The Principles of Scientific Management and their system theory background

Stefan Grote

September 28, 2021

Contents

1 Abstract

In the late 19th century, Frederick Winslow Taylor was a foreman at a steel plant in Pennsylvania, US. While observing his workmen, he identified multiple reasons why workers would, sometimes even deliberately, stay behind Taylor's expectations of how fast a set of tasks could be completed. Believing that major improvements in productivity were possible, Taylor started to develop a new type of management, which aims to perfect and optimize how every task is done. He formalized this new "Scientific Management", sometimes also referred to as "Taylorism", in his book *The Principles of Scientific Management*, which was published in 1911. Even though Scientific Management received a lot of criticism over the years, the positive effects on productivity and effectiveness were undeniable, resulting in aspects of the management still being visible in today's production routines.

2 Historical context

In 1880, at age 25, Frederick Winslow Taylor became foreman at the Midvale Steel plant in Pennsylvania, US. This was during the Second Industrial Revolution, also known as the Technological Revolution, where steel as a resource gained importance due to it becoming mass manufacturable. He was impressed by how much his workmen would stay behind his expectations of how much should be possible in a single day [3]. While investigating, he identified several reasons for that:

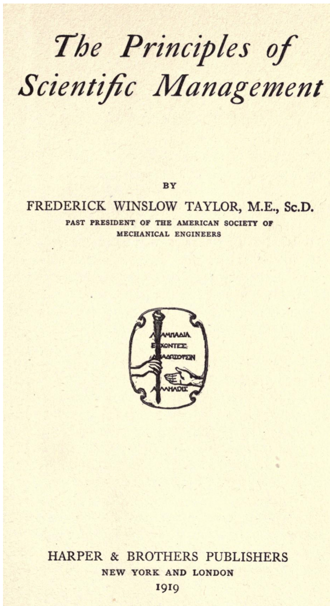
- Each worker was responsible for a complete production routine.
- There was no specification about how a production routine or production step is supposed to be done. As a result, each worker had their own way of doing it.
- Employers were looking for "the perfect man" for the job, instead of telling workers how do to it.
- Responsibility of how the work was done lay with the worker.
- Workers would choose the easiest way or the way of least resistance.

These observations present an image typical to a factory during these times. His investigation were focused around empirical studies about how the workers would accomplish the tasks they were given. In addition to the above mentioned problems he made another, at that time unexpected, discovery: Adding breaks to a workers schedule was increasing their overall productivity. Planned breaks for a specific amount of time later became a core part of the work plans Taylor developed when actually implementing scientific management.

Taylor was convinced that he could minimize losses resulting of these problems by applying scientific methods to manufacturing. This idea was contrary to the general belief at that time: manufacturing and production was not perceived as being able to be analysed and formalized. Instead, a workman who was an expert in his craft was believed to being always required to complete a job or task.

3 The Principles of Scientific Management

Seeing the gravity of the problems described in chapter 2, Taylor was encouraged to work on them and possibly find solutions. The results of his findings were published in his book *The Principles of Scientific Management* in 1911 [1]. This chapter focuses on presenting the main arguments from this book.



The Principles of Scientific Management

BY

FREDERICK WINSLOW TAYLOR, M.E., Sc.D.
PAST PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

HARPER & BROTHERS PUBLISHERS
NEW YORK AND LONDON
1919

Title page of [1][1]

[1] `https://upload.wikimedia.org/wikipedia/commons/9/90/The_Principles_of_Scientific_Management%2C_title_page.jpg`

3.1 Fundamentals

The Fundamentals of Scientific Management is the first chapter in [1] after the introduction. Here, Taylor prepares the basis for his principles by showing how both the task of the management and why workers work less than they could.

According to Taylor, the main task of management is to make maximum prosperity possible for both the employer and the employee. This can be achieved by a simple chain of events: By increasing the productivity of workers, the company makes more profit. More profit then results in higher wages. This is only possible, if both sides do their absolute best. Therefore, the views of employers and employees are not necessarily contradictory.

On the other hand, Taylor identified three reasons, why employees would deliberately work less than they could ("to soldier"):

1. Belief, that an increase in output of a single worker or machine would result in the dismissal of then obsolete other workers.
2. Workers are paid for work they done. Not showing, how fast it can actually be done, results in higher wages for less work.
3. "Rule-of-thumb" methods still had more importance than scientific approaches to solving a problem.

