

INDUSTRIAL EDUCATION FROM A BUSINESS STAND-POINT.

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An Address delivered before the Philadelphia Board of Trade and the Franklin Institute, June 6th, 1881. With additions by the author.

If I were to come before your Board of Trade with a statement that there had been discovered within easy access of Philadelphia a bed of iron ore, of vast extent, and of a quality far superior to any known deposit, if I could support this statement by the testimony of eminent mining engineers, if I should submit to you samples of iron and steel manufactured from this ore, and should produce vouchers from experts as to their superior excellence; and if I should further announce that the Baldwin Locomotive Works and the Phoenix Iron Works were ready to accept the product of this ore for their supplies, —I think there is very little doubt but that sufficient capital could be found here in Philadelphia to develop the enterprise. In accepting your invitation to speak before your Board of Trade this evening, I desire to present a subject of far greater importance to the material interests of this city and State than all the mineral wealth of the district; and if I cannot justify liberal expenditures in promoting it on grounds as substantial, tangible and practical as can be urged for investment in any of the mining enterprises of the State, I shall have entirely failed in my argument.

Before entering into the details of the discussion I wish to say a word or two in explanation of the term value, a term which I shall have frequent occasion to use. In a commercial sense, value means the price or worth of the thing bought or sold; in economic science—setting aside for the time being any discussion of the effect of supply and demand upon value—the value of an article may be said to depend upon the original value of the raw material and the value of the labor which has been expended upon it. And, further, the original value of the raw material is usually so slight that we may say, speaking broadly, that any particular value set upon an article, such as \$1 or \$10, means that an equivalent amount of human labor has been, as it were, detached from the indi-

vidual, concreted and put into definite shape for exchangeable purposes. One step further: human labor is but the expression of human thought. From the rudest kind of labor—labor which expresses hardly more than the force of mere animal push or pull—to the labor of the designer, the artist or the poet, all is but the expression of that wonderful human force which we call thought. Thus much being true, we reach the conclusion that human thought, as expressed by human labor, constitutes the principal factor in all values. As the full discussion of this statement will lead us to some important educational, commercial, and political considerations, I desire to make the point perfectly clear, and therefore invite your attention to a few illustrations of the manner in which thought creates values.

I hold in my hand a piece of steel. Its value is perhaps five cents. As yet it may be said to represent hardly more than so much raw material. In this hand I hold another piece of steel, of a similar quality, but less in quantity, and yet this latter has a value of twenty dollars. What makes this difference in value? Simply this, that human thought has been playing, as it were, about this latter piece of steel, and has made it the basis upon which it has concreted itself, so that we have an instrument of great practical use, a micrometer caliper—mainly the product of thought as expressed by skilled labor. Take this copper lamp. Here, again, we have perhaps ten cents' worth of raw material, carrying a value of five dollars, four dollars and ninety cents of which expresses the value which has been created by thought or skilled labor. In this porcelain vase observe how an insignificant value of raw material is made to carry a still greater value, created by thought. In this instance, we have a few cents' worth of clay transformed by skilled labor into a work of art, and carrying a value of over fifty dollars. Again, in these pieces of cotton goods, and in these Hamburg edgings, we have a few cents' worth of raw material, cotton, carrying values, created by skilled labor, a thousand fold greater than the value of the raw material itself. If we examine industrial products in any department, we find the same condition of things holds true—that the main value in the things made is the product of human thought.

As an extreme illustration of the great value of thought which iron and steel can convey let me quote the following calculation made by Dr. George Woods, of Pittsburg:

Seventy-five cents' worth of iron ore may be made into:

Bar iron, worth	\$5 00
Horse shoes, worth	10 50
Table knives, worth	180 00
Fine needles, worth	6,800 00
Shirt buttons, worth	29,480 00
Watch springs, worth	200,000 00
Hair springs, worth	400,000 00
Pallet arbors, worth	2,577,595 00

