hand-loom on which the finest silks of Lyons and the finest velvets of Rhenish Prussia are to-day woven; and from these points the typical weavers could be assembled with their simple looms on which they make those finest goods, which are in themselves a work of art.

In the matter of printing textile fabrics, the art began by stamping figures of a coarse and rude kind by hand upon the cloth; and that same art is still carried on in the same way in China and in Japan, and could be brought before the eye in the exhibition; while the progress in the art of printing textile fabrics could be witnessed in the next section as it is now carried on by the use of machines of the finest and highest types. But this art would end again in the bringing from France the block printers, who still print by hand the finest examples of the French cretonnes.

This conception of the method of the proposed exhibition is wholly consistent with making the exhibition itself a medium for bringing into notice the finest examples of modern machinery and the finest types of modern fabrics. The only difficulty which might be experienced in carrying out this conception might be that too many makers of machinery and venders of the fabrics of the finest types would apply for place.

The personal factor and the element of individual profit may therefore be brought to bear in connection with this plan, as well as in any other way. The plan only gives a definite point or purpose to the undertaking, and would make the whole exhibition an example of progress and a means of comparing the mechanism by which the people of different countries and races have clothed themselves or otherwise provided for material wants in the past and do now clothe and serve themselves in the present.

If it were too great an undertaking to bring together typical examples of the garments of the past as well as of the present, nevertheless, pictures may be gathered to hang upon the walls of this exhibition, artistic in their conception, typical of the art in the different countries in their execution, and yet object lessons in the history of the textile arts.

I have in my possession six pictures painted in China on silk, giving the whole story of cotton, from the field to the fabric, which were sent to me by Messrs. Russell and Co. to exhibit at Atlanta, accompanied by a complete set of garments worn by the common people of China. They were sent to me without cost, but were evidently expensive. I have already mentioned the little artistic clay figures which can be purchased in India, showing every type of costume, at a mere trifling cost.

If we pass on from the textile out to the treatment of metal, taking iron as an example, we find that iron is still treated in Spain as it was when the Toledo blade became famous. It is treated in Africa in the crudest manner. In the heart of the southern mountains, iron and steel are still made directly from the ore in wayside furnaces heated with charcoal on what I believe are called "Catalan forges." How various or how widespread over the world are the different methods of treating the ore of iron, I am not informed, but all these primary methods could be brought, with those who practise them, into one section of the exhibition; and since the introduction of the most modern type of furnace worked by gas has been adopted, it has also become possible to set up small examples of the most modern form of producing iron and steel and working these metals into manifold shades. The whole history of metallurgy as applied to iron can be brought before the eye; and here again the element of personal interest may be brought to bear on the part of those who desire to exhibit the most modern types of stoves, smelting furnaces, and the like.

Perhaps the most interesting and the most varied of the many arts which can be brought together into view would be the types of the tools and machines used by various races and nations in the conduct of agriculture. Herein again, the plough, as pictured upon the walls of the Pyramids, could be brought from the fields of Egypt, with the fellahin, who still make use of that prehistoric implement; and alongside could be placed the modern polished steel plough, of which I have a record among my insurance papers that when accidentally placed outside a barn it concentrated the rays of the sun, and reflected them in such a way as to set the barn on fire. Herein, again, there would be a rush of competitors to exhibit the best types of the most modern agricultural tools and machines.

Again, the one art which is of all others prehistoric is that of the potter. Would it not be possible to bring the potters from many lands into a single section with their primitive implements, placed alongside the most modern type of apparatus with their artists as well as their ovens?

Lastly, there is nothing like leather. How easy it would be to bring into the same section the worker in leather from different parts of the world; the cobbler from that part of this country which has not yet been penetrated by the railway, alongside the modern machines by which each visitor, having been measured on entering the section, may have a last prepared to fit his or her foot, and a pair of finished boots made to measure ready to put on, within the time that would be necessary to get even a superficial idea of the mechanism by which the work had been accomplished.

