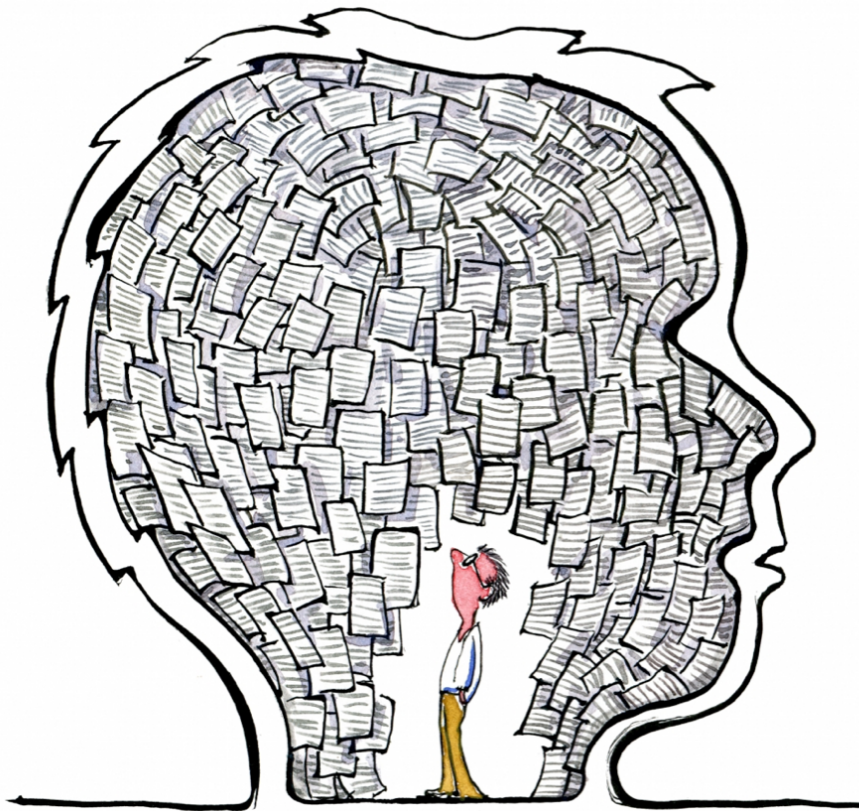


Theories of Work: Origins of the Design and Management of Work



By David Joyce

www.theoriesofwork.com

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— **Chapter Two** —
Management Arises

Design and Management — Concepts —

- The Organisation, Top Down Hierarchy, Hierarchical Responsibilities, and the Organisation Chart.
- Division of Labour, Line Executives and Staff.
- Decentralisation and Division of Responsibilities, Operating Units and the Departmental Divisional Structure.
- Specialization and Functionalisation.
- Working Hours, Child Labour, Unions and Workplace Inspection.
- Personnel Management.
- Management Reporting and Real Time Data.
- Cost Accounting.
- The Salaried Manager, Management Schools, Textbooks and Manuals.
- Standardisation of Tasks, High-Skill Tasks to High-Cost Workers, and Quality of Output.

DIVISION OF LABOUR

Management plays a very important part in the government of undertakings; of all undertakings, large or small, industrial, commercial, political, religious or any other.⁸⁶

Although management is a recent invention, one could argue that the organisation, division and supervision of a humans began thousands of years ago.

For example, Archaeologists now believe that the Great Pyramid of Giza (at least) was built by tens of thousands of skilled workers.^{2 51}

The vast majority of the workforce provided support services such as scribes, toolmakers and other backup services.^{2 49 50}

⁸⁶ Great writers on organizations By Derek Salman Pugh, David J. Hickson, Ashgate; 3 edition (November 30, 2007) p.144.

² en.wikipedia.org/wiki/Egyptian_pyramid_construction_techniques

⁵¹ A.Altenmüller, A. M. Moussa, in Studien zur altägyptischen Kultur 18 (1991), p. 36

The tombs of supervisors contain inscriptions regarding the organisation of the workforce.²

^{49 50}

There were two crews of approximately 2,000 workers sub-divided into named gangs of 1,000.^{2 49 50}

The gangs were divided into five phyles of 200 which were in turn split into groups of around 20 workers grouped according to their skills, with each group having their own project leader and a specific task.^{2 49 50}

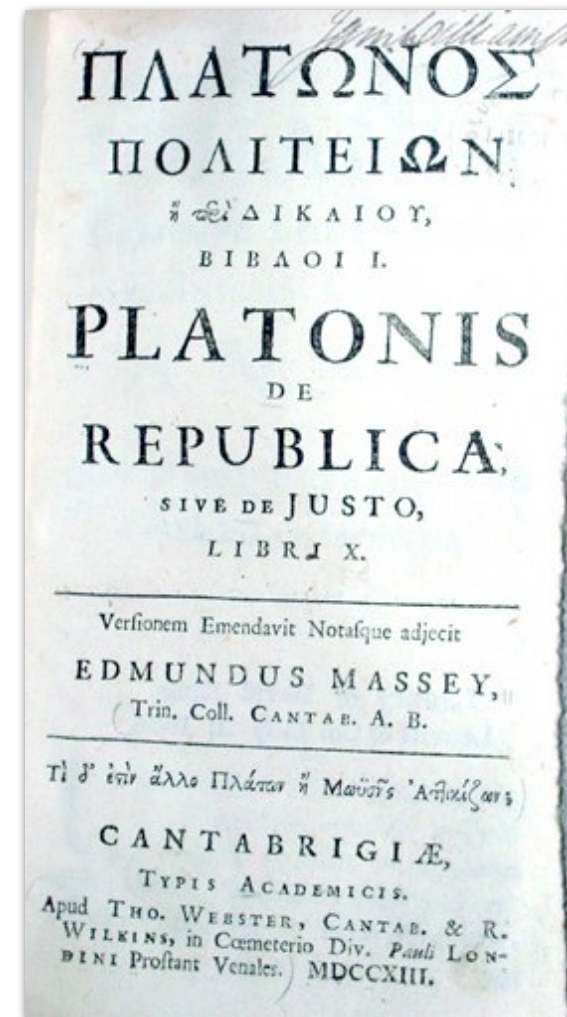
⁴⁹ Joyce Tyldesley The Private Lives of the Pyramid-builders BBC February 17, 2011

⁵⁰ Great Pyramid tombs unearth 'proof' workers were not slaves
The guardian January 11, 2010

In Plato's Republic, he described that the origin of the state lies in the natural inequality of humanity, which is embodied in the division of labour.⁴⁶

“Well then, how will our state supply these needs? It will need a farmer, a builder, and a weaver, and also, I think, a shoemaker and one or two others to provide for our bodily needs. So that the minimum state would consist of four or five men. ...^{46 167}

Plato, The Republic



¹⁶⁷ Plato: The Republic, Page 103, Publisher Penguin Classics edition (31 May 2007)

Image: Plato's "Republic" from year 1713. Source: www.columbia.edu/cu/seminars/Special/Symposium2003/slide8.html Columbia University PD-Art
en.wikipedia.org/wiki/File:Plato_Republic_1713.jpg

Xenophon, in the fourth century BC, makes a passing reference to division of labour in his “Cyropaedia”.⁴⁶

The 14th-century Arab Muslim scholar Ibn Khaldun emphasised the importance of the division of labour in the production process, in his *Muqaddimah*.⁴⁶

Another more well known example would be full time armies such as the Roman army, where the use of formalized ranks came into widespread use with the Roman Legions.

Immediately beneath the commander (or his legate) were six military tribunes.³

The fighting men in the legion were formed into ranks, rows of men who fought as a unit.^{3 52}

⁴⁶ en.wikipedia.org/wiki/Division_of_labour

Legions were divided into ten cohorts (roughly equivalent to battalion and immediately subject to the legion), each consisting of three manipula, each of them of two centuries (a rather small company in modern terms), each consisting of between 60 and 160 men.^{3 52}

Each century was led by a centurion, who was assisted by a number of junior officers. Centuries were further broken into ten contubernia (companies) of eight soldiers each.^{3 52}

³ en.wikipedia.org/wiki/Military_rank

⁵² www.roman-empire.net/army/career.html

Staying with Ancient Rome, Diocletian was a Roman Emperor from 284 to 305.⁹⁸



⁸⁹ Management: theory, process, and practice, Richard M. Hodgetts, W.B. Saunders Company (December 1975)

⁹⁰ A quick overview of Diocletian's Tetrarchy, Copyright 2006, Steve Niederloh, www.celatorsart.com/collect_tetrarch_start.html

⁹¹ The Emperor Diocletian, By Natasha Sheldon, Copyright Natasha Sheldon 2010. www.ancienthistoryarchaeology.com/the-emperor-diocletian

⁹² en.wikipedia.org/wiki/Late_Roman_army

⁹⁸ en.wikipedia.org/wiki/Diocletian

¹⁰² en.wikipedia.org/wiki/Tetrarchy

Assuming his position in A.D. 284, Diocletian soon realised that the empire had acquired an unmanageable form,⁸⁹ he did so with the realization that the empire, with all its far-flung provinces, was far too vast to be ruled effectively by one man.⁹⁰

His answer was to divide the overall administration.⁹¹

Diocletian's administrative reforms had the twin aims of ensuring political stability and providing the bureaucratic infrastructure needed to raise the recruits and supplies needed by the army.⁹²

At the top, Diocletian instituted the Tetrarchy.⁹² The term Tetrarchy describes any form of government where power is divided among four individuals.¹⁰²

Image: Istanbul Archaeological Museum, room 6 - Head from a statue of **Roman emperor Diocletianus** (284-305 AD.) -- Picture by : Giovanni Dall'Orto May 28 2006. Author Giovanni Dall'Orto. self[cc-by-sa-2.5 commons.wikimedia.org/wiki/File:Diocletian_bust.png]

This divided the empire into two halves, East and West, each to be ruled by an Augustus (emperor).⁹²

If the two emperors made their capitals in different parts of the empire, they would be able to respond much more quickly to troubles that arose in their area.⁹³

In A. D. 286, he chose Maximinus to govern the West as augustus while Diocletian would rule in the East.⁹³

Each Augustus would in turn appoint a deputy called a Caesar,⁹² or “junior emperors”⁹⁰ (which should lessen the temptation for would-be usurpers to murder the reigning emperors, since power would automatically pass to their Caesars)⁹⁵ who would act both as his ruling

⁹⁰ A quick overview of Diocletian's Tetrarchy, Copyright 2006, Steve Niederloh, www.celatorsart.com/collect_tetrarch_start.html

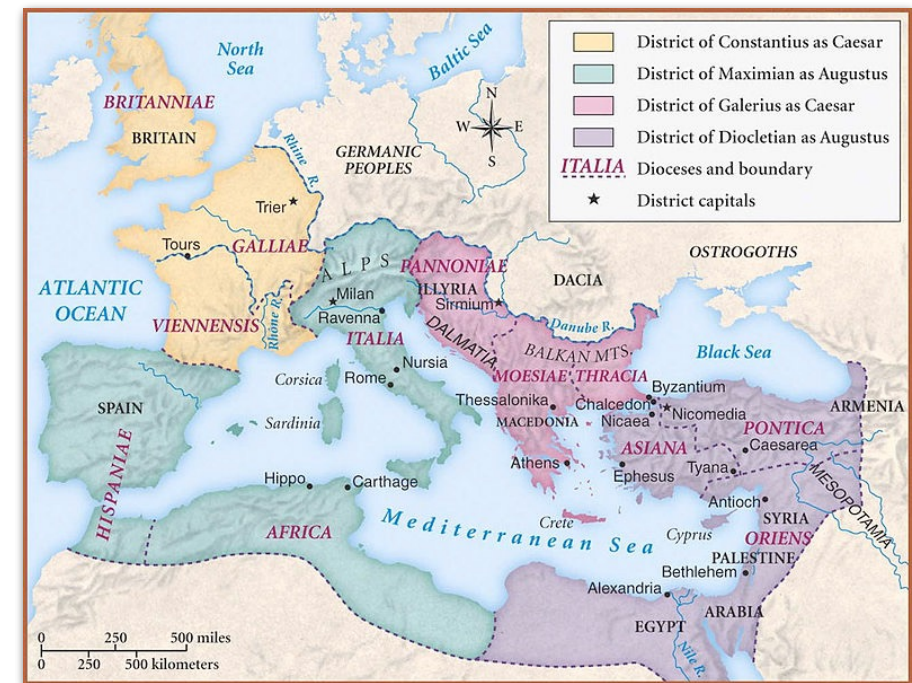
⁹² en.wikipedia.org/wiki/Late_Roman_army

⁹³ The Tetrarchy jaysromanhistory.com/romeweb/latertime/art5.htm

⁹⁵ Tetrarchy of Diocletian www.garstang.us/emperors/tetofdiocletian.htm

partner (each Caesar was assigned a quarter of the empire) and designated successor.^{92 97}

This four-man team would thus have the flexibility to deal with multiple and simultaneous challenges as well as providing for a legitimate succession.^{92 97}



⁹⁷ Goldsworthy, Adrian (2000). *Roman Warfare*. p. 166

Image: **Historic map of Roman Empire during the first tetrarchy**, 2008-18-17, Author Coppermine Photo Gallery, Coppermine Photo Gallery (CPG) is an open source project released under the GNU/GPL terms. en.wikipedia.org/wiki/File:Tetrarchy_map3.jpg

Diocletian reformed the provincial administration, establishing a three-tiered provincial hierarchy, in place of the previous single-tier structure.^{92 94}

The original 42 Principate provinces were almost tripled in number to ca. 120. These were grouped into 12 divisions called dioceses,^{92 94} each governed by an appointed official called a vicarius, or “deputy of the praetorian prefects”⁹⁸ ⁹⁹ equivalent to the English “vice-” (as in “deputy”)^{100 96} in turn grouped into 4 praetorian prefectures;^{92 94} the four main administrators of the empire, the praetorian prefects (one praetorian prefect per tetrarch).¹⁰¹

⁸⁸ Notitia Title XXXIV

⁹² en.wikipedia.org/wiki/Late_Roman_army

⁹⁴ Jones, A.H.M. (1964). *Later Roman Empire*.

⁹⁸ en.wikipedia.org/wiki/Diocletian

⁹⁹ Barnes, Constantine and Eusebius, 9; Rees, *Diocletian and the Tetrarchy*, 25–26.
Barnes, Timothy D. *Constantine and Eusebius*. Cambridge, MA: Harvard University Press, 1981. ISBN 978-0-674-16531-1

Rees, Roger. *Diocletian and the Tetrarchy*. Edinburgh: Edinburgh University Press, 2004. ISBN 0-7486-1661-6

The administration of government was largely left in the hands of the prefects.¹⁰¹

Diocletian separated military from civil command at the lowest, provincial level. Governors of provinces on the frontiers were stripped of command of the troops stationed there in favour of purely military officers called *duces limitis* (“border commanders”).^{92 94}

Most *duces* were given command of forces in a single province, but a few controlled more than one province.^{92 88}

We can see here the early beginnings of what today we would recognise as differing levels of authority, and division of labour and responsibilities across geographic boundaries.

⁹⁶ P. R. C. Weaver, “Vicarius and Vicarianus in the *Familia Caesaris*” *The Journal of Roman Studies* 54.1 and 2 (1964:117-128).

¹⁰⁰ en.wikipedia.org/wiki/Vicarius

¹⁰¹ www.roman-empire.net/decline/diocletian.html

Sir William Petty was the first modern writer to take note of division of labour.⁴⁶



⁴⁶ en.wikipedia.org/wiki/Division_of_labour

⁸³ en.wikipedia.org/wiki/William_Petty

In Political Arithmetic (written in 1690), Petty recognized the importance of economies of scale. He described the phenomenon of the division of labour, asserting that a good is both of better quality and cheaper, if many work on it,⁸³ showing its existence and usefulness in Dutch shipyards.⁴⁶

Classically the workers in a shipyard would build ships as units, finishing one before starting another. But the Dutch had it organised with several teams each doing the same tasks for successive ships.⁴⁶

Petty also applied the principle to his survey of Ireland. His breakthrough was to divide up the work so that large parts of it could be done by people with no extensive training.⁸³

Adam Smith first recognized how output could be increased through the use of labor division.⁴⁵

Adam Smith was a Scottish moral philosopher.⁴⁴

He is cited as the “father of modern economics” and is still among the most influential thinkers in the field of economics today.^{43 78}

He was also one of the key figures of the Scottish Enlightenment.^{43 77}

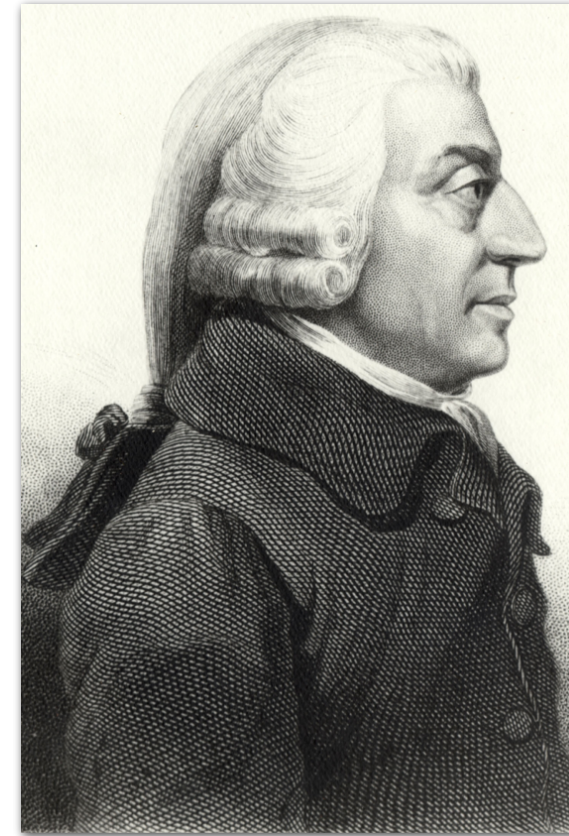
In his later life Smith took a touring position that allowed him to travel throughout Europe, where he met other intellectual leaders of his day.⁴³

⁴⁵ en.wikipedia.org/wiki/Business_process

⁴³ en.wikipedia.org/wiki/Adam_Smith

⁴⁴ Why do we believe in economy of scale?

