which kingdoms—not with any one city—London has to be compared.

What is wanted in the faculty of engineering is, therefore:

1. Increase in staff of professors and instructors at existing centers—say £10,000 a year (£330,000).

2. Extensions at existing centers in buildings and equipment to accommodate additional students—say £150,000.

3. New centers—building, equipment, and endowment of engineering departments at—say seven at £50,000 (£350,000).

4. New subjects—provision for buildings, equipment and endowment of centers for marine engineering and naval architecture (£100,000); civil and municipal engineering (£100,000); railway, dock and hydraulic engineering, etc. (£100,000); electric traction (£100,000); architecture (£100,000), etc. We may say, therefore, that the faculty of engineering needs a capital sum of £1,330,000.

SCIENTIFIC BOOKS.

Bibliotics, or the Study of Documents. By PERSIFOR FRAZER. Third edition. Philadelphia, J. B. Lippincott Co. 1901. Pp. xxiv + 266.

The subject-matter of this book, not very clearly suggested by the title, is the methods used by the handwriting expert and by the chemist, in the identification of writing and the detection of forgery. A scientific man desirous of getting some insight into these methods—or into the best of them—will find this book good reading. It is written with a scientific bent. It considers handwriting much as a zoologist considers animals. The determination of the characteristics of a given handwriting is like the determination of the characteristics of a natural species. The older methods relied on general impressions or on the description of salient features; the newer methods rely on measurement of the details. A person's handwriting, like a natural species, is a variable thing, and the exact study of it must deal in averages and ranges of variation. "It will be readily conceded that at least two factors are present in the performance of an act which is often repeated. One is the general similarity, and the other is the variation in some details which prevents any two acts or results from ever being exactly identical. These are analogous to the two important factors of the theory of evolution, called, by Charles Darwin, hereditary transmission and accidental variation. In order to arrive at an ideal standard of similar recurrent actions, it is necessary to eliminate, as far as possible, the accidental variations. The most obvious way to do this is to take the average or mean of the records of a number of such actions." The first method devised by the author for arriving at the mean was the graphic method of composite photography. This appeals to the eye, and shows directly which parts of a signature are most uniform and which are most variable. A disputed signature may better be compared with a composite of several genuine signatures, than with any one of them.

The more exact method of averages, also devised by the author, begins with actual measurement of details; and it is the inconspicuous details that are most characteristic. The salient features can be changed more or less at the writer's will, or imitated by another person. But the little tricks of curvature and slant and proportions, the minutiæ of shading and alignment, as they are the expression of unconscious habits, so they cannot voluntarily be laid aside, and as they are undetected by the eye, so they cannot be reproduced by a forger. The most useful details for measurement are angles and the ratios of different lengths; these are very inconspicious, yet fairly constant, not changing with the size of the letters.

If, then, a signature is disputed, several genuine signatures are obtained, and a certain number of details are measured in all the specimens; the average measurements of the genuine signature are computed, and the measurements of the disputed signature compared with them. Close agreement throughout stamps the disputed signature as genuine; wide divergence as spurious. Some divergence is of course to be expected, and in fact complete identity is evidence of tracing. But just how much difference can be allowed? How sure is the expert of his decision? It does not appear that the theory

of probabilities has been used in any rigid way. The author's experience leads him to adopt a difference of 15% between the average and the disputed signature as ground for suspicion. Differences of 5 or even 10% are not uncommon in genuine specimens. But differences of 15% are uncommon, and, especially if repeated, are suspicious. The expert's decision must often rest on rather weak foundation as judged from a scientific standpoint, and the more so since he often has but half a dozen specimens from which to determine his average. The work of Mr. Frazer is very suggestive of what might be done in the study of handwriting. An extensive study of the variability of the individual, and of the differences between different individuals, as regards these ratios, angles, and other details, would show how sharply individualized they are, and furnish a scientific basis for the expert.

Another method of the author is the microscopic examination of the margins of the strokes. Under a magnification of 120 diameters, or even much less, a pen or pencil stroke is seen to have irregular edges; it is full of serrations of different sizes, the smaller superposed on the larger. There are usually more of them in one margin than in the other, depending on the position of the pen and other peculiarities of the writer. Whether they are completely individual, it would be premature to say, but they can at least be often used to distinguish between the writing of two persons. With the cooperation of Professor Witmer, the author has made micro-photographs and camera lucida tracings of these wavy margins, and inclines to regard some of them as records of the minute, normal tremor of the hands, produced by fluctuation in the nerve currents that control the muscles. Machine-ruled lines, though not free from irregular margins, showed fewer serrations than lines made by hand. The reviewer is much inclined to doubt this interpretation of the wavy margins, since he finds the serrations more marked on rough than on smooth paper, whereas the friction of the rough paper would tend to conceal the tremor. The rate, too, at which the serrations are produced is not approximately constant, as that of the tremor is, namely, at 8–15 pulses per second; a fast stroke and a slow show about the same number of serrations per millimeter and those in the fast stroke must have been made, in one line measured, at about the rate of 480 per second. Many of the irregularities are probably due to the texture of the paper, and others to vibrations of the pen. Yet one's manner of holding the pen might give rise to characteristic forms of margin.

Still other chapters of the book treat of the chemical and physical tests for inks, of tests for erasure and other tampering, of tests for 'guided hands,' and of other problems incidental to the detection of forgery. There are several excellent plates.

R. S. Woodworth.

Taxidermy, Comprising the Skinning, Stuffing and Mounting of Birds, Mammals and Fish. With numerous engravings and diagrams. Edited by Paul N. Hasluck. London, Paris, New York and Melbourne, Cassell & Company. 1901. 16mo. Pp. 160.

Within the last ten years at least three admirable books on taxidermy have been brought out in the United States, and any new work on the subject should either bring forward some new and improved process of preserving animals, or at least present the most approved methods in a clear and detailed manner. The little book under consideration does neither; the methods described in its pages are the old ones, and not always the best of those, while the amount of space given to each group of animals is so limited that the descriptions are necessarily brief, while there is nothing whatever on the mounting of large mammals, although this is seldom acquired from books alone.

However, the book is intended for the amateur who wishes to preserve some trophy of the chase rather than for any one who really intends to master the art of taxidermy, and there are directions for making screens, polishing horns, tanning skins, and doing various bits of taxidermic fancy work. The small size of the book enables it be to readily put in the pocket, and, as it takes but little room, it might readily be carried to seashore or country on the chance that it might be desired to save some bird, mammal or fish, or make a pair of wings into a screen.

F. A. L.