It is also to be noted in this connection that thought has made itself felt in commerce in the production of articles of beauty as well as of use. This vase, whose absolute utility is no greater than that of a common earthenware pitcher, is rated in the market at a value many times that of a vase of ordinary form and color—and the value of beauty, which thought has created here, is just as important, commercially, in these days of our higher and more exacting civilization, as the value of use which thought has perfected in this micrometer caliper. We reach the conclusion, therefore, that in industrial articles, whether they be for use or for beauty, it is the value of the thought expended upon them which principally determines their commercial value. And if we extend our observations, we see that this state of things holds true all about us. The room in which we are assembled, the building of which it forms a part, the contents of this building—what has given to them the value which they represent? Certainly not the raw materials of which they are composed; rather it is the thought which the raw materials are carrying. Step out into your streets, observe the contents of your warehouses and your stores. You find thought expressed in finished products, and you find also food and materials on their way to serve as a supply to this thought as it labors in the expression of its ultimate purpose. Look further. In your machinery and wonderful mechanical contrivances you have this same human thought attaching itself to the elemental forces of the universe, and subduing steam, electricity, magnetism, to the common service of man. Now, it is human thought acting through human labor, and vivifying it with various degrees of intelligence and skill, that is accomplishing these myriad works, and creating these myriad values.

With these illustrations before us, and with this survey of objects which surround our daily lives, we must see plainly that there are two factors which enter into whatever is produced by human hands—raw

materials and the thought which has made use of these raw materials. And we see, further, that of these two factors, thought is by far the more important, material being simply the foundation, or the basis, upon which thought displays itself. Bearing these facts in mind, if we look at the enormous industrial forces which are gathering in England, France and the United States, and observe how human thought is displaying itself in these activities, we may, perhaps, realize something of the commercial changes which are taking place about us, and of the more important ones which are impending in the near future; and we may reach some appreciation of what thought really means as an article of commerce, and of the effect which the development of human thought in industrial directions is likely to produce, morally, socially and politically.

Take England, for example. The careful student of modern English history must look to the trade and commerce of Great Britain for the true explanation of the great political questions which now agitate the English people; indeed, the Irish question, and the still greater question of land tenure in England, which lies behind it, are matters which will ultimately be adjusted by the commerce of Great Britain, and it is the industrial element in this commerce upon which the other elements mainly depend. England will be able to hold her own and to overcome the many forces which are now setting against her only so long as she can maintain the industrial supremacy which she has secured by selling the thought of her people. When her manufactures fail, she will fail irretrievably in her commerce, and many of her institutions will share in that ruin.

Although England is perhaps the most striking example of national dependence upon the concretion of human thought, we find it to be true in all civilized countries of the first rank, that the elements which go to make up national power are centering more and more around the industrial forces. It is upon these industrial forces that the leading States now rely for the maintenance of their political as well as their commercial supremacy; it is through the immense activity of the industries that the four quarters of the globe are being probed for food and raw materials, that methods of transportation and distribution have been developed, and that the huge manufacturing centres which play so great a part in modern political economy have reached their present importance. Industrial development has become, indeed, a profound national question. Under these circumstances it is not out

of place for us to study with much care the industrial development of our own country.

For the purpose of bringing the matter concisely before your minds, let me invite your attention to a few commercial statistics in regard to the relative wealth which England, France, and the United States are creating by the concretion of human thought in industrial labor, and the bearing which this wealth has upon commerce :

ENGLAND.			
		Imports.	Exports.
Raw material,	. . . . .	\$784,236,980	\$117,727 03
Food,	. . . . .	885,086,960	33,217 32
Manufactures,	. . . . .	174,894,340	854,093 19

FRANCE.			
		Imports.	Exports.
Raw material,	. . . . .	\$425,320,200	} \$250,838,600
Food,	. . . . .	364,721,800	
Manufactures,	. . . . .	84,183,600	347,098,200

UNITED STATES.			
		Imports.	Exports.
Raw material,	. . . . .	\$182,057,686	\$310,900,287
Food,	. . . . .	215,219,419	439,996,838
Manufactures,	. . . . .	247,065,378	73,081,365

It will be observed in the exhibits of England and of France that it is the manufactures which give life to the commerce of each nation, consuming food and raw material on the one hand as imports, and exchanging manufactured products on the other, as exports.

An examination of these statistics shows us that in the markets of the world England and France are great sellers of the thought of their people, while the United States sells but \$73,081,365 of thought, and buys foreign thought to the amount of \$247,065,378. It is true that the industrial power of the United States appears at some disadvantage in this exhibit, owing to the fact that most of our manufactures are consumed in our home market; but while this table more than suggests the industrial advantages which we have over England and France, by reason of our supplies of food and raw materials, it also makes painfully evident the fact that, in proportion to our opportunities, we are far behind the other two nations in the extent and variety of our industrial development.

