Philosophy of the Taylor System

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FILOZOFJA
SYSTEMU TAYLORA

PRZEZ
PROFESORA HENRY LE CHATELIER,
CZŁONKA AKADEMJI FRANCUSKIEJ

TŁUMACZENIE I UKŁAD
INŻ. KAROLA ADAMIECKIEGO,
PROFESORA POLITECHNIKI WARSZAWSKIEJ.

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NAKŁADEM INSTYTUTU NAUKOWEJ ORGANIZACJI
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HENRY LE CHATELIER

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Principles of Organization:

1. **The law of division of labor/Principle of Descartes**: "Every problem should be divided into as many parts as possible and as necessary to solve it best."
2. **The law of concentration** - of tasks, machines, people according to required output.
3. **The law of integration** – of the divided tasks

Stages of Organization

1. **Set a goal** that is *single, precise, limited, and useful.*
2. **Examine the means and conditions** that need to be applied to achieve the intended goal.
3. **Prepare the means and conditions** (tools/equipment/training) required for implementation.
4. **Implement** precisely according to the adopted plan.
5. **Control**: after each activity, the results should be checked to determine if the intended goal has been reached

Principles and Stages of the Scientific Method

1. **Law of causality** - At its core, science hinges on a fundamental *trust* in the unyielding nature of its laws, known as *determinism*.
2. **Detailed specification** of all the conditions on which each phenomenon depends, that is, its causes or factors.
3. **Ranking of factors** by importance. Experiments should be conducted economically. This means that the cost of the experimental resources used should correspond to the sought-after results.
4. **Measure and determine numerical relationships** - the results of measurements and experiments should be expressed in mathematical functions.

Scientific means to accomplish a goal.

1. *Observation*, which gives us the initial understanding of a phenomenon.
2. *Experimentation*, which allows us to establish first the qualitative and then the quantitative relationships between these phenomena.
3. *Calculation*, which, from undeniable experimental laws, derives further conclusions and infinitely expands our knowledge.

Guiding principles for teachers regarding habits that should be instilled in students.

1. Adopting a clearly defined idea of the intended goal.
2. Investigating the most appropriate ways to carry out a specific task.

3. Performing the work according to the chosen method.
4. Checking the actual result, its quality, and operating cost.

Fundamental requirements in the application of a task-based work system

1. Conduct preliminary studies to define the task.
2. Issue instructions to the workers, guiding them on how to execute the task.
3. Implement a compensation system aimed at motivating the worker to adapt to the task.

Human Factors

There exists another kind of scientific study which should receive special attention: it is the detailed examination of the motivations (drives) that prompt a person to act.
Three fundamental principles:

1. The factory worker is not merely a machine.
2. The worker is a thinking being.
3. The worker is a feeling being.

It is therefore necessary to examine their manual work, their thoughts, and their feelings.

Three types of relationships

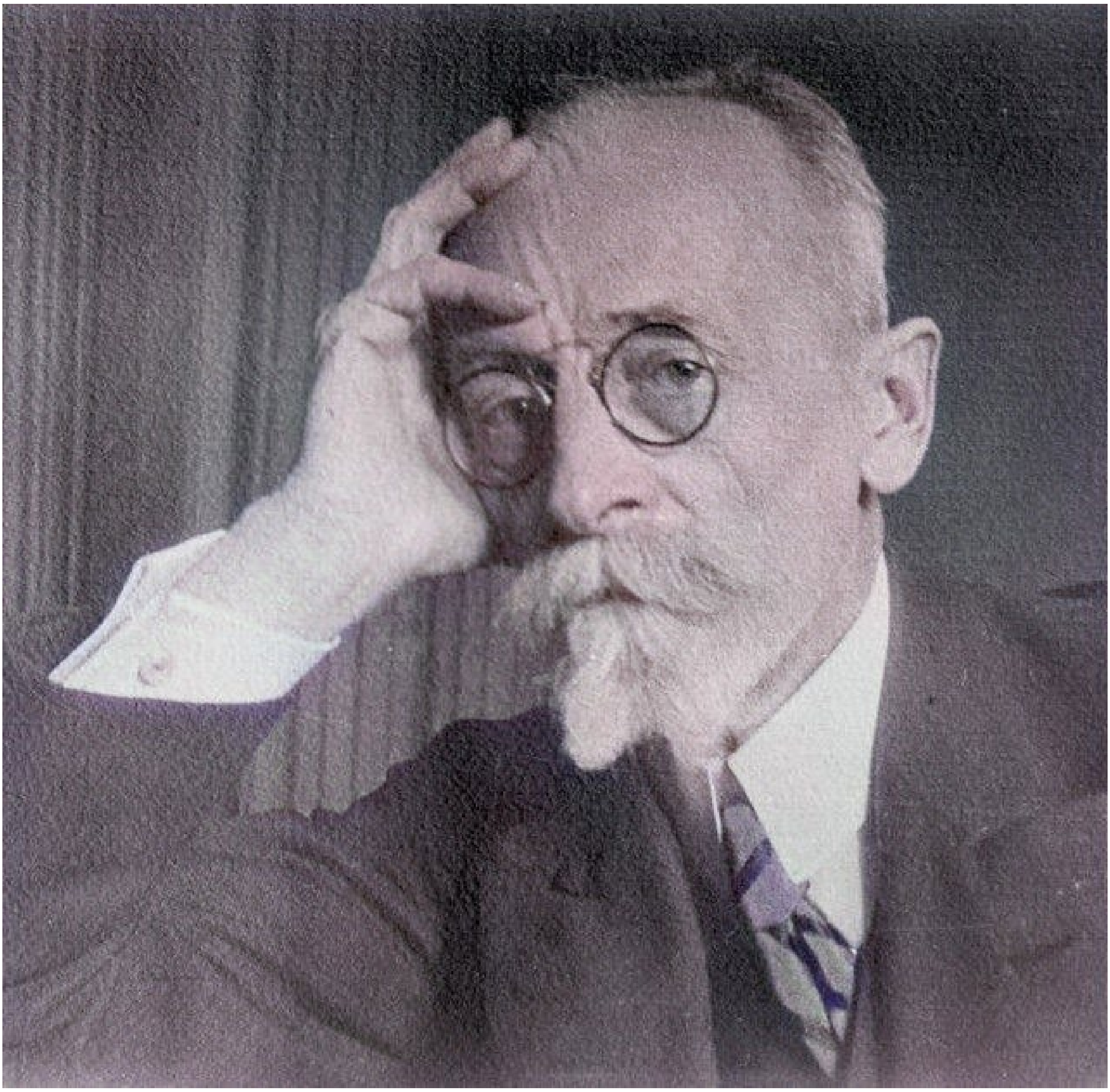
1. cooperation,
2. teaching (transmission of information)
3. leadership

