1905

Normal College News, February 25, 1905

Eastern Michigan University
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Editorial from the News of February 18.

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Louis XIV Delivering to Chevalier de Cadillac the Ordinance and Grant for the Foundation of the City of Detroit, Presented in the Name of the French Republic by His Excellency, M. Jules Cambon, Ambassador of France to the United States.

Through the Courtesy of Mr. C. M. Button and the Michigan Pioneer and Historical Society.
Modern Views on the Structure of Matter.

Matter Nothing But Electricity.

B. W. PEET, M. S.

In very early times philosophers were interested in the structure of matter as a means of explaining common phenomena. Many guesses were made, but none were generally accepted until October 21, 1803, when John Dalton announced his famous atomic theory before the Manchester Philosophical Society.

According to this theory all matter is made up of elements or a combination of elements, and these elements, whether solid, liquid or gaseous, consist of a vast number of very small indivisible particles or atoms. The atoms of the same element have the same weight, the atoms of different elements have different weights and chemical action is simply the union or separation of the atoms of the elements.

Generally speaking, it is thought that atoms do not exist alone, but that the moment an atom is expelled from combination, it unites with some other atom or atoms; either with an atom of its own kind or an atom of some other element. The smallest particle of matter, therefore, which is capable of independent existence consists of a group of atoms held together by chemical affinity and these groups of atoms are called molecules. The chemist's conception of matter is that it is made up of an innumerable number of molecules, packed more or less closely together. In a solid like ice the molecules are in close contact, limited in their freedom of movement; in liquids, like water the molecules are farther apart and free to move about one another and conform to the shape of the receptacle in which they are placed; in gases they are still farther apart, and tend to separate almost indefinitely. But in all these changes the atoms which compose the molecule remain associated.

The above theory is the foundation upon which the science of chemistry has been built and aids in explaining a large number of scientific facts. Every college student has learned to think of the atom as the smallest division of matter, but if we are to accept the views presented by J. J. Thompson, Sir Oliver Lodge and their followers, we can no longer think of the atom as the limit of the divisibility of matter, but as a complex body made up of minute particles, sometimes called electrons and sometimes called corpuscles. Further, we are led to believe that matter is composed of electricity. Sir Oliver Lodge maintains that matter is electricity and nothing else; J. J. Thompson suggests that the atom is an aggregation of a number of simpler systems and that the corpuscle is a constituent of the primordial system and carries a definite charge of negative and positive electricity.

Sir Oliver Lodge says: "Our present view of an atom of matter therefore is something like the following:—Picture to one's self an individualized mass of positive electricity, diffused uniformly over a space as big as an atom.* * * Then imagine, disseminated throughout this small spherical region, a number of minute specks of negative electricity, all exactly alike, and flying about vigorously, each of them repelling every other, but all attracted and kept in their orbits by a mass of positive electricity in which they are embedded and flying about. * * * These oppositely charged electrons are to be thought of as flying about inside the atoms, forming a kind of cosmic system under their strong mutual forces, occupying the otherwise empty region of space which we call the atom—occupying it in the same sense that a few scattered but armed soldiers can occupy territory—occupying it by forceful activity, not by bodily bulk."

Atoms differ then only in the number of electrons or corpuscles which they contain. If the atoms of an element are such that they contain sixteen times as many electrons as hydrogen, we call the element oxygen, if they possess thirty-two times as many, we call it sulphur, and so on, the number of electrons being proportional to the atomic weights of the elements. The property of an element, then, depends upon the number of electrons it contains. It is evident that the heavy metals, like lead, uranium and radium contain a large number of electrons. In fact we have an overcrowded condition. The atom becomes unstable and gives off some of its electrons and we say the substance is radio-active.

All the elements are to be regarded as different groupings of one fundamental constituent. "The electron or corpuscle is the most definite, indestructible and simple unit which we know in nature. It has displaced the so-called atom of matter from its fundamental place of indivisibility." One must not make the mistake, however, of thinking that this new view of the structure of matter is to take the place or will overthrow the long accepted atomic theory. It simply modifies it.

J. J. Thomson has probably done more towards developing the present theory of matter than any other one man. Through painstaking and most refined experimentation and most ingenious measurements, he has given us the following interesting knowledge:

1. Each electron or corpuscle has a definite charge of electricity, about 1.66 x 10^-19 coulomb, and also a mass of 1.67 x 10^-27 kilograms.
2. The electrons are the same from every kind of matter.
3. Light is due to the sudden change of motion, either in speed or direction, of an electron and probably to no other cause.
4. Electric currents are due to the interaction of these little electric charges. They make their way through metals by being drawn from one atom to the next, as a fire bucket is passed from hand to hand, in liquids the atoms carry the electrons to the electrode, where it is dispersed and passes on through the metallic conductor.
5. The so-called cathode rays are nothing but flying electrons. When stopped suddenly by a massive obstacle, they give rise to the X-radiation or Roentgen rays.

The chief defect in the electrical theory at present is that positive electricity, if it exists, has never been isolated from the rest of the occult. Until this is done the hypothesis that the atom is composed solely of electricity must remain a hypothesis.

The complexity of the so-called elements has been maintained by scientific men for some time. In 1869 Sir Humphrey Davy suggested the combinatorial nature of the elements in a lecture delivered at the Royal Institution. Faraday hinted along the same line in some lectures at the Royal Institution in 1869.

In 1815 Lavoisier suggested that all the elements were built up of atoms of hydrogen, or that hydrogen might be the primal matter of the universe. Since Pictet's time there have always been scientific men who entertained the idea that all matter was made up of one prismatic substance, and if we are to accept the thought of our leading scientific men, this dream is about to be realized.

The complex nature of the atom was given further support by the discovery by Newlands (1869) and Mendeleev (1869) of the periodic law; namely, that the properties of the elements are periodic functions of their atomic weights, in other words, there is a periodicity in the properties of the elements when they are arranged in the order of their atomic weights. The property of an element depends upon its weight.

Further evidence is afforded in the similarity of the structure of the spectra of the elements in the same group in the periodic series. Spectroscopic evidence alone has led physical scientists to postulate the complexity of the elements. Many of the so-called elements give a very complex spectrum, i.e., several lines, and it is thought that a primary substance should give but one line.

Radioactivity of some of the elements carries the argument still further. It is now believed that the radiation from radium, uranium and other elements is due to the changes going on within the
atoms of the radio-active substances. It is possible that the overcrowded condition of electrons in radium causes a collision between parts of the atom, and electrons are thrown out of their orbits, just as every now and then among the stars two bodies encounter each other and a great blaze of radiation, or a temporary star results. Even in the atoms, where there is less crowded condition, electrons may be thrown out of their orbits, though less frequently, so it is possible that every kind of matter is radio-active to some extent.

Ernest Rutherford, of Montreal, has measured the projected atomic fragments of radium and found their mass to be the same as that of the element helium, and Sir William Ramsey, has witnessed the helium spectrum gradually develop in a tube into which nothing but radium emanations had been put. It is indeed interesting that one element should break down into another element. The dream of the alchemists, in a way, has at last been realized. We have always thought of the alchemist as working after the impossible, but the present view of the structure of matter teaches us that the properties of an atom depend upon the number of electrons, so if by any means we can change the number of electrons present in iron to the number found in gold, we shall have changed iron to gold. This, though improbable, is not altogether impractical.

Although this new view of the structure of matter is interesting to the scientific world and will explain many things that have heretofore been mystifying, it will not interfere with the physical welfare of mankind, so the general public give it but a passing thought. It teaches us, however, that something lies beyond us, that nature has no assignable boundaries. The so-called absolute or unconditional is forever beyond the philosopher's reach.

Some of Sieur de Cadillac's Troubles.

III.—Sketches on Michigan History.
Professor R. C. Ford,

The French in Canada very early recognized the strategic importance of the region bounded by the Great Lakes, and by a comparatively early date courageous Jesuit fathers had explored the country for the Cross, only to be followed by officials of France, claiming possession for the crown. As long as the fierce Iroquois held the shores of Lake Ontario, Niagara and Lake Erie, all entrance into the remote western country was along the famous canoe route of the Ottawa River, Lake Nipissing, and so on into Lake Huron. From this direction came the priests, traders, voyageurs and soldiers who settled Sault Ste. Marie and Michillimackinac. But after the Iroquois had been crushed by Frontenac, the greatest governor general that ever came into New France, it became possible to utilize the Lake Erie route westward, and the desirability of having a strong post on the strait (détroit) between Lake Erie and Lake Huron soon became apparent. With a station here all of the approaches to the Great Lakes country from the east would be completely guarded.

From time to time through the latter part of the seventeenth century plans were discussed by various governors looking toward a formal occupation of the lower strait, and as early as 1688 we find mention of a fort built by Du Lhut at the southern end of Lake Huron. But Antoine de la Motte Cadillac, who was getting to be a man of note in New France in these years, seems to have been the only one with enterprise enough to push the project.

Cadillac, born about 1660, was a Gascon gentleman of distinction, who had crossed the ocean in quest of adventure and fortune. He first served as a captain in the king's army in Acadia, then wandered further west and in 1694 was placed in command at Mackinac. From this time on the idea of a post near the northern inlet of Lake Erie became a pet scheme of his, and he worked most assiduously to bring it about. So insistent was he in the matter that in 1699 or 1700 he returned to France and argued his cause before the court at Versailles so successfully that he secured the favor of the king and his minister, Pontchartrain. He was commissioned commanding of the post he should establish, and various honors were assured him. But promises were as cheap then as now. He raised the flag of France over his new settlement at Detroit July 24, 1701.

It is not our purpose to review in any detail the events of his governorship at Detroit. We prefer, rather to dwell upon some of the almost forgotten experiences of his life in the west for the sake of their picturesque human interest.