Our inferiority in this direction was everywhere noticeable at the Centennial. I remember having been called to the Exhibition in March, 1876, before the opening, and meeting in the Main Building the manager of a New Jersey pottery. He was jubilant over the glories of his exhibit, and the certainty which he felt of securing a high award. Being at the building a month later I met this New Jersey potter again. He was standing before the English and the French exhibits of porcelain and pottery then just uncovered. I found he had experienced a complete change of heart. Frankly acknowledging himself beaten, he said, "I am going home to learn."

The Centennial is an old story, but it taught us many valuable lessons. What could be more suggestive to the thoughtful man than the general display made by Great Britain and her Colonies? Those who recall this exhibit will remember how, on coming from the western entrance of the Main Building, we first came in contact with the raw materials from the Colonies, and that Australia was conspicuous by its exhibit of a monolith showing in bulk the extent of its gold product. Every step forward was the putting behind of these raw materials and meeting a higher degree of thought and skill; until in the grand transept, in the exhibits of the Doultons and the Mintons, we found the very soil of England transformed by skilled labor, and bearing values far greater than that of the gold of Australia; while in the Elkington exhibit gold and silver themselves became raw materials on which to float thought expressed by skilled labor more valuable still.

At this Exhibition we were forced to recognize the industrial superiority of France as well. I am told that the poorest grades of cotton in the French exhibit surpassed the very finest cotton products which we had to show. It may be said that the development of our textile industries has only just begun.

Acknowledging, then, the general inferiority of our industrial development, as we must, save in a few directions, and acknowledging also the importance of industrial power to any great nation, the question arises, How can our industrial manufactures be promoted? I answer, *By the promotion of that factor which is the main element of value in them, human thought expressed by skilled labor.*

The nature of the thought required, and the manner of expressing it, are indicated by the industrial articles which we have been examining. Take this caliper, for instance. As we have seen, but a few

cents' worth of iron ore is here carrying a value, created by thought, four hundred fold beyond the value of the material. Now, in order to render the raw material—iron ore—suitable for this ultimate purpose, thought has played all about it, has brought great natural forces to bear upon its constituent atoms, and has recombined its inherent forces in a manner suitable to sustain the idea that thought has desired to impress into and upon it. Again, in the case of this vase, thought has been, as it were, playing about the raw material of common clay, readjusting its constituent elements to serve an industrial purpose, and the material, when thus reconstructed, has become the basis, as it were, upon which thought has expended itself in a purely æsthetic direction, creating great value by ministering to æsthetic tastes. Again, in this copper vessel we have thought working through skill; and, without changing at all the constituent elements of the material, it has created a new value by impressing thought upon the metal by the skillful work of the hand.

Thus we see that thought, to create these wide-spread industrial values, needs to be enriched by science, which shall inform it with regard to the constituent elements of the materials it has to deal with, and the nature of the chemical and physical forces which may be brought to bear upon them; and also by æsthetic art, that it may make use of the principles which govern the production of beauty. Furthermore, it requires the aid of graphic art, as a definite language in which to express its conceptions, and a knowledge of the manual arts, that there may be sufficient skill of hand to embody in the desired materials the thought expressed by graphic art.

Such is an outline of what is necessary for the development, enrichment and application of thought for industrial purposes. To elaborate the details of each subject is impossible within the present limits, and only the general features of each can be referred to here. Grouping them under the three heads of Science, Art, and the Manual Arts, the fundamental elements in each subject may be outlined and illustrated as follows:

First. In Science, a knowledge derived from practical observations of the laws and phenomena of chemical and physical science, such as light, heat, electricity, magnetism, mechanics, molecular motion, chemical affinities, quantitative and qualitative analysis, etc., etc.

These are some of the more fundamental features, and need not be more than referred to here.

Second. In Art, a knowledge of the features of graphic and æsthetic art, which are three fold in their nature and relate to

1. Construction, or how industrial objects are made.
2. Representation, or how objects appear.
3. Decoration, or the enrichment of articles by ornament for the purpose of increasing their value.*

Third. In the Manual arts a knowledge of the fundamental manipulative processes in dealing with raw materials. The worker in iron for example, must be familiar with the processes of bending, drawing out, welding, punching, etc.; and in wood work a knowledge of planing, cutting and splitting, sawing, joining, turning, etc., is essential. In steel work we have the following, among various manipulations: Filing to line; sawing and filing; free-hand filing; fitting; chipping, etc.

