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WHERE IS THE LIMIT OF INVENTION?

Let one take up the Patent Office Reports, beginning with the first volume, and pass cursorily through them to the very latest, and he will, if not familiar with the number of inventions which are there recorded, probably be struck with astonishment, and rise with a feeling that after all this struggle for the complete mastery of the physical forces, there must remain very little to be done; that the field must have been worked near or quite entirely over, and that scarcely anything, in comparison, can remain for inventive talent to grapple with.

A closer and more rigid examination would, however, correct this mistake. Scrutinizing the character of each invention separately, he would find that by far the greater portion of even those entitled to be called useful, at the date of their devising, can, from the very nature of things, only remain useful till some advance in other departments renders them obsolete, and creates a want for other and entirely different appliances.

Besides this, each important invention is the parent of a large family of minor ones. See how numerous are the inventions which have been born of the application of steam as a motor. Governors, cut-offs, boilers, boiler feeders, high and low-water detectors, low-water alarms, steam whistles, valves, cocks, steam-engine indicators, apparatus for testing the strength of boilers, etc., etc., have been invented, each one of the classes specified or omitted including, we had well-nigh said, countless inventions of greater or less utility.

A discovery of means whereby electricity could be so cheaply employed as to exceed, or even to compete on equal terms with steam, as a motive power, would be inevitably followed by generation after generation of inventions, till the whole civilized world would teem with them. It would take a long time to cull out and count the inventions born of the Morse system of electro-magnetic telegraphy, yet this system is scarcely more than a quarter of a century old. The introduction of insulating cables for submarine telegraphy, and the extension of the system to very long distances, created a demand for more delicate recording apparatus, which, notwithstanding the large number of exquisitely ingenious devices created to supply it, is still unfilled.

"The eye is never satisfied with seeing, nor the ears with hearing." The human mind constantly feels a craving for something more than it possesses. Any creation of inventive genius which appeals to this craving is sure to be received with favor, be it nothing more than a sixpenny toy.

Looking at the progress of invention in this light, it will be seen that instead of approaching its ultimate limit, the field enlarges as we advance. In short, it has no limits. It is infinite as is the capacity of mankind to desire. We are all of us to-day longing for swifter means of travel and communication; for cheaper books; for more extended educational facilities; for more powerful instruments of scientific investigation; for fuller gratification of our tastes in the arts; and we are willing to employ, and keep employed, the creative genius which devotes itself to the supply of these wants.

Every announcement of a new discovery in chemistry or physics, heralds to the world the fact that a new "placer" has been opened, wherein rich veins of ore may perchance be found by the skilled inventor. When "oil was struck" in Pennsylvania, a few years since, who would have dared to predict the extent of the field it opened to inventive genius? No doubt the mechanical devices and chemical processes to which it has given birth may be numbered by thousands, and the improvement in the general welfare of the race resulting therefrom, is simply incalculable.

No, the end is not yet; and it will never come so long as man remains constituted as at present. There are as many chances to win now in invention as there ever were, but it requires now higher qualifications for eminent success. The more inventions multiply the greater the necessity for higher standards of technical education, and the more general diffusion of theoretical as well as practical knowledge.

THE PROFESSION OF THE MECHANICAL OR DYNAMICAL ENGINEER.*

The term "Mechanical Engineer" is a very unsatisfactory one, and its meaning is very indefinite. To some it conveys the idea of practical engineer; another will confine it to the profession of steam engineering, while the courses of study designed to fit young men for the profession of mechanical engineering are variously styled as "Mechanics and Engineering," "Applied Mechanics," "Industrial Mechanics," and "Applied Mathematics."

The necessity for a more accurate defining of the limits of the two great branches of engineering which in the terms "Civil Engineering" and "Mechanical Engineering" have had a very imperfect line of demarkation, has impelled the Sheffield Scientific School of Yale College to apply a new and more definite term, *"Dynamical Engineering,"* to the chair of "Mechanical Engineering," in that institution.