Characteristics of Taylor's System:

1. **General order**: applied to every manifestation of human activity and encompassing certain common-sense rules, certain principles of the scientific method.
2. **Practical applications**: mixed with these general rules, are some of their practical applications to various industrial issues, such as: boiler cleaning, power transmission using belts, metal machining on machine tools, storage of items during their manufacture, wage systems, and so on.
3. **Human factors**: connected with the first two, contains a set of synthetic regulations concerning factory administration and dealing with workers, that is, issues less related to manufacturing processes, but directly concerning the human factor.
4. **Execution**: This last part of Taylor's system is the easiest to implement immediately. All people are essentially the same, and there is little difference in the art of commanding. Therefore, it is understandable that these methods quickly aroused interest among industrialists, relegating the foundational principles, which these methods are merely individual applications of, to the background. Too often, we encounter attempts to mechanically apply Taylor's rules without delving into his philosophy. This is risky and leads to many disappointments.

Three key points of Taylor's System:

1. Preliminary studies should be conducted scientifically, based on precise measurements.
2. Monitoring the manufacturing process is the duty of leadership.
3. Friendly and cordial relationship between management and workers is required.



Karol Adamiecki
Source: Polish National Archives

Translator’s Forward to the Polish Edition, Karol Adamiecki (1926)

The so-called "Taylor system," as the foundation of scientific management, has long since made its impact felt in our country. However, for quite some time, its echoes were faint, failing to leave significant impressions even on those who should have been most receptive to them. It was only after the war—particularly when our society, after years of unfortunate experiences, started to understand that boosting productivity is crucial for improving prosperity and strengthening the state's stability—that we saw heightened interest in methods designed to enhance efficiency and productivity. Therefore, we hear more and more frequently expressions such as "Taylorism," "Taylor's system," and "scientific management." In recent times, it has even become somewhat fashionable in our country and many people have been discussing this topic.

Judging by this publicity, one might suppose that many people in our country understand what scientific management is all about. But this would be a false conclusion, because upon closer examination, it will be found that their number is simply negligible. Even among those who have read Taylor's works and sifted through many works of other authors in this field, there are very few who have properly understood the fundamentals of the subject.

This is due to a number of reasons. First of all, Taylor himself puts too little emphasis in his works on the most important things and fails to express his thoughts methodically enough, sometimes putting too much emphasis on less important details. Then, among the great literature, as it appeared on Taylorism, there are a lot of books and articles that don't explain, but rather, obfuscate the matter. Some authors, supporters of Taylor's system, often focus primarily on secondary details, missing the forest for the trees. Conversely, opponents tend to interpret Taylor's ideas in ways that best support their counter-arguments, sometimes distorting his original intent in the process.

In addition to the above reasons that make it difficult for the reader to understand Taylor's organizational principles, there are other factors that contribute to the formation of entirely false and negative perceptions regarding these principles in many people’s minds.

Socialists, who consider the issue of productivity from the perspective of the political struggle between "labor" and "capital," contribute especially to the dissemination of these erroneous concepts in public opinion. For them, Taylor's assertion regarding cooperation, collaboration, earnings dependent on the individual efficiency of the employee, raising his prosperity without the need to resort to toppling the entire social system, etc., are simply heresy that strikes at the "holiest" canons of Marxist faith. Therefore, adherents of this faith, in their fight against the Taylor system, distort its fundamental ideas and spread the worst possible opinion.

Since the literature on Taylorism coming from these spheres is very abundant, especially in the field of journalism, the conviction has arisen among many people that Taylorism is a monstrous means of overloading and exploiting the worker to the benefit of capitalist entrepreneurs.

To strengthen this completely false opinion, there are also contributions from some theorists in the field of the psychology and physiology of work, who, whether due to a lack of understanding of Taylor's basic idea or under the influence of preconceived notions, express negative opinions about the Taylor system.[1]

Various amateurs also contribute to discrediting the Taylor system, as well as scientific management in general, in the eyes of the public. These individuals try to introduce certain details of the organization in practice, having a weak understanding of the main principles, especially many of the so-called "scientific organization advisors," who have in view not so much the true improvement of the organization, but their own interests. These people, not having the necessary experience, are often very imaginative in advertising, as well as in writing books and articles calculated for effect.

The principles of scientific management, despite their wide publicity, have penetrated only very few minds. This is due to various circumstances and the fact that new ideas take time for the human mind to process. However, because the application of these principles in all fields of productive work is of utmost importance and urgency, accelerating the process of their dissemination becomes necessary. One of the most effective means to this end is to familiarize Polish readers with the principles of scientific management in their purest form. Therefore, works of the proper creators of this science or the best commentators should be added to our literature.

Regarding Taylor's principles, there is only one commentator who presented them in exactly this form and captured Taylor's main guiding idea even better than the author himself. It is the famous professor, Henry Le Chatelier, who was the first to understand the importance of applying science to organization in Europe and became a fervent defender and pioneer of the Taylor system. If a Polish reader truly wishes to understand the full depth of this system, they should study this book. In my opinion, this is not only the only way to thoroughly familiarize oneself with the Taylor system, but also to understand how powerful the scientific method can be in production processes, where empiricism almost exclusively prevails. Professor Henry Le Chatelier is an unparalleled pioneer in this regard, an apostle of experimental science, and undoubtedly correct in claiming that only with its help can man reach the furthest limits in understanding the laws of nature and their application.

