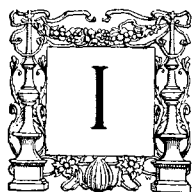


The Chemists of the Future

BY ELLWOOD HENDRICK



IN the *Garden of Epicurus* Anatole France expresses the opinion that we might have done better had we been created as insects. "If I had created men and women," he says, "I should have framed them on a type widely different from that which has actually prevailed—that of the higher mammals. I should have made men and women, not to resemble the great apes as they do, but on the models of insects which, after a life as caterpillars, change into butterflies, and for the brief final term of their existence have no thought but to love and be lovely. I should have set youth at the end of the human span."

I sometimes wonder whether our efforts at education are not designed, after all, to give us a modicum of the glory of the insect; to avoid the toothless and bent decrepitude to which we are the normal heirs in age. If we cannot, as the years come upon us, unfurl our glittering wings and spread them in joyous flight through a world of sunshine and flowers and honey and love, we can dream constructive dreams, and thus achieve the golden vision even while the clutch of age turns our faces into comedy masks. Time was when flesh was devoured in its natural warmth and love was of the forests. The thought offends us and we are striving after something else, after a different order of living. We try to fit a boy at school for an enduring usefulness, a prolonged activity. Our ideas are built upon a reign of peace, and the wish for long life and cumulative happiness underlies the system of education to which all are agreed.

We miss a point, I think, when we urge boys to study in order that they may grow to achieve the power to command other men. This defect in ideals, however—if such it be—is less the fault

of the teacher than it is of the *mores*, of the folkways; of the fathers and mothers even more than of the boys themselves. It is not a fault of the teaching of science, for in the nature of its ideals, this differs from the teaching supposed to be preparatory to less specialized walks of life. We do not care to develop in the chemist, the physicist, or the biologist, the power to command. It is the last thing we think of in connection with his education. Being curious, and seeking the joy of the work, which are the states of mind most needed in the study of science, differ vastly from the desire to command.

Here is a thesis in philosophy which we can touch upon only in passing, but it is important. Bossing a job is not an achievement in happiness unless one has the gift to do it. As a life task it assures worry and care and it inhibits all independence. The man who rules cannot have his own way unless he is an absolute monarch, and even then his people are not always obedient. The greatest triumphs are not to be found in bidding somebody else to do things, but rather in the doing of things ourselves. The lawyer, the physician, the surgeon, the chemist, the man of research, each conquers by his own thought and work. There would seem to be a more appealing satisfaction in their achievements than there is in being superintendent of a boiler-factory, although they make less noise, we must admit. These things we know, but it often seems that our knowledge of them is passive, especially when we urge boys to study to the end that they may command.

Old standards are changing and traditions are taking wing, but we must hold on to an ordered system in spite of everything. The destructive reformer and the angry reactionary are alike the enemies of peace and progress. Neither needs to think; he has but to whip himself into a passion and call up the fires of

wrath against whatever is not to his liking. The blind protagonists of single causes, whether they be for sabotage in industry, or for Latin and Greek at the expense of everything else, or science at the expense of everything else in education, are all alike Prussian in their practice of the philosophy of conquest or destruction.

It is in regard to education that we meet immediately an issue of which most of us have grown weary; simply because there has been so much talk and so little light shed upon it. The question whether a boy should address his studies to science or to the humanities has been asked with all the insistence and inconsequence of a parrot, that repeats, day in and day out, a single question to which it would not know the answer if it were given.

It has been a favorite subject for juvenile debating societies. The grown-ups have held mock trials over it in which the arguments were presented, not as in learned discussion, to seek the truth, but rather as briefs of lawyers at court designed to win the case and save the positions of the least useful teachers. As a result we see our secondary schools giving up their most valuable classical asset, the study of the Greek language, and more particularly its literature, and the maintenance of the study of Latin by way of compromise; taught strictly by volume, at so many lines per day, with no thought that the pupil shall even learn the language or that the study of it shall be more to him than an intellectual treadmill.