In the inaugural address of Prof. Trowbridge, the reasons for the adoption of this term are given by him as including those we have already stated, and he adds that its indefinite character

arises from the fact that the term *"Mechanical"* is not employed in the sense which it would derive from the word *Mechanics*, as descriptive of a science of mathematically applied principles; but from the more restricted sense in which it is used to designate the work of construction of a machine, and the labors of the artisan or mechanic. It originated in the large machinery establishments, and at first referred especially to the manipulations necessary to produce and combine the material parts of a machine, rather than to the intelligent application of the laws of statics and dynamics, in designing and adapting machinery for the performance of specific work. In the sense derived from the word mechanics as a science, civil engineering is also a mechanical science; the only difference between this and mechanical engineering being that one is based on the principles of *statics*, and the other upon *dynamics*. These considerations would have little importance if the questions involved were merely those of words; but, as before remarked, they involve confusion of ideas, especially in the popular understanding of the subject. It has not always been deemed essential, for instance, that a mechanical engineer should be thoroughly acquainted with the *science* of mechanics, and his calling has been regarded as a trade or an art, rather than as a learned profession; as depending more on knowledge and experience in manipulations, or the labor of the hands and the use of tools, than on the exertions of the intellect.

We are glad that the new term "Dynamical Engineering" has been adopted, and think with Prof. Trowbridge that its singular appropriateness will be generally recognized.

In the address under review Prof. Trowbridge also makes some able remarks upon practical and theoretical instruction:

The practical course ignores books, and the study of the natural sciences. A boy on entering a machine shop is placed at some simple mechanical work, the use of the file, or chipping hammer, or lathe. In two or three years he may acquire experience in finishing the finer parts of machinery.

* * * * * * * * *

If he obtains a position in the drawing or designing room of such an establishment, he may acquire a knowledge of drawing, but his time is absorbed in making tracings and working drawings under the direction of superiors who have no time to impart general instruction in the fundamental principles of the work on which he is engaged. A shop, or machinery establishment is a business establishment, not a school of instruction, and it is rather a favor to young men, to allow them the limited privileges of such information as they may acquire through their own observations and experience.

Such a course may lead to a high degree of skill and excellence in the specialties of one establishment, but even in such a case the knowledge is gained by imitation. New problems even in that specialty—which involve new forms and dimensions—are apt to be discussed and solved by reference to the nearest example or precedent.

The instances of men who have reached an enviable degree of excellence by passing the first years of their training in the workshop are regarded as exceptional, and as resulting from peculiar qualifications of industry and application.

Theoretical knowledge as well as practical is necessary in order to avoid fatal errors. The only resource of practical men who are deficient in such knowledge, in solving new problems, is an actual trial involving expense and risk. On the contrary the young man who begins by a thorough course of theoretical study takes with him into his practice written experiences, deductions, and classifications, with a knowledge of an accumulation of facts which he could not acquire in a lifetime of practice.

The questions connected with the dynamical theories of heat employed as a source of power;—the propulsion of ships by steam, the movement of heavy railway trains, the raising of water, the construction of heavy steam and water-wheel machinery for rolling mills, forges and factories—all involving the movements of heavy masses, and the overcoming of corresponding resistances—are subjects which can be successfully treated only by the most rigid applications of the principles of mechanics.

This is a branch of the profession which no amount of practice alone, can reach. Sooner or later, every one who aspires to become a consulting engineer must devote himself to the study of the laws, theories, rules, and formulæ, which constitute this science.

Strength of materials and the proportions of parts to endure the strains to which they must be subjected are also subjects for the most rigid application of theoretical knowledge.

In the course of study which a young man desiring to enter the profession of Dynamical Engineering should pursue, the art of drawing is considered as of primary importance, though not by any means the most difficult accomplishment to acquire. Next in order is a sound knowledge of pure mathematics; next the science of mechanics, both independent of and in connection with its practical applications; and lastly a thorough knowledge of chemistry, physics, and metallurgy.

The fields of usefulness open to men possessing these qualifications are extensive and increasing, and the indirect benefits to be derived from the training of men in this way to take charge of the industries of the country will be felt in the increased economy of production, and the consequent reduction of cost in all that the necessities, tastes, and luxuries of modern civilization demand.