Professor John Seddon, Managing Director Vanguard. July 2010



⁷⁷ www.bbc.co.uk/history/scottishhistory/enlightenment/features_enlightenment_enlightenment.shtml

⁷⁸ Davis, William L, Bob Figgins, David Hedengren, and Daniel B. Klein. "Economic Professors' Favorite Economic Thinkers, Journals, and Blogs," Econ Journal Watch 8(2): 126-146, May 2011.[1]

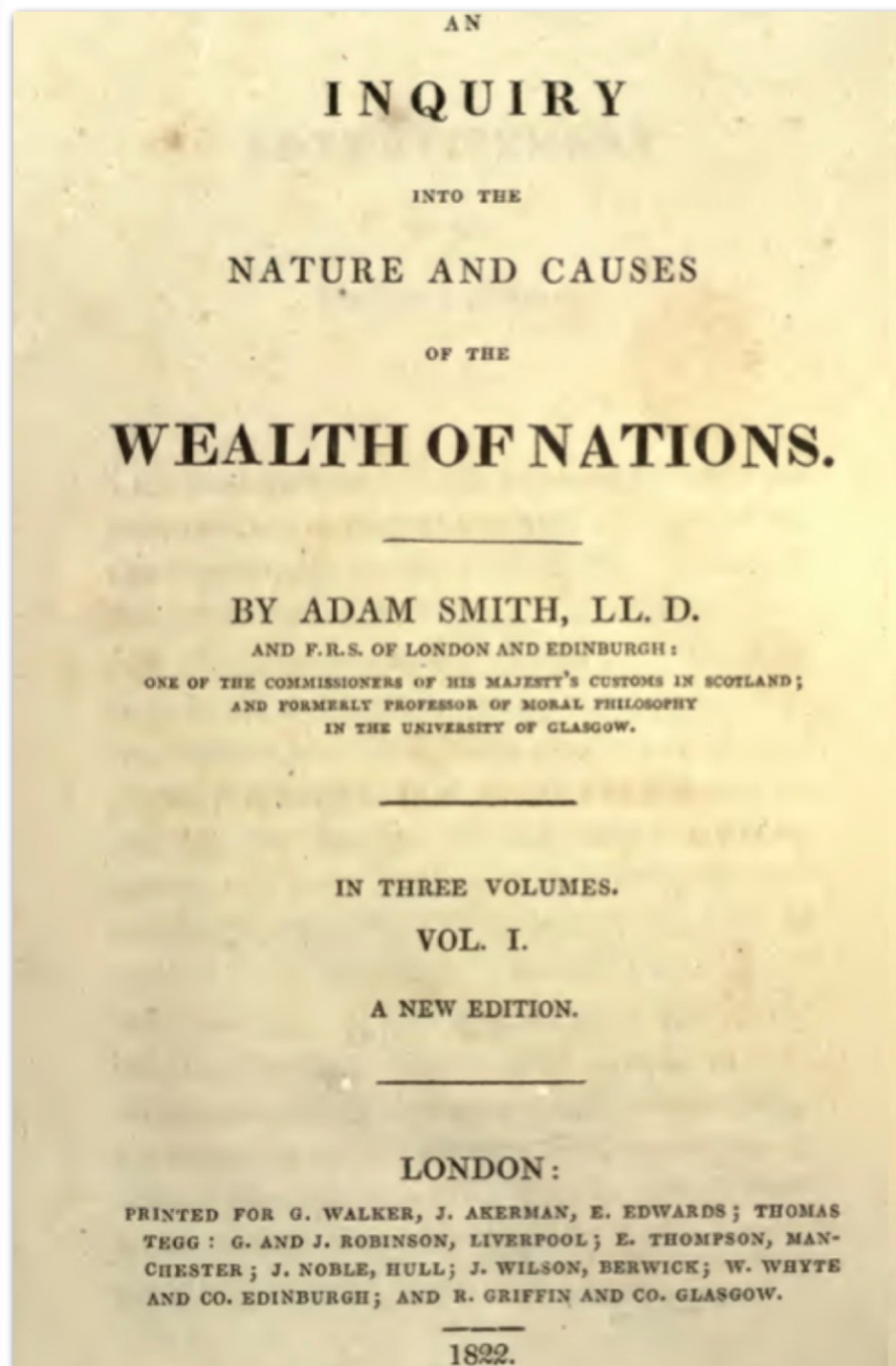
Image: Profile of **Adam Smith**, Original work in 1787. Etching produced in 1811, 1828 or 1872, Etching created by Cadell and Davies (1811), John Horsburgh (1828) or R.C. Bell (1872). The original depiction of Smith was created in 1787 by James Tassie in the form of an enamel paste medallion. Public Domain en.wikipedia.org/wiki/File:AdamSmith.jpg

Smith then returned home and spent the next ten years writing *An Inquiry into the Nature and Causes of the Wealth of Nations*, publishing it in 1776.⁴³

It was an instant success, selling out its first edition in only six months.^{43 156}

In the first sentence of *The Wealth of Nations*, Adam Smith foresaw the essence of industrialism by determining that division of labour represents a qualitative increase in productivity.^{46 47}

His example was the making of pins.^{46 47}



⁴³ en.wikipedia.org/wiki/Adam_Smith

⁴⁶ en.wikipedia.org/wiki/Division_of_labour

⁴⁷ *An inquiry into the nature and causes of the wealth of nations*, Author Smith, Adam, 1723-1790, London : Printed by A. Strahan for T. Cadell jun. and W. Davies

¹⁵⁶ Buchholz, Todd (1999). *New ideas from Dead Economists: An introduction to modern economic thought*. Penguin Books. ISBN 0-14-028313-7.

Unlike Plato, Smith famously argued that the difference between a street porter and a philosopher was as much a consequence of the division of labour as its cause. Therefore, while for Plato the level of specialization determined by the division of labour was externally determined, for Smith it was the dynamic engine of economic progress.^{46 47}

Smith says nothing about Petty in *The Wealth Of Nations*.⁸³

Previously, in a society where production was dominated by handcrafted goods, one man would perform all the activities required during the production process, while Smith described how the work was divided into a set of simple tasks, which would be performed by specialized workers.⁴⁵

⁴⁵ en.wikipedia.org/wiki/Business_process

⁴⁶ en.wikipedia.org/wiki/Division_of_labour

Smith saw the importance of matching skills with equipment - usually in the context of an organization. For example, pin makers were organized with one making the head, another the body, each using different equipment. Similarly he emphasised a large number of skills, used in cooperation and with suitable equipment, were required to build a ship.⁴⁶

In his book *An Inquiry into the Nature and Causes of the Wealth of Nations*, inspired by an article in Diderot's *Encyclopédie*, Smith described the production of a pin in the following way: ⁴⁵

⁴⁷ *An inquiry into the nature and causes of the wealth of nations*, Author Smith, Adam, 1723-1790, London : Printed by A. Strahan for T. Cadell jun. and W. Davies

⁸³ en.wikipedia.org/wiki/William_Petty

“To take an example, therefore, from a very trifling manufacture; but one in which the division of labour has been very often taken notice of, the trade of the pin-maker; a workman not educated to this business (which the division of labour has rendered a distinct trade), nor acquainted with the use of the machinery employed in it (to the invention of which the same division of labour has probably given occasion), could scarce, perhaps, with his utmost industry, make one pin in a day, and certainly could not make twenty.

*But in the way in which this business is now carried on, not only the whole work is a peculiar trade, but it is divided into a number of branches, of which the greater part are likewise peculiar trades. ...*⁴⁷

workmen, that it is impossible to collect them all into the same work-house. We can seldom see more, at one time, than those employed in one single branch. Though in such manufactures, therefore, the work may really be divided into a much greater number of parts, than in those of a more trifling nature, the division is not near so obvious, and has accordingly been much less observed.

To take an example, therefore, from a very trifling manufacture; but one in which the division of labour has been very often taken notice of, the trade of the pin-maker; a workman not educated to this business (which the division of labour has rendered a distinct trade), nor acquainted with the use of the machinery employed in it (to the invention of which the same division of labour has probably given occasion), could scarce, perhaps, with his utmost industry, make one pin in a day, and certainly could not make twenty. But in the way in which this business is now carried on, not only the whole work is a peculiar trade, but it is divided into a number of branches, of which the greater part are likewise peculiar trades. One man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; to make the head requires two or three distinct operations; to put it on, is a peculiar business, to whiten the pins is another; it is even a trade by itself to put them into the paper; and the important business of making a pin is, in this manner, divided into about eighteen distinct operations, which in some manufactories are all performed by distinct hands, though in others the same man will sometimes perform two or three of them. I have seen a small manufactory of this kind where ten men only were employed, and where some of them consequently performed two or three distinct operations. But though they were very poor, and therefore but indifferently accommodated with the necessary machinery, they could, when they exerted themselves, make among them about

twelve

One man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head: to make the head requires two or three distinct operations: to put it on is a particular business, to whiten the pins is another ... and the important business of making a pin is, in this manner, divided into about eighteen distinct operations, which in some manufactories are all performed by distinct hands, though in others the same man will sometime perform two or three of them.

I have seen a small manufactory of this kind where ten men only were employed, and where some of them consequently performed two or three distinct operations.

But though they were very poor, and therefore but indifferently accommodated with the necessary machinery, they could, when they exerted themselves, make among them about twelve pounds of pins in a day. ... ⁴⁷

workmen, that it is impossible to collect them all into the same work-house. We can seldom see more, at one time, than those employed in one single branch. Though in such manufactures, therefore, the work may really be divided into a much greater number of parts, than in those of a more trifling nature, the division is not near so obvious, and has accordingly been much less observed.

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twelve

There are in a pound upwards of four thousand pins of a middling size. Those ten persons, therefore, could make among them upwards of forty-eight thousand pins in a day.

Each person, therefore, making a tenth part of forty-eight thousand pins, might be considered as making four thousand eight hundred pins in a day.

*But if they had all wrought separately and independently, and without any of them having been educated to this peculiar business, they certainly could not each of them have made twenty, perhaps not one pin in a day; that is, certainly, not the two hundred and fortieth, perhaps not the four thousand eight hundredth part of what they are at present capable of performing, in consequence of a proper division and combination of their different operations.”*⁴⁷

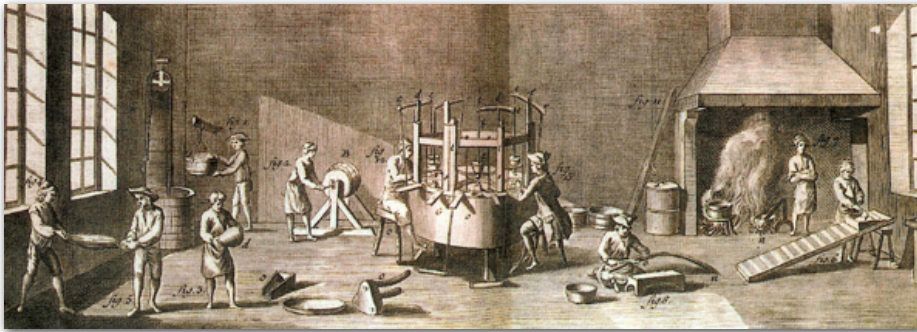
THE WEALTH OF NATIONS.

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twelve pounds of pins in a day. There are in a pound upwards of four thousand pins of a middling size. Those ten persons, therefore, could make among them upwards of forty-eight thousand pins in a day. Each person, therefore, making a tenth part of forty-eight thousand pins, might be considered as making four thousand eight hundred pins in a day. But if they had all wrought separately and independently, and without any of them having been educated to this peculiar business, they certainly could not each of them have made twenty, perhaps not one pin in a day; that is, certainly, not the two hundred and fortieth, perhaps not the four thousand eight hundredth part of what they are at present capable of performing, in consequence of a proper division and combination of their different operations.

In every other art and manufacture, the effects of the division of labour are similar to what they are in this very trifling one; though, in many of them, the labour can neither be so much subdivided, nor reduced to so great a simplicity of operation. The division of labour, however, so far as it can be introduced, occasions, in every art, a proportionable increase of the productive powers of labour. The separation of different trades and employments from one another, seems to have taken place, in consequence of this advantage. This separation too is generally carried furthest in those countries which enjoy the highest degree of industry and improvement; what is the work of one man, in a rude state of society, being generally that of several, in an improved one. In every improved society, the farmer is generally nothing but a farmer; the manufacturer, nothing but a manufacturer. The labour too which is necessary to produce any one complete manufacture, is almost always divided among a great number of hands. How many different trades are employed in each branch of the linen and woollen manufactures, from the growers of the flax and the wool, to the bleachers

The result of labor division in Smith's example resulted in productivity increasing by 24,000 percent (sic), i.e. that the same number of workers made 240 times as many pins as they had been producing before the introduction of labor division.⁴⁵



Following his ideas the division of labor was adopted widely.⁴⁵

The notion of describing process, specialisation and division of labour was born. In modern economic discussion the term human capital would be used.⁴⁶

Image: **Pin factory illustration** from "An inquiry into the nature and causes of the wealth of nations", Author Smith, Adam, 1723-1790, London : Printed by A. Strahan for T. Cadell jun. and W. Davies. Public Domain
molinahistory.wordpress.com/2011/09/01/looking-for-mr-darrells-economics-site/

Smith's insight suggests that the huge increases in productivity obtainable from technology or technological progress are possible because human and physical capital are matched, usually in an organization.⁴⁶

It is worth noting that Smith did not advocate labor division at any price and per se. The appropriate level of task division was defined through experimental design of the production process.⁴⁵

In a further chapter of [Wealth of Nations] Smith criticizes the division of labour saying it leads to a "mental mutilation" in workers; they become ignorant and insular as their working lives are confined to a single repetitive task.^{46 47} Concerns largely ignored in today's organisations.

⁴⁶ en.wikipedia.org/wiki/Division_of_labour

⁴⁵ en.wikipedia.org/wiki/Business_process

⁴⁷ An inquiry into the nature and causes of the wealth of nations, Author Smith, Adam, 1723-1790, London : Printed by A. Strahan for T. Cadell jun. and W. Davies

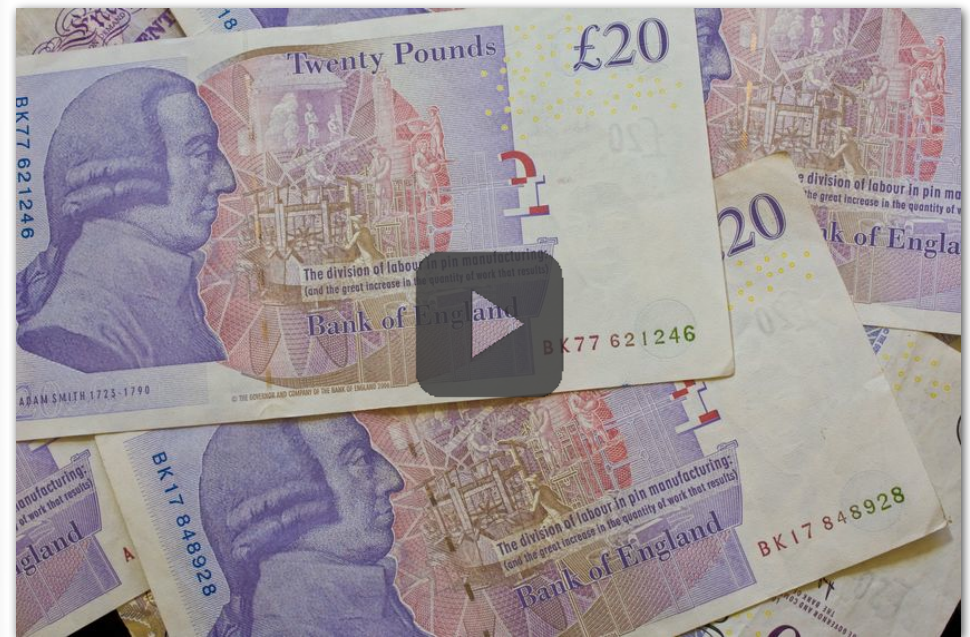
He separated out the activities required to manufacture a pin from a single craft-based job into a number of simple, standard tasks. These tasks could then be carried out by unskilled workers. As he anticipated, the benefits were greater consistency and lower unit costs.⁴⁸

This is the Adam Smith pins argument: greater productivity results from breaking tasks down into their parts.⁴⁴

One can still easily see today the influence Adam Smith had on British Industry.

On the back of a twenty-pound note (which entered circulation in 2007) there is a picture of Adam Smith and the words:

*“The division of labour in pin manufacturing: (and the great increase in the quantity of work that results)”*⁴⁴



⁴⁴ Why do we believe in economy of scale?