His real troubles began at Michillimackinac, with the Jesuits, who were in charge of the mission there. Now, Sieur de Cadillac was religious, but his religion was of a kind that did not interfere with the practical things of life, as he saw
them. His attitude toward the Indians differed from that of other officers of the King, even that of the priests sometimes. He did not appear so much concerned about their life in the other world as in this world. In a letter dated at Detroit, Sept. 25, 1702, he says:

"How can these barbarians be made Christian, unless they be made wise first? How can they be made men unless they are humanized and made docile? And how can they be tamed and humanized except by their companionship, with a civilized people?"

It seems that shortly before Cadillac's appointment to Michillimackinac the Jesuit had raised the question of the sale of brandy to the Indians, and argued strenuously against it, because of the way it worked against their missionary labors. Louis XIV, and his ministers and bishops took up the matter and after much discussion referred it to the learned faculty of the Sorbonne for an opinion. Those scholars had settled weighty theological matters before, and this proved easy. Their verdict was to sustain the Jesuits in their contention, whereas the King promptly forbade export or brandy to Michillimackinac. We know exactly how Cadillac stood on this first Prohibitory Law in Michigan, for under date of Aug. 3, 1696, he writes from Mackinac in part as follows:

"In regard to the decision made by the court concerning the transportation of liquors to this place, I am far from daring to disapprove it; but nothing can induce me to be entirely silent on a subject involving so deeply the interest of the King."

He goes on to say that the post is beautifully situated, but that the location of the station, and the food, too, would make the use of brandy imperative.

"The houses are arranged along the shore of this great lake huron and fish and smoked meat constitute the principal food of the inhabitants, so that a lack of brandy, after the repast, seems necessary to work the business meals, and the cruelties which they keep in the winter. The air is penetrating and corrosive and without the brandy that they use in the morning, sickness would be much more frequent.

In all probability Cadillacl was never very fond of the Jesuits, seeing he was such an admirer of the Franciscans, and in the latter part of this letter he says some things concerning the Jesuit workers at his post which started a long train of annoyances for him:

"Perhaps it will be said that the sale of brandy makes the labors of the missionaries unfruitful. It is necessary to examine this proposition. If..."

From manuscripts collected by C. M. Murton of Detroit and published in vol. 33, of Mich. Pioneer and Historical Collection. The people of the stage are under great obligations to Mr. Burton for the valuable manual he has collected on Michigan History.

Sir;

"All that I have to answer at present, as to what you write to me of, is that what Father de Carbell and I have done has not been in order to hinder the settlement of your post, but to act for the best. You will perhaps know that too well hereafter, condemning your hasty accusations yourself ...

But there is another matter on which you should collect. Our Fathers with the Miamis send us word that they wrote to you by one of your men who wintered at their mission, sent on purpose, that the Iroquois, the Louspe, and the Hurons who are near you, and particularly the man who complains so loudly and whose complaints you listen to,—who apparently only makes so much fuss in order the better to conceal his own designs by fixing your attentions on us alone,—are acting in concert to establish at Sabeche an English post entirely opposed to that at Detroit. etc."

The Father Carbell mentioned hero was particularly troublesome and obnoxious, Cadillacl during the first few years of his stay at Detroit tried hard to divert the Indians and their trade from Mackinac to his post. In a report sent to the Marquis de Vaudreuil, Governor-General, under date of Aug. 31, 1703, he says:

"Thirty Hurons from Missihmludonic arrived here on the 30th of June to incorporate themselves with those who have settled here. Thus only about twenty-five of them remain at that place, where..."
Father de Carheil, their missionary remains ever resolute. This autumn I hope to tear this last feather from his wing; and I am convinced that this obstinate vicar will die in his parish without having a parishioner left to bury him."

And in a letter to Count Pontchartrain of same date he thus refers to the Jesuits:

"You wish me to be a friend of the Jesuits, and to have no trouble with them. After much reflection I have found only three ways in which this can be accomplished: the first is to let them do as they please; the second, to do whatever they desire; and the third, to say nothing of what they do."

But Sieur de Cadillac had other troubles besides those with the zealous Jesuits. In the management of his post at Detroit he was subjected to all the heart-breaking trials that can possibly be imagined. His garrison was kept depleted, stores were often short, people who had the ear of the Governor-General intrigued against him, the court failed to appreciate him, his own men were often unfaithful to him. The Company of the Colony which took over the trading privilege at Detroit soon after its settlement was glad to relinquish such a losing venture after a few years' monopoly.

In 1704 Cadillac, who had gone to Montreal on a visit was arrested at the instigation of the directors of the company, who were pro-Jesuit in their sympathies, and arraigned on various charges. The case dragged on for a year, and upon Count Pontchartrain's arrival at Quebec Cadillac appealed to him. Here he was exonerated, for in 1706 he was put in charge of his post again, and maintained in supreme control till his removal to Louisiana in 1710.

But as complete as was his authority, one may see from a perusal of his papers that the position was not a pleasant one. He was ambitious for his colony, and constantly alert for its best interests, but the heart of the wilderness was 1,200 leagues, as he said, from the king's favor, and the king's memory, and most of his fine schemes came to naught. When he went to Louisiana his property at Detroit, which was left there for his successors to enjoy, was inventoried as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A warehouse</td>
<td>3,000 Francs</td>
</tr>
<tr>
<td>Dwelling</td>
<td>2,500</td>
</tr>
<tr>
<td>Two other houses</td>
<td>1,500</td>
</tr>
<tr>
<td>A barn</td>
<td>1,200</td>
</tr>
<tr>
<td>A stable</td>
<td>500</td>
</tr>
<tr>
<td>A dove-cot</td>
<td>400</td>
</tr>
<tr>
<td>Ice house</td>
<td>300</td>
</tr>
<tr>
<td>Chapel and priest's house</td>
<td>3,000</td>
</tr>
<tr>
<td>Mill</td>
<td>8,000</td>
</tr>
<tr>
<td>400 arpents of land</td>
<td>40,000</td>
</tr>
<tr>
<td>29 cattle</td>
<td>9,000</td>
</tr>
<tr>
<td>Furniture, goods, etc.</td>
<td>7,000</td>
</tr>
</tbody>
</table>

76,400 Francs.

By 1720, when he was pressing his case at court his total claim amounted to 126,531 francs. His contentions were finally sustained and adjusted by the king and council a couple years later, but by this time the petitioner was dead!

The state of Michigan has a great mine of historical material in the collection of C. M. Burton, of Detroit. It is well known that Mr. Burton has spared neither time nor money in accumulating documents, manuscripts, maps and volumes dealing in any way with the history of the old northwest and Michigan in particular. The State Pioneer and Historical Society, of which Mr. Burton is president, through its publications, is popularizing much of this matter relating to the early days, and should be in the library of every school in the state. To secure these publications address the Michigan Pioneer and Historical Society at Lansing.
Sketches in the History of Arithmetic.

1. Number Symbols.

Professor A. L. Lyman.

There are three distinct stages in the historical evolution of number systems: (1) The objects themselves are presented, the idea of number not being separated from the quality of the object. (2) One group of objects is presented to represent the number of things in another group. (3) The idea of number is entirely abstracted from the objects and number symbols are used.

The Etruscans, when asked how many children he has will place them before his questioner as the most effective way in which he can enumerate them. There has always been an almost universal tendency to represent numbers by means of the ten fingers. This is the origin of the decimal scale of notation. When the human race became more advanced in civilization, symbols were invented.

The earliest symbols probably consisted of groups of strokes: || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || || |
With such cumbersome symbols of notation the ancients found arithmetical computations very difficult; the operations of multiplication and division being almost impossible. These symbols were little used except to record numbers.

The ancients did their computing largely by the assistance of the abacus. There were many forms of this instrument; but in all cases a plane surface was divided into spaces or columns and a pebble or other object represented different values in different spaces. (The Latin word for pebble is *calcining*, hence the word *calculation*.) Among the Greeks a pebble in the right hand space represented 1, in the next space 10, and so on. But 9 pebbles were placed in each space as 10 of them would represent 1 in the next higher space. The Romans used an abacus on which could be represented all numbers between 1 and 9999999 and certain fractions. Addition and subtraction by means of the abacus were comparatively easy, but multiplication and division, especially the latter, were very complicated.

It seems but a short step from abacal counting to the principle of local value and the introduction of symbols to represent the first nine numbers and zero. Yet it was not till about 1200 A.D. that arithmetical processes began to be simplified in Europe by the introduction of such symbols together with the principle of local value. It was three or four centuries later before they acquired anything like general use.

The origin of our present system of notation is obscure. The Arabs brought this system, including the zero and place value to Europe soon after the conquest of Spain. This is the reason that the numerals used today are called the *Arabic* numerals. The Arabs, however, did not invent the system. They received it and its figures from the Hindus.

According to Ball, the number symbols 4, 5, 6, 7, 9 and probably 8 are the initial letters of the corresponding numeral word in the Indo-Bactrian alphabet in use in the North of India about 150 B. C. 2 and 3 were formed by two and three parallel strokes written cursively and one by asingle stroke. For several centuries this system had no zero and consequently no place value. When the zero was introduced is uncertain, but it probably first appeared about the close of the fifth century A. D. The Arabs called the sign, 0, *Sifr* (*Sifra*—empty). This became the English *cipher*.

The Fraction.

Historically the fraction is very old. A manuscript, entitled "Directions for Obtaining a Knowledge of all Dark Things," written by Ahmes, an Egyptian Priest, about 1700 B. C. begins with fractions. In this manuscript all fractions are reduced to fractions with unity as the numerator. The first exercise in the book is $2/3=1/6+1/8$.

While the Egyptians reduced all fractions to those with constant numerators, the Babylonians used them with a constant denominator of 60, only the numerator was written with a special mark to denote the denominator. This method of zero and the substitution of the base 10 for 60 to become the modern decimal fraction. Sexagesimal fractions are still used in the measurement of time and angles.

The Romans used duodecimal fractions exclusively. They had special names and symbols for $1/12$, $2/12...11/12$, $1/24$, $1/48$, etc. To the Roman fractions were concrete things and they never advanced beyond expressing them in terms of *uncia* ($1/12$), *Silicu* ($1/4$ *uncia*), *Scrupulum* ($1/24$ *uncia*), etc., all subdivisions of the *as*, a copper coin weighing one pound.