And yet for a number of years past there has been a voice calling in the wilderness, the voice in Ghent of a young professor, ripe in scientific and humanistic scholarship, who declared that the history of science is not written, and yet that the history of civilization is the history of science. That was Dr. George Sarton, of the University of Ghent, who issued and bore the expense of a periodical called *Isis*, printed in several languages, to prove his contention. While engaged in this propaganda there came the German hordes, and they murdered and destroyed, but, fortunately, he and his family escaped. Now he is engaged

as research associate of the Carnegie Institution and his light begins to shine again. He proposes the New Humanism, which is based upon the History of Science, and along with his work he labors unceasingly for an institution for the study of this very thing.

Let us give our imagination play for a few minutes while we follow him. I shall draw random sentences translated from an essay called "*Le Nouvel Humanisme*," published in the *Scientia* of Bologna. . . .

No real scientific education exists as yet [says he]. . . . The intellectual *élite* is divided into two groups which for want of better terms I shall call "literary" and "scientific." . . . Because of an unuttered tradition, all questions of education have remained the exclusive concern of the literary group, while the scientific body distributes information of technical knowledge. . . . The literary savants are the real educators. . . . Therefore our system of education is still of a medieval type. There has been added to it by successive steps a scientific tuition increasingly complex, but such tuition has somehow remained outside the system: the heart of education has scarcely been influenced by it. . . .

History is the memory of our race; . . . it is the experience of humanity. . . . It is our duty as men to know the past. But is it not our duty also to know the present? And the future . . . may it not inspire us? The past is unchangeable; we have no power to modify it, but the future is in our hands. Therein lies all the hope, all the dignity and all the greatness, of our life. Now the knowledge of the present and the exploration of the future both imply a scientific education. . . . It is not so much the scientific knowledge that counts as the scientific spirit. It is disinterested. The real men of science are inspired by the same idealism as are the best among the literary men. They have the same desire to attain the truth, the same *nostalgie de la beauté*—but they have more respect for the truth and a profounder need for precision in facts. . . .

A history of human progress should be focused on the narration of the activities that are really progressive. . . . Where, then, do we find the certain marks of progress? . . . Is our progress in moral or religious realms? Are we purer than the Christians of the Evangelistic period or than the first Buddhists? Are our sculptors greater than the Greek or Assyrian sculptors or than those of Nara? Are our painters greater than those of the T'ang period or the Italian primitives?

. . . Progress is a vague notion and it is open to discussion in nearly every field except that of science. . . . But with an outlook upon progress all humanity appears as one immortal man who remains almost the same throughout the ages except that his experience—his science—grows ceaselessly. He has periods of wonderful renaissance of youth and of inspiration, but even outside of these his experience continues to grow. The story of his life is the story of this accumulation of knowledge. . . . Human progress is a function of the development of science, and a general history of which the fundamental theme is not the history of science can be neither complete nor exact. . . .

It is not sufficient to add the history of science to history as it stands. . . . It is necessary to construct a new historic synthesis. A history of progress must first of all point out the continuity of progress. The history of civilization as it is presented to our day and generation leaves out that which is most essential and thus it is not only incomplete, but false.

These sentences are but glimpses into his argument. Of course he refers to the study of science in the scholastic sense, and not to it as merely incidental to the successful prosecution of business or to that quality of specialized study that provides a trade rather than a learned profession.

The conclusion is reached that, if this larger view of the New Humanism were to prevail and we were to begin again, reconstructing history on the basis of science—that is, of man's development through the conquest of nature—there would be opened up a past which offers to historians the most engaging field. The whole argument invites them to enter those delectable meadows, ripe for the harvest. As for discouraging philology, it would encourage it as nothing else would. Latin and Greek are but partial demands; among others, Pali is needed, and so is Chinese and Hebrew and Sanskrit and Arabic, to mention but a few of its calls upon scholarship.

We are trying [he says] to consider the history of mankind as we would write the history of a great man; instead of addressing ourselves solely to his seasons of sickness, his quarrels, and his plays, or the accidents of his life, we should address ourselves more particularly to the development of his genius; to the observation of his growth. We have no such history of mankind as yet.