Professor John Seddon, managing director Vanguard. July 2010

⁴⁸ Watch out for the toolheads! Everything you need to know about lean manufacturing tools and why they won't work in service organisations, Vanguard Education, Copyright © Vanguard Consulting Limited

Image credit: www.123rf.com/photo_4760246_reverse-of-british-twenty-pound-notes.html
slallison / 123RF Stock Photo

THE BABBAGE PRINCIPLE

After Adam Smith, an Englishman Charles Babbage augmented Smith's observations and raised a number of provocative questions about production organization and economics.²⁰²

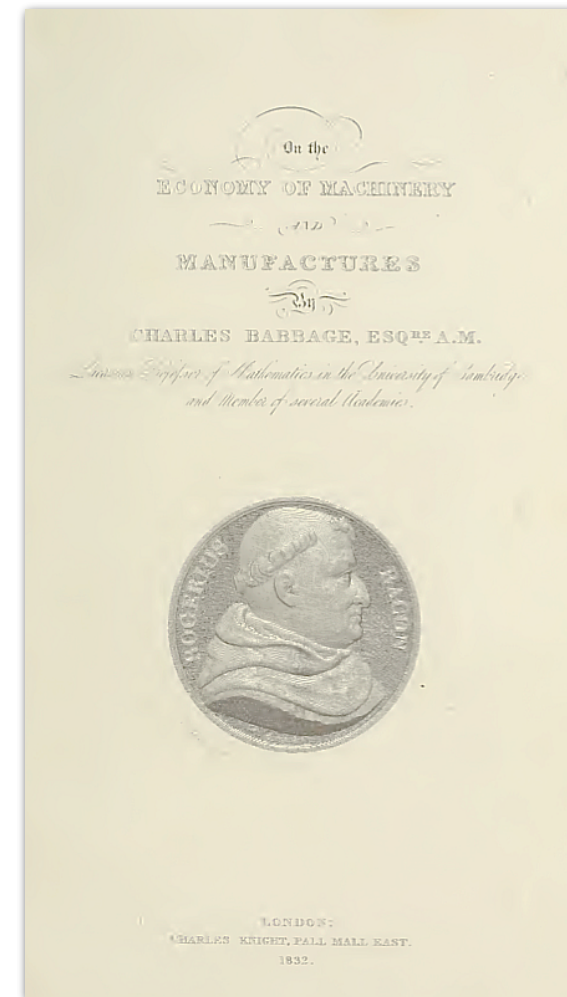
His thoughts were summarized in the book, "On the Economy Of Machinery and Manufactures" (1832)²⁰¹ on the organisation of industrial production.²⁰²

The book sold well, and quickly went to a fourth edition (1836).^{202 203} It sold over 10,000 copies and has been claimed as "the first management best-seller".²⁰⁹

Babbage represented his work as largely a result of actual observations in factories, British and abroad.²⁰²

²⁰¹ Production and Operations Management. By K.C. Arora, Publisher Laxmi Publications (December 30, 2005) p.18.

²⁰² en.wikipedia.org/wiki/Charles_Babbage



²⁰³ Mauro F. Guillén (15 October 1994). Models of Management: Work, Authority, and Organization in a Comparative Perspective. University of Chicago Press. p. 207. ISBN 978-0-226-31036-7. Retrieved 18 April 2013.

²⁰⁹ Makers of Management: Men and Women Who Changed the Business World By David Clutterbuck and Stuart Crainer p.13
Macmillan Interactive Publishing; Book Club (BCE/BOMC) edition (3 May 1990)

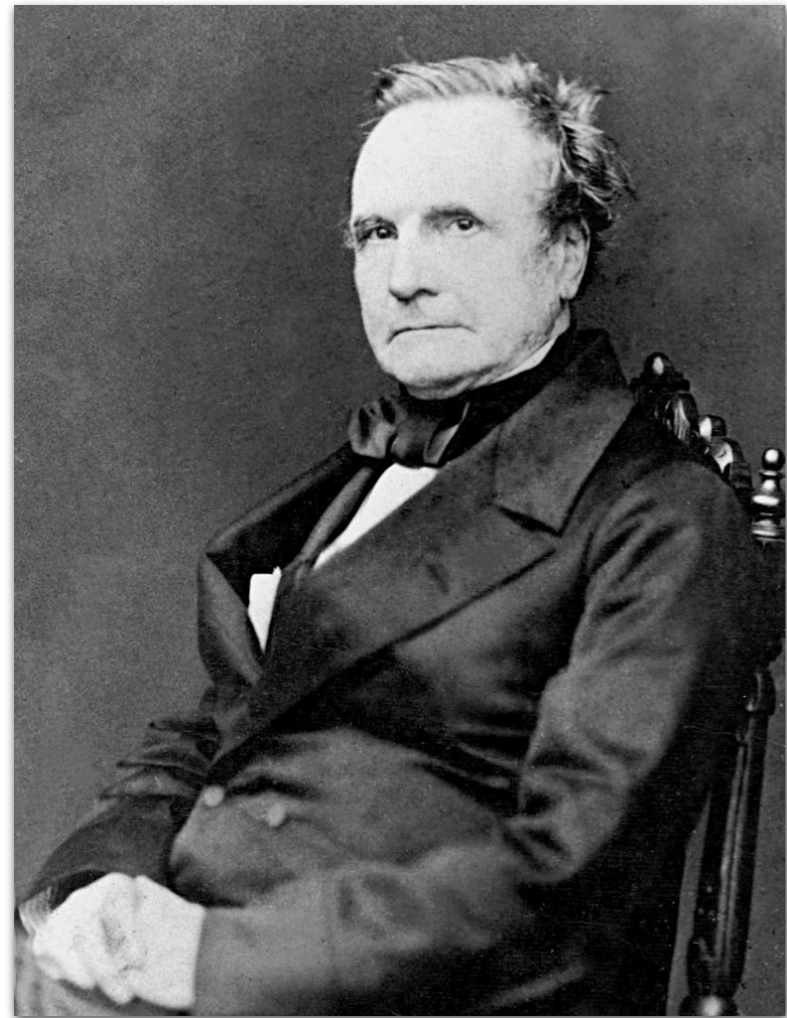
Image: **On the Economy of Machinery and Manufactures (1831) Front Cover**,
Author: Babbage, Charles, Book contributor: The Computer Museum Archive.
Public Domain archive.org/details/oneconomyofmachooabb

In Economy of Machinery was described what is now called the Babbage principle. It pointed out commercial advantages available with more careful division of labour.²⁰²

What Babbage remarked is that skilled workers typically spend parts of their time performing tasks that are below their skill level. If the labour process can be divided among several workers, labour costs may be cut by assigning only high-skill tasks to high-cost workers, restricting other tasks to lower-paid workers.^{202 204}

He also pointed out that training or apprenticeship can be taken as fixed costs; but that returns to scale are available by his approach of standardisation of tasks, therefore again favouring the factory system.^{202 205}

²⁰² en.wikipedia.org/wiki/Charles_Babbage



²⁰⁴ Giddens, Anthony; Held, David (1982). *Classes, Power and Conflict: Classical and Contemporary Debates*. University of California Press. p. 155. ISBN 978-0-520-04627-6. Retrieved 18 April 2013.

²⁰⁵ Guang-Zhen Sun (2005). *Readings in the Economics of the Division of Labor: The classical tradition*. World Scientific. p. 10. ISBN 978-981-270-127-5. Retrieved 26 April 2013.

Image: **Charles Babbage**, Date: 1860. Public Domain
en.wikipedia.org/wiki/File:Charles_Babbage_-_1860.jpg

Babbage earned a place in history as the patron saint of operations research and management science.²⁰⁸

Babbage's theories are said to have influenced the layout of the 1851 Great Exhibition.^{202 206}

He was a mathematician, philosopher, inventor and mechanical engineer, who is best remembered now for originating the concept of a programmable computer.²⁰²

Babbage's machines were among the first mechanical computers. While Babbage's machines were mechanical and unwieldy, their basic architecture was similar to a modern computer.²⁰²

Considered a "father of the computer"^{202 207}

he has also had a profound impact on how today we design and manage work.

²⁰⁶ Peter H Hoffenberg (2001). *An Empire on Display: English, Indian, and Australian Exhibitions from the Crystal Palace to the Great War*. University of California Press. p. 178. ISBN 978-0-520-21891-8. Retrieved 18 April 2013.

His prominent contributions were not in the broader areas of management but in the areas of costing, engineering and incentives, based on a belief in specialization and allocation of rewards according to productivity.²⁰⁸

COMPUTERS

Today, computers and computer programs are integral to both the design and the management of work.

To pause on the subject of division of labour for a moment, whilst we are here, it's worthwhile having a brief look at this design and management norm, that Babbage, and a colleague named Ada Lovelace, would influence.

²⁰⁷ Halacy, Daniel Stephen (1970). *Charles Babbage, Father of the Computer*. Crowell-Collier Press. ISBN 0-02-741370-5.

²⁰² en.wikipedia.org/wiki/Charles_Babbage

²⁰⁸ *Management Thought*, By Jayanta K Nanda, Publisher Sarup & Sons, New Delhi (1 Jan 2005) p.30

Augusta Ada King, Countess of Lovelace, now commonly known as Ada Lovelace, was an English mathematician and writer chiefly known for her work on Charles Babbage's early mechanical general-purpose computer, the Analytical Engine.²³⁰

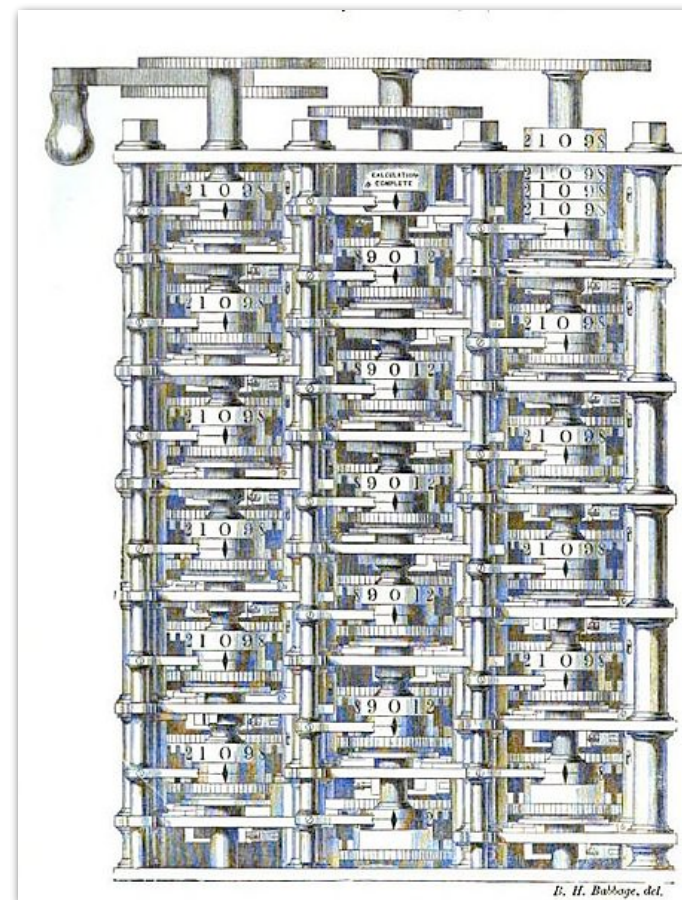
As a young adult, her mathematical talents led her to an ongoing working relationship and friendship with fellow British mathematician Charles Babbage.²³⁰

During a nine-month period in 1842–43, Ada translated Italian mathematician Luigi Menabrea's memoir on Babbage's newest proposed machine, the Analytical Engine,^{230 231} which she supplemented with an elaborate set of notes of her own, simply called Notes.^{230 232}

²³⁰ en.wikipedia.org/wiki/Ada_Lovelace

²³¹ Menabrea, Luigi Federico (1843), "Sketch of the Analytical Engine Invented by Charles Babbage", *Scientific Memoirs* 3, archived from the original on 15 September 2008, retrieved 29 August 2008 With notes upon the memoir by the translator.

These notes contain what is considered the first computer program – that is, an algorithm encoded for processing by a machine.^{230 232}



²³² Fuegi, J; Francis, J (October–December 2003), "Lovelace & Babbage and the creation of the 1843 'notes'", *Annals of the History of Computing (IEEE)* 25 (4). pp. 19, 25.

Image: **Part of w:Charles Babbage's Difference Engine No. 1**, as assembled in 1833, exhibited 1862, and later in the South Kensington Museum. Date: 1853, Author: Woodcut after a drawing by Benjamin Herschel Babbage Public Domain en.wikipedia.org/wiki/File:Difference_engine_plate_1853.jpg

The notes are longer than the memoir itself and include (in Section G), in complete detail, a method for calculating a sequence of Bernoulli numbers with the Engine, which would have run correctly had the Analytical Engine been built (only his Difference Engine has been built, completed in London in 2002²³⁴).²³⁰

Based on this work, Ada is now widely credited with being the first computer programmer²³³ and her method is recognised as the world's first computer program.^{230 235}

Many of today's workforce are reliant on, and bound to, computer programs. It's not uncommon to see a large proportion of an organisations' workforce spending the majority of their day working on a computer.

²³³ Fuegi, J; Francis, J (October–December 2003), "Lovelace & Babbage and the creation of the 1843 'notes'", *Annals of the History of Computing* (IEEE) 25 (4). pp. 16–26.

²³⁴ "The Babbage Engine". Computer History Museum. 2008.

²³⁵ Gleick, J. (2011) *The Information: a History, a Theory, a Flood*, London, Fourth Estate, pp. 116–18.

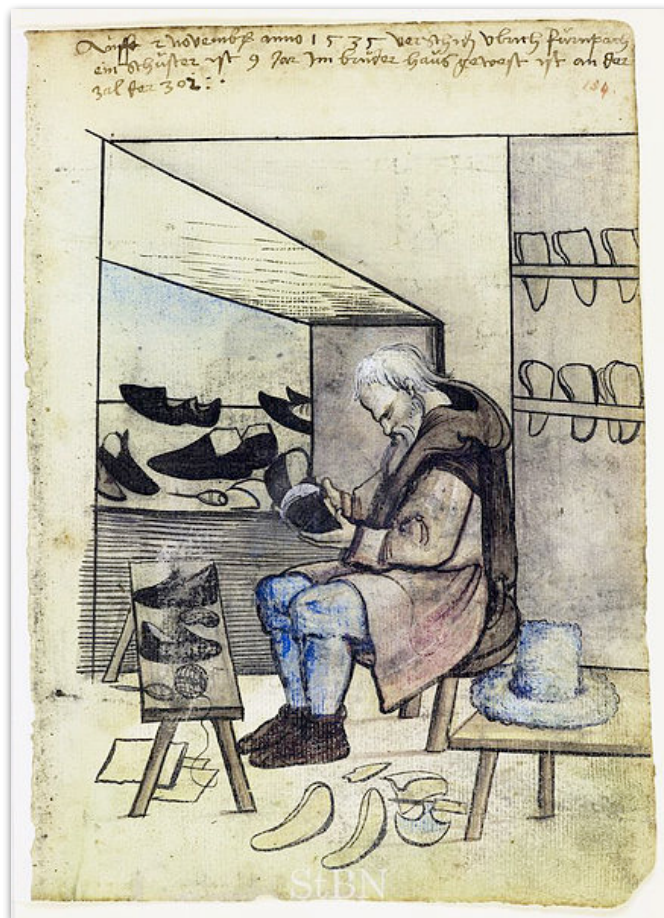


²³⁰ en.wikipedia.org/wiki/Ada_Lovelace

Image: Depicted person: **Ada King, Countess of Lovelace**, Artist: Alfred Edward Chalon (1780–1860), Date: 1840, Medium: watercolor, Dimensions: 250 mm x 183 mm, Current location: Science Museum Science & Society Picture Library, Accession number: Inventory number 1995-0796 (see on gallery's website) Image No. 10312035, Source/ Photographer: www.fathom.com Public Domain en.wikipedia.org/wiki/File:Ada_lovelace.jpg

DIVISION OF LABOUR EFFICIENCY

Continuing on with with labour division, the American system contributed to efficiency gains through division of labor. Division of labor helped manufacturing transition from small artisan's shops to early factories.⁷



Key pieces of evidence supporting efficiency gains include: increase in firm size, evidence of returns to scale, and an increase in non-specialized labor.⁷

The need for firms to train uneducated people to perform only one thing in the productivity chain allowed for the use of non-specialized labor.⁷

Women and children were employed more frequently within larger firms, especially those producing furniture and clothing.⁷

⁷ en.wikipedia.org/wiki/American_system_of_manufacturing

Image: **Shoemaker, 1535**, vlrch (Ulrich) fürnpach (Fürnpach; Fürnbach) , schuster (Schuster)
Transkription und weitere Informationen siehe www.nuernberger-hausbuecher.de/75-Amb-2-317-154-1/data Date, 1535, Source: Hausbuch der Mendelschen Zwölfbrüderstiftung, Band 1. Nürnberg 1426–1549. Stadtbibliothek Nürnberg, Amb. 317.2°, via www.nuernberger-hausbuecher.de/en.wikipedia.org/wiki/Artisan

INDUSTRIAL ORGANIZATION

As we have discussed so far, most histories of the industrial revolution focus on technological developments, such as interchangeable parts, steam power, and the assembly line. Very little has been written about how nineteenth century plants were organized and managerial power was delegated.³⁰

The factory system that began to appear in the 1800s posed challenges that earlier organizations had not encountered.⁸⁰

The earliest factories (or mills) had grown up in the later 18th century. Conditions of work were grim and factory owners often imposed excessively long hours on their workforces.²⁰⁰

³⁰ Nelson, Daniel (1980) *Frederick W. Taylor and the Rise of Scientific Management* Madison Wisconsin, University of Wisconsin Press p 4

⁸⁰ Management, Richard L. Daft, Martyn Kendrick, Natalia Vershinina, CENGAGE Lrng Business Press; First edition (24 May 2010) p.43.