1) Here, professional reluctance on the part of a certain group of physiologists and psychologists also seems to play a role; they cannot forgive Taylor for daring to enter their field as an engineer, trying to solve some problems related to the physiology and psychology of work. Perhaps it would have been more politically astute on his part to seek help from physiologists and psychologists on these issues, but it would not have helped him solve his problems any better, because thirty years ago, physiology was just taking its first steps in the field of research on human work, and psychology entered this path much later. Therefore, if some of Taylor's solutions in this area seem too empirical and inaccurate in the light of the current state of the physiology and psychology of work, one cannot draw a negative conclusion about his principles from this. Simple justice, however, would require that he be credited even with the merit of trying to solve these problems as best he could, and above all, of having tackled them at all, thereby giving impetus to physiologists and psychologists to take an interest in them and enter the path of scientific research on the physiology and psychology of work.

Professor Le Chatelier's works on the Taylor system appeared in the form of a series of articles published in various journals or pamphlets over the course of several years, starting in 1914. Since in these articles Prof. Le Chatelier presented the Taylor system each time as a compact whole, illustrating it only with various examples, it was necessary not only to translate them, but also to arrange the content in such a way that the author's main guiding idea would be best highlighted without too much repetition. Undertaking this task, to a certain extent editorial, is a great honor for me, as the author completely trusted me in this regard, leaving me complete freedom in the arrangement. I tried to do this task as well as possible, avoiding shortcuts that would detract from the flow of thought expressed by the author. In this way, the first part was composed from several articles. The second part included translations of the rest of the articles without any changes to the arrangement. Although some of the ideas expressed in them are repeated from the first part, I did not consider it appropriate to make any deletions, both for the sake of preserving the integrity of the topic of each article and because these repetitions provide appropriate emphasize.

Prof. Le Chatelier, in almost all of his articles on the Taylor system, makes comments and comparisons concerning industrial work and the education of technicians in France. I have kept these comments in their entirety in this translation, as they can be applied completely, and perhaps even to a greater extent, to our own circumstances.

In presenting this book to the Polish reader, I am convinced that it will have the same impact as it did in France, which is not only to contribute to a proper understanding of the Taylor system, but also to increase the number of people who will pave the way for true science in production workshops.

Finally, I cannot refrain from expressing my tribute to the venerable Professor Le Chatelier and my great gratitude for his kindness and assistance that he showed me in translating his work.

I would also like to thank Professor W. Broniewski for allowing me to include the biography that he recently wrote on the occasion of the 50th anniversary of Professor Henry Le Chatelier [of his marriage to Geneviève Nicolas], and in this way contributed to popularizing the name of this great and deserving man among Polish readers.

Karol Adamiecki, Warszaw, Feb, 1926 r.

Witold Broniewski
Source: Polish National Archives

Introduction to Henry Le Chatelier, Witold Broniewski

"I have always highly valued practical applications and devoted all my scientific energy to applying science to industry. In my opinion, the role of a scholar is not to isolate oneself in an ivory tower; on the contrary, he should strive to enhance the well-being of his fellow citizens with his work."

This is how one of the most outstanding contemporary scientists, Le Chatelier, described his activity during the celebration of the 50th anniversary of his scientific work in 1922. He is indeed a distinguished representative of industrial science, which he defines as follows in the introduction to one of his more famous works (1912):

"In essence, industrial science does not differ from ordinary science but represents its complete development. Industrial science, instead of dealing exclusively with rare elements, focuses its efforts on elements more commonly used or those which are believed to be applicable in the near future. Moreover, industrial science, without neglecting the analytical method, so crucial for the gradual development of our knowledge, considers it appropriate to supplement it with a synthetic review, in which the interdependencies of phenomena, and therefore abstract concepts, are no longer grouped by analogy, but, on the contrary, are centered around tangible and real manifestations to which they actually belong. These groupings are made in such a way that each elementary factor is given attention proportional to its importance or, in the words of Taine, to its "beneficence" (in relation to the sought-after industrial outcome)."

It might seem that these assumptions are too clear to be denied. Therefore, the reasons why we often know much more about rare substances than about common and useful ones are usually not of a fundamental nature but rather secondary. People prefer not to discuss them as openly as Le Chatelier does in the introduction to another of his works (1908):

"For some, science is just a lucrative profession with a regular promotion and a pension in sight. If you're lucky enough to stumble upon a topic that's not very interesting so that no one revisits it for decades, it's a secure investment of effort, as any errors will only come to light once the published work has yielded all its beneficial results. If we take large textbooks of general chemistry, we can safely say that at least half of the substances described therein never existed."

These few quotes sufficiently indicate the principles Le Chatelier adhered to. He fought for them, sometimes sharply, with words and pen, but more often he embodied them in action. Le Chatelier's life can serve as an example of how a huge impact on the industry can be made by work done not with so-called "precision sufficient for industry", meaning carelessly, but accurately, precisely, often seemingly purely theoretical and abstract, yet always so considerate of that factor of "beneficence" in both near and distant consequences.

The primary basis for Le Chatelier's enduring scientific fame remains his "principle of opposition" [or “equilibrium”], often also called "Le Chatelier's principle." Proclaimed in 1884, it was further developed a few years later (1888) in the work "Recherches experimentales et théoriques sur les equilibres chimiques" (Experimental and Theoretical Research on Chemical Equilibriums).

Let's recall those times, so relatively close chronologically, but conceptually already distant from us. At that time, chemistry was almost exclusively a collection of recipes, and a chemist considered his work complete when he isolated a compound and placed it in collections. The formation of these compounds was supposed to be determined by Berthelot's principle of the greatest work (1879), which excluded the possibility of the stable existence of endothermic compounds.

Even the atomic theory did not seem firmly established yet, as in France it was supported by Wurtz and opposed by Berthelot with equal passion.

In this period, Le Chatelier puts forth the "principle of opposition," which was ahead of its time by several years in its fundamental view of chemical phenomena. This principle states, "Any system in chemical equilibrium—according to this principle—undergoes a change due to a shift in equilibrium factors in such a way that if this change occurred by itself, it would cause the opposite change in the considered factor."

Thus, the starting point is not a stable compound but a system in equilibrium, or a partially dissociated compound when it comes to a chemical system. Understanding a chemical compound is no longer based on its isolation but on determining its equilibrium conditions depending on temperature, pressure, and concentration.

