ontogeny has for the plant taxonomist a wealth of information as yet unrevealed regarding the affinities of genera within the family and species within the genus. In these matters of more intimate relationship, the form, position and venation of leaves, the nature of the petioles, stipules, pubescence and glandularity, all shown in the seedling, are significant.

Here, however, as in the other subjects of which I have spoken, the real obstacle to further inference at present is an astonishing lack of material and data. It is safe to say that of the one hundred and fifty thousand flowering plants recorded in the recently issued Index Kewensis not one fiftieth part has been carefully traced through the earlier stages of development. Enough is known, however, to show that species even of the same genus often possess striking differences, and in other cases remarkable similarities, in the seedling stages, that these particular differences and similarities often become lost or obscured as the plants advance to maturity, and the conclusion is unavoidable that these juvenile characteristics must, at least in many cases, show ancestral traits, and, if properly studied, yield even better clues to real affinities than any which we now possess.

By way of summary, it may be said that systematic botany is very far from being a completed subject, that from our present standpoint we can see in various directions long vistas of further possibilities for fascinating exploration and profitable discovery, that among the subjects which seem to invite immediate attention the most important are: (1) The determination of the modes and degrees of variation, an investigation which alone can yield data for a more critical discrimination of plant categories; (2) far more complete study of plant ranges, which can scarcely fail to throw much new light upon the forces controlling distribution; and (3) a further examination of plant ontogeny as the most hopeful source of information regarding the more intimate affinities and proper arrangement of plants.

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*THE CHANGE OF FRONT IN EDUCATION.**

Dr. Samuel Johnson considered education as needful to the 'embellishments of life.' In his day very few were educated at all, and those few for society or public service. The toiling masses had no education, were supposed to need no education, and while discussing details educators and scholars took no thought of what we call the common people.

Said Johnson (in his 'Life of Milton'):

"The truth is, that a knowledge of external nature, and the sciences which that knowledge requires or includes, are not the great or the frequent business of the human mind. Whether we provide for action or conversation, whether we wish to be useful or pleasing, the first requisite is the religious and moral knowledge of right and wrong; the next is an acquaintance with the history of mankind, and with those examples which may be said to embody truth, and prove by events the reasonableness of opinions. Prudence and justice are virtues and excellences of all times and of all places. We are perpetually moralists, but we are geometricians only by chance. Our intercourse with intellectual nature is necessary; our speculations upon matter are voluntary and at leisure. Physiological learning [by which he means a knowledge of the laws and phenomena of the external world] is of such rare emergency, that one may know another half his life without being able to estimate his skill in hydrostatics or astronomy; but his moral and prudential character immediately appears.

* Address of the Vice-President and Chairman of Section I, Social Science and Statistics, of the American Association for the Advancement of Science, Denver meeting, August, 1901.

"Those authors, therefore, are to be read at schools that supply most axioms of prudence, most principles of moral truth, and most materials for conversation; and those purposes are best served by poets, orators and historians."

This statement was, no doubt, entirely adequate to the demands of Johnson's time. Polite conversation and elegant manners were the chief characteristics of an age in which Chesterfield was a bright and shining light. With the dull, hard-working, unlettered crowds, that plodded on in the steps of their grandfathers, educators had nothing to do; for such they had no educational theories.

How wonderfully conditions have changed, both as to the curriculum and as to the constituency of education. It is interesting to picture, in fancy, the bewilderment of a Sam Johnson in the learned circles of this scientific and industrial age. Imagine him attempting to join in the discussions of our British and American Associations for the Advancement of Science, in our educational conferences, or in the halls of exchange, where the active minds of our generation do mostly congregate. He would find it difficult, in spite of the wonderful vigor of his intellect, to be either useful or ornamental, though he could easily be amusing.

From the days of John Milton, in 1608, to the end of the eighteenth century, university training culminated in a preparation for the professions of law, medicine and theology, and in the training of the nobility for the duties and responsibilities of government and elegant society.