3.2 Principles

The Principles of Scientific Management is the next and last chapter of [1]. Before presenting his principles, Taylor gives an overview about a different and widely used type of management: "Initiative and Incentive". The of a worker describes "his best endeavors, his hardest work, all his traditional knowledge, his skill, his ingenuity, and his good-will" [1], and it's the task of the management to make workers use their whole initiative. The management accomplishes this by giving incentive, for examples promotions, raising wages and similar aspects.

In Taylor's new Scientific Management, incentive is only given in an indirect way: Only by sticking to his principles, an increase in productivity and therefore wages can be achieved. Taylor's four principles of scientific management are:

1. “They develop a science for each element of a man’s work, which replaces the old rule-of-thumb method.”
2. “They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could.”
3. “They heartily cooperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed.”
4. “There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men.”

According to Taylor, the advantage of Scientific Management over Initiative and Incentive lies in combining the initiative of the worker and the new tasks of the management. This results in an even higher productivity and effectiveness.

He “proves” this by making multiple examples where scientific management was used and how it improved the workflow. The most notable example was the one about the worker “Schmidt”. Schmidt was one of many workers tasked with transporting pig iron from one place to another. Taylor was convinced that the average amount of pig iron transported per day per worker could be increased drastically, so he picked a worker who already showed signs of soldiering, who turned out to be Schmidt. In order to motivate him, Taylor offered him an increased wage. But as mentioned before, incentive alone is not enough according to Taylor. In addition to the increased wage, an assistant of Taylor was assigned to always stay by Schmidt’s side. This assistant was telling Schmidt exactly what he was supposed to do, how to do it, and when to do it. This included the in chapter 2 mentioned breaks, Schmidt’s complete work schedule was planned exactly. He was just supposed to follow these orders. And according to Taylor, Schmidt’s productivity increased and he was able to meet the new expected standards. One after another, all other workers were trained the same way, which in the end resulted in the whole process of transporting the pig iron to be completed much faster.

It is necessary to mention here that, while the general idea about Schmidt is true and that he actually existed (his real name was Henry Noll), Taylor altered many details about the story so they would better support his argument. As discovered in [6], for example wage increase was not initiated by Taylor, but by the steel company where Schmidt worked. They moved from a flat-rate wage to a piece rate, and only to reach the previously earned money workers already had to transport a lot more pig iron every day. Also, not all workers were able to reach that new level. Those who didn't were simply excluded from Taylor's research.

4 Evaluation of Scientific Management

In this chapter, the previously presented ideas and approaches from Taylor will be analysed in a more detailed way. In addition to that a connection will be established between his Scientific Management and the term "System" as presented and discussed in our lecture.

4.1 Meaning of Taylor's principles

In this section each of the principles will be looked at in more detail, in an attempt to get a deeper understanding of them and to identify their contribution to the "scientific" aspect of Scientific Management. The principles are directed towards the management, so the subject "They" in each principle means the management and the managers of each factory or institution in particular.

4.1.1 First principle

> "They develop a science for each element of a man's work, which replaces the old rule-of-thumb method."

As mentioned in section 3.1, "rule-of-thumb" methods were still prevalent. And by their nature, they were the cause of errors and differences in production times, because every worker would accomplish a task differently, namely doing it the way he thought of being the best (for himself). Obviously, this negatively impacts the overall productivity of the entire workforce; instead of them all doing it the same best way, each of them relies on their own custom way of doing it. Taylor wanted to conquer this by scientifically finding the best way to do something. In this case "scientific" meant gathering people, who already were an expert in doing a certain task, and observing how each of them completed the task. After that, Taylor would try to combine everything he saw into one new method, which would only use the best and most efficient way to do each subtask. In other words: Tayor used empirical studies to determine the best aspects of existing "rule-of-thumb" methods, and combined into what then became the new norm to do something (the "one best way", according to Taylor). Whether this should be called a "scientific" approach in the traditional sense will be discussed later, but it at least made this method of finding a norm applicable almost every area of the secondary sector of the economy.