Le Chatelier's principle applies to both physical and chemical systems, so it has an exceptionally broad scope and can be considered the third principle of thermodynamics. A particular case of this principle is the principle of the greatest work, while its numerical expressions, also in specific cases, are indicated by the well-known formulas of Clausius and Carnot-Clapeyron.

Le Chatelier and his closest associates applied the law of opposition to study major metallurgical reactions, especially in iron metallurgy. Among the most notable of these studies is the so-called "Boudouard curve", which indicates the equilibrium between carbon and its oxidation products. This explains the formerly mysterious phenomena that in the lower part of the blast furnace, carbon dioxide reacts with carbon, yielding carbon monoxide, which in turn breaks down in the upper layers of the furnace into carbon and carbon dioxide. Based on the law of opposition, the phenomenon observed with surprise by Sir Lowthian Bell becomes clear and understandable: at 1,000°C and with equal volumes of carbon monoxide and carbon dioxide, ferric oxide is reduced, and iron is oxidized. Also, based on the law of opposition, Le Chatelier determined the conditions for the synthesis of ammonia from nitrogen and hydrogen, indicating that the reaction should occur at the highest possible pressure and not very high temperature. This synthesis, later resumed by Professor Haber a few years afterward during the war, allowed the Germans to produce synthetic ammonia on a large scale and, by oxidizing it, nitric acid.

The second major foundation of Le Chatelier's fame is his work in the field of metallography, of which he is one of the pioneers. It started with the application of the thermoelectric cell for temperature measurement (1887). At that time, they indeed knew how to measure temperatures up to 400° using a mercury thermometer. While a gas thermometer did exist, its use was a complicated laboratory experiment, suitable for determining reference temperatures, but not for measurements in ordinary furnaces and on standard samples.

Neither the calorimetric method of W. Siemens nor the method of Sainte-Claire-Deville, based on the density of iodine vapor, provided precise results. Practically speaking, temperatures above 400° were not measured but were estimated visually based on the color of the light, without really knowing, for example, whether the "cherry glow" corresponds to 700° or 900°.

The principle of using a thermoelectric cell for temperature measurement was already indicated by A. C. Becquerel, but it was dismissed as imprecise, since metals such as bismuth and antimony were used for the cells, whose thermoelectric capability depends on the direction of the crystals and changes through recrystallization after each heating. Therefore, Le Chatelier's main contribution was to point out suitable metals: platinum and an alloy of platinum with 10% rhodium. This "Le Chatelier cell", as it is commonly called, was so aptly chosen that even today, when we know the thermoelectric capability of so many alloys, it is used as the standard. Measuring temperatures up to 1600° immediately became easily feasible with considerable accuracy, close to 1%. Moreover, measurements could be taken in any furnace, on any sample, and regardless of the speed of temperature change, even as significant as during quenching.

This invention was almost immediately exploited by Osmond to study transformations occurring in steel, which were completely unknown at that time. "As an example of mutual interactions," Le Chatelier himself recounted, "I recall that after teaching Osmond how to use the thermoelectric cell, I learned from him about the principles of microscopic metallography."

The principles of microscopic metallography were very complex at that time; preparing a polished section required several hours of skilled work, and only a few people in Europe knew how to prepare and observe them.

Here too, Le Chatelier managed to simplify the laboratory operation to such an extent that nowadays it's carried out in just a few minutes, not only in laboratories but also in factories. Specifically, the invention of a suitable microscope, also bearing the name of Le Chatelier, eliminated the difficulties of lighting and setting up the sample. The introduction of aluminum oxide instead of iron oxide, and especially the use of rotary polishers, accelerated the micrographic work.

Microscopic metallography was not sufficient to determine the structure of alloys, as both chemical compounds and solid solutions appear under the microscope as homogeneous crystals.

Indeed, already in the 1830s, Rudberg began studies on the melting point of alloys, and in the 1860s, Matthiessen investigated their electrical properties. However, these studies remained inconclusive because the relationship between the structure of alloys and their melting point, or electrical properties, was unknown. Le Chatelier's work between 1895 and 1900 aimed to establish this relationship. He compared the results of the melting point method (later called "thermal analysis") with electrical methods, chemical methods, and with the results of micrography, laying the foundation for the currently important indirect methods in metallography.

In the context of work on iron and steel, while Osmond deserves credit for determining the allotropic forms of iron and the metallographic components of steel, Le Chatelier provides the first correct diagram of the iron-carbon system (in 1899), which was later incorrectly referred to as the Heyn and Charpy diagram. He also provides a theoretical explanation for the phenomena occurring during the hardening and tempering of steel.

Le Chatelier's work in the fields of metallography and metallurgy remain monumental, but he also made significant contributions in other branches of industrial science. In the realm of cements, he demonstrated the dominant role of the $SiO_2 3CaO$ compound. In ceramics, Le Chatelier applied the method of expandability and pointed out the influence of the allotropic forms of silica on industrial production results.

In the field of explosives, Le Chatelier investigated the conditions causing combustion and explosion phenomena and applied his acquired knowledge to both the study of powders and the design of a safe miner's lamp.

Beyond his independent scientific and industrial-scientific creativity, Le Chatelier's promotion of the doctrines of others should also be taken into account. He promoted such doctrines even more vigorously than his own ideas when he saw benefits for science, as he generally did with phases, or for industry, as in Taylor's system. The Phase Rule, announced as early as 1876 by J. Willard Gibbs in a publication of a provincial Academy in Connecticut, America, which was almost unread by anyone, was "rediscovered" in that publication at the end of the last century. In France, Le Chatelier became its passionate defender and commentator, translating Gibbs' work and indicating numerous scientific and practical applications of the new law to solutions of salts and alloys.

In 1904, Le Chatelier founded, not without difficulty, the first and only metallurgical journal in France, "*La Revue de Metallurgie*". Through it, he sought a platform to rejuvenate the French industry, which couldn't keep pace with its American and German competitors. From almost the first volume of this journal, Le Chatelier began his campaign in favor of the scientific organization of factories according to Taylor's system. Translations of Taylor's works were published, and a detailed chronicle of the development of Taylorism in America and its branches outside metallurgy was presented.