There are various industries whose manipulative processes might be educationally arranged in a similar way.

Having thus seen that in industrial products the most important and most valuable factor is human thought, having seen further that for the practical development of this thought it needs to be enriched by a knowledge of Science and Art, and equipped with a knowledge of the Manual arts, our next inquiry is, How can these results be secured?

Before answering the question directly—and especially as by our statistics we have brought the commerce of England and France into contrast with our own—let us turn our attention for a moment to what England and France, our two most powerful industrial and commercial competitors, are doing in the way of protecting their commerce by protecting and stimulating their industries.

A brief survey of their efforts in this direction will show us that to an extent far beyond what is comprehended in this country they are utilizing the forces of public education as tributary to this end. Our statistics show us that England is leading the whole world in commerce, and this through the industrial development which is carrying her commerce along with it. If we look carefully into the imperial

* These features were illustrated by a number of charts and drawings, showing how drawing is practically applied in industry.

The work in iron, wood, and steel was illustrated by examples of shop work from the Institute of Technology, Boston. The teaching of special or complete trades in this elementary construction was discountenanced.

policy of Great Britain, we shall find that this result is no mere accident, neither is it wholly the result of fortuitous circumstances.

It is a result which has been deliberately planned. For more than thirty years England has been spending immense sums of money for the avowed purpose of developing her industries through increased skill and taste. So systematic have been her efforts, so munificent her expenditures, that she has established industrial museums and schools of science and art by the side of every important industry in the kingdom, and has expended over \$20,000,000 in supporting them; and she is now supplementing these efforts by still broader provisions for the industrial education of her artisans in her national schools.

It is generally conceded that it is to these efforts that England mainly owes her present industrial supremacy.

If we turn to France, we find similar efforts in progress. In many respects the higher branches of technical education are better systematized and better developed in France than in England. At the same time, the trade education in France—that is, the training in the trades themselves—is broader than in England.

The recent efforts of England, however, through her national schools, will soon place her still further in advance. It may be said in this connection that France is endeavoring to meet England on her own ground, as will be seen by an examination of the recent provisions for public education in France.

If we were to extend our observations to Germany and Austria, we should find in those countries, also, the evidences of an earnest industrial arming. Indeed, Austria, a State which thirty years ago was behind nearly all Europe in education, is now looking to the development of industrial education with a liberality and a degree of practical foresight which challenge our most serious consideration.

To measure the exact effect in dollars and cents of such educational investments is, of course, impossible; yet it is the concurrent testimony of all who have given attention to the subject, that by such means only can industry be promoted in any broad way, while the results which have flowed from the efforts which have been undertaken, particularly in England and France, have been simply incalculable. If time permitted a study of the details of English and French commerce for the past few years it would be full of interest in this connection.

These facts show us that for industrial development—for the pro-

motion of thought in industry—public education is a most powerful weapon, and our commercial statistics tell us only too plainly that we in this country, with the most opulent material resources, and with a most intelligent and enterprising people, have hardly begun a course of industrial development.

For the purpose of substantiating the statement made in the beginning of these remarks, permit me to turn aside for a moment from the main argument, to bring this matter directly home to you here in Philadelphia:

I am assured that the annual product of your local manufactures is about \$500,000,000. If this be so, you have an immense interest at stake in this question, and if what I gather from some of your leading manufacturers be true, your industries are far from having reached their maximum development in the matters of skill and taste. This being true, the assistance they need, the *vital protection* they need, is to have more thought in them—a higher degree of skill and taste among the artisans engaged in them. By providing this thought and this skill they will be most securely protected, and I do not think it too much to say, with the results of European experience before us, that the expenditure of \$1,000,000 annually for broad industrial education would soon return you an increase of ten times that sum, in the enhanced value of your products, without additional cost for material, and with a reduction of cost in many directions. With such facts before you, with your vast industrial interests at stake, with the great activity of your industrial competitors on the other side of the water, aiming their industrial forces directly at your workshops, deem me not impertinent if I ask, What are you doing in the way of practically protecting your most important interests? Where are your schools of Science and Art, and your Industrial schools for artisans, such as you find at Birmingham, Sheffield, Leeds, Kommatow, Mulhouse, Creusot, Zurich; or your Industrial museums like those at London, Paris and Vienna?