With this in mind, this new norm needs to constantly be reevaluated because choosing a non-perfect norm directly influences the productivity and therefore profits. This is a task of the management (see section 4.1.3). On the other hand, when developing a new norm it is important to understand what this norm means, and how the expected execution times are "calculated". Because as described before, this new norm is developed in an ideal environment: the observed experts got all necessary resources and tools at their disposal and they were not performing under pressure as the average worker on his job would, if he had to reach a certain rate. This means that the new norm is inherently flawed in the sense that it could almost never be regularly reached, unless the same conditions would be created for all workers. But that is unlikely, or rather near impossible. In addition to that, a norm will always be based on the experts observed. Other experts or other companies conducting the research will most likely be using different methods, which in return means different results.

Lastly, changes in a norm can be differentiated into two categories, organizational and technological changes. Organizational changes focus on the environment and the conditions, which influence the worker executing the norm. This includes for example changes to the workplace and readiness or supply of resources and tools. Technological changes are about the "How", they include changes about the different steps in the production, tool changes or upgrades and similar aspects.

4.1.2 Second and third principle

> "They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could."
>
> "They heartily cooperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed."

The second principle focuses on the worker executing the norm developed through the first principle (see previous section). And again Taylor uses the term "scientifically", but what does it mean here? To explain it, we can take a look at the example of Schmidt again (see section 3.2). Schmidt was not randomly selected, but because he met a set of criteria. These criteria included "soldiering" (see section 3.1), so after seeing that Schmidt was not working to his maximum capabilities, Taylor decided to pick him for his attempt of applying a found norm to a single worker. This was done through an assistant of Taylor, who is not described in detail, but it can be safe to assume that he is not just another worker, but instead could be seen as a member of the management.

This assistant is assigned to one worker at a time, which means this one worker has the full attention of the assistant. Mistakes or deviations from the norm can be detected and corrected immediately, which definitely shows resemblance to science in the traditional sense. This can also be seen as the implementation of the third principle: the management (here their representative, the assistant) and the worker are supposed to cooperate and implement the principles of science together. But how is this "working together" going to happen if there is such a discrepancy between the assistant and the worker he is assigned to. In a way, the assistant is a bridge between the management and the worker: he translates the developed norm into clear commands every untrained worker can understand. But the worker never really had anything to say in this relation. He is just supposed to mindlessly follow every order he is given, which begs the question if the phrasing "heartily cooperate" in the third principle is actually fitting. It would appear, that instead of a cooperation this looks more like one-way relation where the assistant/management is in full control and the worker is supposed to obey and follow their "principles", no matter if he is capable or not.

And this permanent surveillance was not just a worry, but actually used and implemented, for example by using stopwatches to compare the results of a worker to the developed norm. As later showed in section 5.1, this was one of the major concerns of the workforce. Being controlled by technology like that and living/working "by the clock" was unimaginable and pretty much grotesque at that time. That being said, the simple truth is that the time to complete something and the quality of the result are the main forms of measurement of an employee until today. And since the quality aspect was covered by developing a norm and everyone doing the same steps, the time to complete it was the only measurement left.

4.1.3 Fourth principle

> "There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men."

The fourth and last principle describes the shift of responsibility happening because of Scientific Management. Before, as mentioned in the principle, the responsibility was only with the worker. He was given a task, and the only thing that mattered was that he completed it in time and with the expected quality. This is similar to the following quote:

> "Do what you want - but be profitable" (Werner Glissmann, member of the works council at IBM) [9]

Management only cared about results and would only act upon them, for example when they did not meet the expectations and requirements.

Scientific Management adds a new layer to management through principle 1: While results are still as important as before, management now tells the worker how he is supposed to do something. This enables the management to compare the productivity of each worker, while at the same time moving responsibility from the worker to the management: Because the management now chooses the methods, the worker is no longer responsible if the chosen methods are flawed, not as effective as other, etc. The only responsibility remaining with the worker is doing things exactly as he is told. As long as he is following orders and reaching the estimated time it takes for a production step, the management can not blame him for anything.

The in the principle described additional work for management which can not be done by the worker can be summarized as follows:

- Find a norm (principle 1).
- Teach the norm to the workers (principle 2).
- Survey the workers and the norm to determine if the norm needs changes and/or the workers need additional training. If training is not a promising to result in an improvement, replacing the worker can also be necessary solution (principle 3).
- Precise workflow planning, both in
  – large scale like planning the production as a whole to minimize delays between the different steps and in
  – small scale like for example clear written instructions which every worker receives when starting his day and which tells each worker exactly what he has to do today and if there are any deviations from the regular work day.
- Ensure a continuous and steady of supply of resources and tools required by the norm.
- Adapt to changes. For example a change in demand on the market could make employing new workers or reevaluating the norm and it's requirements necessary.