During the Industrial Revolution, many workers were put out of employment or had their wages reduced because of uprising machinery.²⁴

Many women and children were hired for factory work because of their small, nimble body structure, which makes them capable of running and fixing the meticulously designed machines.²⁴

²⁰⁰ Contains Parliamentary information licensed under the Open Parliament Licence v1.0. www.parliament.uk/about/living-heritage/transformingsociety/livinglearning/19thcentury/overview/earlyfactorylegislation/

²⁴ Labor Unions in Industrial Revolution www.studymode.com/essays/Labor-Unions-Industrial-Revolution-49840.html

Children as young as four were employed in production factories with dangerous, and often fatal, working conditions.^{25 84}

In England and Scotland in 1788, two-thirds of the workers in 143 water-powered cotton mills were described as children.^{25 183}

In 1800 some 20,000 apprentices were employed in cotton mills. In the next decade as many as a fifth of workers in the cotton industry were children under the age of 13.²⁰⁰

An estimated 1.7 million children under the age of fifteen were employed in American industry by 1900.^{25 185}



⁸⁴ E. P. Thompson *The Making of the English Working Class*, (Penguin, 1968), pp. 366–7

¹⁸⁵ "The Industrial Revolution". The Web Institute for Teachers.

Image: Photographer: Hine, Lewis Wickes Flashlight **photo of children on night shift going to work at 6 PM on a cold dark December night**. Work shift lasts all night, 12 hours. They do not come out again until 6:00 AM
Child workers on their way to a night shift at Whitnel Cotton Mills. North Carolina, USA 1908. NMFF.003473 Date: 26 January 2011, 11:25:00 Source: Flickr: NMFF.003473
Author: Preus museum CC 2.0 en.wikipedia.org/wiki/File:Child_Labor_in_United_States_1908,_12_hour_night_shifts.jpg

²⁵ en.wikipedia.org/wiki/Child_labour

²⁰⁰ Contains Parliamentary information licensed under the Open Parliament Licence v1.0. www.parliament.uk/about/living-heritage/transformingsociety/livinglearning/19thcentury/overview/earlyfactorylegislation/

¹⁸³ "Child Labor and the Division of Labor in the Early English Cotton Mills". Douglas A. Galbi. Centre for History and Economics, King's College, Cambridge CB2 1ST.

Robert Owen was a Welsh social reformer and one of the founders of utopian socialism and the cooperative movement.¹⁷⁷

He is frequently referred to as the father of modern personnel management.¹⁷⁸

In 1792¹⁸⁰ at just twenty one, he was manager of a new, steam-powered mill¹⁷⁹ (Bank Top Mill, Piccadilly, Manchester¹⁸⁰) with 500 employees.¹⁷⁹

Later, he formed a partnership to build new mills in Manchester. In 1799, the partnership bought the extensive cotton mills and workers' village at New Lanark, with Owen as manager.¹⁷⁹

The mill of New Lanark had been started in 1785 by David Dale and Richard Arkwright¹⁷⁷ (whom we met in Chapter 1).



¹⁷⁷ en.wikipedia.org/wiki/Robert_Owen

¹⁷⁸ Ivancevich, J.M., Lorenzi, P. and Skinner, S.J., Management: Quality and Competitiveness, Richard D. Irwin, Boston, MA, 1994, pp. 40-67.

¹⁷⁹ robert-owen-museum.org.uk/300_words

¹⁸⁰ robert-owen-museum.org.uk/time_line

Image: **Robert Owen** 1771-1858. de: Robert Owen 1771-1858. Date: 1845, Source: painting of John Cranch 1845, Author: John Cranch, Permission (Reusing this file) Reproduction of an photo that is in the public domain because of its age.
[en.wikipedia.org/wiki/File:Portrait_of_Robert_Owen_\(1771_-_1858\)_by_John_Cranch,_1845.jpg](https://en.wikipedia.org/wiki/File:Portrait_of_Robert_Owen_(1771_-_1858)_by_John_Cranch,_1845.jpg)

The water-power afforded by the falls of the Clyde made it a great attraction. About two thousand people had associations with the mills. Five hundred of them were children who were brought at the age of five or six from the poorhouses and charities of Edinburgh and Glasgow.¹⁷⁷

He provided meals at the factories for on-duty employees and set up company stores to sell necessities at cost, and sought to improve the community by building houses and streets and making the community and factory attractive.
¹⁷⁸

New principles were also adopted by Robert Owen in raising the standard of goods produced. Above each machinist's workplace, a cube with different coloured faces was installed.¹⁷⁷

¹⁷⁸ Ivancevich, J.M., Lorenzi, P. and Skinner, S.J., *Management: Quality and Competitiveness*, Richard D. Irwin, Boston, MA, 1994, pp. 40-67.

Depending on the quality of the work and the amount produced, a different colour was used. The worker then had some indication to others of his work's quality. The employee had an interest in working to his best.¹⁷⁷

The relationship between Owen and his workers remained excellent, and all the operations of the mill proceeded with the utmost smoothness and regularity.¹⁷⁷

The business was a great commercial success.¹⁷⁷

His greatest success was in the support of the young, to which he devoted special attention. He was the founder of infant childcare in Great Britain, especially in Scotland.¹⁷⁷

¹⁷⁷ en.wikipedia.org/wiki/Robert_Owen

Owen attempted unsuccessfully to bring in legislation to ban children under the age of ten from any employment.²⁰⁰

He was a zealous supporter of the factory legislation.¹⁷⁷

He continued to campaign inside and outside Parliament, and a parliamentary inquiry into child labour in factories, led to the passing of the Cotton Mills Act of 1819.²⁰⁰

The 1819 Cotton Mills and Factories Act stated that no children under 9 were to be employed and that children aged 9–16 years were limited to 16 hours' work per day,^{177 188} but they were restricted to cotton mills.¹⁸⁹

However, the means of enforcing such legislation remained a serious problem.²⁰⁰

²⁰⁰ Contains Parliamentary information licensed under the Open Parliament Licence v1.0. www.parliament.uk/about/living-heritage/transformingsociety/livinglearning/19thcentury/overview/earlyfactorylegislation/

¹⁷⁷ en.wikipedia.org/wiki/Robert_Owen

It was not until 1833 that a system of factory inspection was introduced to enforce the regulations.¹⁸⁹

What made the 1833 Act so important was that it established a system to ensure that regulations were enforced.¹⁹⁹

A small, four-man “inspectorate of factories” was created, responsible to the Home Office, with powers to impose penalties for infringements.¹⁹⁹

Inspection in the workplace had been born.

In its early days the inspectorate was far too small to enforce the Act in 4,000 mills, and so the Act was widely evaded.

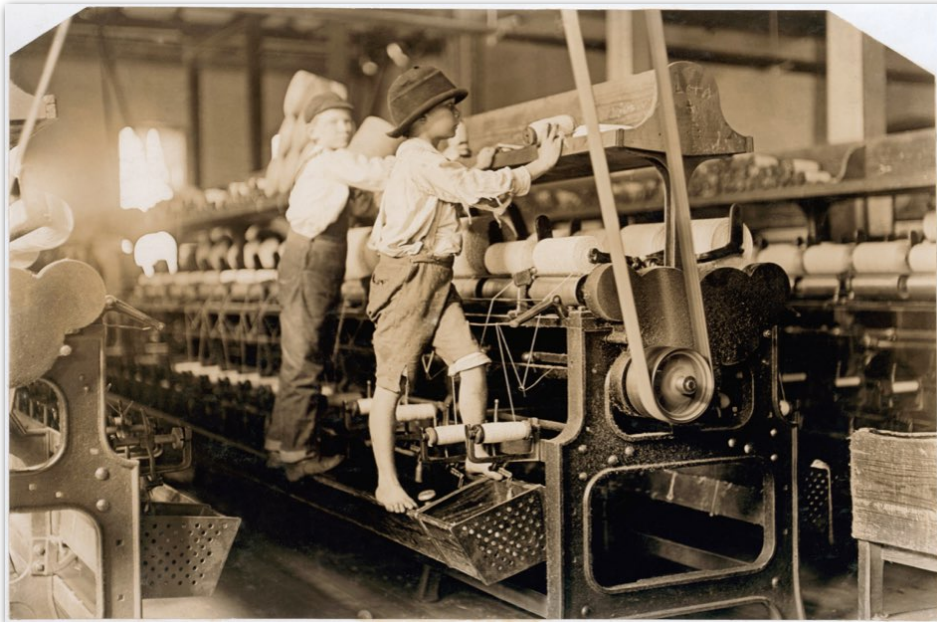
¹⁸⁸ Early factory legislation. Parliament.uk. Accessed 2 September 2011.

¹⁸⁹ robert-owen-museum.org.uk/Robert_Owen_1771_1858/factory_reform

¹⁹⁹ Contains Parliamentary information licensed under the Open Parliament Licence v1.0. www.parliament.uk/about/living-heritage/transformingsociety/livinglearning/19thcentury/overview/factoryact/

The Industrial Revolution concentrated labour into mills, factories and mines, thus facilitating the organisation of combinations or trade unions to help advance the interests of working people.¹⁸²

These unions were formed to address issues like child labor, 12 hour work days, safety and wages.¹⁸⁴



Employers had to decide between giving in to the union demands at a cost to themselves or suffering the cost of the lost production. Skilled workers were hard to replace, and these were the first groups to successfully advance their conditions through this kind of bargaining.¹⁸²

Other problems arose in tooling the plants, organizing managerial structure, training employees (many of them non-English-speaking immigrants), scheduling complex manufacturing operations, and dealing with increased labour dissatisfaction and resulting strikes.⁸⁰

¹⁸² en.wikipedia.org/wiki/Industrial_Revolution

¹⁸⁴ Sandrine Bardot, compensationinsider.com/the-history-of-performance-reviews-infographic/

⁸⁰ Management, Richard L. Daft, Martyn Kendrick, Natalia Vershinina, CENGAGE Lrng Business Press; First edition (24 May 2010) p.43.

Image: **Children working in a mill in Macon, Georgia, 1909.** Author Lewis Hine. This image is available from the United States Library of Congress's Prints and Photographs division under the digital ID nclc.01581 en.wikipedia.org/wiki/File:Mill_Children_in_Macon_2.jpg

MANAGEMENT EDUCATION

Solving these problems required further innovation, and the subsequent dissemination of that knowledge through education. Schools of technology and engineering would provide the home for this education.

In 1794 the French revolutionary government would group together a number of similar institutions to establish the École Polytechnique – the school of all the technologies.²⁶

It is seen by many as a source of organizers.²⁷

Enter Colonel and Brevet Brigadier General Sylvanus Thayer, also known as “the Father of West Point”,⁴⁰ who was an early advocate of engineering education in the United States.⁴⁰

⁴⁰ en.wikipedia.org/wiki/Sylvanus_Thayer

²⁷ Conversations with William Hopper



²⁶ The Puritan Gift: triumph, collapse and revival of an American dream, Kenneth Hopper and William Hopper, I. B. Tauris (April 3, 2007) p.38. By permission of Ken Hopper and Will Hopper

Image: Portrait of **Sylvanus Thayer** by en:Robert W. Weir photo of portrait originally found at domain usma.edu. PD-ART en.wikipedia.org/wiki/File:SylvanusThayer.jpg

In the U.S. President Madison and Secretary of War James Monroe were alarmed at the educational deficiencies of the Army's officer corps.²⁶²

In 1815⁴⁰ when Major Thayer expressed interest in spending time abroad expanding his knowledge of military and technical studies, Madison and Monroe provided him with \$5,000 to buy books, maps, and "other learning materials" for the nation's struggling young military academy.²⁶²

When in France he studied for two years at the French École Polytechnique.⁴⁰

²⁶² Who Was Sylvanus Thayer? By Genevieve Chan © 2013 Thayer School of Engineering at Dartmouth.
www.dartmouthengineer.com/2004/09/who-was-sylvanus-thayer/

⁴¹ en.wikipedia.org/wiki/United_States_Military_Academy

⁷³ "A School for the Nation". Smithsonian National Museum of American History. Retrieved 10 January 2009.

⁷⁴ McMaster, R.K. (1951). West Point's Contribution to Education. El Paso, TX: McMath Printing Co. p. 6.

In 1817, President James Monroe ordered Thayer to West Point to become superintendent of the U.S. Military Academy.⁴⁰

Under his stewardship, the Academy became the nation's first college of engineering.⁴⁰

Thayer making French the language of West Point and using French textbooks he had brought back, was very important in bringing technology into the U.S. from France.²⁷

Founded as a school of engineering, for the first half of the 19th century, USMA produced graduates who gained recognition for engineering the bulk of the nation's initial railway lines, bridges, harbors and roads.^{41 73 74 75}

⁴⁰ en.wikipedia.org/wiki/Sylvanus_Thayer

²⁷ Conversations with William Hopper

⁷⁵ Endler, James (1998). Other Leaders, Other Heroes. Westport, CT: Praeger Publishers. ISBN 0-275-96369-1. p. 12.

West Point was to have a profound impact on the application of technology in the civilian world.⁴²

In all, more than 120 West Pointers would work on American railroads before the Civil War, in engineering, supervisory or executive capacities.⁴²

Up until 1824 the academy was the only engineering school in the country [US].⁴¹

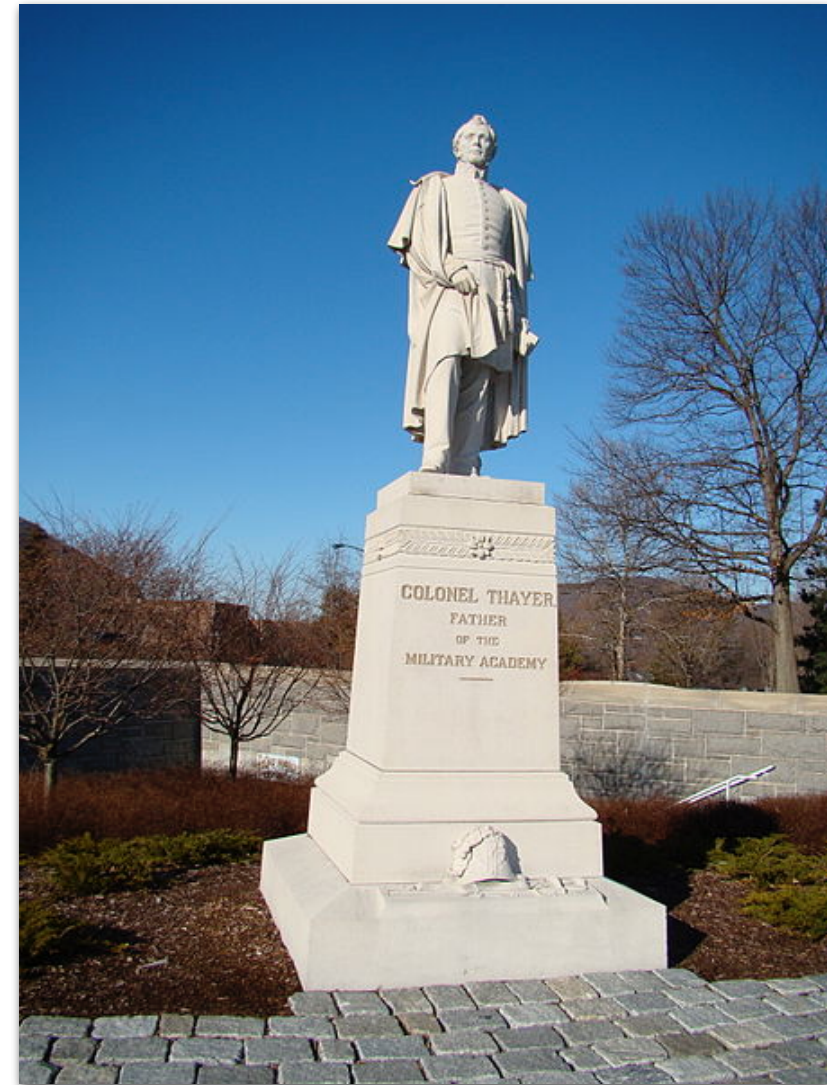
It was so successful in its engineering curriculum that it significantly influenced every American engineering school founded prior to the Civil War.^{41 74 75 76}

⁴¹ en.wikipedia.org/wiki/United_States_Military_Academy

⁴² *The Puritan Gift: triumph, collapse and revival of an American dream*, Kenneth Hopper and William Hopper, I. B. Tauris (April 3, 2007) p.39. By permission of Ken Hopper and Will Hopper

⁷⁴ McMaster, R.K. (1951). *West Point's Contribution to Education*. El Paso, TX: McMath Printing Co. p. 6.

⁷⁵ Endler, James (1998). *Other Leaders, Other Heroes*. Westport, CT: Praeger Publishers. ISBN 0-275-96369-1. p. 12.



⁷⁶ Brubacher, John; Rudy, Willis (1997). *Higher Education in Transition*. Transaction Publishers. ISBN 978-1-56000-917-7. Retrieved 19 January 2009.

Image: **Thayer Statue at West Point**, Date: December 2008, Source: Own work, Author: Ahodges7 en.wikipedia.org/wiki/File:Thayer_Statue_at_West_Point.JPG

Management Education pioneers, Andrew Ure and Charles Dupin were the early proponents of the study of management.²¹⁰

Andrew Ure was a Scottish doctor, scholar and chemist.^{211 212}

He was Professor of Natural Philosophy (specializing in chemistry and physics) at the recently formed Andersonian Institution in 1804. His evening lectures on chemistry and mechanics enjoyed considerable success.²¹¹

The central purpose of the college was to provide technical education for working men, many of whom subsequently became managers in local factories.²¹³

²¹⁰ Organisational Behavior By Dr. Hawa Singh Publisher V.K. (India) Enterprises p.40

²¹¹ en.wikipedia.org/wiki/Andrew_Ure

²¹² Cardwell, Donald (2004). "Ure, Andrew (1778–1857)". Oxford Dictionary of National Biography. Oxford University Press. Retrieved 2012-07-21.

