would not be very difficult to imagine that birds flying directly from the overflow to the reservoir might carry the organisms there.

To get rid of the trouble in this case was comparatively easy, because the reservoir was small and it was not a difficult matter to entirely change the water in the reservoir by keeping the pumps going full force day and night for a few days. In three weeks from the time my attention was first called to the matter, I was unable to find any Uroglena in the reservoir water, and I have heard no complaints since.

It is not known that the Uroglena, even in very great abundance in the water, causes any disturbance or inconvenience to our bodies. It is most important, however, that the city engineers and waterworks superintendents should know this, in order to so inform the people when they make their complaints. The suffering public under such circumstances are apt to imagine that all sorts of ills are caused directly by this to them unseen pest, and they are too prone to find fault with the water supply. While we can not prophecy when Uroglena may appear in or disappear from a water supply, we can state with much certainty that it is perfectly harmless, and that it does not necessarily indicate a bad condition of the water. The Lafayette water, for the past two years at any rate, has been absolutely free from all dangerous contamination, and the recent appearance there of Uroglena does not mean that the water supply is at all degenerating.

The Engineering Research Laboratory in Its Relation to the Public.

By W. F. M. Goss.

In the present era of the world's progress we hear much of our "material prosperity" and of the "development of our resources." Feeling sure that the earth was made for man, man is anxious to make his possession yield him its best. Nor is he contented with what his own immediate neighborhood can furnish. If there is anything in the ends of the earth, or in the air, or in the sea which is capable of making for his advancement, he rests not until he has secured it. The business of the world, therefore, increases with every hour, and its problems multiply.

In the midst of its hum and hurry, the engineer is a prominent figure. It is his province to study the properties of matter and to make them useful to man in structures and machines. He deals with the mining and reduction of ores, the chemical and physical properties of metals, and all the great variety of processes by which iron and steel are shaped for purposes of construction; with earth-work dams, with systems of municipal piping, with steam engines and pumping machinery, with locomotives and other railway equipment, with bridges and buildings, with ships and harbor improvements—in fact, with structures and machines of every conceivable type.

The engineer is the servant of the people. His ingenuity and skill are the starting point which leads to the employment of all the artisans who fill our shops and factories; his work makes possible the peace and comfort of household life, the success of social affairs and the perfection of business methods, and it often serves to furnish inspiration for modern thought and to give direction to its tendencies.

The basis of the whole science of engineering, extensive as it is, is to be found in facts which have either been deduced from practical experience or derived from especially conducted experiments. The early engineer could neither lean upon accepted theories nor look to precedent for guidance. It was not what Brindley, and Telford, and Watt, and the two Stephensons *knew*, but what they *did*, that helped to inaugurate our present era of engineering. Since their day, every important structure has served a double purpose: first, that for which it was especially designed, and, secondly, that which regards it as a subject for observation and study. Where such structures have been a complete success, information concerning them has become a matter of record, and the essential facts have been given a place in the annals of good engineering practice; and where structures have failed, the causes have been carefully studied, that the fault might be understood and consequently avoided in future work. Successes, therefore, have inspired imitators, and failures have warned all followers.

But while it is in this manner that a large part of our present fund of engineering data has been brought into existence, and while the process still goes on, it is admitted to have its limitations. The attempt to build a house and at the same time determine the subsequent behavior of certain details entering into its construction, is illogical and expensive. For example, it is poor economy to ascertain the strength of an iron column by finally seeing it fall under the load of a wall. A crack in an arch or a fragment from an exploded boiler may testify to faults in construction, and may even serve as a basis for theories leading to better practice, but the information obtained is dearly paid for in the damage suffered by the collapse of the arch or the explosion of the boiler.

Again, great as are the losses occasioned by failures, they do not equal those which occur through fear of failure. The fear that workmanship may be bad or materials defective leads to lavishness which could not be justified if our information were more definite. It is indeed true that "factors of safety are factors of ignorance." When it is doubtful just how great a resistance can be withstood by a given bulk of material, we make success certain by building many times stronger than is really necessary. If we could know at the outset the exact value of the stresses involved and the actual strength of the materials to be employed, it would become obvious that such a practice as this could give no additional security, and its result would be wastefulness.

In the domain of machine construction the same general principle applies. The demand is everywhere made for machines that will act with a higher degree of efficiency; that is, do their work with less wear and tear and at a lower running expense. There is no lasting market for inferior goods, and success in competition is to be obtained as the result of merit. Thus it is that designing engineers who give their thought and skill to planning great bridges, buildings and machines are successful in proportion to their ability to simplify and cheapen and at the same time perfect, while all unite upon the general principle that a bridge must not only stand, but it must also involve a minimum of material, and a machine must not only run, but must do its work with the highest degree of efficiency.