Of course the management is responsible for more than this, but for example commerce has already been it's responsibility before, hence it is not listed here again.

4.2 System theory background

Before the system theory background of Scientific Management can be analysed, some definitions have to be made to lay the basis for the following analysis. In the lecture we used the following definition for a system:

> "A system (lat. greek "system", "composed", a whole consisting of parts; connection) is a set of elements that are interconnected and interact with each other, forming a unified whole that possesses properties that are not already contained in the constituent elements considered individually. (Petrov, 2020)" [10]

This definition is not very specific in the sense that "interacting elements" applies to a lot of things in our world. In return, this results in the definition creating a lot of systems of different scales, which can sometimes even lead to statements like the following one:

> "If you don't know what it is, call it a system." (Alfred Winter, 2019, in a lecture about clinical information systems at the University of Leipzig)

This means that in order to precisely look at systems, it always needs to be clear which elements are currently important and on what scale or level the system is operating. This will become more clear later when actually analysing Scientific Management.

In the lecture the "normal" system definition was extended to the definition of a technical system. The relevant difference or aspect of a technical system is that in a technical system the existing parts and elements are used as a basis, and new elements are added and built on top of the existing ones. This is not the case for Scientific Management: instead of using the existing structures like workflow, assigned workers etc. (which would be the elements of the system) and building something on top of them, they get broken down into the smallest pieces. A complete workflow, which was one complete element before, now consists of many elements of the smallest scale (the smallest possible work steps). These small elements then get reorganized and potentially modified (according to the norm developed through principle 1), so they can be reassembled again producing the same result as the original workflow, but now including the improvements made by the norm.

In a way these new elements forming one original workflow can be seen as a new (sub-)system: they interact with each other (one small step follows the other) and they form a unified whole (the result of the original workflow), which means the system definition applies. This is why it is important to keep the scale in mind when dealing with systems to avoid scope creep. This can be achieved by identifying and separating subsystems whenever possible.

In Scientific Management this scope creep or complexity problem also hat to be contained and dealt with. The main problem of too much complexity in projects with multiple persons working on them is usually an increasing overhead. Overhead describes additional expenses, information or work that has to be done, but is not directly contributing to the result of the project. For example if only one person works on a project, this person always has access to all information regarding the project, whereas when multiple people work on it, they have to share information with each other and engage in communication. This is the reason why assigning twice the amount of people to a project in most cases doesn't mean the project will be done twice as fast, because the more people work on it, the more "additional" work has to be done. Another more technical example can be found in internet communication: information is sent via packages through the internet. These packages contain the desired information, but also an overhead consisting of the sender's and the target's address, how old the package is, what kind of protocol is used and so on. Reducing this overhead means reducing bandwidth usage and therefore effectively reducing loading times.

To avoid these negative effects, every worker would now only be responsible and work on one small part, one element of the new norm. This way there would be no communication gaps with their colleagues, because there was no need for communication in the first place. After finishing their work, the result would simply be given to the next worker, who would perform his task. It was no longer necessary for a single worker to be aware of the complete workflow, instead the management would have to keep an overview.

This relates back to the previously mentioned organizational changes regarding the production cycle: the work needed to be done is split up in to the smallest possible parts and standardized at the same time. This standardization process is also apparent when looking at a different aspect: the demand for standardized mass production of wares and products was on the rise due to the industrial revolution (and will continue to rise). Connecting the standardization of both products and production to meet the market's demand the best and most efficient way possible seems logical. This also laid the foundation for the assembly line, which got first used at Ford in 1913 [11], and gained increased importance over the years. The assembly line complies with the principles of scientific management in the sense that after the worker got teached the new norm, he just has to stand next to the assembly line and repeat the same steps on each product. This also reduces the previously described overhead, because ideally the worker never has to leave his position during a shift, because every tool and resource he needs gets delivered to him automatically. Ford describes this process as follows:

> "a man must not be hurried in his work - he must have every second necessary but not a single unnecessary second. We have worked out speeds for each assembly [...] to put all assembling in mechanically driven lines." (Henry Ford, 1922) [11]

Even though Ford doesn't mention the principles of scientific management directly, this approach bares some obvious similarities to the first principle. The assembly line and it's speed become part of the norm. It constantly gets monitored to check, if it's speed is still matching the speed of the other parts (= the workers) participating in the production cycle. This emphasizes the individual worker loosing all importance and becoming just another (exchangeable) part in the machine that the factory or institution has become. This will be further discussed in section 5.1.