²¹³ Management Theory, John Sheldrake, Thomson Learning; 2nd Revised edition edition (19 Dec 2002) p.5

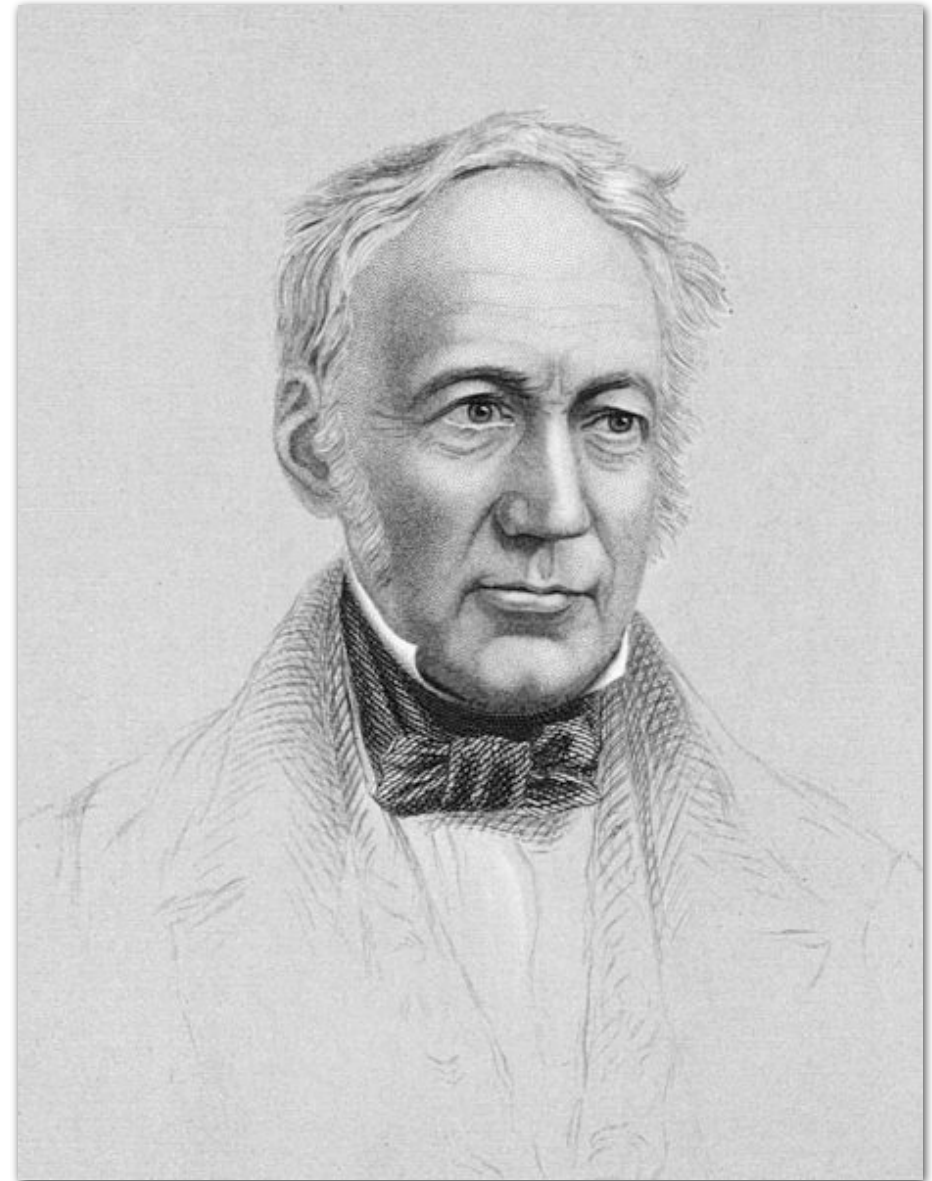


Image: Portrait of **Andrew Ure** (1778 - 1857), American chemist. Engraving, original size 15.9x11.3 cm. Date: 19th century, Source: www.sil.si.edu/digitalcollections/hst/scientific-identity/fullsize/SIL14-U001-02a.jpg Author: William G. Jackman en.wikipedia.org/wiki/File:Andrew_Ure.jpg

Ure called on British industry to invest more in knowledge and training and to take steps to improve the welfare of workers.²¹⁴

His visits to English textile mills led to his publication of *The Philosophy of Manufactures* (1835) and *Account of the Cotton Industry* (1836), dealing with the textile industry.²¹¹

In one of the earliest systematic texts on management, *The Philosophy of Manufactures*, called for mill owners to organise their “moral machinery” on principles that were as sound as those that organized the mechanical works in their factories.²¹⁷

Andrew Ure included human factors into his, “*The Philosophy of Manufactures*”, Ure recognised the mechanical and commercial

²²⁰ *The Philosophy of Manufactures: Or, An Exposition of the Scientific, Moral, and Commercial Economy of the Factory System of Great Britain*, Author: Andrew Ure, Publisher: C. Knight, Year: 1835 Public Domain archive.org/details/philosophymanufouiregoog

factors of manufacturing but also added a third factor that was the human factor.²¹⁵

“The object of manufactures is to modify the productions of nature into articles of necessity, convenience, or luxury, by the most economical and unerring means.

They have all three principles of action, or three organic systems; the mechanical, the moral and the commercial.

*They have also three interests to subserve, that of the operative, the master, and the state, and must seek their perfection in the due development of each.”*²²⁰

²¹¹ en.wikipedia.org/wiki/Andrew_Ure

²¹⁴ *Management History: Text and Cases* By Morgen Witze Publisher Routledge; 1 edition (February 3, 2010) p.19

²¹⁷ *Managing and Organizations: An Introduction to Theory and Practice* By Stewart Clegg, Martin Kornberger, Tyrone Pitsis Publisher: Sage Publications Ltd; 2nd edition (March 3, 2008) p.288

²¹⁵ *Manufacturing and Operations Management Second Edition* March 2008 By Nirali Prakashan p.13

In the preface of the book he claimed that he had written the book so that

“ masters, managers, and operatives would follow the straight paths of improvement ” ²¹⁹

and hoped that it would help

“ prevent them from pursuing dangerous ideas.” ²¹⁹

Ure also wrote that he

“ felt it is his duty, on being solicited from time to time by his pupils, now spread over the kingdom as proprietors and managers of factories, to prepare for publication a systematic account of their principles and processes.” ²²⁰

²¹⁹ Andrew Ure www.spartacus.schoolnet.co.uk/IRure.htm

²²⁰ The Philosophy of Manufactures: Or, An Exposition of the Scientific, Moral, and Commercial Economy of the Factory System of Great Britain, Author: Andrew Ure, Publisher: C. Knight, Year: 1835 Public Domain archive.org/details/philosophymanufoiuregoog

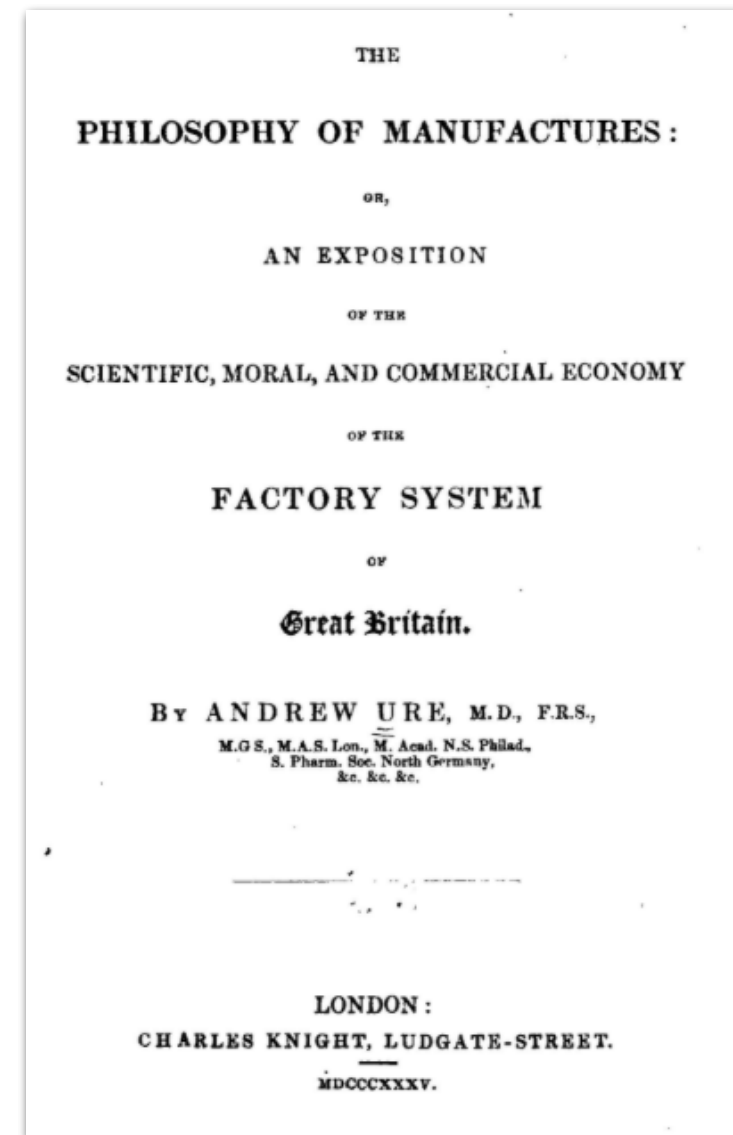


Image: The Philosophy of Manufactures: Or, An Exposition of the Scientific, Moral, and Commercial Economy of the Factory System of Great Britain, Author: Andrew Ure, Publisher: C. Knight, Year: 1835 Public Domain archive.org/details/philosophymanufoiuregoog

Like Adam Smith, whose ideas he enthusiastically embraced, Ure argued that any disadvantages accruing to the individual as a result of the division of labour were far outweighed by the benefits accruing to society as a whole.²¹³

Whilst Babbage had a vision of a computer-run technology, Ure envisaged the fully automated factory that would bring complete control of production into the hands of the capitalist.²¹⁸

Ure saw his work as a definite advance on Babbage's and through his own experience as a consultant in industry conferred greater authority on his writing.²¹⁸

²¹⁸ The Machinery Question and the Making of Political Economy 1815-1848
By Maxine Berg Publisher: Cambridge University Press; First Paperback edition
(March 31, 1982) p.197

²²¹ A Determination of the Tasks of Technology Managers in the Central American
Maquilas of US based multinationals using structured observations
By Robert Dean Morrison May 2008 p.18

²²⁰ The Philosophy of Manufactures: Or, An Exposition of the Scientific, Moral, and
Commercial Economy of the Factory System of Great Britain, Author: Andrew Ure,
Publisher: C. Knight, Year: 1835 Public Domain
archive.org/details/philosophymanufouiregoog

Andrew Ure began teaching what were likely the first management classes focussed on teaching manufacturing processes at Anderson College.²²¹

From 1816 - 1818, French engineer and management writer Charles Dupin visited Ure and returned to France.²²¹

Dupin pioneered industrial education in France.²²⁵ He made the first attempts at systematic management education.²²⁷

Ure stated in Philosophy of Manufactures

*“ It is known that the manufactures of France have have derived great advantage from the illustrated systems of instruction published under the auspices of its government and patriotic societies.”*²²⁰

²¹³ Management theory By John Sheldrake p.5

²²⁷ Essentials of management By Walter Jack Duncan pp. 75-76

²²⁵ The AMA Dictionary of Business and Management
By George Thomas Kurian AMACOM (April 23, 2013) p.96

Dupin had studied geometry at the École Polytechnique and then became a naval engineer.²²³

In 1819, Dupin was appointed as a management professor in Paris. His writings on various aspects of management were well known throughout France.²¹⁰

He wrote extensively on industry, work, and the welfare of workers.²²⁶

Often he spoke before the Academy of Sciences of the Royal Institute of France on these subjects as well as on more academic pursuits in the fields of engineering and mathematics.²²⁶

²¹⁰ Organisational Behavior By Dr. Hawa Singh Publisher V.K. (India) Enterprises p.40

²²³ en.wikipedia.org/wiki/Charles_Dupin

²²⁶ The history of management thought By Claude S. George Prentice Hall; 2nd edition (May 15, 1972) p.75

²²⁷ Essentials of management By Walter Jack Duncan pp. 75-76

²²⁸ Proceedings - Academy of Management Of the 51st Annual meeting p.92

He formally tried to structurise the subject matter of management.²¹⁶

He began teaching factory management in France in 1819.²²⁸

Supposedly, by 1826 his materials on management had been presented in 100 French cities to more than 5,000 workers and supervisors.²²⁷

Dupin emphasized worker welfare and the need for integrity and accountability in management.²²⁹

²²⁴ From Newton to Hawking: A History of Cambridge University's Lucasian Professors of Mathematics By Kevin C. Knox Publisher: Cambridge University Press (March 5, 2007) pp. 267-268

²²⁹ Farm Management: Theory and Practice Concept Publishing Co (2011)
By Reji D. Nair

²¹⁶ Management Principles And Practices By M.Sakthivel Murugan Publisher New Age International Pvt Ltd Publishers (December 1, 2008) p.46

Under the impulse of Charles Dupin, French economists travels in England led to the following recommendation: the industrious should be trained in management (Dupin, 1827).²²²



Image: **Charles Dupin**, Julien-Leopold Boilly (1896–1874), Date: 1820, Medium: lithograph
en.wikipedia.org/wiki/File:Charles_Dupin.jpeg

At the end of the 1820s, this specialised form of teaching was effected in the industrialised provinces.²²²

The teaching of management “best practice” had begun.

Dupin produced a major mechanics textbook for artisans and factory foremen to “render their conduct more moral while impressing upon their minds the habits of reason and order that are the surest foundations for public peace.”²²⁴

His *Discourse on the Condition of the Workers* (1831) introduced such concepts as time study and balanced workloads.²²⁵

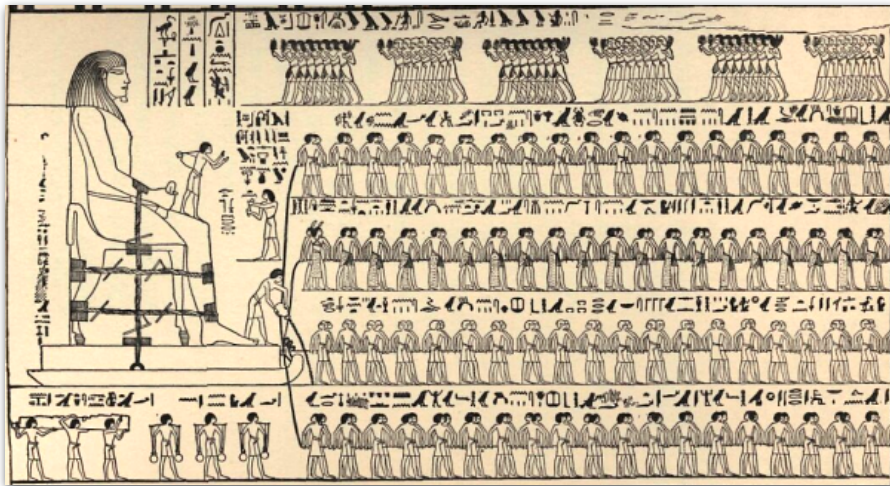
²²² *Studies in the History of French Political Economy: From Bodin to Walras*
edited by Gilbert Faccarello p.303

²²⁴ *From Newton to Hawking: A History of Cambridge University's Lucasian Professors
of Mathematics* By Kevin C. Knox Publisher: Cambridge University Press
(March 5, 2007) pp. 267-268

²²⁵ *The AMA Dictionary of Business and Management*
By George Thomas Kurian AMACOM (April 23, 2013) p.96

THE ORGANIZATION CHART

In today's design of work we see division typically represented in an organisation chart with functional and departmental specialisation.



The Egyptians are thought to be the first people to use charts to illustrate the division of labor employed for large projects like the building of the Pyramids.^{103 104}

Today, the organization (org) chart is defined by various sources as a graphic representation of how authority and responsibility is distributed within a company or organization.

169

We have already discussed the early beginnings of what today we would recognise as differing levels of authority, and division of responsibility, through the exploration of Diocletian's administrative reforms in A.D. 284.

The first organization structure of the modern West was laid down in the canon law of the Catholic Church eight hundred years ago. It set up a strictly scalar organization.¹⁰⁵

¹⁰³ Charting History History of Organizational Charts www.orgchart.net/wiki/Charting_History

¹⁰⁴ "Organization Charts" 12Manage: The Executive Fast Track. 1 July 2008

¹⁰⁵ Management Task, Responsibilities, Practices, Peter F. Drucker, HarperBusiness April 14, 1993) p. 525

¹⁶⁹ Taking the Org Chart into the 21st Century © Pat Heydlauff, all rights reserved 2012 engagetolead.com/site/taking-the-org-chart-into-the-21st-century-2/

The French Encyclopédie published in France between 1751 and 1772 had one of the first organizational charts of knowledge in general.¹⁰⁶

The “figurative system of human knowledge”, sometimes known as the tree of Diderot and d’Alembert, was a tree developed to represent the structure of knowledge itself, produced for the Encyclopédie by Jean le Rond d’Alembert and Denis Diderot.¹⁰⁷

¹⁰⁶ en.wikipedia.org/wiki/Organizational_chart

¹⁰⁷ en.wikipedia.org/wiki/Figurative_system_of_human_knowledge

ENCYCLOPÉDIE,
OU
DICTIONNAIRE RAISONNÉ
DES SCIENCES,
DES ARTS ET DES MÉTIERS,
PAR UNE SOCIÉTÉ DE GENS DE LETTRES.

