

used a dipper dredge and was paid at the rate of 25 cents per cubic yard. Sixteen thousand cubic yards of material were taken out. Owing to the difficult setting of the slope, the bank being elevated and of quick sand, this scheme had to be abandoned at elevation minus 16 as the company's buildings were endangered. After a survey of the river bed the contractor decided to start the crib by steps, as shown on the accompanying cross-section. Owing to the pressure on the back of crib and to the live load added by a travelling 16-ton crane to take materials from the boats to the warehouse, 40-foot and 35-foot piles were driven spaced each 10 feet.

The crib contains 5,865 cubic yards and is estimated to have cost \$5.20 per cubic yard, summarized as follows:

Timber and bolting	\$1.21 per cubic yard
Stone filling	2.25 per cubic yard
Labor	1.24 per cubic yard
Contingencies50 per cubic yard

Piles cost 75 cents per lineal foot sunk and fifty-two were placed.

ENGINEERING GRADUATES AND INDUSTRIAL DEMANDS*

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THE current technical press has contained several articles regarding the capabilities of engineering graduates in the industrial world. At the meetings of the various technical societies there have been frequent criticisms of present educational methods and engineering curriculums.

It is alleged that the present curriculums are unsuited for modern industrial conditions; that educators are too academic and are not in touch with the progress of industry and the problems encountered in the commercial field; that educational methods are antique and inefficient; that the content of the curriculums is out of date and unbalanced.

Charges are made that engineering graduates are lacking in thorough training and knowledge; that they use bad English; that their knowledge of fundamentals is very hazy; that their training makes them more suited for designers than anything else; that graduates have no knowledge of commercial methods, apparatus or economics; that as a whole the graduates have a hazy idea of several things but accurate knowledge of none.

It is stated that engineering graduates are from one pattern; that initiative and personality are repressed rather than cultivated; that they have become inaccurate and lazy through improper training.

Other criticisms are made but, in general, the foregoing statements express the sentiments of those advocating reform in curriculums and educational methods. The men who make the criticisms are industrial engineers; men who judge engineering schools by their product and its fitness for their requirements; men who demand efficient employees; men whose viewpoint is necessarily that due to their environment.

The criticisms may be just in some respects; there may have been too great a tendency to remodel and change engineering educational methods and curriculums from a purely academic point of view. From an analysis of the

criticisms it may be possible to consider more specifically industrial demands. At all events the criticisms should be considered with a view to eliminating them through educational campaigns or through educational changes.

A consideration of the points alleged leads inevitably to a historical sketch of the growth of engineering and changes in industrial conditions; the growth of the engineering school and finally the changes in the relations between the schools and the industrial world.

Historically, engineering may be divided into three eras, each era being determined by the chief industrial demand. These eras are as follows in point of time: the era of the designer and inventor; the era of the operator and constructor, and finally the era of the specialist and executive.

The demand for inventors and designers was greatest at the beginning of the so-called industrial age. The invention of the cotton gin, power loom, steam engine, machine tools; the discovery of new forces for use in transportation and communication and for the transformation of energy; the development of the factory and concentrated manufacture as against the individual producer, all these things created a great demand for inventors and designers—men who were qualified by fundamental knowledge of science to design and produce new machines, to discover new applications for available forces and to investigate existing forces with a view to developing machines for commercial applications.

The years from 1890 to 1900 saw the multifarious applications of the forces, materials and ideas developed during the previous era. The railway, the telephone, the power plant, the steam engine, the electric motor and generator, the turbine and water wheel, the machines for the manufacture of diversified products—all these were developed and applied with great rapidity.

The great development in commercial applications of engineering machines created a demand for skilled operators and constructors. Men were desired who were capable of constructing machines from design drawings; men were wanted in the drafting rooms to make the drawings; men were wanted to operate the engines, machines and power plants used for commercial purposes. The combined demands for the above types of men were so great that the industries were forced to train men through the adoption of the apprenticeship system.

The years from 1900 to the present time were noted for the concentration of power production; of manufacture; of sales organizations; of financial resources. The industrial world was organized and concentrated for economical reasons. The engineering fields were divided and subdivided for reasons of efficiency. It was an era of efficiency and economy in design, operation and production. The industrial world desired executives, highly trained specialists in engineering, organizers, business managers and financiers in connection with its engineering and industrial problems and conditions.

The foregoing historical divisions of the industrial age are not strictly accurate as each division is not a discontinuous function of time. There is a demand for all types of men at the present time; as the limits in industrial developments have never been ascertained, however, the most insistent demand is as outlined, and the supply is least. The demand for designers, operators and constructors has been greatly lessened by the increased supply of such men developed by the industries and the technical schools. The gauge of the peak demand for men is found in the salaries. At this time few designers, operators or constructors receive \$10,000 per year, yet many executives, specialist engineers, sales engineers, consulting engineers

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