When all these and many other arts had thus been brought together, to be conducted under one great roof by representatives of many races and many nations, each according to his kind dwelling in his accustomed way and conducting all the household arts as they are conducted at home, the Arab in his tent, the African in his hut, the Mexican Indian in his adobe house, the mountaineer of the South in his log cabin, the native of Japan in his dwelling of wood and paper, the Chinaman, the Aleut, the Alaskan, and all the rest — what could be more attractive or instructive? And lastly, what would pay better in a mere commercial sense?

I therefore submit that my conception of an exhibition which shall give the history of industrial progress, by means of object lessons drawn from the past, but yet existing in the present, is wholly consistent with the necessary element of personal interest and personal profit on the part of those who contribute the modern examples of existing machinery.

In addition to these object lessons, the art of the painter, and even of the sculptor, may be invoked to decorate the walls; the art of the engineer and of the mill constructor may be called in to build the structures; while the services of the statistician, the economist and the ready writer, and the engraver would be required to prepare the catalogue and to write the descriptions, so as to tell the whole story of what the eye could see in part.

This would be the main conception to be carried out, either in the main building or in the main series of buildings. Auxiliary buildings may be added by States, in the manner previously indicated, in which examples of every crude material, together with maps and descriptions showing the resources of any section of the country, might be brought together. If, in addition to this, it was thought expedient to make preparation for a great fair or bazaar where goods could be exhibited and sold according to the will of the contributor, that purpose might also be provided for in the exact measure of the demand which would ensue for space or place. The conditions precedent to carry out this conception consist, first, in finding the money which will be required to make the preparation, and, second, the men (especially the man) capable of laying out, executing, guiding, and directing the whole work.

AN UNKNOWN ORGAN OF SENSE.

IN the frequent dwelling upon questions of development, which one cannot avoid in these days, one sometimes wonders whether the future is destined to endow man with any senses which he is not now in possession of. However that may be, it is probably unknown to a great many of the laity that within a few years past a new organ of sense has been discovered, the existence of which had not before been so much as suspected. It was always known that the internal ear was a curiously complicated structure, and there was little hope of being able to make out the separate functions, in hearing, played by all its different parts. But it was not suspected, even when Flourens had made his celebrated experiments in 1824, that one part of it — the three narrow semicircular tubes which spread out in three planes at right-angles to each other — might be the organ of a totally different sense. It is only now that the question has been definitely set at rest by the admirable experiments of Brener. There can no longer be any doubt that the semicircular canals are the organ for sensations, whether conscious or not, which enable us to determine both the direction and the amount of all rotations performed either by the

head alone or by the head and body together. The argument by which this has been established is interesting, if only as furnishing another instance of the ins and outs of that great scientific method by which truth is being constantly tracked to its lair.

It was first noticed that the semicircular canals could be destroyed without any injury to the sense of hearing, but that their destruction was followed, in various animals, by convulsive motions of the eyes, the head, and the body, and that these motions were in different directions as different ones of the three canals were destroyed. It was next pointed out that certain diseases in human beings which were accompanied by feelings of dizziness and loss of equilibrium were connected with injury to those organs. Finally, distinct sensations were said to be felt upon the performance of certain motions, not to be confounded with either a muscle-sense or a sense of touch, and not to be explained except by the hypothesis of some peripheral organ. But at this stage of the discussion, physiologists went too fast and too far; many of them held that the semicircular canals are spatial sense-organs upon whose activity depends every perception of the position, or of the direction of motion, of the body. The limitation of their functions to the perception of rotations only has been performed by Delage, and in the following way. He pointed out the aid to be got, in such cases, from the study of illusions.

