Government restrictions and regulations for the health and safety of the employees and the protection of the public must be carefully observed. If the site is in a large city, the building laws will probably place further restriction upon the designer and give him something to puzzle over in his spare moments. In addition to this, there are usually many special by-laws relating to smoke, noise, or other nuisances. In order to obtain reasonable insurance rates the rules of the Fire Underwriters must be carefully followed. Labor conditions must be studied, not only in their relation to the cost of the work, but there are places where the unions can dictate what the nature of the building is to be.

The size, shape and position of the lot will practically determine the proportions and arrangement of building or buildings. In some cases the position of railway switches, and the like, control the general lay-out. The proximity of high buildings may make impossible the natural method of lighting and change the orientation.

The probability of future extension must be taken into consideration from the start and a general scheme sketched up for as far ahead as possible. A good plan is to build the plant in units so that the addition of a unit to each department will maintain the proper proportions of the whole plant. The installation of one machine in one department may require the addition of a whole wing to the building, to take care of the corresponding increase in another department. In this case, provision should be made for as many wings in proportion to the space provided for such machines. However, it is not always possible to apply this system. For example, in a plant where there are to be many electric motors (and the number is likely to increase) it would show great lack of foresight if the transmission system were so designed that it were necessary to re-wire the plant and put in larger distribution mains every time another motor was added to the equipment. Here is an instance where it would be true economy to anticipate the greatest capacity that would ever likely be required, and provide for it at the start. Now the building itself is usually a construction to which this rule applies. Not only should a reasonable amount of room be provided for future needs, but it is even more important that the probability of any increase in floor loads or the capacity of crams, etc., be taken into account at the start. It is usually very unsatisfactory, and always expensive to try and strengthen a building for loads greater than originally planned for, even though the type of construction will permit it. No one who has not had to face such a problem and be responsible for the results, can appreciate what it means, besides, it is exceedingly aggravating to the owner to find a scheme of extension blocked or crippled just through the lack of a little foresight in making the original lay-out.

Problems of Finance.

The questions of finance which the designer has to consider usually have nothing to do with the securing of the money necessary to carry out the work. But the problem which he does have to keep in mind always is how to get the utmost efficiency from every dollar invested. This means more than merely saving money in the construction. "Savings never pay dividends." It means even more than getting good value for the money spent, for every dollar invested is just one more on which must be paid interest, taxes, etc., if the enterprise is to be a success. If, instead of putting the dollar into unnecessary expensive construction or some inappropriate ornamentation, it is so used that it will save something in the cost of maintaining or operating the plant, this means increase in profits. The dollar so invested is helping to earn dividends and is not dead capital.

Thus all the financial problems to be considered here center around the principle of the ultimate value. Will it pay in the long run? But until an infallible rule can be discovered to answer this question it will be necessary, after using every device of mathematics and human wits, to still trust to Providence for the results.

The success or failure of an investment depends on the rate of interest received from it and time it has to run. In the case of a building these terms mean the amount of service got out of it, its life or period of usefulness, and its final or "scrap" value. Just what constitutes economical construction for a particular building will depend upon the values given to these conditions.

As an illustration of extreme conditions, take the temporary grandstand for a football match, and a ten-story office building. For the former, which is to be used for a few hours only, the very cheapest type of construction is economical, while for the latter, whose period of usefulness will be fifty years or more, only the most permanent construction, in spite of the greater cost, will pay.

Where the answer to this question with reference to some particular building is not so obvious, it is necessary to assume a certain number of years for the period of usefulness and fix on a sum which will fairly represent its value at the end of that period. From these figures it is possible to determine the per cent. which the value of the building decreases annually. For example, if the original cost of the building is $10,000 and it is estimated that at the end of twenty years its value will be about $3,585, it can be shown that the annual decrease in the value is nearly 5%. This decrease is called "depreciation," and if the books of the owner are kept correctly it will be taken care of in one of three different ways:

1. The value of the building as an asset will be decreased 5% every year. This is an approximate method and is only correct for the twentieth year.

2. A sufficient sum of money will be put aside each year and invested as a sinking fund so that at the end of twenty years it will amount to the total depreciation—in the above case, $6 415. The amount of the sinking fund at any time gives the depreciation of the building to date.

3. A certain sum will be spent annually in repairs so that at the end of the period the building will still be worth its original cost, $10,000.

Assuming that it is possible to get 5% per annum interest on money, the amount necessary to deposit in the sinking fund every year would be $194 (all problems of this nature are solved by the regular rules for annuities—a very interesting and profitable study for anyone having to do with long time investments).

This same amount, $194, represents the average sum which will have to be spent in repair to keep the building at a constant value by the third method. If to this we add the interest on the investment, 5% on $10,000=$500 we have $694, which is the actual amount the owner is paying each year for the building apart from such charges as taxes, insurance, etc.

Suppose a cheaper construction were used, so as to save $2,000 in the cost of the building, but that as a consequence the depreciation amounted to 10% per annum, instead of 5%, then the value of the building at the end of 20 years would be $973. The sinking fund would be $212.44, and the annual cost of the building, 5% on $8,000=$400, $400+212 =$612. This means an annual saving of $82 by using the cheaper construction which in 20 years would amount to $2,712—the ultimate saving to the owner.

In the above example the building has been considered simply as an investment but a far more important consideration in a manufacturing building is its relation to the process