But when alchemy developed into chemistry; when physics became an experimental science; when Leibnitz and Newton elaborated the infinitesimal calculus; when Watts invented an efficient steam engine; when Fulton built a successful steamboat; when Stephenson devised the locomotive and constructed a road with smooth rails; and finally when Siemens and Gramme produced the electric motor—vast fields of fascinating and useful material were opened for study and research. Mathematical analysis and the principle of mechanics, which had previously been devoted to the problems of physical astronomy, were now directed to the study of the transformation and transmission of energy, the theory of structures, and the phenomena of electricity. The theory of evolution gave a new meaning to all vital phenomena; and the doctrine of the conservation of energy permeated all study of motion and force.

In the earlier days, Alexander Pope voiced the popular notion that 'the proper study of mankind is man.' 'Nature Study,' which to-day is the bright, attractive feature of the primary school, and equally the inspiring field of the savant, was not countenanced by polite society. For centuries it was held to be little short of blasphemy to wound the earth by digging for ores which were intended to be hidden away from our sight and touch, or to attempt in any way to improve upon God's workmanship. When in 1680 a Spanish engineer proposed to deepen the channels of certain rivers and to restrain their overflows in the interest of navigation, the Spanish Council decreed as follows: "If it had pleased God that those rivers should have been navigable, He would not have needed human assistance to make them so; but as He has not done it, it is plain that He does not want it done"; and the improvements were forbidden. This decree reminds me of a bit of Mrs. Eddy's logic which you may remember in substance as follows: Had the Almighty intended that drugs should be used in treating sick people, He would have placed drugs in the hands of Jesus and his disciples; Jesus and his disciples used no drugs; it is therefore evident that the Almighty does not wish drugs to be used upon people who are sick.

But, putting aside pseudo science, the modern thought of the creation is that it was and is a part of the all-wise plan to fill the earth with unsolved problems, the study and solution of which should develop our best powers, and at the same time cultivate our highest instincts of reverence for the Creator and of love and devotion for His creatures.

It has taken many centuries for the world to discover that the great forces of nature are neither sacred nor profane, neither kind nor cruel, that they neither love nor hate, and that they are more unchangeable than the stars; that shrines and temples, priests and priestesses, tripods and oracles, have been in vain, except so far as they reacted upon the human heart and satisfied its natural craving for the worship of the Superior Being. Instead of building a temple to the far-darting Apollo or to Zeus, the Thunderer, we now stretch over our cities a network for artificial lighting; and all the winds that blow and all the waters that flow are made to furnish their tribute to our comfort and pleasure. We tap the sources of endless energy and transmit it through all the ramifications of our social order, relieving mankind from heavy burdens and creating hundreds of occupations hitherto unknown.

Out of this vast extension of the horizon of human activities, and a corresponding multiplication of occupations, has come an imperative demand for more education and for technically educated men. In our industrial system the crying want has been and is for men who can both plan and execute. The secret of our unparalleled commercial and industrial success lies in the fact that we have put educated brains into our work. Hence a score of professions unthought of 100 years ago have been called into being, and the standards of these new professions are of the highest order.

It is this grand movement towards a study of the materials and the forces of nature and the problems of modern life, sociological, commerical and industrial, that constitutes the change of front in education. This does not mean that we must abandon altogether the old education. We must preserve all that is permanently fine and essential to high thinking and well doing. The great epics of Homer, like the book of Job and the Psalms of David, will live forever, imperishable monuments of the youth of the world, but we shall not perpetually care for Aristotle's speculations about the origin of matter, or the conceited discussions of Cicero at Tusculum. Modern life in all its details has so far departed from the ancient that neither the moralizings nor the tragedies have a lively and sustained interest for us. We are deeply interested in the affairs of to-day, in a civilization not based upon human slavery, nor upon a blooded aristocracy buttressed and supported by millions of laborers ground down in ignorance, poverty and superstition, but based upon the principle of human equality before the law, and of equal rights to life, liberty and the pursuit of happiness.

In turning from an inherited scheme of education which faced backward, which concerned itself largely with the thought, the deeds and the theories of the past, and in proclaiming the universal need, as well as the universal opportunity, of education, we must not fail to preserve the dignity and the nobility of our educational standards. In spite of frequent assumptions to the contrary, modern education is becoming more and more 'liberal.' The defenders of the Johnsonian programs delight in the use of unworthy epithets with which to characterize the tendency of modern education; they plead for 'humanities' as though anything human was foreign to our curriculum. What can be more human than human life as we see it

and as we share in it? What problems can be more human than those which face nine out of ten of the people who reach the age of individual responsibility?

