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# SOCIETY'S DEBT TO THE ENGINEER

JOHN B. GODDARD, E.E., '29

The following article was read before Tau Beta Pi, honorary engineering fraternity, on December 15, 1928. It was judged to be the best one of 22 essays presented to the society at the fall initiation.—  
EDITOR.

The history of engineering can be regarded as coincident with the history of civilization. Man has been described by Carlyle as a tool-using animal, and his gradual evolution from barbaric savagery to his present developed state has been brought about largely through his capacity to fashion tools which have given him power to use the forces of nature for his own purposes.

It is well, however, before undertaking a review of the development of engineering tools and methods and their value to society, to investigate the meanings of the terms "engineer" and "engineering." Engineering may be described as the art of directing the great sources of power in nature for the use and convenience of man as means of production, communication, transportation, construction, and adaptation of machinery. In early times the practice of engineering was directed to two main purposes—firstly, convenience; and, secondly, preservation and protection; hence, were found the early twofold divisions of civil and military engineering. Up to comparatively recent times civil engineering was synonymous with the unqualified term "engineering." It is only since the Industrial Revolution that there has been specialization, and that the many widely different branches of engineering have been developed. The term "engineer" has been generally applied to one who designs or executes engineering works or methods and one who utilizes the mechanical properties of matter in structures and machinery.

It is well known that even a century ago the amenities that engineering science has bestowed were not available, yet a close examination of conditions reveals the fact that probably in every age engineering in some form has been one of the fundamental means by which civilization has advanced.

One of the first great contributions in engineering was that of the man who saw that rocks heated in a fire melted so that they could be fashioned into tools and weapons, and thus the age of metals was inaugurated by an engineer, a man who made use of what he saw or discovered. The engineering skill of early civilizations was shown by their construction of canals, reservoirs, and aqueducts, docks, bridges, and their massive buildings.

Archaeologists remind us that two factors need to be borne in mind in considering early engineering feats. In the first place, time has not to be taken into account, many years being spent in erecting colossal buildings and impressive monuments. In the second place, private enterprise was practically unknown, all large undertakings being worked upon by thousands of workmen, who were paid out of the public treasury.

As civilization moved forward the engineer kept pace, improving methods of drainage, water

supply, communication, transportation, and the manufacture of the necessities of life. With the formation of guilds came the first chance for the engineers to branch away from the only engineering of that time, civil engineering. This was the beginning of specialization in industry and called for the introduction of different kinds of tools and processes in the different trades.

However, with the Industrial Revolution came great changes and the different branches of engineering were born. In the improvement of harbors and canals, and the construction of bridges, the world owes much to the English engineer Smeaton. The beginning of modern road systems and their construction was the product of the genius of the Scotchman John Macadam. Watt with his invention of the steam engine furnished the world with its, at present, most powerful prime mover. The history of transportation was completely revolutionized by the invention of the steam locomotive by Stevenson. The quality of iron and steel was greatly improved by Bessemer in his process of refining. Bessemer's process was almost coincident with Siemens' development of the reverberatory open-hearth furnace.

The automobile, aeroplane, and the many other applications of the internal combustion engine were made possible through its practical development by the German engineer Otto. Count Zeppelin gave the world the rigid airplane and this was followed by the Wright brothers invention of the aeroplane.

In the field of electrical science and development we find Faraday, who brought forth the electro-magnetic theory of electricity and the dynamo. Morse gave the first fast means of communication with his invention of the telegraph. But Bell gave civilization its first really rapid and simple means of communication of information with the invention and installation of the telephone. The incandescent lamp was Edison's greatest contribution. Radio was the invention of Marconi but awaited the hand of DeForest before being made available to civilization. George Francis Train was the father of modern electric street railways.

In the field of chemical engineering Louis Pasteur developed improved methods of sanitation and production of organic substances. The German chemist Wöhler was the father of processes for the manufacture of organic chemicals. Aluminum in commercial quantities was the product of the American engineering genius Hall. Acheson introduced the electro-metallurgical processes of the manufacture of graphite.

Modern civilization rests upon the science of engineering, for it is physical science that makes intelligence and moral energy stronger than brute force. The whole of modern thought is steeped in the science of engineering. It has made its way into the works of our best poets, and even

(Continued on Page 28)

**SOCIETY'S DEBT TO THE ENGINEER**

(Continued from Page 10)

the mere man of letters, who affects to ignore and despise engineering, is unconsciously impregnated with its spirit and indebted for his best products to its methods. It is teaching the world that the ultimate court of appeal is observation and experience, not authority. It is creating a firm and living faith in the existence of immutable moral and physical laws, perfect obedience to which is the highest possible aim of an intelligent being.