Mis en ordre & publié par M. *DIDEROT*, de l'Académie Royale des Sciences & des Belles-Lettres de Prusse; & quant à la PARTIE MATHÉMATIQUE, par M. *D'ALEMBERT*, de l'Académie Royale des Sciences de Paris, de celle de Prusse, & de la Société Royale de Londres.

*Tantum series juncturaque pollet,
Tantum de medio sumptis accedit honoris!* HORAT.

TOME PREMIER.



A PARIS,

Chez { *BRIASSON*, rue Saint Jacques, à la Science.
DAVID l'aîné, rue Saint Jacques, à la Plume d'or.
LE BRETON, Imprimeur ordinaire du Roy, rue de la Harpe.
DURAND, rue Saint Jacques, à Saint Landry, & au Griffon.

M. D C C. L I.

AVEC APPROBATION ET PRIVILEGE DU ROY.

The tree was a taxonomy of human knowledge, inspired by Francis Bacon's *The Advancement of Learning*.¹⁰⁷

The three main branches of knowledge in the tree are:

“Memory”/History,

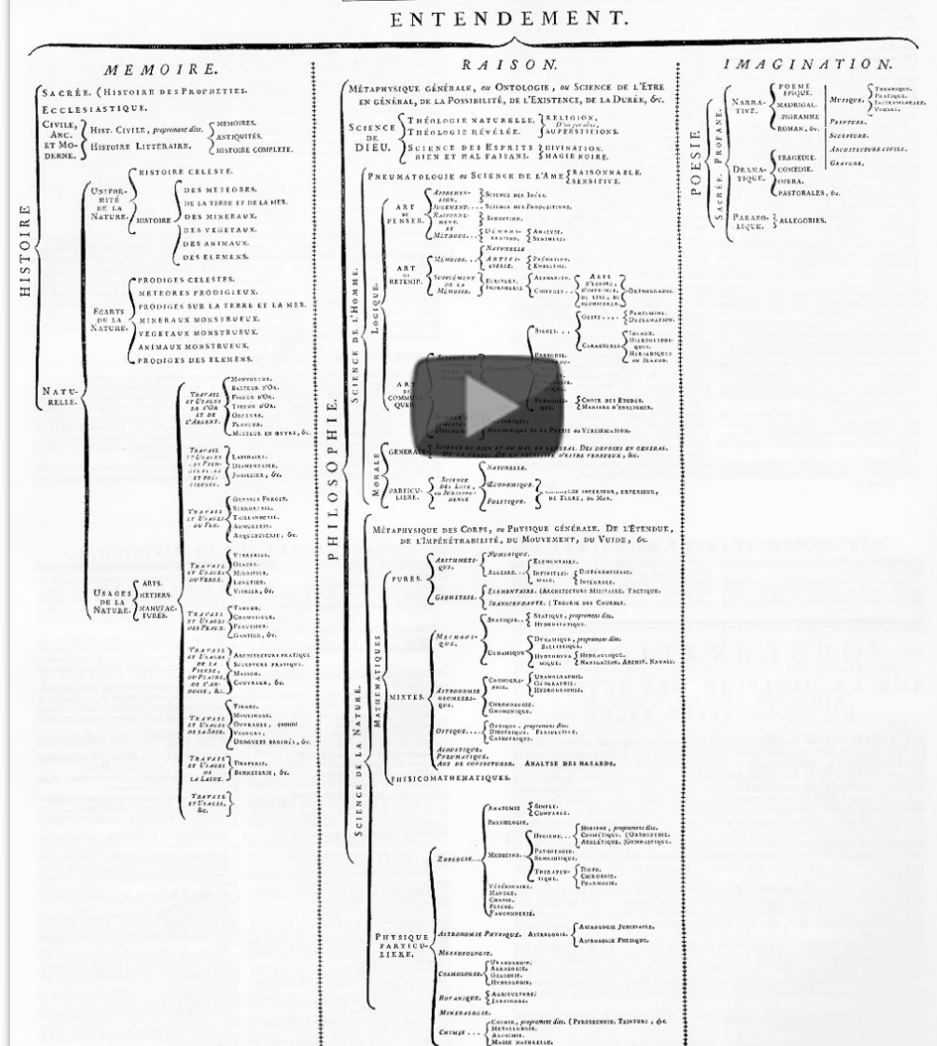
“Reason”/Philosophy, and

“Imagination”/Poetry.¹⁰⁷

You can see the tree here. There are remarkable similarities to the depiction used in a modern day organization chart.

To uncover the origins of corporate organization charts, we must look to the US in the mid nineteenth century.

* SYSTEME FIGURÉ DES CONNOISSANCES HUMAINES.



¹⁰⁷ en.wikipedia.org/wiki/Figurative_system_of_human_knowledge

Image: *The tree of Diderot and d'Alembert* Author *Alembert, Jean Le Rond d'*, 1717-1783;

Diderot, Denis, 1713-1784, Paris : Briasson, 1751 Public Domain

archive.org/details/encyclopedieoudoialem

upload.wikimedia.org/wikipedia/commons/archive/5/58/20130120123644%21ENC_SYSTEME_FIGURE.jpeg

As late as 1840 there were no middle managers in the US, that is, there were no managers who supervised the work of other managers and in turn reported to senior executives who themselves were salaried managers.¹²⁰

Prior to this the traditional business firm [was] a single-unit business enterprise in which an individual, or a small number of owners, operated a shop, factory, etc. out of a single office or facility.¹²⁰

The small, local, early railroads that came into existence in the 1830s were easy to manage, being not very different in structure from some family businesses of the period.¹³

¹²⁰ puttincologneontherickshaw.com/authors-blog/the-rigor-cartis-syndrome/

¹³ The Puritan Gift: triumph, collapse and revival of an American dream, Kenneth Hopper and William Hopper, I. B. Tauris (April 3, 2007) p.66 By permission of Ken Hopper and Will Hopper

Railroads extended outwards for first hundreds and then for thousands of miles, and when they hired first hundreds and then thousands of people, the structure came under strain.¹³

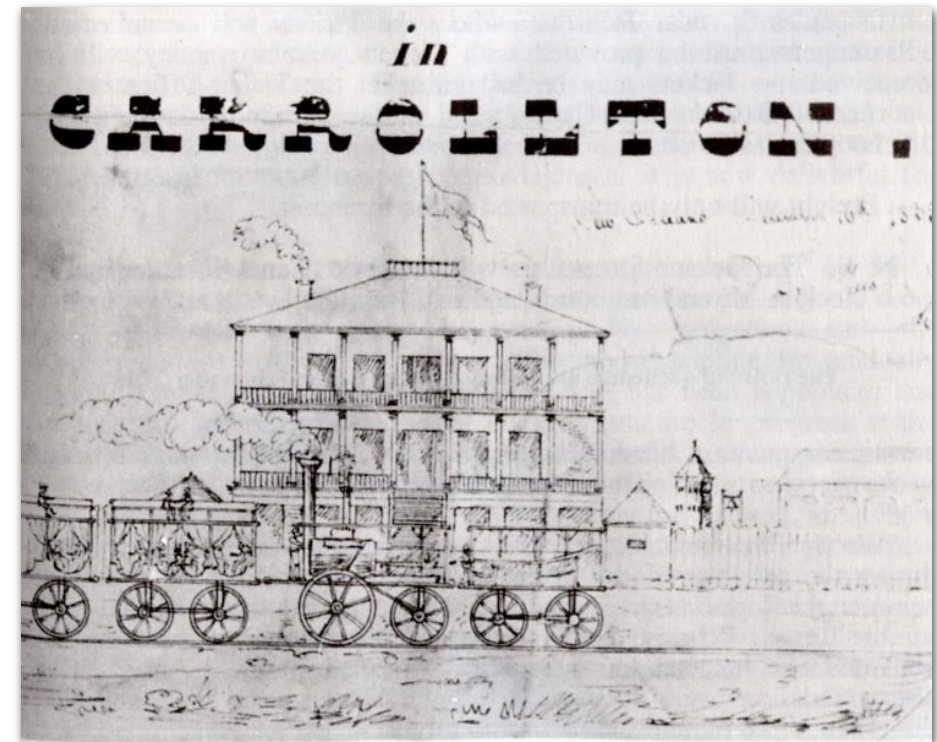


Image: Carrollton, Louisiana (later annexed into the city of New Orleans). **View of New Orleans and Carrollton Railroad locomotive** in front of the Carrollton Hotel. Date: 16 December 1835

Source: Drawing by C. Rothaas dated 16 December 1835 in the New Orleans Notorial Archives, Book 91, Folio 10, via book "The Saint Charles Streetcar or the history of The New Orleans and Carrollton Railroad" by James Guilbeau, The Louisiana Landmarks Society, 3rd edition, 1992. Author: C. Rothaas. PD-Art PD-OLD. en.wikipedia.org/wiki/File:CarrolltonTrain1835.jpg

The Scottish-American engineer Daniel McCallum (1815–1878) is credited for creating the first organizational charts of American business¹⁰⁸ around 1854.^{109 106}

He became the General Superintendent of the New York and Erie Railroad in 1854, then founded the McCallum Bridge Company in 1858. He was an early proponent of the organizational chart as a way to manage business operations.^{122 112}

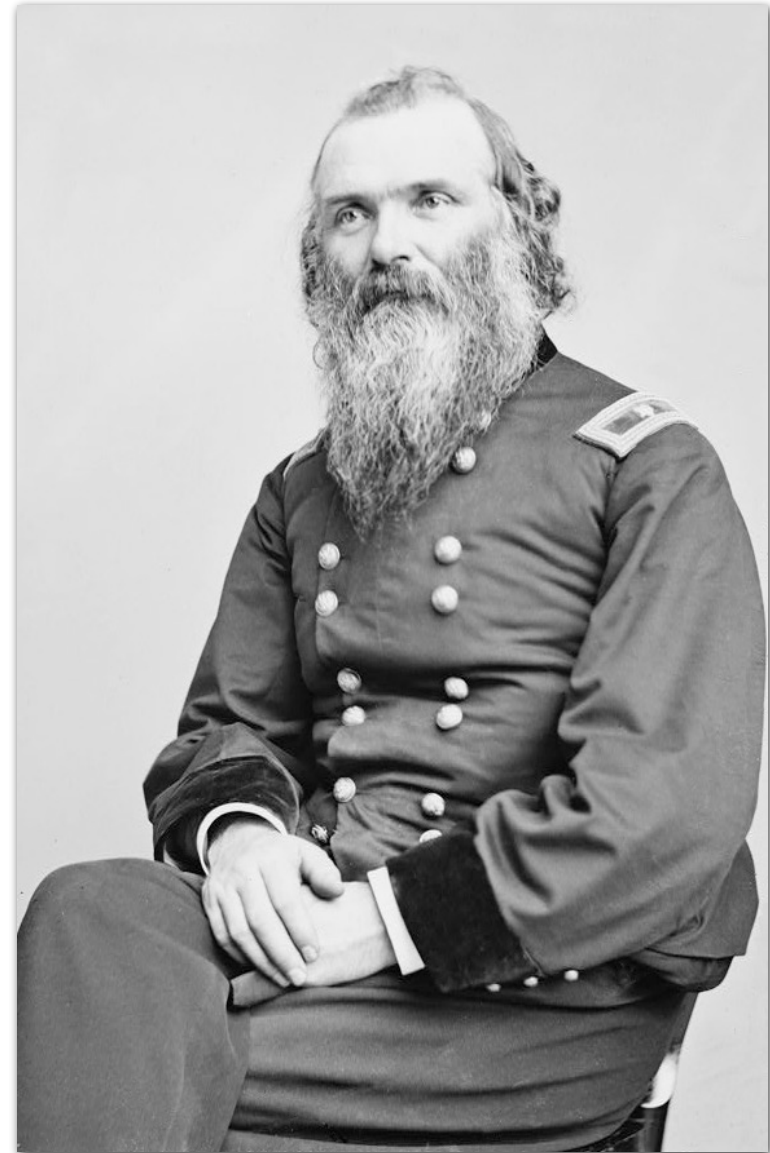
In 1854, Daniel McCallum (a railroad engineer¹²²) took charge of the operations of the New York and Erie Railroad¹¹⁰ as the General Superintendent.¹²²

¹⁰⁶ en.wikipedia.org/wiki/Organizational_chart

¹⁰⁸ Alfred D. Chandler, Jr. (1962). *Strategy and Structure: Chapters in the History of the American Industrial Enterprise*. Cambridge, MA: MIT Press.

¹⁰⁹ Burton S. Kaliski (2001). *Encyclopedia of business and finance*. p.669.

¹¹⁰ Homer Ramsdell and D. C. McCallum, *Reports of the President and Superintendent of the New York and Erie Railroad to the Stockholders, for the Year Ending September 30, 1855*, New York, NY: Press of the New York and Erie Railroad Company, 1856.



¹¹² "The cases of Daniel McCallum and Gustavus Swift" 1 July 2008

¹²² en.wikipedia.org/wiki/Daniel_McCallum

Image: **Daniel McCallum**. Taken prior to 1878, Author Original uploader was Instinct at en.wikipedia. Later version(s) were uploaded by Anetode at en.wikipedia. PD-US en.wikipedia.org/wiki/File:Daniel_Craig_McCallum_image.jpg

With nearly 500 miles of track, it was one of the world's longest systems, but not one of the most efficient. In fact, McCallum found that far from rendering operations more efficient, the scale of the railroad exponentially increased its complexity.¹¹⁰

The problem was not a lack of information: the growing use of the telegraph gave the company an unprecedented supply of nearly real-time data, including reports of accidents and train delays.¹¹¹

Faced with the railroad's financial strain and productivity slumps due to a lack of sufficient management, McCallum split management

¹¹¹ Tom Standage quotes contemporaries who called the telegraph the "highway of thought" in *The Victorian Internet: The Remarkable Story of the Telegraph and the Nineteenth Century's On-line Pioneers*, first edition, London, UK: Weidenfeld & Nicolson, 1998. An excellent recent account of the telegraph's impact is Richard John, *Network Nation: Inventing American Telecommunications*, first edition, Cambridge, MA: Harvard University Press, 2010.

responsibility between the superintendents by having each manage a certain number of employees within his department.^{103 112}

These superintendents wrote weekly reports for upper management, who in turn, reviewed the reports and gave further direction to the superintendents to pass on.^{103 112}

Each superintendent was responsible for the physical geography of the tracks and stations and for the men who moved along the rails: conductors, brakemen, and laborers.¹¹³

¹¹⁰ Homer Ramsdell and D. C. McCallum, *Reports of the President and Superintendent of the New York and Erie Railroad to the Stockholders, for the Year Ending September 30, 1855*, New York, NY: Press of the New York and Erie Railroad Company, 1856.

¹⁰³ Charting History History of Organizational Charts www.orgchart.net/wiki/Charting_History

¹¹² "The cases of Daniel McCallum and Gustavus Swift" 1 July 2008

¹¹³ Caitlin Rosenthal, "Big data in the age of the telegraph", *McKinsey Quarterly*, www.mckinseyquarterly.com, March 2013
fwww.mckinseyquarterly.com/Big_data_in_the_age_of_the_telegraph_3064

Coordinating activities between these two branches, the superintendents managed both the fixed depots and the rolling stock that moved between them.¹¹³

McCallum sought “a proper division of responsibilities”, wishing to confer “sufficient authority” on each divisional superintendent for them to be discharged. With that in mind, he laid down formal lines of authority and provided the means for measuring the performance of individuals, devised methods of cost accounting and improved the flow of information¹¹⁷ throughout the operation.

He first divided the line into four geographical regions and appointed divisional superintendents who were made

¹¹³ Caitlin Rosenthal, “Big data in the age of the telegraph”, McKinsey Quarterly, www.mckinseyquarterly.com, March 2013
www.mckinseyquarterly.com/Big_data_in_the_age_of_the_telegraph_3064

¹¹⁷ *The Puritan Gift: triumph, collapse and revival of an American dream*, Kenneth Hopper and William Hopper, I. B. Tauris (April 3, 2007) p.67-68 By permission of Ken Hopper and Will Hopper

responsible for the day-to-day movement of trains and traffic and the upkeep of roadbeds and buildings within their domains.¹²¹

McCallum also created departmental offices to conduct functional activities-the purchase of fuel, the general handling of freight and passengers business, the building and repair of machinery, and the operations of the telegraph system.¹²¹

A mixed departmental-division structure was thus created.¹²¹

In the previous chapter we met Col. Roswell Lee of the Springfield armory who created the line-and-staff system.