The mind is able to interpret the data of the several senses in accordance with external fact only when the sense-organ in question is working under normal conditions. Unusual conditions are a frequent cause of illusions, and the source of a given illusory sensation can easily be made out, when it is certain that one organ and only one is subjected to circumstances which it is not accustomed to. Even when this simple situation cannot be arrived at, the same thing can sometimes be accomplished more indirectly. Thus when the head is turned far to either side, the eyes being shut, objects which can be correctly pointed at with the head in a normal attitude seem to have shifted their position about fifteen degrees in the opposite direction. This indicates that the organ which gives us the sense of direction when we are at rest is in the head. But it is in the eye and not in the ear, for the illusion persists when we turn the eyes without the head, and it vanishes when, on moving the head, we force the eyes to remain at rest relatively to it. When we have occasion to look far around, we usually accomplish it by moving the head part of the way and the eyes in the head the rest of the way. We have thus acquired the habit, when we move the head to the right, of moving the eyes still farther to the right, and it is this wrong position of the eyes in the sockets which gives rise to the above illusion. It is the muscles of the eye, therefore, which gives us our static sensations of direction. In a similar way it is shown that our knowledge of the position of the body at any instant is derived, when the eyes are shut, from muscular and cutaneous sensations and from a general sensitiveness to the direction of gravitation of the fluids and internal organs of the body.

The feelings which inform us that we are undergoing a progressive motion in any direction, have a similar general origin, but the case is very different with rotations. In the first place, we have a far more delicate sense of rotation than of progressive motion, — a velocity only one third as great can be detected. The illusions that are produced by turning the head to one side while the body is being rotated about any axis are opposite in direction from those produced by the eye, and much greater in amount; they are, in fact, partly counteracted by the eye-illusions. To produce rotation about a vertical axis, the person is seated in a dark rotating box. He feels himself to be rotating about a vertical axis, as he is, but he has only to turn his head over towards his right shoulder to make himself think that the axis of rotation of the box is inclined towards the left, or that the space about him had been shifted to his right. In other words, he cannot help feeling as he would if his whole body were in a continuous line with his head. A sudden change in the position of the head during a swift rotation is enough to cause dizziness, nausea, and a general feeling of extreme unpleasantness, — so much so that Delage says that it requires a very considerable amount of courage to perform the same operation again. There is no other unoccupied organ in the head which might be taken to be the source of this illusory sensation, except the semicircular canals, and hence we are under the necessity of attributing it to them.

A few years ago Prof. William James made the interesting discovery that deaf people were in very many instances not subject to dizziness nor to sea-sickness, and that they had, for the most part, given up diving, because they found it impossible to tell one direction from another when under water. A disease of the organ of hearing would be very likely to attack the closely adjacent semicircular canals, and hence these curious observations add great weight to the theory that they are the seat of sensation for certain motions of the body and the head. It may be mentioned that Professor James suggests trying blisters behind the ears, or even a gentle rubbing, as a cure for sea-sickness.

The argument at this point is not absolutely conclusive, though it is exceedingly strong, but it is put beyond any shadow of doubt by the recent experiments of Brener upon doves, already referred to. He cuts down to the bony semicircular canals, and, without having injured them in the least, he succeeds in sending an electric current through them. The head moves in absolute obedience to the current in either one of the three planes according to the canal which is stimulated, and in each plane it moves in one direction or the other, according to the direction of the electric current. With the interrupted current, no motion at all is produced. But how is it certain that it is only the canals that are stimulated, and that the motion is not due to direct stimulation of the brain? This objection, which has long been considered a very weighty one, has been absolutely set at rest by Brener. He inserts the needle, which conveys the current, into the matter of the brain, and motions of the head are, indeed, produced. But he next diminishes the intensity of the current until it is no longer strong enough to produce any effect in that place, and then transfers the needle to the semicircular canals. The motions are immediately set up again. It is, of course, perfectly natural that the effect of the current upon either the brain-centres or the fibres communicating with them should be the same as upon the nerve-ends, but the fortunate circumstance that the nerve-ends are stimulated by a current too weak to affect the adjacent parts of the brain proves conclusively — and by a very pretty piece of logic — that the specific function of those nerve-ends is, in fact, the regulation of the convulsive motions of the head. That they regulate the motions through reflex responses to sensations,— in other words, that the motions are by way of compensation for a subjective feeling of falling in the opposite direction,— is proved by the experience of those individuals who execute the same movements under the influence of disease. The chain of evidence is, therefore, now absolutely complete that the nerves which are distributed upon the enlarged ends of the semicircular canals are sensory nerves whose function (or, at least, one of whose functions) is to give us knowledge of the character and extent of all rotations executed by the head.