Here is another idea. We have science enough now to provide a beautiful, happy, and good world. What shall we do with it? We are at the parting of the ways. We can follow the German system and cultivate it as a thing apart, as a tool to be used for good or for evil, and let human vanity continue to rule and continue to inflict upon us all the debaucheries of human passions, uncontrolled or miscontrolled. Or we can grow in wisdom and in righteousness out of the great sufferings of these days, and weave into humanity the study and practice of science with a new and big resolution, and gird up our loins and go to it! Why should we not put an end to the petty quibblings and jealousies of scholarship as offenses against the human welfare? We are all ignorant, grossly ignorant, either of one subject or of another. There is no one who even knows the history of the development of our own kind. We need this study to help us correlate facts unto the truth, which is also an art in which we are sorely lacking. With this step taken in advance, we should cease to follow the case-winning methods of lawyers at court; we should order our minds in discussion to seek the truth. Our trouble has been a narrowness of vision and we are suffering from it to-day. The picture of a class-room of bright, energetic, ambitious boys working over so many lines of Virgil, and then so many lines of Virgil, and then so many lines of Virgil, day in and day out, term in and term out, with not a thought of anything to be done or accomplished or made better in the world—as though the place were an undertaker's shop and the effort were to embalm something dead into the minds of the pupils—is disheartening. But the treadmill quality would disappear entirely if the purpose of the study were to dig into the archives and add to the wealth of history the records of man's achievement rather than the record of his wars, his dilections, his foibles, and his vanities. Why not look upward for our high lights? Imagine the joy of being Latin teacher in a school of which the graduating class annually contributed a record of man's advancement in medieval times! There would be no room in it for boys who couldn't

study the language or who did not care for it. It would hardly include all the boys in the form, but think what a class it would be! And the material for this work is ours for the seeking.

It is always pleasant to think how we may lift up all mankind by our own great merit, and how, when we have done this thing, everybody will be sorry when we die. As boys, most of us dreamed of splendid conquests without reference to betterment, by our own power and might, just as though we had been so many little Hohenzollerns; but when we grew older and discovered that the power and might were not ours to command, we thought how we might win esteem and authority by subtlety or wisdom or goodness, according to our respective natures. Most of us, even though we be gray-haired and rheumatic and short-winded, are still prepared to bear the responsibility of greatness, if it should come to us. We never cease to be children. Sometimes, however, it is more profitable, even though it is not encouraging, to look inwardly and take an inventory of what we find. It is better to do this than to try to run away from ourselves or to engage in vain and unprofitable boasting. As men of science and, more particularly, as chemists, let us take such an inventory now. We hear some of our defects frequently enumerated according to the lights of the classical Old Guard, and while they are intense and severe and sometimes a bit monotonous, they are neither complete nor, to my thinking, are they correct.

For instance, in nearly every plea for the humanities that I read in current periodicals the burden of complaint against science and the teaching of it is set forth in allegations as to what Dr. Abraham Flexner thinks. Of course it is not given to us to know what any one really thinks, although one of the purposes of education is to enable us to construe from the spoken and written words of others a reasonable intent of their statements. But if Doctor Flexner, who is himself a ripe scholar in the humanities, really thought the thoughts attributed to him, he would be entitled to the grand prize for idiocy among all

the men engaged in education to-day. I have read many of his writings with great care, and have discussed problems of education with him at length, but I fail to discover in him the thoughts his opponents declare him to have. Indeed, he frankly denies both the thoughts and the motives; nevertheless, the trained minds of a considerable number of fighting classical scholars insist that he is, in effect, the enemy of all art.

Instead of engaging in polemics, let us humble ourselves and consider more intimately some of our real shortcomings. We speak an insufferably ugly language. It lacks both grace and form. Many of our words in constant use surely have no place in gracious speech. Who cares if they are in the dictionaries? Even so, we have no right to disturb the air with offensive noises.