The sexagesimal and decimal fraction prepared the way for the decimal fraction, which appeared in the latter part of the 16th century. About the middle of this century we find the square root of 10 given by Finaeus as $3162$. The author failed to recognize the decimal fraction and at once changed it to the sexagesimal fraction $3.9'43''$. In 1585 Simon Stevin, of Bruges, in Belgium, published *La Disme* in which he explained decimal fractions, extending the principle of local value below unity. Instead of the decimal point he used the notation $7_4^6_9$, or $7\circ 4\Delta 6\circ 5\Delta 9\Delta$ for 7.4659.

Stevin also advocated the decimal division of weights and measures, but it was more than two hundred years before his ideas were carried out in the adoption of the metric system in France. Joost Burgi, a Swiss, used decimals, probably independent of Stevin, in a work written about 1592. Beyer in 1603 used the notation $74659$ in English arithmetic decimals are not mention till 1631. Oughtred writes $7.4659$ thus $7\underline{4}6\underline{5}9$. The form $74659$ and $7465\underline{9}$ are also found. Kepler is said to have introduced the comma as a decimal point. Pitiscus first used the decimal point in his *Trigonometrical Tables* in 1612. The decimal fraction was not generally used before the beginning of the 18th century.

Weights and Measures.

It is curious to note what an important part the *grain of barley, or wheat* has played in the establishment of a unit of weight, both among the ancients and the more modern Europeans. In England as early as 1266 we find the pennyweight
defined as the weight of "32 wheat corns in the midst of the ear." Again about 1600 as "24 barley corns, dry and taken out of the middle of the ear." Still later the artificial grain (1.24 oz. Troy) is defined as "one grain and a half of round dry wheat." The Greeks made four grains of barley equivalent to the hekat, or carob seed. From this is derived the cent, the measure by which precious stones and pearls are weighed. The grain of barley and the eorat have been used by all European countries as the basis of existing weights.

Great inconvenience was long experienced from the lack of uniformity arising from the use of such units, so that Parliament in 1824 passed an act adopting the Imperial Pound Troy as the standard of weight. It was also enacted that of the 5,760 grains contained in the pound Troy, the pound avoirdupois should contain 7,000.

The unit pound is defined by a piece of platinum weighing exactly one pound kept in the standards' office. In case this is lost or injured it can be restored from the fact that one cubic inch of distilled water of 62° Fahrenheit, when the barometer is 30 inches, weighs 252.458 grams.

Calori in his History of Elementary Mathematics says that the name Troy is supposed to be derived from Troyes, in France, where a celebrated fair was formerly held, and the pound was used. Avoirdupois weight was established for heavy goods. The name is commonly supposed to be derived from the French avoirdupois, meaning goods of weight.

The ancients usually derived their units of length from some part of the human body. Thus we find the foot (the distance of the outstretched hand), the cubit (the length of the forearm), the foot (the length of the human foot), the span (the distance between the ends of the thumb and little finger when outstretched), the palm (width of the hand), the digit (breath of finger). The foot was subdivided into four palms and the palm to four digits. The division into inches, or twelve (a twelfth part) applied not only to the foot but to the pound.

For longer measures there was still less uniformity. We find the Hebrew's half day's journey, the Chinese 
\[\text{time} = \frac{\text{distance}}{\text{speed}}\]
the distance a man's voice can be heard upon a clear place, the Greek stadium, probably derived from the length of the race course; the Roman pace of five feet; the furlong, the length of a furrow. The mile fages, a thousand acres, is the origin of the modern mile.

In 1571 the inch is defined in English law as the length of "three barley corns, round and dry." Other other arbitrary measures of length were adopted by the government. The standard unit in England and the United States is the yard. It is a metal bar, kept in the standards' office, at the length of a second's pendulum in the latitude of London. The standard inch and foot are subdivisions of this standard yard.

Symbols of Operation.

Among the ancients there is a total lack of convenient symbols of operation. The Egyptian sometimes indicated addition by means of a pair of legs, 6 drawn as to appear to run towards the right. To indicate subtraction the direction was reversed. The Hindus used the dot for subtraction and the absence of the dot for addition. Addition was generally indicated by simply placing the number submarine to the number to which it was to be added. Other operations were written out in words. The symbols + and - were probably first used by Widman in an arithmetic published in Leipzig in 1489. He used them to mark excess and deficiency, not as symbols of operation. Stietzel used them as symbols of operation in 1544. The (x) as a symbol of multiplication was used by Oughtred in 1631, the dot (.) by Harriot in 1631. The Arabs indicated division in the form of a fraction quite early. The symbol (\(\div\)) was first used by Rahn in his Algebra in 1659. Robert Recorde introduced the symbol (\(\div\)) for equality in his Whetstone of Witte in 1557. Rudolph used \(\times\) to denote square root in 1526. and \(\div\) were used by Harriot in 1631. The vinculum was used by Vieira in 1594; and the parenthesis by Girard in 1626.

Herbert and the Science of Education.

III. The World's Great Educators.

Professor C. O. Hoyt.

The seventeenth century, through Descartes, Locke, Spinosa, and Leibnitz, had seen the beginnings of a new philosophy. Comenius had opened the way to a new education. "Bacon and Descartes had freed natural science, Hobbes the state, and Grotius the law from the authority of the church and had placed them on an independent basis." England had elected a king.

The eighteenth century was an age of revolutions. Not only did the world witness the overthrow of the absolute monarchy in France; but the establishment of a new one in Germany. In
the new world a republic had been born and a
constitution, the first of its kind in the world,
had been adopted by the people.

Learning flourished because great and grave
questions were at issue, for there are revolutions
in the social consciousness as well as in govern­
ments. In France, Rousseau and Voltaire each
taught the doctrine of individualism, the one from
the standpoint of the feelings of man, the other
from the standpoint of reason. These influences
had come from England and from France, then
spread to America, and with Franklin, Jefferson
and Adams, as leaders, found expression in the
realization of a growing national ideal. In Ger­
many, the exile woke the Königsburg philosopher
from his dogmatic slumber. He saw plainly that
education was not world appropriation, but world
building. The burning question was no longer,
How does the world get into the mind, but, How
does it set out the mind? “This was as great a
change in the spiritual world as the Copernican
astronomy had been in the material.”

The growing educational ideal now became
formulated in Kant’s message to teachers: “Let each
soul build up within itself a coherent and rational
world, so that it can lead a free, moral, natural
life in the society of other souls.”

The Swiss Reformer, inspired by Rousseau,
captured the spirit of freedom and began, instinct­
ively at first, to educate humanity. He loved
humanity and aimed to regenerate society by
means of education. Neuhof and Vyeron became
the centers of influence for all time, and future
generations will look back to them as the begin­
nings of a new education. The “Leonard and Ger­
trude” and “How Gertrude Teaches” show the
first attempt to answer the problem set by Kant.

Pestalozzi, his contemporaries and his succe­
sors left a three fold work to be done, as follows:
1. The development of a psychology capable of
an immediate bearing on the problems of teach­
ing; 2. The scientific application of this psychol­
ogy to education; and 3. The revelation of the
possibility of making all the activities of the
school-room, including especially instruction, bear
directly upon the development of moral character.

This work could be done by no ordinary person.
The times demanded a man, who was able to for­
mulate principles that could be practically applied.
A philosopher educator was needed. That man
was found in Herbart, who gave to the world a
Science of Education. As Socrates, Augustine,
Bruno, Bacon, Copernicus, Descartes, Grotius and
Kant each had stood related to his own particu­
lar problem, so Herbart stands to the problem of
instruction.

Johann Friedrich Herbart was the only original
thinker of modern times who did not make the
study of pedagogy a matter of secondary consid­
eration. He brought every available power of his
theory and practice to bear upon it. He regarded
pedagogy as one of the essential constituents of
philosophy, because by it the value of ethics and
psychology as agencies of moral influence, upon
the individual in society can be demonstrated.

His life was an unusually simple and happy one
—always free from care and devoted to philosop­
hal thinking—a striking example of the German
scholar and university professor. We may note
the following epochs in his life: (1.) His boy­
hood and school days, 1776-1794. (2.) His uni­
versity life, 1794-1797. (3.) Private tutor in
Switzerland, 1797-1800. (4.) His preparation for
a professorship, 1800-1802. (5.) Professor at Göt­
tingen, 1802-1809. (6.) Professor at Königsburg,
1809-1833, and (7.) Professor, the second time at
Göttingen, until his death, 1833-1841.

Herbart was born at Oldenburg, Germany, May
4th, 1776. His mother was a woman of strong
will and great intellectual power and was conse­
quently well fitted to direct the education of her
only child. Very wisely, she chose her son’s first
private tutor, one Pastor Uelzen, who did much
to stimulate the boy’s native interest in philoso­
phy, by the clearness, definiteness and continuity
of his teaching.

As a child Herbart showed wonderful powers of
comprehension and remembering, displayed an un­
usual interest in mathematics and natural science,
and possessed not a little musical talent. An essay
on Human Freedom, written by him at the age
of fourteen, indicates an intellectuality which
characterized him in life. He entered the Gymna­
sium of his native town at the age of twelve and
remained there as a pupil until he was eighteen.
His teachers reported of him that “he was distin­
guished among his school fellows for order, good
conduct and unceasing industry in developing and
improving his excellent natural abilities.”

After leaving the Gymnasium he entered the
University of Jena, to study jurisprudence. It
was his father’s wish that he should pursue this
line of study; but not in harmony with his own
inclinations. At this time this university was the
center of philosophic thought and culture. Fichte
was a professor of philosophy and became Her­art’s teacher, who, while he always held a high
estimate of his teacher’s genius, very soon broke
away from his Idealism and became an original
and independent thinker. He now began a study
of the Homeric poems and thus early in his ca­
cer formed the opinion that they should be em­
ployed for the beginning of education. His
mother resided with him in Jena and through her
influence, he formed friendships with many distinguished men and professors, among whom was the poet Schiller, who was a professor of history in the university.