* Inaugural Address before the Sheffield Scientific School of Yale College, delivered Oct. 5, 1870. By William P. Trowbridge, Professor of Dynamical Engineering. New Haven: Printed by Tuttle, Morehouse & Taylor.

THE MONT CENIS TUNNEL COMPLETED.

The readers of the SCIENTIFIC AMERICAN have been made familiar with the history and progress of this enterprise, which for thirteen years has been looked upon as one of the greatest of modern engineering feats; yet, at this time, a brief recapitulation will not be out of place, as telegraphic dispatches have announced the completion of the work.

It was, we believe, about the year 1830 when the tunnel was first talked of. In 1842, the king of Sardinia agitated the subject, and subsequently, under the encouragement of Count Cavour, its projectors appointed a committee of engineers to make preliminary surveys. In 1857 the work was commenced. At first, only the ordinary excavating tools—the pick, spade, and hand drill—were employed, and the work proceeded very slowly.

In 1861 a perforating machine was set to work on the Italian side, and in 1863, a similar machine was put in operation on the French side. No vertical shafts have been sunk; the work proceeded continuously from both sides till the two cuttings met. The cutting has been somewhat more rapid on the French side than on the Italian side.

The machines used were driven by compressed air, conveyed to them through tubes, and ventilation was also maintained by the aid of machinery. Gunpowder was at first used for blasting; afterwards gun-cotton was employed, and, finally, nitro-glycerin.

In 1862 the French Government agreed to defray half the estimated expense of the cutting (65,000,000 f.), in annual subsidies, provided it should be completed in twenty-five years, at the end of which time, should the tunnel remain unfinished, the French should cease to pay anything further. On the contrary, it was stipulated that if the tunnel was completed in ten years from June 30, 1863, the French should pay the full half of the estimated expenses. As the latter condition has been fulfilled, with two and one half years to spare, the French Government will now be held for its moiety.

The Mont Cenis Tunnel, which is eight miles in length, is the greatest work of its kind ever undertaken, and the success and rapidity with which it has been brought to its early termination is a triumph of engineering second to no other on record.

PAVEMENTS.

Want begets supply. When the public become dissatisfied with what they have, and are fully decided as to what is really needed, nothing is surer, in these days of scientific and mechanical progress, than that somehow, by somebody, the need will be met. The public want better pavements. The public will certainly have them. The old cobble-stone pavements, "the car rattling over the stony street," are soon to be things of the past. What is to be *the* pavement? There is no more promising or more difficult field for inventors than this. The man, or the company, who can answer the question satisfactorily, not only does the world a great service, but opens a mine of wealth. Inventors know this, and rush into the field with almost the same eagerness of competition as wealth-seekers thronged to the gold diggings of California, or to the diamond regions of South Africa. New pavements multiply upon us. "Their name is legion." Each claims to be the pavement *par excellence*, but none has yet impressed the public as just the thing. It is not our purpose to discuss the merits of the different kinds of pavements, nor the claims which the inventors of each may put forth, but to call attention to the requisites of a perfect pavement. We have before alluded to this subject, and we return to it for the reason that those who are working in this direction seem almost invariably to lose sight of some feature indispensable to permanent success. And here a remark or two upon the word success may not be out of place. Success in making large profits through corrupt "jobbists" is one thing; a success in a mechanical, scientific, utilitarian point of view is quite another. In the former sense we have had many successes; in the latter sense, as yet, none. We do not mean to say that we have not pavements possessing some of the essentials, but we do mean to say that there has been no pavement extensively laid for which any close student of the subject will venture to predict universal use, or anything like it, say fifteen or twenty years to come.

Let us seek to enumerate the essentials, and let each inventor consider for himself whether his particular device or combination provides for or meets them.

1st. Durability. Not merely sufficient to withstand a few years' wear in some fashionable avenue, frequented for the most part only by carriages, but sufficient to justify adoption in our most thronged and roughly-used business thoroughfares. It may be claimed, with show of reason, that we may have different varieties of pavement for different localities, but it will certainly be conceded that a pavement for which streets adapted to its endurance must be selected cannot claim to be perfect.

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