Another fault of which many of us who think and write of chemistry are constantly guilty is a certain Latinized awkwardness for which we have no other excuse than esthetic inertia. Let us indicate a sentence that might well pass without adverse comment if it were addressed to chemists—so shiftless we have grown to be: "*After crystallization and filtration the utilization of the filtrate is recommended for lixiviation until saturation is reached.*" Such a sentence has no place in good society, grammar or no grammar! We know very well that words with these endings should be avoided when it is possible to do so; but we go right on using them, almost, it would seem, as often as we can, and coining as many as suit our convenience, just as though we were so many Germans! I respectfully propose the study of chemical rhetoric as needed by all of us.

For years we have been familiar with catalysis, the most social of all phenomena of matter. This is an idea teeming with poetry and humor—for human catalysts abound everywhere—but we have not used the expression except to explain the occasional reactions of platinum sponge, precipitated nickel, and a few other bodies of whilom catalytic disposition. We must, indeed, be dull people if we have a concept of this sort and do not use it every day. The process is known to every school-boy

who has studied elementary chemistry. It has to do with certain bodies which, by their mere presence, cause reactions to take place which would not do so otherwise. Let us imagine two bodies in a solution, which should combine, but, somehow, do not. We shake the solution and heat it, and nothing happens. Then we add a minute quantity of the catalyst and, presto! the whole solution froths up and some of it spills over the side, so violent is the reaction! The very thing that we planned to happen does happen. And the little quantity of the body which we call the catalyst is found all unconcerned and unchanged at the bottom of the vessel. When chemists were at work on the technical synthesis of indigo it seemed reasonable to start with naphthalene as the raw material. Naphthalene was cheap and large quantities of it were available. But it was impossible to induce the desired reaction to take place. The research chemist watched his temperatures carefully, when, suddenly, his thermometer broke and a drop of mercury fell into the beaker. He began to sputter with annoyance, when the very thing he had been wishing for took place right before his eyes. Mercury was the catalyst, and his problem was solved.

Now think of the human catalyst! Suppose we sit around a table on a rainy day. Everybody and everything is dismal. The world, in the eyes of every one present, is dreary. Then somebody comes in, wants to know if he may sit down, tells a story, and in five minutes' time he has the entire mental atmosphere changed. The cloud of gloom is dispelled and we, who were despondent before, are now become cheerful and full of hope. The man who came in last was a catalyst. And there are catalysts unto gloom as well as those who instigate reactions of joy. Every one of us knows more human catalysts than are recorded of matter in all the books of chemistry.

We do well to honor the old Scotchman, Doctor Brown, but why, oh, why, have we no better name than Brownian Movement for the remarkable phenomenon which he first observed—this perpetual dance of the colloidal particles which the ultra-microscope shows us? Here is the kinetic theory of matter

made manifest! Here is the unending whirling swirl of the universe in evidence, as distinct, as inevitable, as the rising sun. Think of the poetry, the romance, which all humanity has developed in connection with the morning and evening twilight! Where is the poetry of the Brownian Movement?

Osmosis is another social process. It is a curious kind of an inherent drive within things, and the measure of this drive is called osmotic pressure:

Osmosis is the gentle art

Whereby, as you should know,
A substance sidesteps to the place
Where it would like to go.

Please take it for granted that sugar such as we eat is what is called crystalline, whereas starch is colloidal in its nature. We need not discuss these differences at this time. Let us dissolve a little of either sugar or starch in some water in a beaker or cup. Now let us insert a tube into the solution, the lower end of which we have closed tight by means of what is called a semi-permeable membrane bound upon it. In a little while the water will enter the tube through the semi-permeable membrane and even rise, within the tube, above the level of the solution in the cup. Only the solvent, the water, goes through. The solute, whether it be sugar or starch, remains behind. Neither crystalline nor colloidal can get through this wall which lets in the water until it is driven above the surface of the solution surrounding it. The force which drives the water up until the weight of the column of water within the tube brings it into equilibrium, is known as osmotic pressure.