The direct results of this campaign appeared rather weak since, to the best of my knowledge, there still isn't a single factory in France that has adopted the Taylor system in its classical form. However, this advocacy indirectly bore significant fruit. Several factories, such as Renault, Berliet, and the foundries in Montluçon, adopted work systems that, while not strictly Taylorist and varied across these factories, showed considerably higher productivity than before.

The failure of Taylorism in France was, to some extent, due to the workers' trade unions, which, like elsewhere, were inclined more towards reducing work efficiency than improving it, mistakenly fearing that it would "take bread away from their comrades". However, even more than the workers, it was the engineers who proved incapable of adopting Taylorism. The average French engineer, entering a factory without prior hands-on experience, is unfamiliar with the intricacies of workshop work. Although they might be capable of general management, they tend to avoid direct interaction with the workers. As a result, the real workshop manager is not the engineer but a foreman of the self-taught worker type. The absence in France of the type of engineer competent to effectively manage workshops, the kind that powers American and German factories, did not escape Le Chatelier's notice. Thus, a new campaign in "*Revue de Metallurgie*" advocated for a reform of technical education, partly realized in newer polytechnics in Nancy, Lille, Grenoble.

Despite Le Chatelier's extraordinary contributions to the science and industry of his country, his career was by no means easy. When filling a chemistry chair at the École Polytechnique, a position he had dreamed of in his younger years, as he himself confesses, he was deliberately overlooked. He became a professor at the Sorbonne and a member of the Academy of Skills quite late, at 58, when he was effectively the only candidate after Moissan. He has so far been overlooked for the Nobel Prize. Even the recent celebration in his honor was organized more by friends and students than by a society aware of his immense contributions.

Indeed, Le Chatelier's character, carved from a single mold, is not one of those that make it easy to navigate through life friction-free. In his own society, he was often opposed, but more frequently misunderstood. People couldn't comprehend a scholar involved in industry, an inventor who didn't file patents or seek profit, an advocate for social order and discipline, yet a staunch defender of individual freedom. Above all, they feared his courteous but unmerciful truthfulness. He often didn't hesitate to "throw a stone into the frog's mud," as he put it, in high-profile cases when the accepted custom would have been to discreetly remain silent, detrimental to the general public but pleasing to colleagues or superiors. This is why another prominent figure in industrial science in France, G. Claude, could recently say: "Among us, we have a great scholar; we do not know him, we do not make use of him." He was speaking of Henry Le Chatelier.

-Witold Broniewski.

problem, and discussion of it inspirational in its nature, a great deal can be accomplished at one meeting which emphasizes that problem. On the other hand, the problem of operating conditions, while in part a problem of the spirit and of the mind, is also in large part a problem of details, of experiments and investigations and of the comparison of results. And opportunity for the presentation and comparison of the results must be adequate, if the Society is to contribute to industry the results of the experiments and investigations of its members and guests.

GREETINGS TO M. LE CHATELIER

IT was the privilege of the Society to recognize the pioneer work of M. Henri le Chatelier on behalf of scientific management in France and to extend to him its greetings, by motion of Morris L. Cooke, as follows:

"Mr. Chairman: While sitting here this evening I have recalled a conversation I had with Mr. Taylor sometime in the Fall of 1911. I had just returned from a trip abroad and was recounting to him some of the experiences I had had with our scientific management friends in Germany. And I remember distinctly that Mr. Taylor said to me that when it came to the development of scientific management in foreign countries, his ambition lay in the direction of having it begin first in France.

"Those of us who have had the rare privilege of talking with our guest, M. de Freminville, during his visit to this country, have been impressed by his description, more than is possible through the written or printed word, of the tremendous progress which has been made in the development of scientific management in France during the eight years which have intervened since that conversation with Mr. Taylor.

"To M. Henri le Chatelier, an honorary member of this Society, we owe unbounded admiration for the disinterested way in which he—at first practically alone, and led to it by scientific recognition of evident truth, and devotion to what he believed the best interests of his country—started in to awaken France to the importance of scientific management. It was because of his fidelity and standing as a scientist, because of the admiration which his compatriots have for him, that he drew to the cause such friends as M. de Freminville.

"That in those eight years a small group of men should have accomplished what they have accomplished is remarkable; and I imagine it will not be long before we are made aware of what a significant part the work of that group of men played in the outcome of the late war.

"It seems to me appropriate that tonight the Taylor Society should request M. de Freminville to convey its greetings to M. le Chatelier, and I move you, therefore, that our distinguished guest of this evening be requested to convey to M. le Chatelier our sincerest admiration and unbounded thanks, and assurances that, if at any time this Society or its affiliates can be of service to him or to his country in this work of the further development of scientific management, we are at his command."

The motion was carried unanimously by rising vote, and M. de Freminville arose and responded:

"It is with great pleasure that I shall deliver this message to M. le Chatelier, and you may be sure it will be a great pleasure for him to receive the message, and I know he will send you his best thanks as soon as I have carried the message to him."

THE SOCIETY

THE annual business meeting of the Society, Friday evening, December 5, 1919, was called to order by the Managing Director who in the course of his remarks said:

"This is in many respects a significant meeting of the Society. I believe it was in this building, in a smaller adjacent room, that some ten years ago a group of half a dozen men met together and organized the Society to Promote the Science of Management, which, after Mr. Taylor's death and in his memory, changed its name to the Taylor Society. It is interesting that, by coincidence and not intention, this first meeting of, so to speak, the refounded Society, should be held in a room adjacent to that in which was held the meeting at which some ten years ago the Society was founded.

"It is also interesting and significant that we have with us, for the first time in our history, distinguished foreign guests, and especially significant that two of them are representatives of labor from England and Sweden respectively. It was only a few years ago that the attitude of labor was not one of sympathy with inquiry into the nature and the spirit of scientific management; today we witness most sympathetic inquiry. I imagine we were all to blame, and that the changed attitude marks development in breadth of view and humanness on both sides. A little later I shall have something to say of and to our distinguished guests.

Henry Le Chatelier's Preface to the Polish Translation

Although my field of work is beyond industrial practice, Taylor's work has interested me directly because I see in it a new and very successful application of the scientific method. By resorting to public lectures and numerous articles in newspapers, I tried to popularize the scientific organization of work in France. It flatters me greatly that these attempts of mine have been recognized as deserving to be translated into Polish. Mr. Karol Adamiecki, a master in this field, wanted me to write a preface to this translation. Gladly complying with his request, it seems to me that it will be best if, looking at the matter, I take a slightly different point of view from that which was the case in my previous works, namely, if I consider the role of science in the organization of work.