More and more we are considering the many and not the few, when we draw up our schemes of study and training. As wealth increases, as the hours of labor become shorter, as luxuries multiply, and a taste for literature and art and science becomes general, the number of students entering upon some form of higher education greatly increases. The number of such students to-day per million of people has doubled several times in fifty years.

It is, therefore, not surprising that there should arise, in the minds of many less familiar with the content and the method of a modern technical university, a fear that the standards of character as well as the standards of scholarship should suffer, and, in being less 'select,' that the content of education should be at the same time less fine. Whether this fear be well grounded or not, we must all sympathize with its spirit. We can have no quarrel with those who wish the first fruit of education to be character. I cannot forbear quoting a few sentences from the late president of the Massachusetts Institute of Technology, Gen. Francis A. Walker, upon the tendencies of modern technical education, in reply to certain strictures as to its dignity and unselfishness. In his remarks at the dedication of new science and engineering buildings at McGill University, Montreal, General Walker said:

"The notion that scientific work was something essentially less fine and high and noble than the pursuit of rhetoric and philosophy, Latin and Greek, was deeply seated in the minds of the leading educators of America a generation ago. And it has not even yet wholly yielded to the demonstration offered by the admirable effects of the new education in training up young men to be as modest and earnest, as sincere, manly and pure, as broad and appreciative, as were the best products of the classical culture, and, withal, more exact and resolute and strong. We can hardly hope to see that inveterate prepossession altogether disappear from the minds of those who have entertained it. Probably these good men will have to be buried with more or less of their prejudices still wrapped about them, but from the new generation scientific and technical studies will encounter no such obstruction, will suffer no such disparagement.

"Another objection which the new education has encountered is entitled to far more of consideration. This has arisen from the sincere conviction of many distinguished and earnest educators that the pursuit of science, especially where its technical applications are brought strongly out, loses much of that disinterestedness which they claim, and rightly claim, is of the very essence of education. I differ from these honorable gentlemen. I believe that the contemplated uses of science, whether in advancing the condition of mankind, or even in promoting the ulterior usefulness, success and pecuniary profit of the student of a technical profession, do not necessarily impair that disinterestedness. These gentlemen appear to me to have an altogether unnecessary fear of the usefulness of science.

"The strong desire to become a useful man, well equipped for life, capable of doing good work, respected and entitled to respect, constitutes no breach of disinterestedness in any sense of that word."

Finally he says:

"I boldly challenge comparison between the scientific men of America, as a body, and its literary men or even its artists, in the respect of its devotion to truth, of simple confidence in the right, of delight in good work for good work's sake, of indis-

position to coin name and fame into money, of unwillingness to use one thing that is well done as a means of passing off upon the public three or four things that are ill done. I know the scientific men of America well, and I entertain a profound conviction that as regards sincerity, simplicity, fidelity and generosity of character, in nobility of aims and earnestness of effort, in everything which should be involved in the conception of disinterestedness, they are surpassed, if indeed they are approached, by no other body of men."

Of like import are these words from a recent address of Hon. F. W. Lehmann, of St. Louis. Speaking of the breadth of the modern university, he said:

"The university of to-day has abdicated none of its old functions, but it has taken on many new. Not disdaining mere scholarship, making, indeed, the standard always a higher one, it widens its domain and adapts its teachings to the after-work of life. Its graduates are not simply conventional finished gentlemen, but beginners in the serious business of life, scholars as before, but artists, engineers and artisans as well. The sciences lose nothing because they become utilities. Physics and mathematics gain in interest by application to the building of bridges, and the very sewers of a city become classic to the scholar because one of the means to the classic excellence of a sound mind in a sound body."

Perhaps the characteristic most dreaded by the opponents of the new education is usefulness. They have but to learn that a certain branch of study, course of training or line of culture is useful, and its value is at once compromised. One of the few foolish things that Lowell ever wrote or said was that, 'a university is a place where nothing useful is taught.' I will not discuss a statement which, after all, may not do justice to Lowell's thought, but I will define a university as a place where everything useful in a high and broad sense may be taught. Matthew Arnold would have defined a university as a place where is taught and illustrated 'the best that has been thought and done in the world.'