It is clear, therefore, that what is needed in engineering work is a more perfect knowledge of the materials and forces involved. This is not a reflection upon the knowledge of the past, but a suggestion that its fund is insufficient for the future. The engineering of the last quarter century has done much to make definite matters which were before but little understood. Facts have been gathered and compared, and from them theories have been deduced. Failures are fewer and the efficiency of structural work, and of machines of every sort, has been increased. But the end is not yet. To-day, more than ever before, the attention of the whole engineering world is directed to methods of improving and saving. Its efforts are put forth in response to the demands of a more exacting clientage, and this clientage is the public. It is evident that everything which contributes to the perfection of engineering methods must benefit the people and must arouse their interest, for it is the people who finally reap the advantages, as well as pay the price. Hence public interest in the work of the engineer is keen and critical, and will always sustain any serious movement which promises to advance true practice. Such a movement presents itself in the establishment of laboratories devoted to engineering research.

When all forms of mechanical construction were crude it was possible to improve by the mere application of experience, but as construction became more refined it was necessary to examine with greater accuracy and to proceed with greater care. The crude stage in engineering is now a thing of the past, and every day increases the degree of refinement which characterizes the work. The research laboratory stands as a response to these conditions. It is its function to investigate, in a scientific manner, problems which arise in practice or which may be suggested by practical experience. The fields of science and the field of engineering combined make up its proper domain. Its equipment, therefore, embraces the delicate apparatus of the scientist and the ponderous machinery of the engineer, and its lines of investigation may be chemical, metallurgical, structural, pneumatic, hydraulic, or thermodynamic. Its methods eliminate the complicating conditions of service and allow effects to be traced singly to their causes. For example, efforts to determine the power and efficiency of locomotives while in service upon the road extend back through more than three decades, with no general result that is satisfactory. But the difficulties and inaccuracies which appear in the process of road testing entirely disappear when tests are made in the laboratory, for here it is possible to maintain for an indefinite period an unvarying condition of speed and load, and to employ sensitive apparatus in observing the performance of the machine.

There have been many instances where locomotives on the road have left bent rails in the track behind them, but it required the laboratory to demonstrate that under conditions not uncommon in practice, the drive-wheels of a locomotive leave the track at every revolution. This being proved, the matter of the bent rails was easily explained.

Again, it has been assumed for years that the draft produced by the exhaust steam in a locomotive was the result of an action similar to that of a pump; that each puff from the cylinders supplied a ball of steam which filled the stack as a pump piston fills its barrel, and pushed before it a certain volume of the smoke-box gases until it passed out at the top of the stack. Believing this view to be the true one, designers have shaped the details of locomotive draft appliances accordingly, and the value of proposed improvements has been measured by the completeness with which they have satisfied the conditions of the accepted theory. But the processes of the laboratory have disproved this whole assumption. They have shown that the steam does not fill the stack except at its very top, and that the action of the jet is clearly one of induction. In accordance with these results a new theory has been formulated, and although it is but a few months old, the laboratory facts which sustain it are so conclusive that it has already been generally accepted. These illustrations, drawn from a single field of investigation, will serve to show something of the character of the work done by the research laboratory. They might, with equal justice, have been selected from any one of the many different departments into which engineering research may be divided. But they have served their purpose if they have emphasized the fact that the laboratory process gives results which can not be obtained in any other way, and that these results may be relied upon to guide and direct practice in engineering affairs.

English technical papers admit that the painstaking processes of German laboratories have so well guided German manufacturers that Germany not only competes with England in many lines of manufactured goods, but in some has driven her from her markets. We have a new country, in which large engineering enterprises, both public and private, are always being pushed and are calling for economy in expenditures; and there is a strong national desire for an outlet of manufactured goods through exportation, which can only be secured on merit, in competition with the world. With these facts in mind the conclusion is obvious that there is room and need in this country for research laboratories. All such laboratories are but means to ends. They are not only contributors to the public fund of information, but they infuse into every branch of construction and of operation a spirit of accuracy and a desire for excellence.

Louisville Filtration Experiments. By Geo. W. Benton.

The 1st of August, 1896, completed the routine work of one of the most unique series of experiments the scientific world has had the privilege of witnessing.

The question under investigation was the chemical and bacterial condition of the Ohio River water, as furnished the City of Louisville, Ky., and the relative merits of the several systems of filtration seeking establishment there, and proposing to do away with the mud and its accompanying bacterial impurities, so familiar to the citizens of and visitors in the great cities adjacent to the Ohio, the Missouri and the Mississippi rivers.

The peculiar yellow clay suspended in the Ohio water will not subside even on standing, and ordinary schemes of filtration utterly fail in its treatment, even in times of low water.

In view of the conditions, Mr. Charles Hermany, Chief Engineer, and Mr. Charles R. Long, President, of the Louisville Water Company, decided that the only sure way to treat the question was by means of an experimental plant erected on the ground and operated for a term of months, which should give them definite knowledge of the water in every stage. In accordance with this