This is a question for you to answer for yourselves. Without going into further details, you will agree with me, from what has been shown, that not only does your future industrial prosperity depend upon your securing more thought as expressed by skill and taste in your industries, but also that one of the most important matters which can engage the serious intention of your community and Board of Trade is this question of practical industrial education.

Turning now to the broader, or to the national aspect of the subject, the question arises, how can the education which we have seen to be so valuable, and which is being so earnestly promoted abroad, be introduced in this country?

I answer, it can be introduced in this country better and far more effectually than in any other country. We have simply to avail ourselves of our already established system of public education. By a readjustment of some of its features, and an incorporation therein of certain others, the main object can be accomplished. In this matter I know there are some difficulties in the way, and many prejudices to be overcome; still the thing can be done, and nothing is surer than the fact that the public schools will ultimately be made to answer to broad public needs in this respect.

In engrafting industrial education upon our public education we shall have a great advantage over our foreign competitors in this respect. Our general system of public instruction has already been organized. With all its drawbacks, it is free from many of the bones of contention which surround public education abroad. On the other hand, in promoting industrial development, the public schools will be advancing their own interests. They have of late received the fiercest criticism from many quarters, and the burden of this criticism seems to be that our public instruction is wanting in practical elements. But I cannot state this aspect of the case more strongly than it was stated in an address before the Franklin Institute in 1874, by one of its most honored members, Mr. Coleman Sellers, who summed up his argument by saying, "Our common school education gives us traders, gives us shopkeepers, but it gives us no artisans. I know not if this can be remedied, but I do know we require some other training for our sons and our daughters."

This feeling is so universal a one, and is so closely related to the subject in hand, that I trust you will pardon me for stopping a moment to show, in a graphic way, why it is that our public education is so practically out of joint.

In all education what is it that we educate? Where do we lodge the instruction? What particular organs, senses, faculties, do we develop? The effort is to develop thought. What is thought, and how is it generated? Thought is brain power. Thought in literature, commerce or industry is produced by the legitimate physical action of the brain, and to study the purely materialistic action of the brain

in generating and expressing thought becomes a primary consideration in all education.

Studying the functions of the brain, we find that for educational purposes it may be likened to an organism with a threefold form of working, an organism with a power of absorption, a power of assimilation and recreation, and a power of expressing or giving out. The force or character of a brain is measured entirely by its expressing power, by what comes out of it. Examining a little closer, we find that the brain absorbs through all the five senses, while for expressing purposes it makes use of but two of these senses, or rather of but two organs of these senses—the tongue and the hand. Fig. 1 is a simple

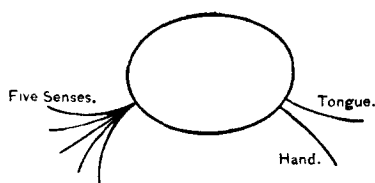


Fig. 1.

diagram representing a brain with the five senses placed on one side, as means of absorbing power, while on the other side the tongue and the hand are placed as organs of expressing power. The other function of the brain, that of assimilation and recreation, cannot of course be graphically represented. It may, however, be said to be the result of the action of the other two functions. Now the equipping of a brain, or the healthy education of a brain, consists in giving it expressing power through the tongue and the hand, coextensive with the power of absorption and the power of recreation.

Applying our popular schemes of education to the brain, and especially those based on the 3-R idea of education, we find what is indicated in Fig. 2, that provision has been made for greatly distending

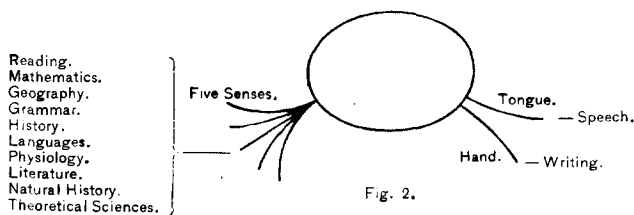
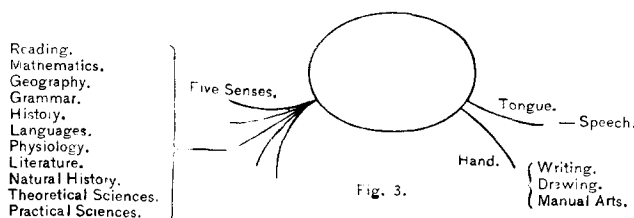


Fig. 2.