Everyone knows Taylorism today, at least by name, but very few people would agree on its true essence. Taylor never tried to formulate the philosophy of his method and contented himself with providing numerous examples of its application, leaving the reader to find the guiding thread. This has created a very harmful misunderstanding in the dissemination of the work of the great American engineer.

Initially, Taylorism was understood as the application of certain methods in work, given by Taylor, such as the use of high-speed steel, the creation of a bureau for preparing work, the functional division of master attributions, bonus payments, etc. Today, there is a tendency to encompass the entire administration of industrial plants under the name of "Taylorism." However, work organization in factories did not wait for Taylor to be born and develop. The work of thousands of workers, sometimes gathered in one factory, would be impossible without some organization. The coordination of their work is an unavoidable necessity; this coordination has been carried out for a very long time with the help of offices, which are at the head of all major enterprises.

In reality, this main and novel property, or using Taine's expression, the *principal* property of Taylor's work, consists of applying research before undertaking any activity, which is entirely based on experiments supported by accurate measurements. Taylor was the first to introduce science into a field where empiricism prevailed. The term "scientific management," proposed by American advocate [Louis] Brandeis, accurately describes Taylorism.

Taylor applied primarily the principle of Descartes, the foundation of all sciences: "Every difficulty should be divided into as many parts as possible and as necessary to solve it best." He takes the division of labor to the extreme, not satisfied with considering each worker's task independently of his neighbor's, but breaking down every activity into elementary movements. Similarly, he replaces one old workshop foreman with four "functional" foremen, each performing only one function: one deals with the general course of work, another with the work itself, a third with the proper maintenance of equipment, and a fourth with personnel. Likewise, when examining machines, he separates the examination of the machine itself from the examination of the tools, and when examining the latter, he separates the examination of their shape, chemical composition, heat treatment, and so on.

This division is essential to be able to measure the magnitudes involved. For the most part, complex objects cannot be measured directly. For example, we cannot measure the total heat, but we can separately evaluate the magnitudes of its two factors: temperature and heat quantity. Similarly, we cannot measure the shape of a tool, but we can measure the angles that various sides of the tool make with the perpendicular to the surface of the metal being worked. We cannot measure the entirety of a worker's professional skills, but we can, if not measure, at least evaluate some of those skills, such as liveliness, aptitude, manual dexterity, and compare them with the corresponding properties of other workers.

The division of problems provides one more benefit: in examining, it is not enough to make visible measurable quantities; these quantities must be variable and independent. In all experimental investigations, only one factor should change when passing from one experiment to another. This is the point on which Taylor places special emphasis in his work on metal cutting.

To explain the importance of this recommendation, let us take the example of the examination of tools made of high-speed steel. Taylor did not divide this examination into the weight of chips removed, the shape of the tool, chemical composition, and hardness because the shape of the tool cannot be changed without changing the weight of the chips removed or the chemical composition of the tool without changing its hardness. Instead, he adopted the following four independent variables: cutting speed, tool shape, chemical composition, and heat treatment - all quantities that can be changed separately, i.e., leaving the remaining three strictly constant.

The last reason for the necessity of division is that our mind is unable to grasp objects that are too complex. If we look at the worker's overall activity, it is very difficult to form a clear understanding of it and predict useful changes that can be made.

On the contrary, by dividing this activity into elementary movements, we can easily distinguish which of these movements are useless and should be eliminated; we also observe movements that should be retained and changes that need to be made.

The division itself is not the goal of science, it is only a necessary introduction to the application of measurements to performance. The real characteristic of the Taylor system is the systematic use of measurements for performance. In his research on shovels, to select the most favorable dimensions, he made various models and weighed quantities of different materials that could be scooped with these shovels, such as coke, sand, iron ore, etc. He measured the time it took for the same worker to fill a wagon, using shovels of different dimensions. When studying the human factor, he proceeds in the same way - by comparing and measuring. While seeking the most effective way to address workers' errors, he experimented with three different methods, noting the success of each approach. For a month, he treats them as rudely as they usually treat themselves, then for a month he talks to them politely like a gentleman, and finally for the next month he imposes fines according to a predetermined tariff, without allowing for any explanations on their behalf. Therefore, Taylorism's foundation lies in the consistent application of the experimental method, always and everywhere.

This experimental method of work organization has not yet been generally understood. If it were, many researchers would undoubtedly follow Taylor's path to establish the best conditions for performing various elementary tasks in our factories. Applying these standard methods to technological work would yield extraordinary benefits. We already have several such studies in France: Mr. Charpy on rolling, Mr. Guillet on projectile forging, and Mr. Nusbaumer on gunpowder manufacturing; but their number is still too small.

On the other hand, we find numerous descriptions of organization and administration in French and foreign journals and congress reports. The proposed models may be good or bad. These are subjects too extensive to be studied experimentally. Everyone organizes in their own way and declares the superiority of their methods, but does not try to give them scientific value. This is undoubtedly material that can give the reader useful guidance, but it has nothing to do with Taylorism.

In my opinion, the path to developing scientific work organization should begin with proper task setting. Each issue is already half solved if it is clearly formulated. We should take different industries one by one, break them down into elementary parts, and compile lists of different questions that can be subjected to experimental control. This first division work can only be done well by engineers who are fully familiar with the industry being studied. I would not have the audacity to undertake this entire work without sufficient competence, but I would like to present here a few general remarks on the methods of proceeding with such a division.

It's not as simple as it might seem at first glance. The same object can be divided in various ways: an orange can be divided into quarters, parallel or perpendicular to the axis, and so on. To choose the most appropriate method of division, one must first consider the goal to be achieved. If we want to study a region of France cartographically, we divide it into rectangles; for studying climate, into horizontal parts, and for studying natural resources in the ground, into geological regions.

In industry, which is far more complex, the possible methods of division are countless. The first division could be made based on the products manufactured, the methods of production, workshops, functional managers of departments, operating cost positions, and so on.