After three years of study in the University of Jena, and before he had completed his work, he returned to Switzerland, where he became the private tutor of the sons of Herr von Steiger, the governor of Interlaken. The education of the three boys was left entirely in his hands, the sole condition being that he should render a bi-monthly written report to his employer of the character of work, the methods employed and the progress of his pupils. Of the twenty-four letters written, but five remain, but these contain the outlines of a course of education based on psychology. Here he came to know Pestalozzi, whom he visited at Burgdorf. His Switzerland period was a productive one from the standpoint of philosophy as well as pedagogy. He was concerned with the problem of self-consciousness, the solution of which laid the foundation of his metaphysics and led to a psychology. Though his experimenting with the boys and his close observance of them, he began the development of his theory of many-sided interest.

Owing to political reasons, in 1799, he resigned his position at Interlaken and went to Freiburg, where he lived with his friend Schmidt. He remained there two years and devoted himself to the study of philosophy in order to qualify himself for a university chair. Two important pedagogical papers were produced about this time: "An Essay on Pestalozzi's "How Gertrude Teaches her Children" and a Treatise on Pestalozzi's A. B. C. of Sense Perception (Ausschauung). The object of the first was to assist mothers in forming a correct notion of the value of Pestalozzi's book. The second was written on the conviction that the principle of sense perception (Ausschauung) was of supreme importance when it should be applied in a developed form to the whole of education.

Herbart obtained his Doctor's degree in Göttingen in 1803 and immediately qualified as a private lecturer and began to lecture on philosophy and pedagogy to crowded lecture room with marked success. On account of the marked attention which he attracted, he received a call to the University of Heidelberg. He refused this call and, in consequence, was made professor of philosophy at Göttingen. This was a period of unusual literary activity. In 1804 appeared The Moral and Ethical Revelation of the World and The Standpoint for Judging the Pestalozzian Methods of Instruction, in 1806 his General Pedagogy appeared. This was his chief work in education. In 1806 he completed his Practical Philosophy (Ethics).

In 1809, the chair of philosophy in the University of Königsberg became vacant and the position was offered to Herbart. He accepted. In regard to this position, quoting his own words, he says: "How happy I was to receive the offer of this, the most renowned chair of philosophy which, when a boy I longed for in reverential dreams, as I studied the works of the sage of Königsburg." During the twenty-four years spent here, he reached the height of his literary and professional activity. He was enabled to bring to a successful culmination a long cherished hope of linking theory and practice in education together, by the founding of a pedagogic seminary or practice school which should supplement his teaching in theoretical pedagogy. In this way he trained many men for inspectors, teachers and professors and his scholarship became a center of great influence. This epoch is characterized by the appearance in 1824 of his Psychology which is based on Experience, Metaphysics and Mathematics.

In 1843, owing to political reasons, he decided to seek a position outside of Prussia and accordingly accepted a call to Göttingen, for the second time, where he remained until his death. The greater part of his time in his later years was spent in the preparation of his university lectures, but he lived to see his system completed. The Outlines of Lectures in Pedagogy appeared in 1838 and completed and supplemented his General Pedagogy.

On August 9th, 1841 he delivered his last lecture. He died on the 11th. His students carried him to his last resting place, which is marked by a marble cross bearing this fitting inscription: "To penetrate the sacred depths of Truth. To strive in joyful hope for human good 'Was his life aim: Now his free spirit with the perfect light, Here rests his mortal frame."

In his opening lecture at Göttingen, in 1802, Herbart said there must be a preparation for the art of teaching by a study of the science. Only in action do we learn the art and acquire tact, address, quickness and decision; but even in action, only he learns the art who has in previous thinking learned the science." In accord with this principle did he build up a science of education, and in following the same principle his successors have extended, elaborated and applied this system. In his lectures on education—translated by De Garmo and Lange and the Folkins—and in De Garmo: Herbart and the Herbartians—we find the best exposition of his system of education.
which in brief outline is as follows:—(1) A system of Ethics and a Psychology as a basis of Education. (2) The Doctrine of Apperception. (3) Many-sided-interest. (4) The Selection of the Material to be used in Education. (5) A method of teaching, and (6) The Government and Training of Pupils. Let us consider each of these more closely.

Pedagogics as a science is based on ethics and psychology. The former points out the goal of education: the latter the way. An application of each to experience is thus involved. It will be seen that the fundamental presupposition of education is a child which is capable of being educated, that this child is plastic and at the same time self active, and that only man exhibits plasticity of the will in the direction of education. It is further presupposed that the teacher, by having in mind a definite aim and well defined purpose in education, and by understanding the laws of mental growth and control of the child, is to pursue such methods and employ such material of instruction as will give the child such experiences and ideas, that will lead him to right action.

Herbart finds the sources of will in the ideas arising out of experience and therefore moral character is a growth arising from experience as gained through knowledge and social intercourse. He says, "The term virtue expresses the whole purpose of education. Virtue is the idea of inner freedom and inner freedom is a relation between an inner perception of what is right and wrong and the execution of the act. Consequently his fundamental ethical ideas would be (1) The idea of inner freedom, (2) The Idea of Efficiency of Will, (2) The Idea of Good-will, (4) The Idea of Equity, or Prevention of Strife and (5) The Idea of Justice.

"Grouping these ideas in their individual and in their institutional bearings, we have for the Individual the conception of virtue. Virtue, therefore involves goodness, clear conscience, efficiency of will, justice and equity in private and in public life." DeGarmo—Herbart, p.54.

The work of the teacher is to develop these moral ideas and to induce the child to transform them into rules of life and conduct.

Herbart's psychology was not written until several years after his General Pedagogy appeared. It has a three fold basis.—Experience or apperception, methaphysics and mathematics. Much of it has little more than historical interest. It has undergone many changes and has served as a wonderful stimulus to thought.

The doctrine of apperception is fundamental. The mind is a unit and not an aggregate of all sorts of faculties. It grows solely through the growth of ideas, created within us through experience. The principle of self activity must not however be ignored. Apperception with Herbart is the assimilation of ideas by means of ideas already possessed. It has remained for his successors to develop these ideas. (See DeGarmo's summary of the present status of the subject, Herbart and Herbartians, p.38-41).

While the ultimate purpose of instruction is involved in the notion of virtue, there must be in order to realize this, a more immediate one set up. This is many sidedness of interest. Interest means self activity of the proper sort, which it is the business of instruction to incite. This is one of the most important elements in the Herbartian doctrine, in fact it is the core of the system. The reasons for this may be briefly summarized as follows: Volition is strictly dependent upon ideas. "Ideas become adjusted into apperceiving masses, with which are associated interests, desires and volitions. A volition is only an idea which has passed through a complete development, of which interest is an essential stage." "The teacher desires that ideas of virtue should develop into ideals of conduct."—De Garmo.

Herbart divided the various kinds of interest into two classes: (1) interests arising from knowledge and (2) interests arising through intercourse with others. He distinguishes three kinds under each. Under the first class (a) the empirical (b) speculative and (c) aesthetic, and under the second (a) sympathetic (b) social and (c) religious. Herbart says: "Empirical interest relates directly to experience; sympathetic interest to human association. Discursive reflection on the objects of experience involves the development of speculative interest, reflection on the wider relations of society that of social interest. With these we group on the one hand aesthetic, on the other hand religious interest, both of which have their origin not so much in discursive thought as in a non-progressive contemplation of things and of human destiny. "De Garmo and Lange, p. 76.

Under instruction he includes a treatment of its materials—the course and the method.

The materials of instruction are the literature and science that constitute human knowledge. Herbart's Switzerland experience led him to incline to the use of the Odyssey as a basis of material, but we shall see how Ziller and Rein have worked out the selection and arrangement of studies in a detailed way.

Herbart distinguishes three ways of procedure
in the process of instruction. (1) The merely presentative, (2) the analytic and (3) the synthetic. Again quoting from his Science of Education "the term synthetic may be applied whenever the teacher himself determines the sequence and grouping of the parts of the lesson; the term analytic, whenever the pupils’ own thoughts are expressed first, and these thoughts such as they chance to be, are then, with the teacher’s help, analyzed, corrected and supplemented." p 108.

The rule of the presentative method is “so to describe to the pupil that he will imagine that he has a direct sense-perception.”

Herbart discusses the subject of methods of instruction more from the standpoint of principle than in the concrete. We must notice these principles in order to understand how his successors have worked out their formal steps. All mental life consists in the reciprocal actions, relations and conditions of the ideas; it is the business of education to supply ideas, to assist in their arrangement, and to bring their proper relations into consequences.” The first step leading to this is the doctrine of attention, which he considers from the standpoint of voluntary and involuntary. The first is brought about through the effort of the will, in response to some remote purpose of the teacher. The second or voluntary attention is primitive or apperceiving. In primitive attention the idea arises solely through its own individual power. The sense impression must have sufficient strength. Excess of sense impression must be avoided. A rapid piling up of one thing upon another must be avoided and there must be restful "points. Apperceiving attention is that state of mind in which each new representation is brought into proper union or relation with those already present. Before setting at work always lead the pupil into a field of consciousness similar to that in which his work is to lie. Mental absorption and reflection represents the principle by which the mind gives up itself to an object of thought and then gathers them about the focus of self-consciousness.

The Formal Steps of Instruction are (1) Clearness (2) association (3) system and (4) method.

School Discipline

Professor S. B. Laird.

I.

A good school is an environment which furnishes healthy reactions along physical, mental and moral lines. The precluding genius must possess the qualifications of a man of general life. He must be a positive force, ever encouraging the good and discouraging the evil. To this end he must possess the qualities of self-control, sympathy, tact, patience and leadership. He needs to know well, not only the subjects taught, but also the pupils themselves, each one of whom is a distinct personality requiring for his thorough comprehension close and continuous study. The teacher should have a clear, well-defined objective point towards which the school is always tending. No two of these under his charge may be in the same stage of development, still he has a fairly true diagnosis of each case. While dealing with pupils on mass he adapts himself and his work to each individual as far as possible. He believes in his boys and girls collectively and individually, and cheerfully and hopefully works towards the realization of the self best wrapped up in each one of them. He is not unkindful of the forces which help or hinder in this important work.