Mach, in his "Bewegungsempfindungen," published in 1875, described many very ingenious experiments which went to show that we are conscious of a specific sensation when the activity of the semicircular canals is excited. These have not been considered conclusive by other writers, and in a later work of his (*Analyse der Empfindungen*, 1886) he lays less stress upon the excitation of specific sensations, and is content to assume that they set free purely reflectory innervations (p. 73). The semicircular canals may still be called a sense-organ, even though we are not immediately conscious of the sensations which they give rise to. The use of the phrase "unconscious sensation" implies that in the opinion of physiologists there is something which may be properly termed a sensation, but which is not *felt* by us in the ordinary meaning of that word. Any message which is sent in to the brain by an afferent nerve, and which gives rise to actions suitable to the circumstances, is called a sensation, even though our conscious self knows nothing about what is going on until after the action is accomplished, if even then. Thus in the eye-illusion first mentioned, the full explanation of what takes place is this: — the angle through which the head has moved is measured by the semicircular canals, and this information is transmitted to the centres of the eye-muscles, whereupon the eyes make the amount of motion appropriate to that position of the head; their unusual position in their sockets is then telegraphed in by other nerves of sensation, and this infor-

mation has its proper effect upon our intelligent judgments of the position of things about us, and these judgments are the only thing, in the whole process, which we know ourselves to be thinking about.

What is the nature of the mechanical stimulation which excites the nerves of the semicircular canals under ordinary circumstances? Brener produces the motions by making a small incision in the canals, and drawing out the liquid contained in them by a piece of blotting paper. If, when the head is moved, the endolymph remained behind for a short time by inertia, and then rubbed against the hairs of the ampullæ as it moved forward, that might be a means for producing a sensation in the nerve. This retarded movement can actually be seen to take place in artificial glass tubes made of the same shape as the semicircular canals, but of a larger size. But when the tubes are made of the same small size as the actual canals, no effect of inertia can be detected. It is not by any means sure that in the real tubes the retardation would not take place, for they differ in many respects from tubes of glass; an actual retardation, moreover, would very naturally explain the illusion of an after-motion in the opposite direction which is, under some circumstances, very persistent after a rotation has ceased. Mach, however, considers that changes of pressure are quite sufficient to produce the required effect; on calculating their amount he found it to be not so inconsiderable, compared with the energy necessary to affect other organs of sense, as might have been expected. But whether due to changes of pressure, or to rubbing, it is no longer possible to doubt that it is to sensations in the semicircular canals, for the most part unconscious, that we owe that exact knowledge of how far and in what direction we have turned the head at any moment which is necessary to our safe progress every time we attempt to move about in space.

CHRISTINE LADD FRANKLIN.

HARVARD OF TO-DAY.[1]

I THANK you with all my heart for this kind reception; but as I look round me and remember how few there are in this large assemblage who have not borne the infliction of my lectures, I am abashed to think how widely my weaknesses and shortcomings must be known. It is fortunate for us old teachers that time so far alters the perspective under which the incidents of college life are seen that our mistakes become less prominent, and our devotion to truth and duty more evident, as we advance in years. Before another generation has passed, I trust that old Father Time will have dealt as graciously with the college work of to-day as he has with our own weak endeavors in the past; but it has seemed to me that many of her friends have of late been criticising Alma Mater very much in the same spirit which her students showed to their teachers in former times, exaggerating her failures and minimizing her successes. In a community of nearly two thousand young men it must be that offences come; and he can have known little of human nature in opening manhood who thinks that by any system of restrictions he can build a wall around the college high enough to keep evil out; and, however much he may dread the conflict, who does not know that no force of character can be attained and no manly virtue won except by meeting the enemy and slaying him?