When examining a workshop, we can divide it into various machines, then each machine into its specific parts. When it comes to a function, such as heating, we must distinguish between heating boilers, furnaces for melting, furnaces for thermal processing, radiators for heating residential rooms, et cetera.

We proceed with this division step by step, as far as possible. For each part of the machine, we identify the degree of metalworking, heat treatment, and shaping. We divide the worker's job into its different parts: positioning the object being processed, giving it the proper shape, cleaning the machine; finally, we break down each of these individual tasks into elemental movements.

We must now make a decision, considering the goal we aim to achieve. Let's take the example of operating costs. Suppose we want to find the lowest price at which we can sell without a loss; then we must divide all expenses into items produced and ready for sale. If, on the other hand, we want to reduce production waste to lower operating costs, we need to divide expenses into different items related to production, and then place all expenses related to useless items under that category to make the role of waste visible.

If we want to know at what moment in time we can accept an order at the lowest possible price just to maintain the factory's activity, we need to separate general costs, independent of the production scale, and so on. However, in this matter of operating cost, there is a whole series of studies as to the best way to group them according to various specific goals.

When studying work in a workshop, we can make the first division based on the category of workers or machines. Which one to choose? If labor costs are the main component of operating cost in the manufacturing process under consideration, we need to adopt the division based on workers; if, on the other hand, depreciation and maintenance of machines are the biggest costs, it is better to choose machines as the unit.

If at the beginning of the study of the entire manufacturing process, we need to push the division to its very limits, then we must make equally necessary regroupings afterwards. People and machines do not work separately; to obtain any useful result, we must coordinate their elemental activities. Therefore, we need to examine the combinations of these activities two by two, three by three, and finally, (N).

Let's first consider the coordination of work between two workers or officials. It can relate to three different types of relationships:

1. cooperation,
2. teaching, and
3. leadership.

Cooperation is encountered when moving a heavy load, such as a railroad tie, which requires the work of two people. How should the tie be held? Should the two carriers stand next to each other or one behind the other? Should they synchronize their steps, etc.? Machine work often requires the assistance of two workers. In the case of rolling, there should be at least one worker on each side of the rollers; in the case of forging, drilling holes, cutting, one worker supplies the material, while the other operates the machine. Should they work in harmony or should one direct the other, as a craftsman directs his apprentice in small building crafts such as locksmithing, masonry, plastering, etc.?

The second category of relationships between two workers concerns the transmission of information, shared between them. The sales department informs the management about the orders received, and the production department reports on the progress of fulfilling those orders. Various officials inform each other about the work being done in the workshops, wages paid to workers, expenses incurred, and orders placed outside. Teaching methods of work falls into the same category. In every industrial production, we have two issues: choosing the methods of production and then implementing them. Beginners should learn from the experience of their superiors; less experienced workers than their older colleagues should be directed and taught by masters of the trade.

The way in which this communication between individuals is conducted is not irrelevant and should be studied.

In what way should an instructor explain to the person doing the work? Should this communication be verbal or written? How should instructional notes describing methods of production be drafted? What details should be included and which should be left to the discretion of the worker? What symbols should be used? Of course, this can vary depending on the type of industry. Taylor extensively studied these issues in mechanical workshops, but we cannot treat a porcelain decorator in Sèvres factory the same way as a street sweeper in Paris. The cost of writing compared to its benefits must also be taken into account, and finally, some degree of local culture must be considered as well.

The third type of relationship between two individuals is leadership. Before starting work, a worker should receive instructions from their supervisor; the warehouse should receive instructions on time for the provision of items or tools necessary for production. Prior to this, the design office and the planning office should receive instructions for the specific production. The latter should have an official whose task is to receive and release personnel. This organization of leadership also involves detailed research. Taylor proposed a complete change in the former role of the foreman in the workshop, removing their duty of giving orders and leaving them only as instructors. Should each person have only one supervisor for all types of their work, or conversely, different supervisors for each type of task? In other words, should the individual be the unit of leadership or the function performed by that individual? To determine which method is better, experiments must be conducted to compare them.

When relationships between individuals, taken in pairs, have already been analyzed, they must be examined in combinations of three if they differ from the relationships in the first case. If three workers, instead of two, work together on the same machine, this does not create a new task. The result obtained for two workers is automatically applied to three. However, there are at least two cases in which the intervention of a third person concerns an object other than the direct relationship between two individuals, for example, conveying or coordinating between two workers or officials can be done through a third person.

For example, messengers are used so that officials or workers do not need to go themselves to communicate and thereby avoid being distracted from their main task. Orders are also sent hierarchically to ensure unity of command or simply so that the head of the department is constantly informed about the means used.

The work of two workers working in different workshops on the same production must also be coordinated. Drawing preparation, production preparation, and planning should be carried out in parallel; tools and objects needed should be delivered to the worker at the same time. Someone must ensure the normal rhythm of all these operations. This coordination task belongs primarily to the management when it comes to the general course of the factory and to the office preparing the work when it comes to individual production departments. Numerous studies must be carried out here. Taylor dealt with some of these combinations, but did not exhaust the subject; details of organization inevitably vary between different industries. For example, the planning office established by Taylor for machine shops seems inappropriate for a greenhouse or cement factory.

When these individual studies are completed, they need to be grouped into a whole. They are parts of a system that cannot function separately. They must be connected to complete the construction of the entire work. We need to compile a guide and production routes (routing), as well as a schedule of hours (dispatching). Let us explain with an example what this grouping work entails. Let us say that we have examined all the relationships between personnel, taking two at a time; we have determined the communications that should be in writing; we have chosen symbols to be used. If the number of communications is (N), we do not create (N) separate sheets of paper, because we would drown in an excess of paper. We group many of them together and write them on one sheet, one next to the other, in a certain order, to obtain the greatest clarity. This also requires further investigation. Another similar issue arises: we need to determine the functions that office employees should perform. We do not employ as many employees as there are different jobs to be done. Each of them performs a certain number of different functions, which also vary depending on the size of the workshop. How to group these attributes? What hierarchy needs to be established between employees?

The last example: a certain order requires the combination of different machine parts, the use of manufacturing tools, the involvement of many workers, the cooperation of numerous clerks receiving orders, preparing and coordinating work, and finally providing the products to the buyer. This requires further research and is the culmination of scientific work organization.