Hence, associates, books, society, church—all exert a potent influence over the citizens of that little republic, styled a school. At times, each and all of these may contribute much along helpful lines, but more often some one at least exerts a disintegrating influence. How to utilize the favorable forces and counteract the unfavorable, will always be an earnest problem for any age or country.

In the management of his school the thoughtful teacher recognizes the relative values of authority, example and suggestion. He believes implicitly in self-directed activity, stimulated and guided largely by ideals which appeal to the pupils’ comprehension and ambition. He thinks of the pupils, whose work and conduct especially are more or less satisfactory, as occupying different planes of development due to will training. The freedom of the will to choose, to change points of view, to follow consistently some line of thought finds expressed or implied recognition in his creed. He has no hope of bringing them to their best estate, either in scholarship or character, without their intelligent choices of means and efforts leading to such desired ends.

School discipline, whose quality and quantity argue for the crystallization of human virtues, means a wise and systematic will training. To this end the rules of the school board and of the teacher, besides all legitimate means for their enforcement are at the disposal of him who is
in authority. A wise selection of means and a careful adaptation of the same to each pupil are essential to the highest success. The proper school atmosphere or spirit must not only be desired, but also generally realized. Cooperation, that mental and spiritual attitude emphasized by Froebel, must be in the school and abound. A beautiful comradeship of teacher and pupils based upon regard, courtesy and good will, is an ever present need. In its light the beginnings of desires to please, resolves to help and to do the right thing find nurture. Generous traits of character come to the surface and are formulated into habits in the presence of a kindly cheerfulness. Action, the essential law of all growth, finds its proper place and proportion. A happy coordination of body and mind thus makes for that true efficiency so much to be desired for American youth.

Scanning the school in thoughtful spirit, he finds many marked differences. Some are much nearer his ideal than others, but all require wise treatment. In all such little communities, determined either by age or mental attitude, will often be found those whose highest ambition seems to be self-gratification. Present enjoyment at expense of teacher or school is their ruling passion. Many rounds of the ladder of self-development must be gained before such a one is doing his best.

How and where shall the teacher begin to train such youth? He must wisely undertake a difficult task. He must place some healthy ideal before such, whose attractiveness shall lure them to exchange idleness for industry, and present pleasure for future good. This change of view will grow easier as habit comes to his aid. Steady, hopeful supervision, with its word of honest praise, works wonders. The transition is seen by all, and soon our troublesome ones have reached a higher plane. Some incentive, wisely chosen and presented, took hold of their ambition and the strenuous effort followed. Activity of a desirable kind and amount came to be self-directing, and the pupil started on the road to self-mastery.

While there is room for congratulations, the goal is not yet attained. To be industrious only when the teacher is near, to be orderly only in his presence, to be generous and kind only when some reward is in sight, is certainly not enough for a citizen of the world. A higher plane must still be sought. Slowly but surely must we stimulate him to climb to the heights, where a sense of honor and a sense of duty combine to control his efforts. A good story, true to life's conditions, which emphasizes fidelity to trust, heroism for principle, unflinching persistence, self-denial for the good of others, will often affect a beginning. Calling attention to the worthy lives of men and women about him, or to those whom history eulogizes, will, if wisely handled, often tend to continue him in his purpose. Since "virtue has its own reward" he will soon find from experience that the compensation is ample for all the sacrifices undergone. He thus becomes a "law unto himself," can be thoroughly trusted, and will not disappoint beyond the limits allowed for immature personalities. Scholarship and character are thus developed side by side, and many a youth owes his instructors a large fee in gratitude and love for aid in the solution of life's greatest problem—self-mastery.

In the realization of the above conditions, and they are not Utopian, there is room for the formation of such habits as contain a promise of success in any sphere of activity. A few that naturally belong to school life and also have the world's endorsement are: Neatness in dress and work; accuracy, frankness, generosity, truthfulness, promptness, persistence and economy of time and effort in the mastery of all tasks. With these habits the business world can have no quarrel, and by their aid the advancing years can collect toll of every passing circumstance and earnest effort.
The Educational World.

The preliminary announcement of the meeting of the National Educational Association has been distributed. The association will meet at Auburn Park, July 3 to 7. Superintendent W. H. Maxwell, of New York, is the president, and Superintendent W. H. Elson, of Grand Rapids, is the State Director for Michigan.

The program for the meeting of the Department of Superintendent has also been distributed by the secretary of the association. The department will meet in Milwaukee, February 28 to March 2. Superintendent Edwin G. Cooley, of Chicago, is president of the department. Some of the topics discussed are: Educational Features of the Louisiana Purchase Exposition; Means of Increasing the Efficiency of our Public School Work; Conditions which cause Variation in the Rate of School Expenditures in Different Localities; Group Morality; High School Extension. Merit System of Appointing and Promoting Teachers; Child Labor; Manual Training Work in Elementary, High School and College Curricula.

Saginaw County.

The Saginaw County teachers assembled for institute work on February 9 and 10. About 40 teachers were in attendance. Commissioner John C. Nafe manages to secure the attendance of almost every teacher in the county at his institutes.

The Saginaw City Training School is in charge of Miss Gertrude Louenecker, a woman who is thoroughly competent for such a position. Much is to be expected from students trained in this school.

The Saginaw Manual Training High school will be ready for business next September. This educational enterprise originated in the proposal of Mr. Burt, a wealthy citizen of Saginaw, to donate to the city the sum of $150,000 to be used for the establishing of a manual training school. The board of education of the East Side accepted the donation, raised $50,000 to put with it, and have constructed a building for the complete carrying out of the manual training idea. The building is equipped with rooms for wood working, metal working, a foundry, electrical work, sewing, cooking, a model kitchen, dining room and bed room. The manual training idea is not permitted to assume undue proportions, but it is to become an integral part of the high school curriculum. It is not to be substituted for big school work, but the high school work is to be enlarged and enriched by adopting as a part of itself the manual training idea.


It was for a long time questionable just where the manual training idea was likely to land upon the shores of the educational sea. Whether it should become an offshoot, closely related to the trade school, or whether it should finally affiliate with other educational subjects and enter as a part of the general educational plan, was a matter that could not be surely predicted fifteen years ago.

There seems now no question but that the tendency is to make the manual training idea a part, and a valuable part, of the ordinary work of every school. It is no longer a fad, but must be reckoned as an essential element in any complete system of education. Whatever constitutes an element in community life, may under our present educational ideals, with justice, claim for itself a place in schools which have for their aim the preparation of their students for community life.

The Summer Institute.

Shall a county maintain a summer institute for two or three weeks, or shall the county commissioner advise his teacher to attend the summer terms of state normal schools and other schools instead? It is probable that every commissioner debates this question with himself every summer. If no county institute is held in the summer, the probability is that a larger number of teachers will be induced to attend other schools, where better opportunities for study are offered than are likely to be found in the county institute organized temporarily, and continuing in session for two or three weeks only. On the other hand, there are always a large number of teachers who will not attend a summer school anywhere else, and who might be helped by attendance upon the county institute. The county institute will afford an opportunity for the teachers of the county to become acquainted with each other, and it will enable the commissioner to organize the work in his county more thoroughly than he can do it in any other way. It looks as if there is an opportunity for both kinds of teachers to be encour-
ed. It seems as if the commissioner could not afford to lose the advantages offered by the summer institute, and at the same time, teachers who feel a disposition to attend summer schools of higher institutions ought to be encouraged to do so.

The Batavia Plan.

The Batavia plan is receiving considerable exploitation in various educational journals in the country. The keynote of the plan is individual instruction. That the individual must be taught, and that any plan of instruction which fails to reach the individual is inevitably doomed to failure, is an educational principle hoary with age. To believe that this truth was revealed to a new educational prophet only six years ago, implies a very large lack of acquaintance with educational matters for the last quarter of a century. That there is something mysterious or strange in the Batavia system, that will make the teachers who adopt it equally successful, is not for a moment to be believed. Enthusiastic teachers, with great faith in themselves or in their system, will accomplish results anywhere that seem remarkable. On the other hand, equally enthusiastic teachers, with equally great faith in the contrary system, will accomplish results equally remarkable. It is not the system, it is the personality of the teachers, their enthusiasm and their faith in the work that they are doing that will command success with any system. It is not wise to look for an educational revolution from the adoption of the Batavia system, or from any other system. Nothing will bring about a revolution in a school except the influences that fire the teachers with enthusiasm and with faith in their work.

At a “festival” held at the University of Berlin on January 7, to mark the sixtieth anniversary of the founding of the German Physical Society, Mr. F. R. Gorton—our Mr. Gorton—had an important part. He demonstrated repeatedly and successfully, in presence of the assembled physicists from all parts of Germany, his new experiments concerning electric discharges in gases. There is no question that he has hit upon something new, which must modify all previous opinion on this head. A considerable portion of the great field of point discharge in gases he has thus made his own; as all previous work performed without the use of ultra-violet light, or radium, or any radio-active substance, must now be repeated and corrected. The radium used by Mr. Gorton in rendering his points sensitive was so small as to be invisible and yet it acted promptly. Mr. Gorton will return to this country in June and teach in the summer school.

The Teaching of Decimal Fractions

IV.—Teaching of Arithmetic.

Professor J. C. Stone.

From a logical standpoint there is no need of teaching common before decimal fractions. The decimal fraction may be treated as a natural extension of our decimal system to the right of ones’ place. However, the conception of $\frac{1}{10}, \frac{1}{4}, \frac{1}{8}$, etc., is more easily gotten than that of $1/10, 3/100$, etc., (i.e., 0.1, 0.03,) therefore from psychological standpoint, the teaching of the simpler common fractions should come first.