Lastly, let's have a small outlook at what the system theory changes introduced by Scientific Management mean today. As described, the main changes introduced are

- breaking down work into smallest possible pieces,
- standardization of these work pieces,

- completion time of these work pieces is more important than ever and
- the worker executing the the work/tasks is nothing more than an exchangeable part.

These changes did lay the foundation for what is today known as business planning (see section 5.2 and figure 1). They also bear similarities with the computer: It may not contain any living parts, but it's based around the concept that an exact input is required which tells the computer what it is supposed to do, and invalid input can cause errors etc. The operating system and other software utilize the provided hardware to offer predefined tasks to the user and attempts to complete them as fast as possible. In most cases executing the same task twice would yield the same result, further emphasizing the spirit conveyed by Scientific Management and it's first principle.

4.3 Actors and relations in Scientific Management

After analysing the principles of Scientific Management and it's system theory background, an important aspect missing are the relations between the groups of people participating in Scientific Management. This topic has already been touched, but without going into detail. The following roles are the main actors in Scientific Management:

- **the manager:** While he already existed before Scientific Management, the role of manager and management in general gained increased importance and responsibility in Scientific Management (see section 4.1.3). He is representing the company he works for and is a member of the leadership. Instead of simply being responsible for commerce, he now has to work together with the experts to find a feasible norm according to principle 1. The focus lies on feasibility (costs, requirements, etc.) because the "How" is determined by the experts. Together with the experts they become the architects of what the workers are going to work on and how they are supposed to do it.

  Management itself is not "managed" by Scientific Management or it's principles. It's tasks are too dynamic and dependant on external influences that standardization would be hindering the workflow more than it would help.

The role of manager persisted until today, but with an increased granularity like junior manager, senior manager, etc. For example in software development, a manager still holds responsibility and is leading entire projects, but is not directly interested in how the developers and other project participants work exactly.

- **the expert:** The experts have to have a great expertise in their field of work to identify possible improvements in the workflow. Together with the management they develop new norms, which in return increases the productivity of the whole factory or institution.

  Before Scientific Management, these experts were considered part of the "normal" workforce. Their skill was needed there, because they developed the "How" without the management paying too much attention. This does not mean that everyone who was good at his job actually became an expert and started to help the management; the bigger part remained in the normal workforce but now not using their skill anymore and instead blindly following orders (which led to conflicts, see section 5.1).

  Today, experts can usually be found in the Research & Development sections of modern technology companies, where they develop the next version of technology or entirely new products.

- **the trainer:** The trainer represents the assistant mentioned in the "Schmidt" example. He is responsible for teaching the worker the developed norm. Though in practice it is unlikely that every worker actually gets one trainer specifically assigned to him, because either you would need the same number of trainers as the number of workers or the workers would never be on the same level of training, because they wouldn't get it at the same time. The latter would actually contradict the general idea of Scientific Management that everyone should only do everything the best way possible, which is why it's better to apply it to everyone participating in one workflow at the same time.

  This is why trainers would instead be responsible for more than one worker at a time, similar to the role of foreman, but now with the connection to management by applying their norm to the normal worker.

Advanced and further training is still an important topic today, and these trainings are often offered by the company or management. Often even external trainers get hired so their expertise gets transferred to the worker. Other training is usually left to the already employed workers; they can teach new employees how the tasks can be executed the best way.

- **the worker:** The last major group is the worker. Mentioned many times before, he forms the largest group and maybe even the most affected one as well. Before Scientific Management, the workforce consisted of many more of less qualified workers, which had to have at least a little bit of experience in the area where they were working.

  Through Scientific Management, this changed. There was no longer a need for highly qualified workers, the only thing that mattered were their physical capabilities and their ability to follow orders. They were the most affected because their daily work changed the most, and in their mind for the worse (see section 5.1).

  Today, the idea and understanding of the "simple minded" worker and that they can only follow order is mostly deprecated, because it devalues the worker. At the same time, "work experience in similar fields" is a common requirement on most job offers.