the absorbing side of the brain, while for the expressing side, the practical side, provision has been limited to the use of the tongue in

speech and to the hand in writing. If now we follow the result of this brain equipment into practical life, we find that speech and writing as means for expressing thought have their applications mainly in the commercial and financial employments and the professions, and only incidentally in the industrial and mechanical employments. With such an inadequate and one-sided brain equipment, it is not possible in any broad, practical way to bring thought or brain power to the service of industry. The fact so generally admitted that we are getting so few intelligent artisans or mechanics from our scheme of public education, that we turn out pupils of both sexes with a decided repugnance to industrial labor, is an attestation to the truth of this statement. The simple fact is, that our education is not broad enough on the expressing side of the brain, that too much attention has been given to the absorbing side of this organ, that no adequate provisions have been made whereby it can discharge its power in work connected with the industries.

In Fig. 3 a remedy for this defect is indicated in the addition of



the study of graphic and æsthetic art, through drawing, and of training in the manual arts, to the previous brain equipment. Observe where these features come in the scheme—on the expressing side of the brain and in the service of the hand, thus giving the brain ample power to discharge thought in its most complete form for use or for beauty. With these features added to the brain equipment its power of expressing thought in all practical directions will be coextensive with its absorbing and recreating powers; and just as soon as the public can clearly see that in the outcome of our public education there is no respecting of persons or of classes, that pupils are trained for honest labor with their hands as well as to living by their wits, are taught to produce something, to *create values* by the action of their brain through the work of their hands, a much deeper interest in public education will not only be manifested, but generous provisions for its support will also be given.

The practical solution of the problem we have been considering is not a difficult matter. It consists of providing better instruction in Science and in Art, and in making provisions for the instruction of our youth in some of the Manual arts.

All that is necessary in the instruction in Science and in Art is to reform the teaching in both subjects, and to make it more practical. Bring Science down from the High School to the Primary and Grammar Schools: teach it not by theory, nor even by the ordinary object lesson, but give pupils an opportunity to work with materials, to make experiments, and thus to observe the results which take place under their own fingers, thereby gaining knowledge as well as manipulative confidence and skill. All this is possible.

In teaching Art a radical reform should be instituted. Substitute for the dilettante drawing which cumbers many of our schools, systematized and practical work like that which we have been considering, and which finds practical applications in education in our industries and in true æsthetic culture.

In regard to training in the Manual arts, the question being one of comparatively recent growth presents more serious difficulty. The principal lines of work have been suggested and illustrated already; but that which has been accomplished in this direction has been done mainly in special mechanical schools like those of the Boston Institute of Technology, or of the Washington University at St. Louis, and a few other technical schools. The present problem is to bridge over the ground between the industrial training of the Kindergarten and that of these technical schools.

I think, however, that a full consideration of the question will show no insurmountable obstacle in the way of attaching like training schools to our public school system, or in the way of ultimately incorporating instruction in some of the fundamental manipulations in the Manual arts into a regular scheme of public instruction. Various efforts are being made to solve this problem, and with the general interest in the subject which now exists, I have no doubt but that the demands of practical public education will make themselves felt in this direction.

If my argument, then, be a sound one, we see that the material prosperity of this people, and especially of this community, is coming to depend to a very great extent upon the development among all classes of a knowledge of industrial science, art, and manual skill; that the promotion of this knowledge is fundamental to any broad material

development, and that as yet but very meagre provisions have been made for it.

We see also that the most efficient provisions which can be made for this education must be made in connection with the public schools; and that in order to give proper elementary industrial training in our schools, we must have more practical and universal teaching in Science, and more carefully systematized, more definite and broader instruction in industrial art; and that training schools in the Manual arts should be grafted upon our present system of school instruction.

These ideas are not new; many of them have been carried into practical effect, as we have seen from our illustrations; but although the subject is not a new one, it is one whose educational, whose commercial, whose political importance is now for the first time gaining recognition. The more careful the study given to this question, the more vital does the necessity for this development of industrial thought appear, and I do not feel as if I could emphasize too strongly the imperative necessity to our political and commercial prosperity of a judicious investment in this tremendous, this incalculable source of wealth, the development of the industrial thought of the nation.

A serious word just here. We hear much in these days about protection to American industry. If my presentation be a true one, we are to-day sadly unprotected against the industrial competition that is coming against us from Europe, a competition against which no tariff can alone protect us. Remember that it is not now the pauper labor, but the skilled labor of Europe with which we have to contend. Europe has been arming for this contest for years, and is now putting millions of skilled workmen into her workshops. Against such a competition no tariff can give adequate protection, and if I may be permitted to do so, I would suggest as a fundamental article in the creed of protection, *The industrial education of the American workman*.