¹²¹ *Life and Labor: Dimensions of American Working-class History* edited by Stephenson, Charles, Robert Asher State University of New York Press (September 15, 1986)

McCallum's great contribution was to discover how to combine a divisional structure with Lee's line-and-staff system; he did this by creating non-geographic, functional or "staff" divisions, that overlay the geographic ones, and determining the precise relationship between the two. Each "staff" division would be endowed with its own miniature line-of-command.¹¹⁷

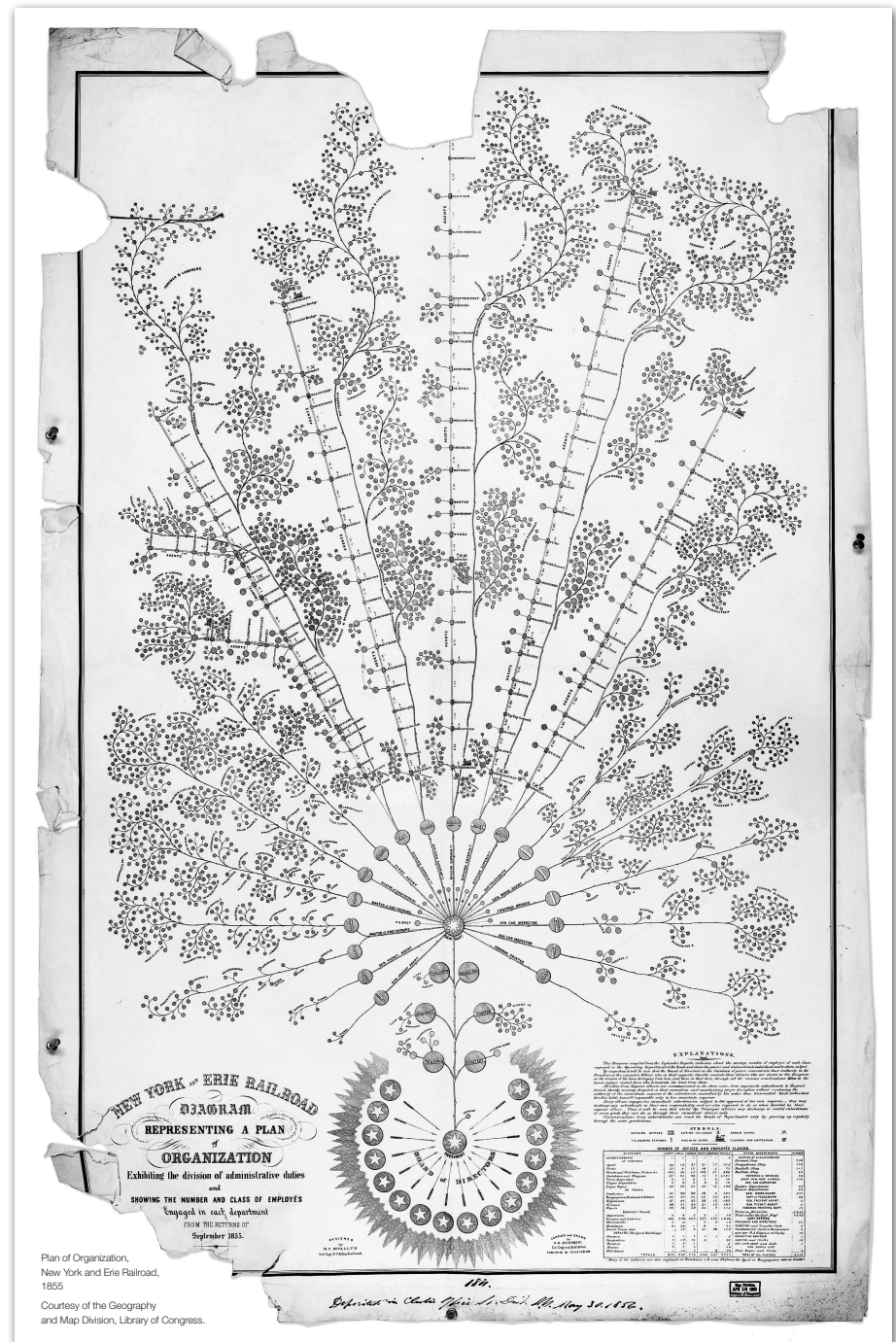
McCallum had drawn up what was probably the world's first corporate organization chart to illustrate the structure of the Erie.¹¹⁴

Here you can see, at a glance, the entire organisation in one single diagram.

¹¹⁷ The Puritan Gift: triumph, collapse and revival of an American dream, Kenneth Hopper and William Hopper, I. B. Tauris (April 3, 2007) p.67-68 By permission of Ken Hopper and Will Hopper

¹¹⁴ *ibid.*, pp. p.70.

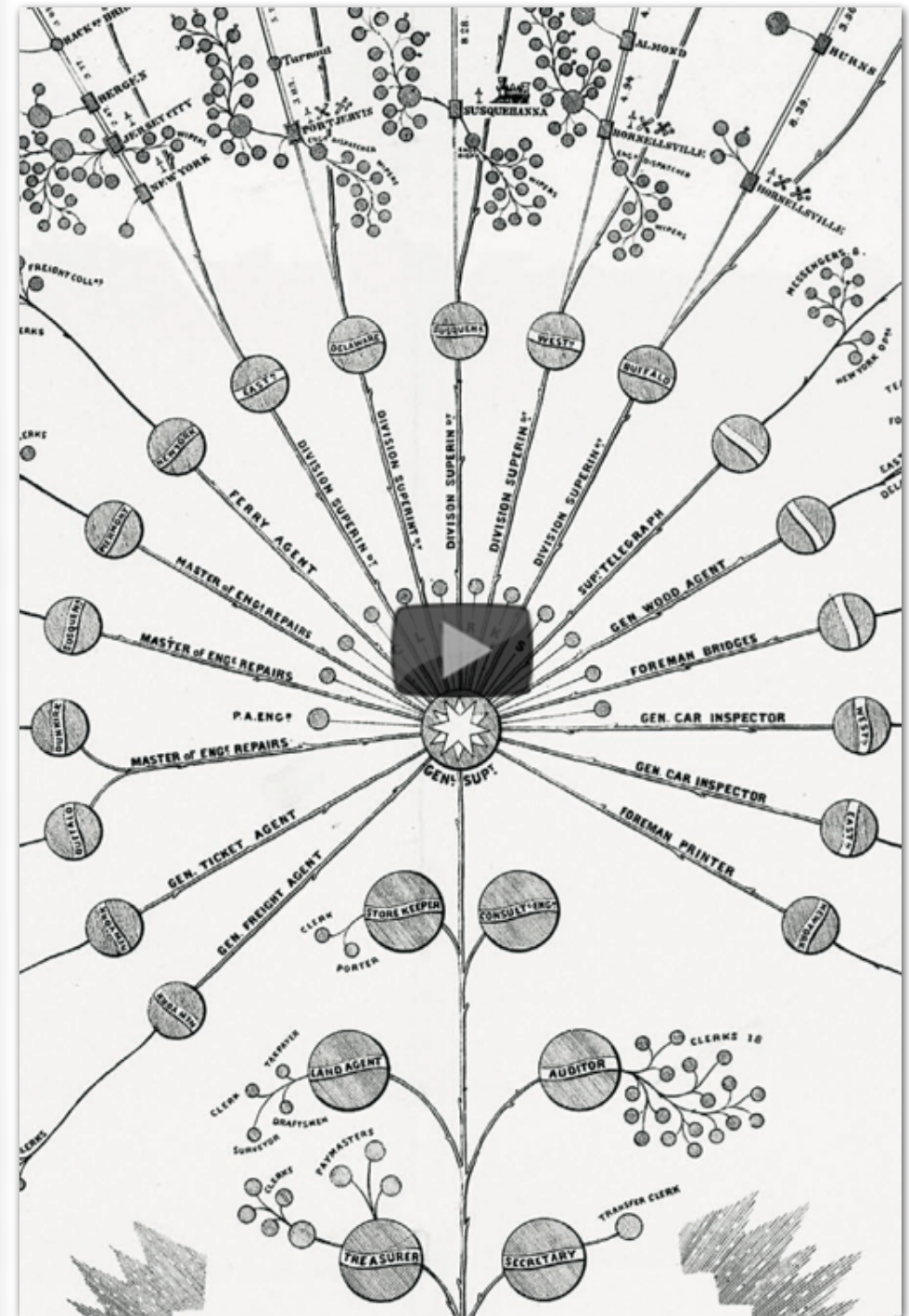
Image: Photocopy of an **1855 organizational diagram of the New York and Erie Railroad**. Original in the collections of the Library of Congress. - Erie Railway, New Jersey, New York, Pennsylvania, Deposit, Broome County, NY Repository: Library of Congress Prints and Photographs Division Washington, D.C. 20540 USA hdl.loc.gov/loc.pnp/pp.print www.loc.gov/pictures/item/ny1255.photos.122185p/ www.loc.gov/pictures/item/ny1255.photos.122186p/resource/



McCallum's charts included lines connecting the superintendents to the subordinates, while keeping them structured within each separate division.¹⁰³

The result of the organizational chart was a clear line of authority showing where subordinates were accountable to their immediate supervisors.¹¹⁵

The organizational chart has been described as looking like a tree, with the roots representing the president and the board of directors, while the branches symbolize the various departments and the leaves depict the staff workers.¹¹⁵

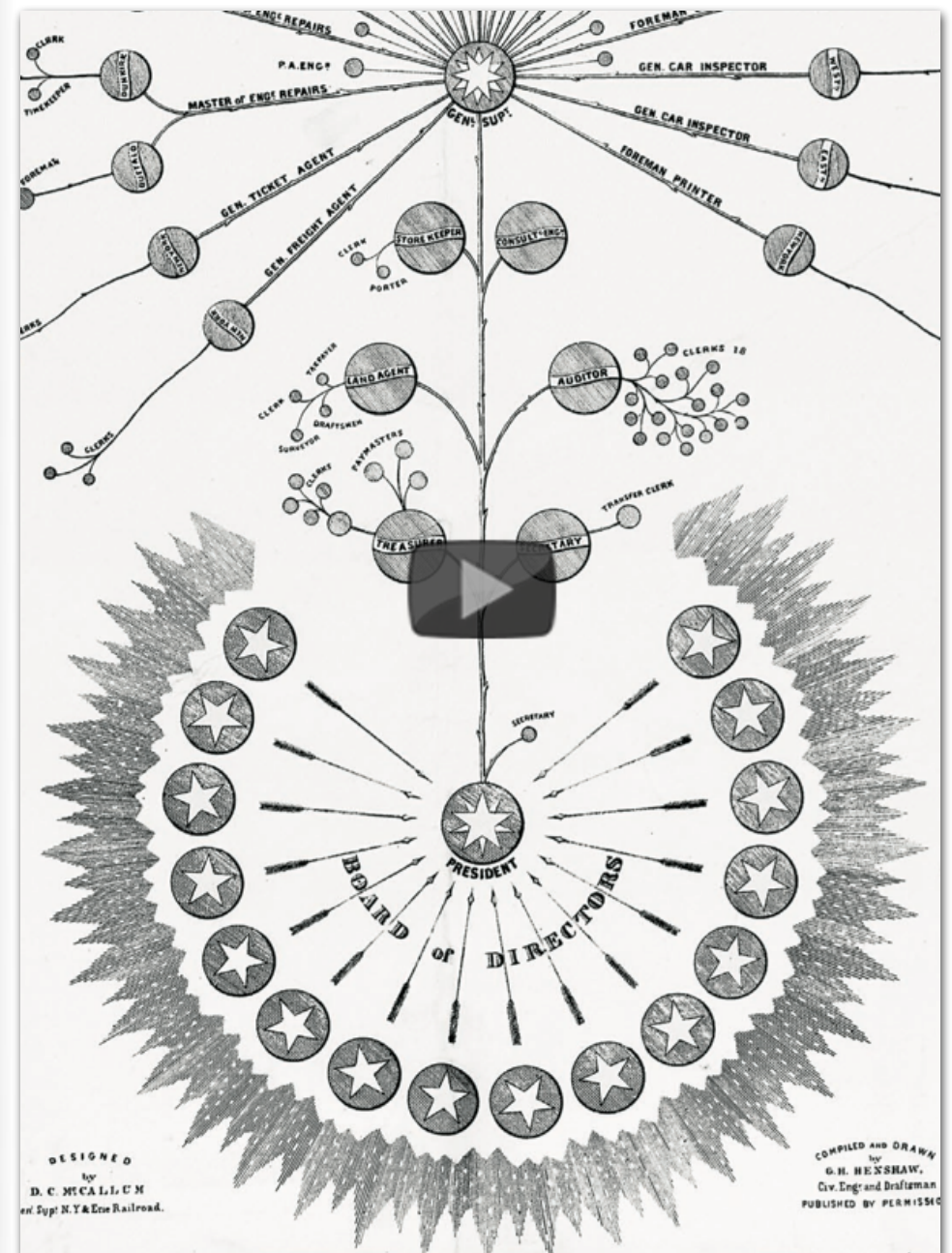


¹⁰³ Charting History History of Organizational Charts www.orgchart.net/wiki/Charting_History

¹¹⁵ Chandler, Alfred D., Jr. (1988). "Origins of the Organization Chart," *Harvard Business Review* 88:2, (March/April):p. 156.

McCallum drew the board of directors as the roots, himself and his chief officers as the tree's trunk, and the railroad's divisions and departments as the branches.¹¹⁶

You can see the board of directors at the bottom of this exquisite tree.¹¹⁸



¹¹⁶ dailyfillip.wordpress.com/2013/03/05/big-data-in-the-age-of-the-telegraph/

¹¹⁸ Improving performance through better board engagement. From McKinsey. February 23, 2013 livepaola.wordpress.com/category/governance/

Image: Photocopy of an 1855 **organizational diagram of the New York and Erie Railroad**. Original in the collections of the Library of Congress. - Erie Railway, New Jersey, New York, Pennsylvania, Deposit, Broome County, NY Repository: Library of Congress Prints and Photographs Division Washington, D.C. 20540 USA hdl.loc.gov/loc.pnp/pp.print www.loc.gov/pictures/item/ny1255.photos.122185p/ www.loc.gov/pictures/item/ny1255.photos.122186p/resource/

At a glance you can see the entire organisation, but as you zoom in you can easily follow a line of command through each of the divisions of responsibility right down to the number of workers in each specialism represented by leaves. Each leaf depicts the number of staff workers in each role.

For example if we follow the Buffalo line of command we have; a Master of Engineer Repairs, a Chief foreman, 2 Clerks, an Engineman, a Screw cutter, a Painter, 2 Boiler Makers, 19 Blacksmiths, 3 Foreman, and 13 Machinists.



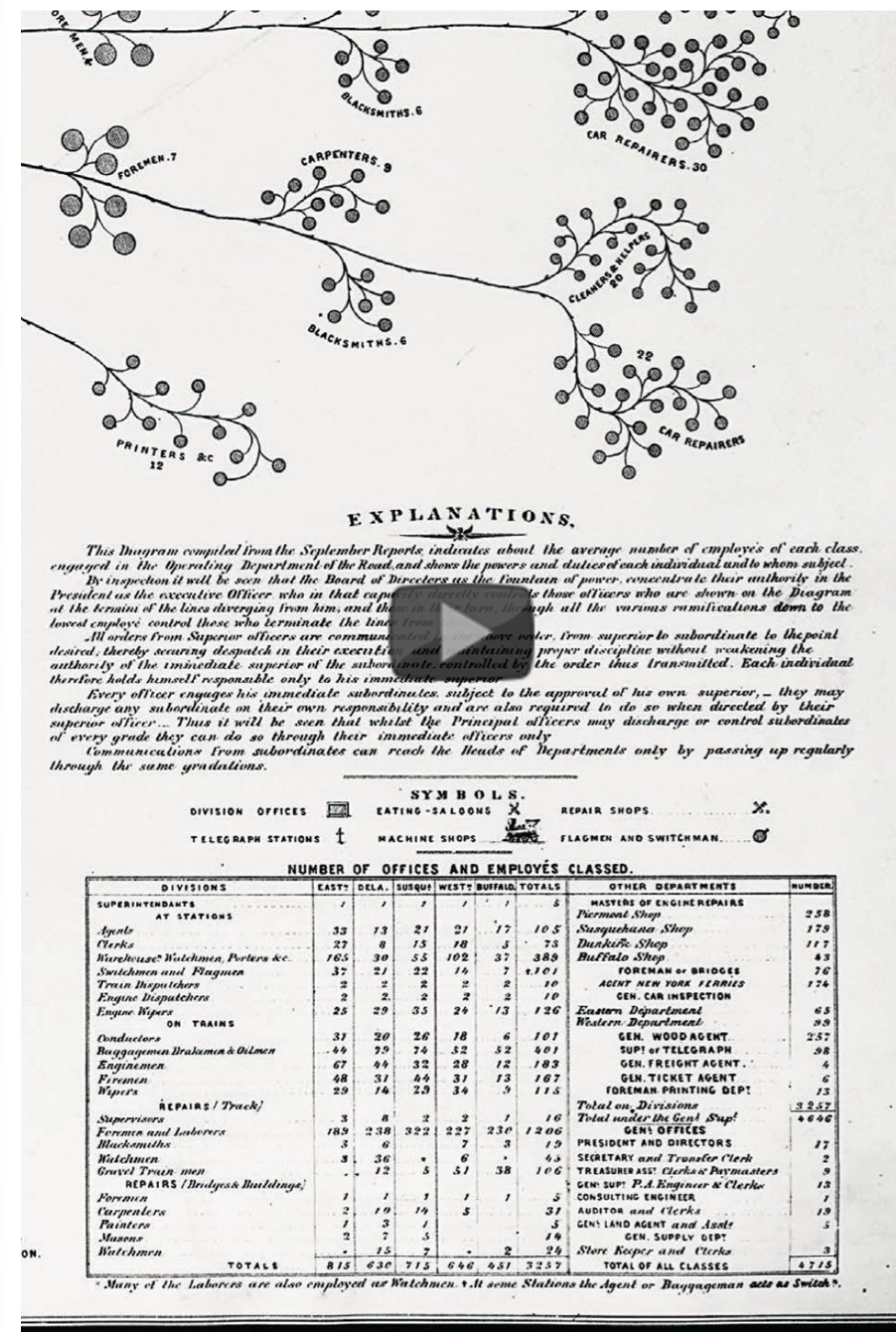
Here you can see the explanations of the diagram along with the number of offices and number of employees at each office.

The explanation reads:

“This Diagram compiled from the September Reports, indicates about the average number of employees of each class, engaged in the Operating Department of the Road, and shows the powers and duties of each individual and to whom subject.”