Taylor sees the strength of Scientific Management in combining the initiative (see section 3.2) with the new tasks of the management. One way to create incentive by moving from flat wages to a piece rate, as described in the "Schmidt" example. Doing this also means giving the worker the possibility to actually reach the expected quota. An example for the organizational aspect this is the story of Adolf Hennecke, who managed to reach almost 400% of the usual daily mining quota. He was able to accomplish this, because he had an ideal working environment: he was allowed to chose his dig site beforehand and he was given the best tools [12]. These circumstances are obviously not normal, which means using Henneke's performance as a "norm" or benchmark is unfair because it can't be reached.

This means that this benchmark is actually a social benchmark, which develops itself through the competition between different companies.

Ford actually tried a different approach than Scientific Management. Instead, Ford increased his wages so much the experts of automobile construction wanted to work for him and didn't leave. In a way he had no need to develop a norm and teach it to his worker, because his worker were already experts who would keep the Know-How focused inside his company.

5 Influence of Taylor's work

In this chapter the influence and consequences of Taylor's *Principles of Scientific Management* will be looked at. Both the immediate responses after the publication in 1911 and the remaining aspects in today's forms of management will be presented so a possible change in perspective throughout the years will become more clear.

5.1 Application of scientific management

When put into practice, Scientific Management actually yielded good results. After finding the "one-best-way" to do something (principle 1), workers would be trained to do that exact method over and over again (principle 2). Workers would also be supervised and checked using different methods (principle 3). For example, stopwatches were used to measure a workers performance, until they were forbidden in 1916 due to the Hoxie-report [2]. By selecting the methods, the management automatically took on more responsibility, because if those methods were not good, competitive or "state of the art", it is now the managements fault and no longer the workers (principle 4).

But even though productivity increased, Scientific Management received criticism for multiple core aspects. After strikes in weapon factories, a special committee, which commissioned the Hoxie-report [2], was formed to examine Scientific Management and its methods [4]. Criticism regarding Scientific Management includes, but is not limited to, the results of the Hoxie-report and the following bullet points:

- Measuring time and fatigue is too inaccurate, and destroys the solidariy between workers.
- Work is now split up in physical and mental work, which results in few highly qualified and many under qualified workers.

- Physical work is split up in to many small parts, resulting in monotonous repetition.

- Scientific management itself results in outsourcing and lower wages, because now even unskilled workers can complete more complex tasks by simply following instructions.

Furthermore, Scientific Management increased the conflict of interests of the workman and the management. Ideally, the increased profits created through Scientific Management should be (at least partly) returned to the workman in form of higher wages, better working conditions etc. But in reality companies often decided to not do that and treat the profits as pure company profits while continuing to exploit the workman.

In spite of this, the ideas of Scientific Management spread internationally and influenced others to implement or extend them. It even reached Vladimir Lenin in Russia, who described Scientific Management as "Man's Enslavement by the Machine" [7] in 1914, but later in 1918 recognized that "The Russian is a bad worker compared with people in advanced countries" and that they "must organise in Russia the study and teaching of the Taylor system and systematically try it out and adapt it to our own ends" [8].

Lenin's description in [7] actually was quite on point. Because for an outside observer, a factory or institution implementing Scientific Management would look just like a machine. It would run at maximum efficiency, every repeated task would be executed the same perfect way it was done before, and it would only slow down if a part of the machine, in this case a worker, would fail to meet the expected productivity. And since it is a machine, parts are replaceable, which is one of the reasons why a machine is usually this effective. So for an outside observer, Scientific Management would look almost ideal in terms of results, but the cost for reaching this maximum in productivity will always be the exploitation of the workman. This is why mainly workman were opposed to Scientific Management becoming their work ideology.

The exploitation mentioned here can be seen in two different ways: The first and more obvious one is the physical exploitation. Making workers do dull and repeating steps without allowing them to ever actually use their own skill and ingenuity is bound to negatively influence both their physical and mental condition.

The second form of exploitation is a little bit more subtle and became a more worrying factor in recent years, and even made it's way into some science fiction and dystopian media. By pulling all the skill and Know-How from the workers, it would be possible to create a machine that does the exact same repeated steps that the worker used to do, effectively replacing him and making him obsolete. Discarding the worker in favor of a machine that can do the same things more precise, at a higher speed, doesn't need to sleep and apart from maintenance and the initial investment doesn't cost money, has become a viable and tempting option for management.