Now let us use a permeable instead of a semi-permeable membrane, and perform another experiment. That is, considered as a filter, it must be coarser than the other. We divide an open dish into two parts by means of a permeable membrane. This must be nicely done so that there is no passage from one side to the other except through the wall. Then we fill one side with a solution of sugar and starch in water and we pour pure water into the empty side to the same height as the other. Right away the crystalline—the sugar—will proceed to diffuse through the wall and

keep the process up until there is the same amount of sugar in solution on either side of it. But the starch, being of a colloidal nature, cannot get through at all. It is held back. Again, let us observe these more or less permeable walls of society, permeable to some of us, but forbidding to others. The world is full of them—and every one of us has felt them. Vain old ladies are adepts at fashioning them—to keep certain persons out while letting others in. Observe the osmotic pressure of some persons to get through almost anything permeable! And yet we have no better word for this dividing wall through which crystalloid substances pass freely, but which bars the way for colloids, than permeable membrane. Have we no imagination? No humor? No wit? Here is a great series of phenomena, familiar to all of us, with laws that apply to complex human organisms as definitely as they do to the minute particles which we imagine and compute, but, somehow, we have not grasped their significance; or, if we do grasp it, we remain speechless before the unfamiliar task to expound.

So we who follow science should be modest and acknowledge our shortcomings. We have neglected the humanistic side of science and it will be wholesome to admit it. We have let ourselves be led by the Germans in this respect, whose ruling *Mephistogeist* has denied that there is such a thing. We must shake these German fetters from us and address ourselves diligently and thoughtfully to the great task of bringing chemistry into the humanities. Thus far we chemists have been too narrow in our outlook, and we might as well know it, whether we acknowledge it or not. We are bound to be workers in the hive of progress; we cannot afford to sit back and rest in luxury, because there is far too much for us to do. But if we persevere in our efforts toward the light, maybe we can even influence our friends of classic scholarship to take a more cheerful view of the world, to wander out and get the morning air, to infuse life into their studies, because none needs the benign influence of the humanities more than do the students of science. Then, if teachers of science do their

work earnestly and well, teachers of the classics may take fresh heart and do likewise. They may be less willing to give up Greek than they are now, and this is important because students of science need above all other things that very type of culture which is found in Greek literature.

Our present business, however, is to consider the chemists of the future, and we must address ourselves to a consideration of the means and instruments which we have immediately before us. The history of civilization based upon science is not yet written, and our young men are here. Many of them are about to become chemists, and the question what they shall study is important. If, as all too often occurs, they study only chemistry with just enough mathematics and physics to get through examinations, *and nothing more*, they cannot be regarded as educated in chemistry. They are merely trained in reactions, and all that we can say of them is that they have learned the laboratory trade. They are not chemists in the scholarly sense.

I venture the statement, therefore, that our young men who would study chemistry need at least a comprehensive grasp of Greek literature. The language still lives and it has the sound of rolling waters. There are whole realms of philosophy, of poetry, of drama, for us. There is a golden age made manifest and brought to life before us. Our young men need it unless they are so crippled by native awkwardness of mind that they are halted at the very concept of beauty. All of us who hold the graces of life in esteem need what the ancient Greeks have to tell us. Therefore, I suggest that if men and women of science set a diligent example—which is all that we can do—maybe those who teach Greek will also grow diligent and breathe fresh life into their work and bring to our boys and girls so lovely a vision of the golden age that it will enter their souls and enlighten them. They may make the subject so beautiful and engaging that imaginative young persons will not let the opportunity pass them by. The world of wrath in which we live to-day must be made endurable for later generations, and for this, above all other

qualities than sympathy, we need the clear illuminating thoughts of better days.

There is, indeed, a very practical side to the teaching of chemistry, because of its close affiliation with industry. And it is in industry that the scholarly man is needed, as we shall presently see. Every month we hear of new enterprises starting on a large scale in one place or another throughout the country. Aside from chemical factories, we find chemical work forming a part of nearly all branches of manufacture and commerce. The dry-goods merchant who lacks a working connection with a good textile laboratory can no longer keep up with the procession. He cannot tell his customers the fiber content, the tensile strength, the fastness of the color to light or washing, or the wearing qualities of the goods he sells. He can guarantee his wares if he is so minded, but if he would avoid loss by the return of goods sold, he must buy only from the mills of whose products he is certain. He cannot buy in the open market, for the reason that appearances are often deceptive. He must pay the premium that goods which bear a well-known trade-mark command, and even then his guaranty is an indorsement of the statement of some one else; it is an indorsement based upon faith and not upon knowledge. Sometimes, too, trade-marks are the only stable features of merchandise.