These studies, from elemental research to their final synthesis, take a long time and are very expensive. Therefore, we cannot wait until all these studies are completed before starting production, but we also cannot produce without any work coordination. We must, therefore, start with some coordination, without waiting for the details on which it should be based to be examined. Such a general administration of industrial plants has always existed, but this is not Taylorism, which is primarily aimed at experimentation and precise measurements. We must reconcile these two opposing conditions, first by using empirical organization, without which we cannot do without, at least at the beginning, and then gradually improving it with the help of scientific research. The organization must be Taylorized gradually, and since all experiments require a lot of time and perseverance, satisfactory results can only be achieved through continuous effort.

Henry Le Chatelier.
Paris, November 1925.

Part I - Philosophy of the Taylor System

Introduction

The splendid industrial boom of the last century was influenced by two factors: the development of experimental sciences, which allowed for a more precise understanding of the properties of materials and better utilization of nature's riches, and the application of machines, which, amplifying human force a hundredfold, increased the quantity of products available to the consumer by the same magnitude.

Today, a third factor is beginning to play an increasingly significant role: the scientific organization of work. This organization, by eliminating wasted time, unnecessary efforts, and often even sharp confrontations with workers, enhances both the power of science and the productive capacity of machines. In the United States, numerous individuals, calling themselves "efficiency engineers," strive to improve the functioning of industrial establishments through organization. Many of them possess vast experience, and some have rendered undeniable services to the industry. However, most of them, not yet possessing a methodical, and already well-established, systematic approach, focus their efforts on correcting minor errors or technical details. Only one among them, F. W. Taylor, has thus far produced a comprehensive system encompassing a strict philosophy of scientific management.

The significance of this system was misunderstood for a long time: initially, it was simply seen as a system of bonuses motivating the worker, then efforts were made to reduce it to "*time-study,*" a method of measuring time that was long known and commonly used in factories. As for accuracy, these individual and narrow viewpoints would in no way justify the buzz created around the "*scientific organization of work.*" So how can one explain the reason for such a profound impact on minds by Taylor and his followers? President Wilson chose several of his secretaries from among the most devoted supporters of these new theories; Philadelphia's mayor, Mr. Blankenburg, asked Taylor to recommend someone for the director of public works; newspapers and technical journals were filled with articles promoting or attacking the application of "scientific management" in government arsenals and on railways, leading the American Senate to even undertake a very extensive inquiry on the matter. In Europe, this movement also widely spread: numerous factories are trying to apply the new system, and engineers travel to America to familiarize themselves with it firsthand. Today, there is no doubt that the great importance of the ideas of the famous American engineer can no longer be denied.

Readers of some of the several hundred works and articles on this subject that have appeared over a few years might consider this new work on Taylor's system redundant. Hasn't everything been said already? Thus, I must justify this new endeavor on my part.[1]

Americans tend to possess both a zeal for action as well as an aversion to writing. They believe that it is sufficient to create useful work and that it is not worth wasting time on detailed explanations of results achieved through his efforts. This aversion to literary

1) The author wrote this in 1914. (Translator's [Adamiecki's] note) work sometimes results in works of great value remaining in obscurity. The brilliant discoveries of the renowned scholar, Josiah Willard Gibbs, now revered worldwide alongside Newton, Pascal, Huygens, and Fresnel, remained completely unknown for fifteen years. This founder of chemical mechanics was unknown until Europeans, having revisited the same domain, finally understood his work, and clarified the mathematical terms he presented so plainly in his extraordinary work on the "equilibrium of heterogeneous systems."

Similarly, Taylor's system was misunderstood for a long time, and undoubtedly, the commentator's work has not yet been exhausted. I believe that one can still present several new perspectives on the matter. In this work, I aim to explain the ideas of F. W. Taylor as clearly as possible, just as I once did when interpreting the ideas of J. W. Gibbs.

The widespread application of Taylor's system was often hindered by this very lack of precise understanding of its main principles, which are indeed difficult to grasp. However, it must be admitted that these new methods, which are the fruit of 25 years of observations and experiences gathered during his very active industrial career, sometimes lack uniformity. The great American engineer, when publishing his works, too often confined himself to expressing thoughts as they came to his mind, that is, not entirely systematically. Reading these works is burdensome. To truly understand, one must study them meticulously with a pen in hand.

A comparison will illustrate the difficulty of understanding. The old principles of Euclid, taught by our ancestors, contained not only pure geometry but also its applications to land measurement, the drafting of fortification plans, the theory of optical instruments, and even advice on capturing fortresses or cultivating land. Later, this vast and unwieldy work became clearer; proper knowledge was separated from its applications in teaching. Today, without denying their mutual relationship, we rightly teach theory and practice sequentially rather than concurrently.

So, what does this new industrial orientation entail? Taylor's system combines several perspectives:

5. **General order**: applied to every manifestation of human activity and encompassing certain common-sense rules, certain principles of the scientific method;
6. **Practical applications**: mixed with these general rules, are some of their practical applications to various industrial issues, such as: boiler cleaning, power transmission using belts, metal machining on machine tools, storage of items during their manufacture, wage systems, and so on.
7. **Human factors**: connected with the first two, contains a set of synthetic regulations concerning factory administration and dealing with workers, that is, issues less related to manufacturing processes, but directly concerning the human factor.
8. **Execution**: This last part of Taylor's system is the easiest to implement immediately. All people are essentially the same, and there is little difference in the art of commanding. Therefore, it is understandable that these methods quickly aroused interest among industrialists, relegating the foundational principles, which these methods are merely individual applications of, to the background. Too often, we encounter attempts to mechanically apply Taylor's rules without delving into his philosophy. This is risky and leads to many disappointments.

Ultimately, in my opinion, Taylor's system revolves around two fundamental ideas that are straightforward to understand but, as I've already mentioned, difficult to apply:

1. The study of all industrial issues can and should be done using the strictest methods of experimental science;
2. Applying this scientific method to the psychological study of the human factor leads to certain new rules for work organization in production plants, in particular, work according to a strict task (à la tâche fixe).

The name "scientific management," ultimately adopted by Taylor to define his methods, succinctly and accurately summarizes his entire system, as it truly is a combination of organizational principles with science.