5.2 Scientific Management today

While Scientific Management in it's original form is not used today anymore (because of the aforementioned criticism), some aspects are still visible in today's industry. An example for this is the production line for new cars: the same steps have to performed on every car, and while some can be completed by machines, workers are still needed. Delays caused by mistakes or not following the best procedure slow down the whole process and can potentially result in losses for the company.

Even though it was initially developed for the secondary sector of the economy, sometimes it can be found in the tertiary sector as well: Fast food production and templates for documents or other objects are just two examples for how in the beginning, the best way to do something was found, and then reused over and over again by the employees.

Another example is business planning with so called Gantt-Charts, who were developed by Henry Gantt around 1910-1915 as well [5]. An example can be seen in figure 1:

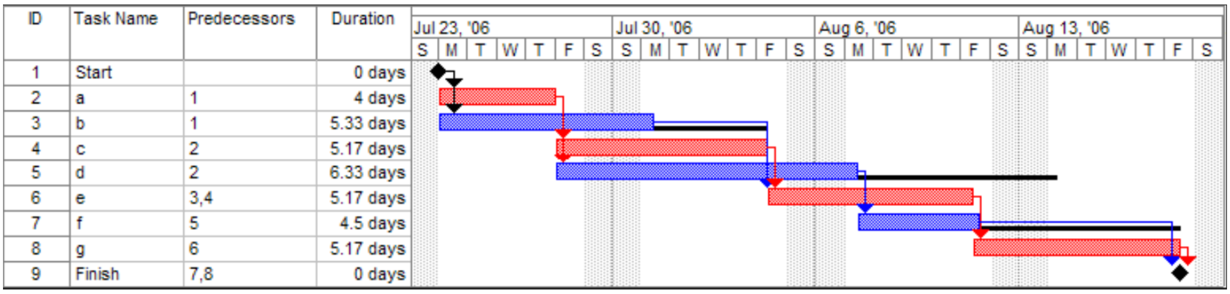


Figure 1: Gantt chart[2]

While it's not necessary to go into too much detail about Gantt charts here, it's still important to point the similarities to Scientific Management. Every task has predecessors, which need to be fully completed before the follow-up tasks can start, and a duration, how long the task takes to complete, or rather: how long it is allowed to take. By looking at the graph, it becomes obvious where delays in some tasks would cause the whole project to delay, and where tasks have a buffer. Gantt charts are still used in todays management to plan projects, and the decomposition of the whole project into small steps with set durations is a clear similarity to Scientific Management by Taylor.

[2]https://upload.wikimedia.org/wikipedia/commons/7/73/Pert_example_gantt_chart.gif

References

[1] Frederick Winslow Taylor: The Principles of Scientific Management, 1911.
`https://archive.org/details/principlesofscie00taylrich/`

[2] Robert Franklin Hoxie: Scientific management and labor. Appleton, New York 1915
`https://archive.org/details/scientificmanage00hoxi/`

[3] Wikipedia: Scientific Management
`https://wikipedia.org/wiki/Scientific_management`

[4] Wikipedia: Taylorismus
`https://de.wikipedia.org/wiki/Taylorismus`

[5] Wikipedia: Gantt chart
`https://en.wikipedia.org/wiki/Gantt_chart`

[6] Wrege, Charles D. and Amedeo G. Perroni: "Taylor's pig-tale: A historical analysis of Frederick W. Taylor's pig-iron experiments." Academy of Management Journal 17.1 (1974)

[7] Lenin, V.: The Taylor System - Man's Enslavement by the Machine, 1914
`https://www.marxists.org/archive/lenin/works/1914/mar/13.htm`

[8] Lenin, V.: The Immediate Tasks of the Soviet Government, 1918
`https://www.marxists.org/archive/lenin/works/1918/mar/x03.htm`

[9] Gräbe, H.: Geld und Wissen im Umbau der modernen Gesellschaft
`https://www.hg-graebe.de/EigeneTexte/Marathon-08.pdf`

[10] Gräbe, H.: System Management, Organizations, Systems. General Management Challenges
`https://github.com/wumm-project/Leipzig-Seminar/blob/master/Summerterm-2021/2021-04-20/Slides.pdf`

[11] Ford, Henry: My Life And Work, 1922.
`https://www.gutenberg.org/cache/epub/7213/pg7213.html`

[12] Gries, R.; Satjukow, S.: Von Menschen und Übermenschen
`https://www.bpb.de/apuz/26965/von-menschen-und-uebermenschen?p=1`