Supt. Gilbert, of Rochester, N. Y., said at Buffalo last month: "The exalted character of a man's work is to be measured by its usefulness to mankind; I believe in the universality of service."

It has often been assumed that this new education is not liberal. Liberality consists not so much in the subject as in the method of study. The liberal method is broad, deep, generous, comprehensive. It recognizes infinite uses, both far and near. It aims at the artist rather than the artisan; the engineer, not the craftsman; the freeman, not the slave. Liberal culture deals with fundamental principles, typical phenomena, general results, not special applications. It is liberal to study the laws of manufacture, trades, commerce, finance and social progress; it is not liberal to seek merely the conditions of a successful business, whether it be law, medicine or manufacture. It is liberal to demand the *raison d'être* of dogma, canon, rule, dictum, formula or usage; it is illiberal to blindly follow authority, to put facts and processes above principles and reasons, to prefer echoes to living voices.

A recent reviewer said that mathematics and electricity are becoming less valuable for general education on account of their increasing usefulness in technical pursuits. The maximum of educational value (he held) appertains to a sort of knowledge which falls short of such a mastery as makes it useful. Of course, I accept no such statements. That man's notion of a liberal education is not yours nor mine.

The list of liberal branches of study is ever increasing. For four years Harvard compelled me to give one-sixth of my time to Greek and one-fourth to Latin; to-day

one may go through Harvard and take his degree without giving one moment to either Greek or Latin, while in Cambridge. The same thing is true at many universities. Are we, therefore, less liberal than formerly? Can we not answer that we are more liberal? People now read Demosthenes and Quintilian and Horace, analytic geometry, physics, thermodynamics and the like, because they wish to be familiar with those authors or to master those subjects, not because they are compelled to by a traditional canon. Does any one suppose that there is not a decided gain in the quality of the result?

Through the technical schools, some of the most valuable educational studies have been developed. How few people realize the surpassing mental discipline that comes from the study of descriptive geometry, laboratory physics and the mechanic arts. I knew nothing of the study of descriptive geometry till years after I left college, and yet no subject I had in college could compare with it as a mental stimulus and a cultivator of the scientific imagination. It ought to have place in every liberal course of study. Modern courses of study contain, of necessity, extensive allowances of laboratory work of one sort and another. Our idea of all such work is that the method shall be unfailingly rational; that facts, though essential, shall be rated as far less important than the principles which underlie them. Where this idea is realized, the study becomes truly liberal.

In spite of the old claim of preeminent liberality, the old college curriculum, when examined historically, is found to have been adopted for reasons of utility. People learned Latin because they wanted to use Latin. All books and state papers were written in Latin, and one needed to both read it and write it, as we must English prose. The physician must read Galen in the original; the clergyman needed the Greek Testament; the lawyers must read the Institutes of Justinian, and the man of leisure and the orator must be able to quote Aristotle and Homer, Virgil and Horace. The first American colleges were organized for the training of clergymen. Every feature of the course was directly useful to the end in view.

It is easy to see the source of a widespread prejudice against technical training. The history of civilization has been the history of masters and slaves, of castes, of contempt for labor and for all useful arts. Every one of the technical professions had its beginning in the crafts and the present technical expert and engineer had as a prototype a man in overalls, with horny hands and a soiled face, who presided over some enginery which was not authorized by the ancients and which at best was generally regarded as ungenteel. Milton placed Memnon, the first ante-tellurian engineer, among the fallen angels, and sent him

'With his industrious crew to build in hell.'

The engineer is by nature an iconoclast. He has small respect for the traditions. He bows not down to the 'tyranny of the ancients.' His glories are in the future. He looks forward, not back. He does not hesitate to smile at the puerile fancies of people who created gods and demi-gods in order to account for phenomena which today submit to mathematical analysis and which bear no comparison with the exploits of modern engineering. The accomplished engineer generally reciprocates the prejudice I have mentioned, for he cannot understand how the worship of the ancients can be really serious; it seems to him three-fourths affectation. This mutual prejudice was fostered by the high wall of separation which at first kept the technical and the liberal branches of study far apart. That wall, I am happy to say, is fast tumbling down, and men are rapidly scrambling over it in both directions. It becomes us, from our various vantage grounds of influence,

to encourage this evolution of a better feeling, a more intimate acquaintance, a mutual respect, and a common zeal for whatever is broad and high and fine.