To-day the making of machinery is not completely done unless the maker knows the steel he is using, and if a machine is to stand wear and tear every member of it should be made of that very material which is best suited to the requirements which it is to meet.

Municipal wastes must be conserved. They *must* be conserved. Our only salvation from a plague of disease is to provide against the pollution with which we now surround ourselves. There are places along the East River in New York where the water is not changed by the tide, and its condition is already septic. Other cities are in like predicament, and we know well that this condition invites disease. We also know that where disease is bidden it is likely to enter. Conditions *must* be changed, and it is chemists alone who can change them.

So with chemical industries cropping out all over the land, with chemical control coming into vogue for nearly all the industries, with a change in the ways of trade under both statutes and custom so that *caveat emptor* is becoming obsolete and the rule is developing that the seller must beware that his goods are exactly as they are represented to be—the day of the chemist is at hand. He will be needed everywhere; in making things, in keeping them, in buying and selling them, and in the disposal of that which is not used.

What manner of man shall the future chemist be? He will soon be part of a group that is spoken of in general terms. He works mostly by himself. Suppose we take a Philistine view of him and train him accordingly, knowing that in great measure, whatever we think of him, that will he be. Because he is likely to work by himself let us say that he does not need social polish such as is required by physicians or lawyers—or by floor-walkers in dry-goods stores. Let us declare that no other collateral education is necessary except enough mathematics and physics to see him through. Let us begin early and turn out chemical journeymen whose business it is to obey orders and get stipulated results. We can provide just such workers in chemistry. They will not be able to express themselves; they cannot possibly rank as professional men; they will be ill-paid; their imagination will be crippled from the start and they will be dangerous withal. This is the Philistine plan for educating chemists, which is warmly advocated, and it is at once cheap and very appealing to the type of mind that looks upon the art of selling goods as the proper and legitimate focus of control and authority. Let us beware of it! And, as I said before, a man so educated is not a real chemist; he is a man who has learned the laboratory trade and no more.

Here we meet the great hazard of science, the danger that every branch of it may be regarded as a tool, but not as a great profession with obligations toward the general welfare. The real problem is, shall we take a broad view and regard the study and application of science as a part of life, recognizing its power for

good and evil, and recognizing that, no matter what we practise, we cannot dis-integrate ourselves from the body politic? Or shall we take a narrow one, such as we have called the Philistine view, and recognize no greater obligations than the man with the hoe, who plies his instrument for a certain time at a given wage, and there his part of the contract stops. There is no real progress to be made unless we insist upon it that degrees in science shall be awarded only to those who are familiar with the relations of science to human affairs as well as with the relations of various bodies to one another. We can't keep the teachers of science out of high-schools, and we do not want to. We want to teach science as widely as we can in connection with human welfare. We must establish new conventions of righteousness, and the substance of these will have to do with the relation of every act to the general welfare. Therefore the substance of my argument is that science be taught as a part of human life, as the key to man's relation with nature, and that it shall not be considered as a mere tool for the convenient accomplishment of good or evil save under the complete responsibility of the man or woman who wields it. Unless we rise to this level we shall be the victims of German ideals, which would be worse for us than a defeat at arms.

There is no such thing as a short and easy road to the mastery of science. Like art, science is long, while life is short. Understanding of it is not proved by university degrees, for the most learned are sometimes without them. The world of science is too great for snobbery, and that which is applied does not cease to be pure. We can all understand some of it, and no one can master it all. Therefore it behooves us to make it as simple as possible, so that as many as possible may understand as much as possible, and let us never lower our eyes from the high ideals of broad and catholic scholarship in science.

Nothing should prevent us from teaching chemistry to journeymen in machine-shops or in mills, to iron- and steel-workers, to factory hands, to everybody within reason who wants to learn it; but if boys and girls are planning to devote

themselves to chemistry, let us see to it that their minds are adequately ripened by cultural study to prepare them to enter the portals of this very learned and distinguished profession.