One word more in explanation. I am aware that in stating the question thus broadly and practically, I lay myself open to the charge of advocating a materialistic education. Such, however, is not at all the result which I believe will follow. In a government like ours the development of good citizenship must always hold a foremost place in all schemes of education.

What is the basis of good citizenship?

It rests, in individual cases, primarily on the power of maintaining

oneself in the struggle for existence; and when you observe the complex conditions under which life is given to us to-day, when you consider the necessity which rests upon every mechanic and artisan of Philadelphia that he shall produce something by the action of his brain and hand, something which shall exchange with the food produced by the Illinois farmer on the one hand, and with the work of artisans or producers in other communities on the other, you see that the first condition for good citizenship on the part of your industrial producers here in Philadelphia is the possession of the power of supporting themselves by selling the expressions of their thoughts in iron or wood or steel or textiles. If it be not too abstract a thought, it may be said in this connection that the degree in which man becomes a good citizen, and the degree in which he becomes interested in the whole scheme of social and political order, can be approximately measured by the means afforded him for the creation of wealth and for the exchange of his products.

It may be alleged that I put even a material value upon citizenship. In one sense, I do. The material value of social and political order should, it seems to me, be the starting point for the consideration of the subject, for, with all due respect to theoretic sentiment, in these days when the rapid increase and aggregation of population in industrial and commercial centres are presenting new problems in social, political and economic science, the responsibilities of life are too real and too fearful to admit of our relying wholly upon theories of human conduct, however sacred or however venerable. Strikes among miners and trade-union operatives are the legitimate, wasteful and barbarous attendants of our present industrial development. These evils are not to be corrected by the establishment of Sunday schools or by the distribution of religious tracts. *We have first to deal with the people engaged in the industrial employments as men, having like interests, hopes and fears with ourselves. We must give those who live by the industries a fair chance; we must afford the men who are engaged in industrial labor an opportunity to live as men, and not as unthinking machines, or as ignorant beasts; and the first great step towards the reconciliation of labor and capital seems to me to be this,—industrial education.*

No, it would be an entirely false conclusion to say that the idea of education we have been considering tends to merely materialistic ends. It is true that its first object is to reach a material result through the

concretion of human thought, either for use or for beauty. In the process, however, the very foundations of human knowledge, we may say of human culture, are laid hold of. The mind of man is pressed by an inexorable necessity against the primal forces of nature, feeling "God's great hand in that darkness;" and in studying the constituent action of these forces, in learning to appreciate their infinite extent, their marvelous power, he is brought into direct contact with eternal things. Whether dealing with iron, or textiles, or precious metals, he comes at last to see that these very materials in their last resolution are but emanations of that supreme power, which, clothed though it may be in the phraseology of the "Persistence of force," or invested with the personality of Zeus or Jehovah, pervades all things.

Industrial education therefore, properly comprehended, means not simply the training for a trade, but the building up of a good citizen, who contributes by his thought, expressed by skilled labor, to the happiness of mankind. Trade and commerce are but servants to such a citizen, and by exchanging his products, they link him indissolubly to the preservation of social and political order, as mere accessories to the full development of his own spiritual individuality.

And this is industrial education from a business standpoint.

Variations of the Hydrogen Lines.—Rutherford first established a classification of stars according to the nature of their spectra by pointing out the differences in the hydrogen lines in different stars. Secchi confirmed his observations and showed that the solar lines, especially those of sodium, magnesium and hydrogen, vary in breadth and intensity in the neighborhood of Sun spots. The late beautiful researches of Huggins have also shown variations, in the violet and ultra-violet portions of the spectrum, which can only be studied by the help of photographic processes. Fievez finds, by experiment, that the breadth of the lines varies in proportion to the elevation of temperature, and that very slight traces of one or more elements can be detected by a sufficient elevation of temperature. In this way he finds that the C and F lines of hydrogen are each bordered by two fine lines, which form a triplet with the principal lines. He regards his observations as interesting, in view of the study of the harmonic or rhythmic structure of spectral lines, which has been pointed out in this Journal (vol. civ, p. 288, etc.)—*Bull de l'Acad. de Belg.* C.