While we may for many reasons congratulate ourselves on the decided change of front we have achieved in education, we must not be blind to the fact that much remains to be done. We must still devise a scheme of secondary and higher education for a stage of progress in which secondary and higher education may become approximately universal. As Sir Walter Besant put it, the twentieth century must not only "open up all intellectual careers to lads [and lasses] who are capable, clever and ambitious, but we must have a system of education broad enough and elastic enough to include the children who are destined for crafts, industries and arts of all kinds; one that will make them good citizens, not ignorant of their civic rights, and alive to their civic duties."

I do not at all assume that we have yet discovered the true system for universal secondary education. The manual-training high school with its opportunities for training and culture along many lines, industrial, commercial, civic, artistic and literary, seems to come near the ideal, but it is by no means generally accepted, and when accepted it is at once exposed to serious dangers.

In our most advanced communities only a small minority of children enter upon the secondary stage of education. In my own city of St. Louis, only about one boy in seven takes a course in a school of high-school grade. In many communities the proportion in secondary schools is greater—in others it is less. There must be some reason for this; either the training and culture are not what they ought to be or our people are so ignorant that they do not know the value of education. I will not admit that poverty offers a sufficient explanation. In either case, it is evident that we have much to do and much to learn.

Of the dangers to which the manual-training high school is exposed, I have spoken elsewhere at length. I will at present only refer to the strong tendencies of 'practical' people, who are more intimate with the old system of apprenticeship than they are with the art of education, to introduce the teaching of special trades. I think we shall be able to stem this unfortunate tendency, but it is well to be forewarned that we may be forearmed. The advocates of the introduction of trade work make three serious mistakes:

1. They assume that the graduate of the manual-training school is unfitted to enter an industrial shop to advantage.

2. They would begin trade work with pupils who are too young.

3. They do not realize that only about 50 boys in 100 are so constructed mentally and physically that they can and ought to learn what are known as the industrial trades.

In my paper already referred to, I have at some length defended the natural right of a boy to the privilege of choice of occupation at an age of some maturity and after a training which enables him to substitute a rational judgment for a boyish whim.

In this connection, I fail to endorse at least one feature in the Report of the Advisory Committee of the Carnegie Technical School. The full report was published in Science for July 12, 1901. For a variety of excellent reasons, the Committee reaches the conclusion 'that some new kind of preparation for the work of life must be introduced into the school training of both boys and girls.' It then proceeds to outline a technical college, a technical high school and an artisan day and evening school, which are to meet this demand. Here we have a clear recognition of a twentieth-century problem and an attempt to solve it.

The artisan day and evening school is somewhat on the order of German and English low-grade technical schools. I earnestly hope that the suggestion of this school may be adopted and that the experiment may be fairly tried in America. The plan for a technical college is in complete harmony with our best engineering schools, and needs no discussion here.

The scheme for a technical high school, however, seems to me faulty. This school would be of high-school grade, taking pupils from the grammar schools and covering presumably four years. The normal ages of entrance and graduation would accordingly be 14 and 18.

Three things in the Committee's outline of this technical high school deserve more attention than I can give them at this time:

1. The elective principle is to be recognized, the student selecting the required number of courses under the direction of the director of the school. Here the pupil at a tender age (only 14 or 15) is asked to surrender his birthright to the privilege of choice when he is 18.

2. The course in mathematics—which begins with elementary algebra—is to include the *elements of calculus!* Of course, it must include solid geometry, higher algebra, trigonometry and analytical geometry! One rarely meets with such an astounding proposition from engineers who are supposed to have studied mathematics and to know what they are talking about. They might as well propose that the pupils shall take thermodynamics in a short course of lectures. To be sure, similar ambitious schemes have been proposed elsewhere for boys just out of the grammar school, but they came from people who could have known very little mathematics, and nothing of the uses of the calculus. This criticism may seem trivial, but in more than one place the scheme attempts too much.

3. The technical studies suggested take the form of trade work or special employments, with well-equipped shops and experimental laboratories under the direction of expert artisans.