There is, nevertheless, a journeyman side to chemistry, and I think we should prepare for it. Laboratory workers in routine analysis are needed, and they can be trained for this in schools. Such a career provides a fair living, and it is no more monotonous than keeping accounts. If these journeymen have ambition and a real desire to become chemists, that is their privilege in their leisure. Those who have the energy and character to study by themselves usually have the good taste to study more than one subject, and we need not worry about their education. They are bound to succeed. Most of us, on the other hand, have noses only for the donkey-path, and we are disposed to follow along the road in which we have been trained to go. If we have been trained as laboratory helpers, without the theory and the vision of chemistry, then that is what we shall remain. If we have been trained as full-fledged chemists, then that is what we shall acknowledge ourselves to be, and we are likely to order our lives according to the standards which we have in mind. This brings us right back to the question that we asked a few minutes ago—What manner of men will our chemists be? What standards of culture, of art, of character, and of bearing will the next generation have in mind as indicating the chemist?

This is a matter of such great importance that it will have a considerable influence upon whatever civilization is to come, provided the world remains free. If we turn out mainly chemical journeymen, they will address themselves to good, tight pipe-fittings, and they may occasionally develop improvements in factory practice, but unless their imagination is stimulated in youth and brought into function in science, we cannot expect the graces of life to enter industry.

I think when we find, for instance, a better name for a permeable membrane, that it would be well to introduce the practice of osmosis into the class-room, and to divide the students who have

imagination from those who have not. The unimaginative ones should be encouraged to take the laboratory workers' short course. Let them become chemists by themselves if they can. But the imaginative ones, the boys and girls who are gifted with the glory of fancy, who have not sloughed off their curiosity during the years at school, as so many of them do, these should be entitled to the privilege of becoming chemists. They must have a sense of history, of people, and of things, because nowhere is nature inanimate; and if we do not understand the ways of people we cannot understand the ways of stuff. They must have good diction and facility of expression, because whoever lacks in this respect is an offender against his profession. He degrades it by his own shortcomings. And without facility of expression his most useful faculty, his imagination, is crippled.

Of course, men will call themselves whatever they please. We cannot legislate titles. But it seems to me of vital importance that only those students of to-day should become chemists who are properly equipped to meet the great responsibilities which are there to encounter. It is the coming profession. It must determine for us in the future what we shall eat and drink and wherewithal we shall be clothed. Whether we grow as an industrial nation or sink into decrepitude is in large measure dependent upon our chemists. If we grow, it will be because they are men of vision, of childlike curiosity and unspoiled fancy; men of taste, of discrimination, who are familiar with human reactions

and with the graces of life. They will be men whose long-range view is glorified by imagination. They will carry the subtle art of the teacher into the works and lead the men and women engaged there into the paths of understanding and delight. Then work in the factory will cease to be drudgery, and good housing conditions and fair wages will cease to be the maximum of merit demanded of employers—when this enlightenment prevails.

There is one great quality that was enjoyed in medieval days that is lost to us. It was that which made their cathedrals so beautiful, their fabrics so rich, and their every product so enduring and strong. Men sang at their work, because they found joy in it. Now we have different customs, different conditions, different problems, but in the very measure that our men and women who constitute parts of great industrial organizations do not find pleasure in their day's work, we have degenerated. If we would be great in industry we must make our industries great by making our workers intelligent and ambitious and fine in understanding. We must make it possible for them not only to produce things, but to see that they are producing. Therefore, if our chemists and engineers, who are to direct our industries, are wise men and so illuminated that they can show a light ahead to those who work under them, we may look for the dawn of a new era of peace and good will. That will be the day—and may God speed its coming!—when ideals of service will rule in our hearts.

The Débutante

BY CHARLES HANSON TOWNE

BEHIND the door of Winter
The Spring, on tiptoe, stands,
With daffodils and crocuses
And tulips in her hands.

She trembles on the threshold;
Then bravely lifts her chin,
As if to say, "I'm not afraid!"
And, laughing, rushes in.