If the treatment of decimals follows that of common fractions, nothing new need occur in the development except the notation. To discover the laws of “pointing off” in product and quotient, one may simply change the decimal to the form of a common fraction and operate as with common fractions. For example, $0.3 \times 0.26 = \frac{3}{10} \times \frac{26}{100} = 78/1000 = 0.078$ by the notation of decimals. As this method is familiar to all, it will not be discussed here.

There is no need, however, of this change to the form of a common fraction. My own preference is to have the pupil discover the laws without this change; but instead of this, to discover them by considering that decimals are the natural extension of our notation to the right of ones’ place. To make clear the fundamental principles of our decimal system of notation, suppose we take the number 222 and proceed somewhat as follows: The 2 in the first place at the right represents what? The 2 in the second place, what? In the third place, what? Compare the value represented by the 2 in the second place with that of the 2 in the first place. The third 2 with the second. Compare the 2 in the first place with the 2 in the second place; with the 2 in the third place. If we call the second 2 ones, what must we call the first 2? If we call the third 2 ones, what must we call the first 2? The second 2? Suppose we call the second 2 ones, then what are each of the others? If the third 2 is ones, what is the number represented by these three 2’s? (Ans. 2 and 2 tenths and 2 hundredths, or 2 and 22 hundredths.) It is necessary then, before we can read a number, to know which of the figures is to represent the number of ones. We might denote this by a bar above the ones, thus, 222, or in any other convenient way, but the conventional way is make a period at the right of the ones. Thus, 222 denotes that the 2 to the left of the period is 2 ones. What, then, is the 2 at the right? The second 2 at the left?
Decimals have been denoted in several ways. The decimal point was first used a little less than 200 years ago.

Following this development of the notation have pupils read numbers to see if the notation is fixed. Thus, read 242.342, 2.342, 24.342, 2.342. Then take up the converse, i.e., write numbers from dictation.

Addition and subtraction come naturally when the notation is understood. If the fundamental principle that only like units can be added or subtracted is known, the pupil will naturally put the decimal points under each other. If not, then a few simple questions like, what figures represent like units? What numbers then can be added? How can we write the numbers so that like units will come under each other? What an advantage is this? etc.

Multiplication.

When the multiplier is an integer, there is no difficulty, for the multiplication is based upon the same considerations as when the multiplicand is an integer. The pupil knows that to multiply any unit does not change the unit, but merely changes the number of them. For example, let us multiply 2.5 by 7. Now, 7×5 tenths are 35 tenths, or 3 ones, and 5 tenths; the 0.5 is written, and the 3 carried to the ones' column; next, 7×3 ones is 21 ones: 21 ones + 3 ones = 24 ones.

To multiply by a decimal. To prepare for this, first compare such numbers as 26 with 2.5; 2.5 with 0.25; 3.1 with 0.34; 3.1 with 24; and in this way lead the pupils to discover the effect of moving the decimal point.

We are now ready to multiply by a decimal; that is, to find a part of a number. 0.7×3.16 means 7 tenths of 3.16. But the pupil knows that to find 7 tenths of a number means to divide the number into 10 parts and take 7 of these. i.e., multiply one of these parts by 7; so 0.7×3.16 is 7×0.1 of 3.16.

Now the pupil has just discovered the effect of moving the decimal point; hence he knows that if of a number is obtained by moving the decimal point one place to the left, hence 0.1 of 34.6 = 2.46. Then 0.7×3.16 = 7×3.16 = 24.22.

I have found that far less confusion arises in pointing off in the product when using this method. It is not even essential that the pupil knows that the "number of places in the product is equal to the sum of the number of places in both multiplier and multiplicand." He will finally come to see it and make use of it in the work, but there is no advantage in calling his attention to it too early.

Division of decimals. Since the division of decimals, when the divisor is an integer, is based upon the same considerations as in integers, the pupils will have but little difficulty here. For example, divide 0.03241 by 6. What is the first number at the left to contain 6? (Ans. 32.) What unit does the 32 represent? (Thousandths.) What, then, is the unit of the quotient? (Thousandths.)

Hence, it is seen that the development is the same as that of integers, for dividing a number representing any unit into an integral number of parts does not change the unit.

Now, when the divisor is a decimal, it may be changed to an integer, if at the same time a proper change is made in the dividend so that the quotient will remain unchanged. Suppose the problem is 0.315÷0.6. We may proceed as follows. What shall we do to 0.6 to obtain an integer? When then shall we do to the dividend that the quotient may not be altered by changing the divisor? Then what does the problem become if we change it so as to have an integral divisor, and yet have the proper quotient? (Ans. 5.25.) What, then, is the unit of the quotient? (Thousandths.)

My using this plan, the law for the relation of the number of decimals in the quotient to those in the dividend and divisor is not necessary, but sooner or later it may be observed. There is nothing gained by calling attention to such a principle.

In written work, there is a decided advantage in placing the quotient above the dividend, placing each quotient figure directly above right hand figure of the number in the dividend from which it was obtained. Thus for example let us divide 62.222 by 25.6.

Work,

\[
\begin{array}{c}
62.222 \\
-25.6 \\
\hline
36.622 \\
-25.6 \\
\hline
11.02 \\
-10.4 \\
\hline
0.622 \\
\end{array}
\]

\[
2.47 \\
266632.23 \\
512 \\
120.3 \\
1924 \\
17.93 \\
17.93 \\
\]

Development.

How may 25.6 be changed to an integer? How and why must the dividend be changed? State the principle.
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What is the first number at the left to contain 256?
What unit does 632 represent?
What then is the unit of the quotient?
Where may the quotient figure, 2, be placed to show that it represents two ones?
Where, then, with reference to the dividend, will the period of the quotient be written?

Observe that this device simplifies the pointing of the quotient. It is not, however, a device without reason, but is based upon fundamental considerations.

My own observation is that this treatment of decimal fractions is much simpler than the treatment of changing to the forms of common fractions. Since this method is based upon the very principles of our notation, and simple principles observed in the operations with integers, it is not so far removed from what the pupil already knows as to require the memorizing of new laws or rules.

While the other method is logical, the pupil after discovering the laws through the common fraction forms depends upon memory. The laws are so far removed from the fundamental principles which are well grounded that the work seems to me to be more mechanical.

Hints on Winter Nature Study
Mary A. Goddard, B. S.

It has been and is the prevalent idea that botany consists in analyzing flowers and is only to be studied in the spring and summer, an idea common in the Normal, as is evidenced by the greater number of students electing this work in the spring quarter. Important as it is to know the names of plants so we may intelligently speak of them and come to feel toward them as friends whose names are familiar, still this is a very small part of botanical study. What are reasons for teaching and studying botany? When we consider that we are either directly or indirectly dependent upon plants for clothing, fuel, the greater part of our food, often shelter; that to fungal and bacterial forms of plant life are due many of the diseases of both plants and animals; we realize the vital connection between our own and plant life, something of the breadth of the study of botany and the close relation in which it stands to human activities. So broad is the field, that in no locality or season of the year is there any dearth of material for study.

But it is not alone in an economic view that we see the vital relation of botany to life; it is an important educational force from every point. Prof. Hodge in his nature study writings and in his recent excellent paper on Dynamic Biology, published in the September Pedagogical Seminary, has so well expressed the value of this line of work and has advanced such practical ideas, that we may well call attention to some of his thoughts. He emphasizes the fact that the paramount value to be gained from any branch is "character, will to do good, power to create happiness. No lesson that does not contribute toward this end can claim the right to a place in the course." He lays stress on its economical value, for often parents can be induced to see the importance of this work, only as it appeals to them from a financial standpoint. It is a well known fact that the country has suffered severe financial loss through the destruction of its forests and that proper measures for the preservation of the remainder and the establishment of new ones, will mean great gain, not only financially, but in better climatic conditions. Scientific investigations show that crops are not merely being damaged by insect pests, noxious weeds and injurious fungi, but in certain localities some are in great danger of extermination. One infested orchard means the destruction of large numbers of others, unless vigorous measures are adopted. Nature study teaches the laws which govern these things, showing how these evils may be overcome, often by simple means. But nature study has a higher side than this. It has an aesthetic value. "Man needs the beautiful to complete his satisfaction in Nature." Our own lives testify to the truth of this statement. The doing of things with nature is an education which gives an interest close to the heart. To be working with nature means there is no time for temptation and evil. The social and ethical values of the work are many. Much evil is done through ignorance. If a boy understands the usefulness of birds his desire to kill them is replaced by his interest in studying them. Nature study affords opportunity for stimulating children to do their best, perhaps in the way of raising vegetables, and "to do a thing in the best possible way is an ethical matter." Finally this work should create a love for God. We agree with Prof. Hodge, when he says, "If we can find a nature study that shall insure a sincere love, we shall be laying the surest possible foundation for religious character."

Some one has said, "Life is education; conversely education is life." Prof. Hodge adds, "it is life itself." Then if we are to understand life we must know Nature, which is so large a part of life. "Largest values, both scientific and human, center about what living organisms do." The child should be given living things to study, and his work should center about his own neigh-
horizon and town. To him is given an opportunity to work with the rest of nature for progress. He may help in the development of the lower to the higher. Such forces of nature are birds, insects, moulds, blights and mis. give him abundant opportunity for studying living things, and the teacher need not fear letting the child study something of which the teacher knows little. Let him study such things as destruction of grain by fungi, the injurious black knot or the work of the earth worms, and thus bring information to the teacher, thereby developing a sympathy of purpose of benefit to both.

Now a few words as to what may be done in botany study in winter. There is much valuable outdoor study in connection with trees which can best be given while they are bare of their leaves. Trees in winter reveal a beauty and grandeur not seen in summer and vice versa. Children should be taught to recognize at least our common species in winter. Each may be dressed. They should learn to know them by their general shape, character of their bark, and nature of their buds. The last point mentioned is the surest means of identification in the winter, as a rule. Be brief with common-sense, studying many trees of a species before drawing conclusions.

