an assembly-line type of manufacturing is offered by a large automobile engine plant on the outskirts of Cleveland. This plant was designed and built around an automation process, and is perhaps one of the most frequently cited examples of the use of automation in a manufacturing process. A number of other factories embodying automation techniques have been built by the auto industry for the production of specific parts for automobiles. The Cleveland foundry and engine plant, however, is one of the first in which automation has been applied to a complete assembly-line process.

Office Work. The use of automation is not limited to the factory in any sense. Office work, particularly in fields such as statistics where great masses of data are processed regularly, is especially adaptable to automation. Insurance companies, in whose offices are processed a huge amount of statistical data,

² Some well-informed industry spokesmen, however, hold that the term "automation" is not correctly applied in this context.

have applied automation to this type of work with marked success.

Extended use of automation in the office has been made possible by the development of giant electronic computers capable of digesting vast quantities of mathematical information and producing almost any required computations. Although popularly labeled mechanical or electronic "brains," such machines are limited to handling data pre-recorded on tape, and then operations on these data are restricted to those functions for which explicit instructions have been provided by means of a taped program. Even with these limitations, the potential uses of such equipment are impressive. For example, entire payrolls for large companies can now be computed and accurate checks drawn in a very short time with a minimum of human assistance.

In this connection, it has recently been reported that the U. S. Bureau of the Census, in collaboration with the National Bureau of Standards, has developed a pilot model of a new device which is able to scan specially designed questionnaires and to produce computer tape automatically without hand operation. The questionnaires to be "read" by this device are filled in by the respondent by placing dots in specially designated locations. The dots are then translated into numbers by an electronic scanner on the device.

Many, although not necessarily all, of the modern computer devices and other types of high speed office equipment fall very clearly into the narrower and more technical concept of "automation," involving the use of the feedback principle.

Limitations of Automation

As in the case with every innovation, automation has a number of serious limitations which must be overcome before its actual use can approach its potential.

One serious impediment to a fuller use of automation is the need for extensive redesigning of present manufacturing processes in most cases where the employment of automation is contemplated. The obstacles here are not insurmountable, but the problems in most enterprises are considerable.

Because automation does not lend itself readily to diversification, extensive use of automatic control in most industries would require a maximum of standardization of products. A careful study of consumer reaction to further standardization of goods might be required before industry would want to go far in this direction. On the other hand, it is possible that methods will be devised whereby a greater degree of diversification can be obtained from automated factories than is the case at present.

The initial expenses involved in procuring the equipment for an automation process are, of course, extremely high. Such a large capital outlay requirement represents a serious obstacle to automation in many cases.

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