What Mr. Carnegie will do with this last suggestion remains to be seen, but any attempt to embody it in a real technical high school of secondary grade will be full of interest to the educational world. If any man was well prepared to give the scheme a fair trial that man is Andrew Carnegie; but it will cost a vast amount of money and its experience will teach us how not to do many things.

I have high respect for the members of the Advisory Committee, but I think a less ambitious scheme would be more successful. You cannot teach the higher mathematics in a high school, and I have no great faith in the value of attempts to teach employments, commercial or industrial, within the limits of any secondary school. Such attempts are certain to mislead and ultimately hinder those they aim to help. Any trade or special employment must be dwarfed and narrowed before it can be brought down to the grasp of an untrained boy, and its very narrowness unfits it for the best educational uses.

The school is the place where one should learn the fundamental unchanging laws and manifestations of force and materials. Special occupations, like special constructions, should be analyzed in their elements, and pupils should become expert in such analyses, in so far as they involve universal elements that pupils can comprehend. But there are many things essential to a business employment which cannot even be apprehended in school. As William Mather, M.P., says:

"There is no possibility of teaching in a school that sort of knowledge which practical work carried out on commercial principles, within restrictions as to time of

execution, etc., can alone make any one familiar with." ('Technical Ed'n in Russia,' p. 12.)

As to values, let us teach intrinsic values, not market values; the latter are fluctuating with time and place, the former are permanent.

No scheme of American education is complete without a careful study of the duties and responsibilities of citizenship. The tramp, like the political leech, assumes that the world owes him a living; the good citizen knows that he owes it to the state to earn his own living, to support his family and to contribute his share to the necessary expenses of the city, state and nation. Hence the youth must learn how the city, state and nation are respectively organized and what their proper functions are; and when he is a man he must to the extent of his ability see to it that those functions are placed in the hands of public servants who are both capable and honest. The corrupting influence of a politician who fosters selfishness in his neighborhood, that he and his neighbors may profit at the expense of other neighborhoods, must be counteracted by a generous education which shall cultivate a love of justice and plant the seeds of manly and noble ideals. If democratic governments are to survive, the whole people must be educated to the highest standards of citizenship, and the new education must face and solve the problem of securing those results.

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SECTION C (CHEMISTRY) OF THE AMERICAN ASSOCIATION.

In accordance with the recent custom, the meetings of Section C were held conjointly with those of the American Chemical Society, the officers of the latter presiding on Monday and Tuesday and those of the former during the remainder of the session. The meetings proved to be of unusual interest, a large number of valuable papers being presented. Eighty persons, representing twenty-three different States, were in attendance.

The Section was first called to order Monday, August 26, at 11:30 a. m., by Vice-president, Jno. H. Long. Mr. Franklin Guiterman was introduced and welcomed the members on behalf of the chemists and metallurgists of Colorado. Brief responses were made by F. W. Clarke, President of the American Chemical Society and Vice-president Long. Section C was then organized in accordance with the provisions of the constitution. The following were the officers for the Denver meeting:

Vice-president, Jno. H. Long.
Secretary, Wm. McPherson.
Sectional Committee: J. L. Howe, Vice-president, Section C, 1900; A. A. Noyes, Secretary, Section C, 1900; Jno. H. Long, Vice-president, Section C, 1901; Wm. McPherson, Secretary, Section C, 1901; W. D. Bancroft, C. S. Palmer, A. Lachman.
Member of General Committee, H. W. Hillyer.
Member of Council, C. S. Palmer.
Press Secretary, C. L. Parsons.

After the organization of Section C, the officers of the American Chemical Society took charge of the meeting. With the exception of Wednesday afternoon, two sessions were held daily until the final adjournment on Friday. Wednesday afternoon was given up to a visit to the Denver Smelting Works, under the direction of Mr. Franklin Guiterman. A special train conveyed the visitors to the Argo, Grant and Globe Works, successively. In the evening a subscription dinner was given at the University Club by the courtesy of the House Committee. After the final adjournment on Friday a number of the chemists accepted the invitation of Mr. J. D. Hawkins to visit the works of the various smelting companies at Colorado City.

At the meeting of the General Commit-