Late in the winter branches from fruit trees, maple, elms, willows, lilacs, horse chestnuts and others should be brought into the house, thus forcing them to bloom early. See which ones can be forced him and keep a record of the order in which the buds burst. Some will be found to open weeks before the others. It is marvelous to see the various devices by which nature protects her buds and the process of their unfolding is intensely interesting and should be watched and studied carefully. Children should learn to tell fruit buds by their shape, so they can visit orchards early in the spring and make an estimate of the coming fruit crop. They should learn to read the age of the branches and the history of the trees by the scars. They may thus tell what years have been fruitful ones.

The shameful treatment which our beautiful shade trees have received at the hands of telephone companies and even men appointed by the town to do trimming should give us a realization of the need for developing in the hearts of the children a love for trees. Love of anything creates a desire to have it preserved in all its perfection and beauty. Let the children by extensive observation, determine how trees should be trimmed. Once thoroughly arouse them and the interest of parents follows, making them anxious to do their part toward preserving one of the chief adornments of any city.

It is a great to every tree layer in our little city to see the mutilated condition of many of its beautiful trees. Large branches have been cut away, leaving long stubs which make it impossible for nature to heal the wounds, so far are the cuts from the growing tissue of the trunk. The stubs stand there until decay sets in and then offer an easy path for the entrance of fungi and bacteria to the trunk of the tree. Their deadly work brings away there, and the days of the tree are numbered. This full a number of beautiful maples on Olive street were fearfully haggled in giving them a trimming they did not need. Great branches were chopped off, often two or three feet from the trunk, with an axe, and the bark was torn away for mile distances in several places. If it were not for indifference and ignorance these abuses could not be. This evil should be dealt with by law, but there will be no such law while people fail to understand the extent of the damage done or care too little to interfere. Teachers may, by instructing and arousing the children, reach the officers and citizens, developing a know ledge and civic pride that shall end this shameful devastation and mutilation.

Such indoor plant study may be done in winter. As space is limited I will only quote some important books and refer to books giving extensive directions. Some of the best study books before mentioned is, of course, indoor work. Now is a splendid time for studying seeds and their germination. Also such important physiological activities as plant respiration and oxygen may be advantageously be taught at this time. House plants in the houses may furnish some needed material. Many interesting experiments are described in such books as Stevens' text book, Bergin's Foundations of Botany, MacDougal's Plant Physiology and Gann's Teaching Botanist. Other valuable books for either this or the outdoor work are Coulter's Plants, Ladunga Native Life, Leavitt's Outlines of Botany and Bailey's Punting Boote. Valuable bulletins may be had for the asking of the Department of Agriculture, at Washington, D.C.
A Lesson on Paris
Mattie Alexander Martin, B. A.

I. AIM:—To teach the importance of Paris: to show that it is the political, manufacturing, commercial, and artistic center of France.
   To lay especial emphasis upon its importance because of its beautiful and historic streets, parks and buildings.
   To arouse an interest in these by telling the children a few of the many things which may be learned about them.

II. PREPARATION:—
   A. 1. Name most important city in Rhone valley.
   2. Reasons for a large city's being located here.
      a. Nearness to coal.
      b. Nearness to silk.
      c. Gateway from Mediterranean to many parts of Europe.
   B. 1. Name most important city on Garonne river.
   2. Reasons for its importance.
      a. In grape-raisinng region.
      b. Good harbor and nearness to ocean.
   3. What conclusion drawn from this?
   C. 1. Most important city on the Mediterranean?
      a. Why not situated at mouth of Rhone?
      b. Commands what trade?
      c. More or less important in this respect than Lyon?

III. PRESENTATION:—
   Paris, the greatest of all!
   Largest city on continent, third in the world, numbers more than 2,500,000 inhabitants. Probably more beloved and admired than any city in the world.
   A. Reasons.
      1. Situation.
         On Seine, where island facilitated bridging.
         River better than Rhone or Loire (slower and less subject to overflows.)
         On highway from Mediterranean to north.
         In midst of very fertile region.
         Near England and other important countries.
      2. Capital.
      3. The heart of France; the city which contains most around which the Frenchman's love and loyalty clusters.

B. Some of Paris' treasures:
   1. Champs Elysees (one of the most beautiful avenues).
      a. Great width.
      b. Beautiful trees.
      c. Flowers and statues.
      d. Exquisite neatness.
      e. Gaiety of people seen there.
   2. Louvre (Museum).
      a. Art treasures.
      b. Artists represented (only pictures of artists who have been dead ten years admitted).
   3. Hotel des Invalides.
      a. Soldiers' Home.
      b. Napoleon's tomb (description.)
   4. Versailles.
      a. Built by Louis XIV.
      b. Occupied by Louis XIV., XV., XVI.
      c. Interesting rooms.
      d. Halls now used for picture galleries.
      e. Neptune fountain.

IV. ASSOCIATION AND COMPARISON:—Other French cities and Paris as to—
   1. Commercial importance.
   2. Political importance.
   3. Artistic treasures.
   4. Love and devotion inspired in French people.

V. GENERALIZATION:
   Paris is the center of the political, commercial and artistic life of the French people.
   It contains the greatest art treasures in the country, and many of the greatest in the world.
   It is the most beautiful, the gayest, the most brilliant city in the world.
   It calls for the most ardent love and devotion of every Frenchman.

VI. APPLICATION:—
   If there is born a desire to read, to see more of this wonderful city, the lesson will have accomplished a purpose.

The above lesson was taught about the middle of the first quarter in the seventh grade, after the children had studied the British Isles and had advanced far enough in the study of France to come to the consideration of its principal cities.
It should be said, in passing, that in this grade physical geography is taught only as a basis for a study of the people of a country, their industrial, political and social life. Since this is the case, it is hardly necessary to explain the point of view taken in considering Paris.
It seemed wise to reach Paris by way of the third important cities considered in the preparation—those, of course, had been presented in a previous lesson, and the children themselves were able to show after a study of productions and industries, the reasons for the growth of a city in each of the several positions. It was desirable to have them discover for themselves, as many reasons as possible why Paris should be the greatest of all; it is interesting to note that they were able to give all of these reasons except the third; and in the last class in which this lesson was taught, one child called attention to the fact that another reason for Paris' importance was that "the French loved it so."

Under B. "Some of Paris' Treasures," the presentation was largely unbroken by facts elicited from the children; but reference to their own knowledge and experience was made as often as possible: for example, a comparison of the care of our best kept cities with that given to Paris; a suggestion that in our own school building could be found photographs of pictures and statues from the Louvre; a reference to our own soldiers' homes, and the reasons for their establishment.

The lesson is one which is not dependent upon school room accessories for its success: a map every school will be likely to have, and the only other requisites are children and a teacher—the substitution for the latter of a more hearing of classes bringing very disastrous results, instead of evidences of continued interest, and an effort to satisfy this by further questions and reading about this city which so fully justifies such effort to learn more of her.

Library Book Lists

G. M. Walton.

The convenient book lists in the educational papers, and the personal letter received by all librarians asking for help in the selection of books, emphasize the number and growth of school libraries, and also the necessity of reliable lists in more permanent form than either the irregular supply of the periodicals, or those received through personal appeal, etc.

Of all book list s—those with the personal element, that is the most satisfactory, for example, a primary teacher who had used the Normal College library, and had done practice teaching in the training school, would rely with most certainty on a specific list from the critic teacher under whom she had worked, and granted that the latter of inquiry were explicit as to the material wanted and the amount of money to be expended, and the grade of work covered, the amount of labor and time required (or demanded) of the critic, would be no more than the dictum which every man owes to his profession, "from the which," in the words of Lord Bacon, "as men do of course seek to receive continuance and profit, so ought they of duty to endeavor themselves by way or means to be a help and an ornamental thereto."

Another form of book list, if possible more personal and more valuable, is that which is made by the teacher when the particular book is examined, or recommended, and note is made, in some permanent form, of author, exact title, and publisher, and at least approximate cost, together with some annotations to show when and where and why the note was made.

One source of material that is within the reach of all, at a very small outlay of time or money, is the wealth of illustrated articles in magazines. These are almost as many dealers in old magazines, as there are booksellers, and often a magazine is a year old it can (generally) be bought for less than half price, of these dealers. Most reading lists contain references to Harpers' Monthly, St. Nicholas, and similar periodicals, and one's personal lists may very easily be enriched with such references. For example there is a fine article on Castle Life in the Middle Ages in Scribner's Magazine, vol. 5, No. 1 (January, 1888).

The dealers in magazines advertise in most papers: The Boston Book Company, Boston, Mass., is one of the largest and best.

There are many good lists in permanent book form, such as should be in the smaller school library, and on the very shelf of every teacher. Among the very best are the following:

Guide to the study and use of reference books: a manual for librarians, teachers and students, by Alice B. Kroeger, librarian and director of library school, Drexel Institute, Philadelphia. (Published by Houghton Mifflin Co., Boston, $1.25.)

The book is well arranged by classes, with directions as to the use of reference books, a suggestive list of 160 reference books, and a good index.

Classroom libraries for public schools, listed by grades, (from the first to the ninth inclusive) to which are added a list of books suggested for school reference libraries, arranged and published by the Buffalo public library, (address Public Library, Buffalo, N. Y., 25c.)

The book is divided into four parts, first, the lists arranged alphabetically by authors, according to grades, and giving publishers and price of each
The German Forests
Ida Fleischer, Ph. D.

No factor is of greater importance in the recreation of the mental and physical strength of the German nation than the forests.

From the most ancient times the German people have lived close to nature's heart. They worshipped their gods in sacred groves; their most venerable sanctuaries were the woods. There young Siegfried, a favorite of the gods, gained his manly strength. He learned the lessons of nature until his ear was so delicately attuned that he could understand the language of the birds. The knights of mediaeval poetry met their adventures in the forests. The sweetest gems of modern poetry would be insipid without their woodsy fragrance. German folk-lore without the mysterious woods were impossible.