The discreditable stories which have been so widely circulated about our college have brought upon us the scrutiny of a whole army of reporters; and, whatever of truth or of falsehood there may have been in the sensational paragraphs they have published, of this I am sure, that few societies of men, however sacred their object, could have borne the scrutiny as well. When I have indignantly repelled the scandals, I have been told that I knew nothing about that phase of college life. Thank God I do know nothing about it; and I am in constant association with hundreds on hundreds of young men who know as little about it as I do. We do not expect to solve the problem of evil at Harvard in this generation; but there is this very marked difference between the evil influences of to-day and those of only a few years back. Then the evil was everywhere pervasive. The classes were so small that all the members were brought into more or less intimate association, and one could not avoid meeting the hateful forms of vice, however greatly he might be repelled by the sight. Now associations are determined to a far greater extent by mutual tastes and affinities; the bad influences are confined to a limited class, and the great majority of our students in passing through college see as little of degrading vice as they would at their homes.

Several years ago an anxious mother consulted me about sending her son to this college. The son was anxious to study in our laboratory, but the mother feared the evil influences of the place. Nevertheless the boy came, as I afterward learned, in consequence of my representations, graduated with highest honors, and is now one of the most promising of the younger members of his profession. The mother followed her son to Cambridge. After she had lived among us for some time, she said to me one day: "I am so much delighted with this place. Things are so different from what I expected. I was told such horrid stories, and not one word of them is true." We have at least one sincere advocate, who has been convinced by experience; and there are numbers of young men who graduate from Harvard every year as guileless as this earnest woman's son.

My friends, I can assure you that the great danger of our dear college at the present time is not over dissipation, but over work. Sixty thousand dollars cannot be distributed in prizes every year without producing an enormous strain; and those of us who are directing the workers know how intense the activity is. We may know little of the evil around us, but we do know a great deal of the good. We know of lofty purposes and of earnest endeavor. We know of perseverence under great discouragements, and of victories won against heavy odds. We know of self-control and of self-devotion. We know of Christian duties habitually practised, and of truth and right manfully upheld; and we maintain that the character of a community of scholars is to be judged by such traits as these, and not by the occasional lapses of its weaker members.

Moreover, I am not one of those who think that a man is necessarily condemned because he is born with a gold spoon in his mouth, or that educated leisure is an unmitigated evil. The college has done a good work in educating rich men, and it owes a great part of its present influence to the noble use which many of its alumni have made of inherited wealth. Such men are educated more by association than by direct instruction; and, as a former president of the college once said, they gain something if they merely rub their backs against the college walls; and if this was true in the past, how much more is it true in the present, when the intellectual life of the college is so much more active, the standard of scholarship so much higher, and the opportunities of cultivating special tastes so greatly enlarged. You cannot expect of such men the asceticism of an anchorite, or the plodding diligence of a scholar; but the university owes them an education, and the duties and obligations are not wholly on one side.

During the last twenty-five years the life at the university has been rendered safer and more healthy, in every respect, by a greatly increased enthusiasm for learning, which extends to almost every department of this large institution. In no one respect has the improvement in the college been more striking than in this; and probably no officer of the college has had better opportunities of observing the change than myself. For forty years I have lectured to the successive freshman classes, beginning with the class which entered in 1849; and many of the older men around me will remember the boyish pranks which in their college days not infrequently amused the class, and greatly tried the temper of the teacher. The lecture was always an up-hill work, — a duty to be enforced on the one side, a task to be endured on the other. The lecturer was always waiting on disturbance, the class always waiting on deliverance. Not only was there no general enthusiasm, but the first suspicion of such a thing in a college lecture-room would have been regarded as a dangerous precedent, alike compromising the dignity of the teacher and violating the traditions of the place. Now, although the classes have so outgrown the accommodations that not only all the seats, but all the approaches to my lecture-room, are crowded almost to suffocation, a more orderly, a more attentive, or a more enthusiastic audience cannot be found. This change is due not simply to our elective system, but far more

[1] Address by Josiah Parsons Cooke, LL.D. at the commencement dinner at Harvard University, on June 26, 1889.