About one quarter of the area of the German country is to this day covered with forests which are distributed through Germany quite evenly with the exception of the northern part of the country. This extensive possession of forest-land is considered by the people a most precious inheritance. Its importance in the economic and industrial life of the nation, its effect upon climate and soil, its significance in the physical, mental and moral health of the people, is in calculable. While we may express in figures the great material profits gained from the extensive timberlands, the greater ideal advantages are to be sought in the very life of the nation. P. D. Fischer, Under-Secretary of State, in the Reichs-postamt, says in a report: If we should point out in what the special charm of traveling in Germany consists, and what the traveler should see in Germany above all other things, we must mention the German forests in the first place, and think of their attractiveness in grateful reminiscence.

A brief description of one of the great forests may, perhaps, be in place here.

To the people of northern Germany the wooded Harz Mountains are most accessible. Whoever can, flees the close city during the summer months and swarms of tourists of all classes and conditions may be met at this time. The most delightful mode of travel, however, is afoot, encumbered by as little of the world's possessions as possible. On well constructed paths it is easy to walk through the densest forests from city to city, from village to village, filling lungs and heart, and soul with the balm of nature.

In the Harz Mountains, as also in the Schwarzwald, the dark needle woods predominate. The Black Forest has its name from this fact. Beeches, oaks, birches, ashes and wild fruit trees are interspersed.

The Harz Mountains possess great historic interest also. They belonged to the territory of the ancient Saxon dukes whose emperors built their residences in this beautiful region, and whose hunting horns resounded on the mountains and in the valleys. The first emperor of the Saxon line, Henry (919-936) was proclaimed king while he was on the chase, whence his name, the "Fowler." The "Finkenherd" in Quedlinburg marks the place to this day. Goslar was a favorite residence of the Saxon emperors. Emperor William 1. had their palace restored in the ancient style. One of the most beautiful modern castles in Germany is the possession of the counts of Stolberg-Wernigerode in Wernigerode. The castle and Grafschaft has been the property of the counts of Wernigerode since time immemorial (gerode, place where the trees have been rooted out; Wern, the name of the person by whom this was done). The southern part of the county Wernigerode contains the highest part of the Harz Mountains with the Brocken and the delightful Ilsethal. The
Harsburg, the ruins of which may still be seen on
the Burgberg, was built by emperor Henry IV. (1065-
1106). It was his largest and strongest fortress
from which he planned to bring his unruly Sax-
ians to submission. It is here that the conflict
took place between the emperor and his subjects,
between the Head of the worldly government and
the Head of the church. The proud Harsburg
was destroyed by the Saxons, and Henry had to
bow before the pope at Canossa. In memory of
the well known words of Bismarck, in the Reichst-
tag: "Nach Canossa geben wir nicht," a Canossa
column was reared on the Burgberg in the year
1875. Harsburg at the foot of the Burgberg is a
fashionable, modern bathing resort.

These mountains and forests are rich, indeed, in
historical reminiscences, but they are richer by far
in legend. There is no spot without its story. In
many cases history and legend are so inextricably
entwined that it is impossible to disentangle the
web: the castle in Wernigerode carne there by
a wish, the fountain in the market-place at Goslar
was a gift from his infernal majesty, the witches
still hold high Sabbath on the Brocken, and
Princess Lisa bathes in the brook and turns her
admirers into stones, the priest of the hoof of
prince Rode's giant horse will be visible till the
end of the world. Loneliness would be impossible
in these woods. They are densely populated with
dwarfs, gnomes, kobolds, fairies, giants and other
supernatural and enchanted beings. Where would
the metals come from if the little earthmen (Erden-
maenlein) were not melting them by the fires
in the center of the earth? Even the trees and
flowers are alive, and nod and whisper to you.

You are in the very land of phantasy, of fancy.

The Production of Artificial Silk

Ina A. Milroy, Ph. D.

Silk has always been the most highly prized of
textile fabrics. This is on account of its fineness,
lustre, its softness and rustle, and last but
not least, its susceptibility to coloring stuffs and
the ease with which the coloring process may be
carried out.

It is little wonder, then, that many have sought
to produce an artificial product, which could take
the place of the real silk, and still be less expen-
sive. This has not yet been accomplished. But
artificial silk is actually manufactured, which, while
it is not identical with the real article, still pos-
sesses certain important qualities of the same to
such an extent, that it is called artificial silk. Real
silk and artificial silk have an entirely different
origin. Real silk is an albuminous substance,

which is produced by the silk worm, while arti-
ficial silk is more or less pure cellulose. Chemi-

cally the substances have nothing in common, and
the mystic of the real silk is also wanting in the
artificial. On the other hand, the lustre of the
artificial silk is greater than that of the real.

The first experiments for the artificial produc-
tion of silk were made in the eighteenth century.
The results were of no practical importance. It
was about 1828 that Count St. Hilaire Chardounet
produced a thread from nitro-cellulose, which
equaled the real silk thread in fineness and lustre.
This product was shown at the Paris Exposition in
1855 and called "Sole artificielle." It was there
actually woven into cloth, and of course excited
the interest of all silk manufacturers.

The popularity of this artificial silk had, how-
ever, one drawback, it was easily inflammable—it
could even explode at the means employed to
remove this objection destroyed the lustre and the
susceptibility to dye stuffs.

In 1869 Chardounet succeeded in reducing the
nitro-cellulose with potassium sulphate, and
thus removed the tendency to take fire easily,
while at the same time the threads retained their
original lustre. It was some time, however, before
the new fabric came into general use, owing to the
disfavor and even suspicion with which it was still
regarded by the people in general, and this produ-
dice was strengthened by the skill manufacturers,
who recognized in the new industry a rival to
their own. But the beauty and usefulness of the
new material caused public sentiment gradually
to change, until now there are several large
factories producing it and the demand for it is
constantly increasing.

There are two processes of manufacture. In
the one, nitro-cellulose (gun cotton) is employed:
In the other, a solution of cotton in an amonius-
cal solution of copper oxide (Schlenk's re-
agent). The idea is the same in both methods.
Cellulose is dissolved and the solution is passed
through capillary openings forming a fine thread,
which immediately hardens on coming into con-
tact with the air.

1. The Nitro-cellulose Process.

Pure cotton is used for the raw material. This
is thoroughly washed and boiled in a weak solu-
tion of alkali to remove all fat. It is then washed
again and dried, after which it is treated with a
mixture of nitric and sulphuric acids and is thus
changed to nitro-cellulose or gun cotton. This
product looks like ordinary cotton, but is more
crisp when subjected. When a small portion is
brought near a flame, it burns with a high. Ordin-
ary cotton is quite insoluble in a mixture of equal
parts of alcohol and ether, but nitro-cellulose almost wholly dissolves, and a liquid is obtained which leaves on evaporation a nearly transparent skin, which is insoluble in water. This solution is the collodion used in surgery and in photography. The substance dissolved is termed pyroxiline, and is a mixture of the following compounds:

Dinitrocellulose: \( C_6 H_5 (N_2O_2)_{2} O_3 \)  
Trinitrocellulose: \( C_6 H_7 (N_2O_2)_{3} O_3 \)

Formerly this nitro-cellulose was carefully washed to free it from acid and then after drying, it was dissolved in a mixture of ether and alcohol. It was Chardounet who discovered that nitro-cellulose containing 25 per cent water was much more easily soluble in the ether-alcohol mixture than the perfectly dry, and thus the somewhat dangerous process of drying could be avoided.

The thoroughly washed nitro-cellulose is placed in a centrifugal machine and the amount of water reduced to 25 per cent, when the pyroxiline hydrate, as it is now called, is placed in a mixture of alcohol and ether (40 per cent alcohol, 60 per cent ether) and it becomes a 15—20 per cent solution of collodion. Naturally every manufactory has its own method, but this was the process employed by Chardounet and the others are only modifications of his method.

The solution of collodion is then brought into a vat, from which a large tube leads, which in its turn branches into many smaller tubes, and with these are connected the capillary openings. The solution is filtered through cotton and is forced by means of air pressure upon the fluid in the vat, through the capillaries into the water which surrounds them, where the fine threads harden.

Several threads are then passed through a collector and reeled. The fineness or coarseness of the finished thread depends upon the concentration of the collodion solution, the air pressure and the speed employed in reeling.

After a certain number of revolutions, the threads are taken from the reels, dried, twisted, separated into skeins of equal length and again reeled. This, then, is the first part of the process. The second is the reduction of the nitro-cellulose to perfectly harmless material. The skeins are put into a bath of ammonium sulphhydrate and the nitro groups are thus eliminated—all but a very small per cent. This small per cent can, however, be detected by the diphenylamine reaction and the nitro-cellulose thread thus distinguished from the thread obtained by the second process. The skeins are then washed, bleached and dried and are ready to be made up into cloth.

It is well known that a solution of copper oxide in ammonia dissolves cotton. The second process of manufacturing artificial silk is based upon this fact.

The cotton is cleaned in the same manner as was mentioned under the first process and then dissolved in a solution of cupric oxide in ammonia. This solution is treated exactly as the collodion solution and emerges from the capillary openings as a thin blue stream, which instead of passing into water passes into a weak solution of acid. This removes the copper and the ammonia and the fine cellulose thread remains. These fine threads are treated as in the foregoing process. At first the product obtained by this method was inferior to that of the other. But owing to recent improvements, the quality of the thread derived, now equals that of the nitro-cellulosic thread. The chemical composition is also the same, although different methods of coloring must be followed. The threads obtained as first described can be colored directly, i.e., without the use of a mordant; while those obtained by the second method must be treated with tannin or tartar emetic before the dye stuff is applied.

The use of artificial silk in the form of ribbon, lace, etc., by milliners is well known. It is also used for dress goods, curtains, and as a decorative material in upholstering furniture. The production is not confined entirely to this very thin cloth. A thick and still elastic thread has also been produced and is used in the manufacture of hats and trimmings. Besides, it has been discovered that mantles for the Welsbach light made of the new substance are more elastic, give a brighter light and last longer than those which are now in general use.
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