*By inspection, it will be seen that the Board of Directors as the foundation of power, concentrate their authority in the President as the Executive Officer, who in that capacity directly controls those officers who are shown on the diagram.”*²³⁶

Image and Source: ²³⁶ Photocopy of an 1855 organizational diagram of the New York and Erie Railroad. Original in the collections of the Library of Congress. - Erie Railway, New Jersey, New York, Pennsylvania, Deposit, Broome County, NY Repository: Library of Congress Prints and Photographs Division Washington, D.C. 20540 USA hdl.loc.gov/loc.pnp/pp.print www.loc.gov/pictures/item/ny1255.photos.122185p/ www.loc.gov/pictures/item/ny1255.photos.122186p/resource/



"All orders from Superior officers are communicated in the above order, from superior to subordinate.

Each individual therefore holds himself responsible only to his immediate superior.

Communication from subordinates can reach the Heads of Departments only by passing up regularly through the same gradations."²³⁶

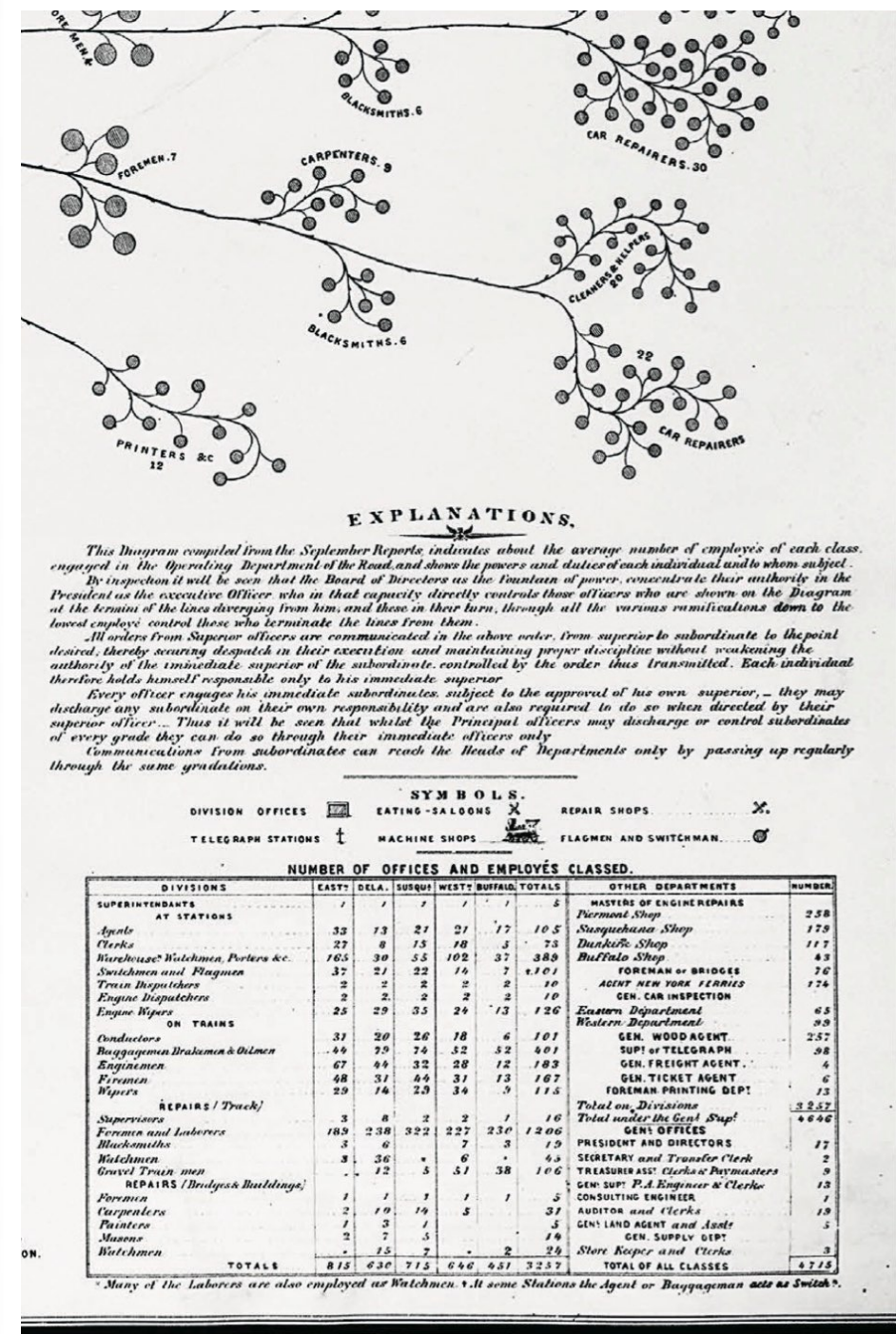


Image and Source: ²³⁶ Photocopy of an 1855 organizational diagram of the New York and Erie Railroad. Original in the collections of the Library of Congress. - Erie Railway, New Jersey, New York, Pennsylvania, Deposit, Broome County, NY Repository: Library of Congress Prints and Photographs Division Washington, D.C. 20540 USA hdl.loc.gov/loc.pnp/pp.print www.loc.gov/pictures/item/ny1255.photos.122185p/ www.loc.gov/pictures/item/ny1255.photos.122186p/resource/

MANAGEMENT TREATISE

McCallum's innovations became of interest to Henry Varnum Poor, editor of the American Railroad Journal, the leading business periodical.¹¹⁴

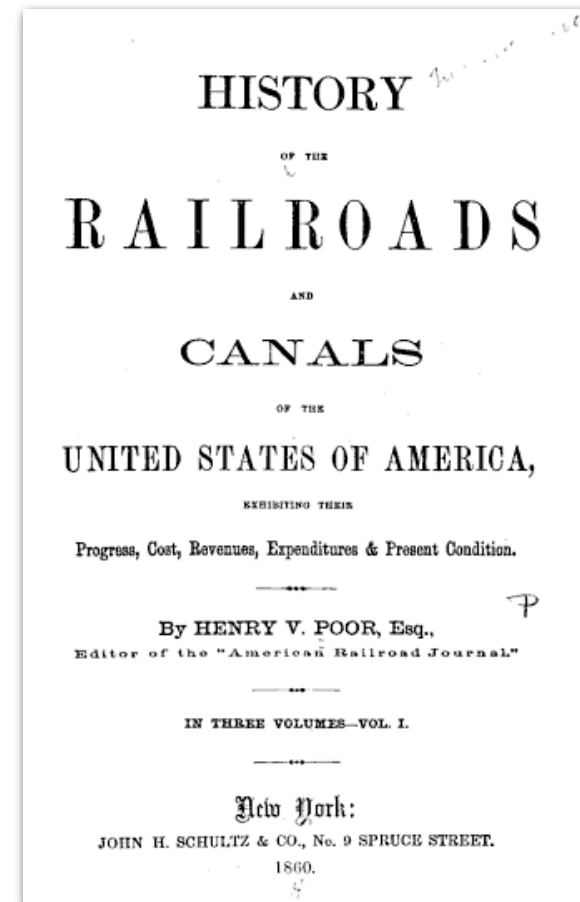


His brother John Poor became a minor railway magnate in association with the European and North American Railway, and was heavily involved in the building of the Maine rail network.¹³⁸

In 1860, Henry Poor published History of Railroads and Canals in the United States, an

¹³⁹ A History of Standard & Poor's, www.standardandpoors.com/about-sp/timeline/en/us/, accessed 11/2012

attempt to compile comprehensive information about the financial and operational state of U.S. railroad companies.^{138 139}



¹³⁸ en.wikipedia.org/wiki/Henry_Varnum_Poor

¹¹⁴ The Puritan Gift: triumph, collapse and revival of an American dream, Kenneth Hopper and William Hopper, I. B. Tauris (April 3, 2007) p.70. By permission of Ken Hopper and Will Hopper

Henry Varnum Poor was a financial analyst¹³⁸ and later established H.V. and H.W. Poor Co. with his son, Henry William, which published annual updated versions of his book.^{138 139}

Standard & Poor's, the financial research and analysis bellwether, traces its history back to this publication.^{138 139}

From McCallum's Erie, Poor derived his principles of management, which he summed up in three words:

organization (meaning the proper division of labor among employees),

communication (meaning an accurate system of reporting)

and information (meaning a data bank of useful information on which sensible decisions can be based).¹¹⁴

¹³⁸ en.wikipedia.org/wiki/Henry_Varnum_Poor

²⁴⁰ en.wikipedia.org/wiki/Alfred_D._Chandler,_Jr.

Poor's editorials, taken together, constitute one of the most important treatises on management ever published in America – or indeed anywhere.¹¹⁴

Alfred Chandler, Professor of business history, Harvard²⁴⁰, whose materials have been used several times in this book, wrote his dissertation on Henry Varnum Poor, who was his great-grandfather. His dissertation eventually became his first book, Henry Varnum Poor, Business Editor, Analyst and Reformer, published in 1956.¹⁸⁷

Chandler also had connections to the DuPont family^{240 241} whom we met in the previous chapter.

²⁴¹ Carol May, "Alfred du Pont Chandler, Jr.," Edmund's Community Courier (Edmund Chandler Family Association), March 2, 2010.

¹³⁹ A History of Standard & Poor's, www.standardandpoors.com/about-sp/timeline/en/us/, accessed 11/2012

¹¹⁴ The Puritan Gift: triumph, collapse and revival of an American dream, Kenneth Hopper and William Hopper, I. B. Tauris (April 3, 2007) p.70. By permission of Ken Hopper and Will Hopper

¹⁸⁷ Alfred D. Chandler Papers. HBS Archives. Baker Library Historical Collections. Harvard Business School.

**DECENTRALIZED, LINE-AND-STAFF,
DIVISIONAL FORM OF ORGANIZATION**

At the Pennsylvania Railroad (PRR) J. Edgar Thomson, head of the railroad, took ... [McCallum's innovations] much further.¹³⁵

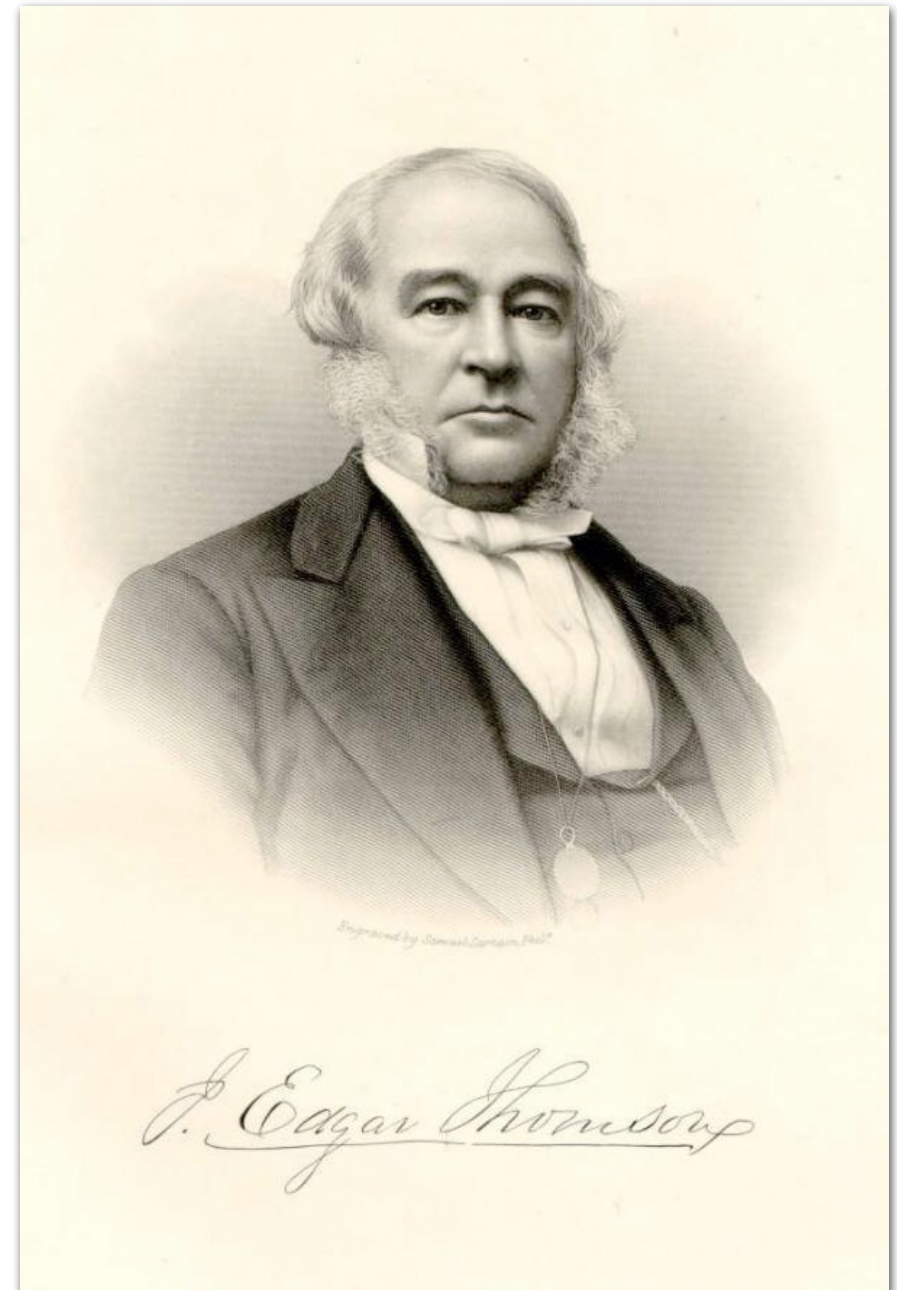
He divided the managers into staff and line positions.¹³⁵

Perhaps few men have contributed so much to the shaping of nineteenth century American business yet have received so little public recognition as John Edgar Thomson.¹²³

¹²³ Ores to Metals: The Rocky Mountain Smelting Industry by James E. Fell, Richard H. Peterson The Business History Review Vol. 55, No. 2 (Summer, 1981), pp. 252

¹³⁵ Development of Modern Management Chapter A For Additional Information staff.jccc.net/vclark/addinfo-L.htm Johnson County Community College

Image: The image of **J. Edgar Thomson** credited to Scharf, Thomas J., and Thompson Westcott, History of Philadelphia. 1609-1884. Philadelphia. L.H. Everts and Co., 1884, is being used on ExplorePAhistory.com courtesy of Accessible Archives, Inc..



His Pennsylvania Railroad was in his day the largest railroad in the world, with 6000 miles of track, and was famous for steady financial dividends, for high quality construction, constantly improving equipment, technological advances (such as replacing wood with coal), and innovation in management techniques for a large complex organization.^{124 126}

He oversaw the building of the PRR's 250-mile main line between Harrisburg and Pittsburgh, a segment that included the Horseshoe Curve,¹²³ in the Allegheny Mountains of western Pennsylvania, which opened in 1854.¹²⁴ It was an engineering marvel and the accomplishment for which Thomson is remembered by most persons.¹²³



¹²⁴ en.wikipedia.org/wiki/John_Edgar_Thomson

¹²⁶ Ward, James A. "Power and Accountability on the Pennsylvania Railroad, 1846-1878." *Business History Review* 1975 49(1): 37-59. in JSTOR

¹²³ Ores to Metals: The Rocky Mountain Smelting Industry by James E. Fell, Richard H. Peterson *The Business History Review* Vol. 55, No. 2 (Summer, 1981), pp. 252

John Edgar Thomson was an American civil engineer and industrialist.¹²⁴

He served as PRR's first Chief Engineer and third President, making it the largest business enterprise in the world and a world-class model for technological and managerial innovation.¹²⁴

¹²⁵

Thomson made the Pennsylvania the technological leader of the industry. It took the lead in moving from wood to coal, and from iron to steel (in rails, bridges and cars). With Philadelphia emerging as the center of the locomotive industry, new innovations were offered first to the Pennsylvania, which embraced them.¹²⁴

¹²⁴ en.wikipedia.org/wiki/John_Edgar_Thomson

¹²⁵ Elliott, Alan R. "Edgar Thomson Led The Railroad Revolution," *Investor's Business Daily* July 30, 2009. online edition

¹²⁷ *Handbooks of Management Accounting Research*, Volume 2 edited by Christopher S. Chapman, Anthony G. Hopwood, Michael D. Shields p. 1074

It was here, the first appearance of a decentralized, line-and-staff, divisional form of organization that became a model for most post-Civil War reorganizations of the railroads was in evidence.¹²⁷

Thomson's starting point, however, was the work of another engineer, the Erie's general superintendent Daniel C. McCallum, who had outlined a new organization for his road just two years earlier.¹³⁰

His organization manual for the Pennsylvania Railroad¹²⁸ issued in December 1857, would contain many of the Scots-American's words and phrases.¹²⁹

¹²⁸ *Organizational Studies*. Vol. I, Modes of Management p. 88

¹²⁹ *The Puritan Gift: triumph, collapse and revival of an American dream*, Kenneth Hopper and William Hopper, I. B. Tauris (April 3, 2007) p. 71. By permission of Ken Hopper and Will Hopper

¹³⁰ Ward, James A. "J. Edgar Thomson: Master of the Pennsylvania (Contributions in Economics and Economic History)" Praeger (October 14, 1980) p. 107-108.

Thomson took this idea and merged it with his rival B&O departmental structures to create the first line and staff managerial organization in American corporate history.¹³⁰

His goal was to imitate the motivational and entrepreneurial advantages of small business with the economies of scale of specialist staff in railroading. He sought to combine the advantages of centralization and decentralization by locating responsibility and authority at the divisional level.¹³⁴

He devised a decentralized system based on geographical districts¹²⁴ much as Dioceses had done before.

¹³⁰ Ward, James A. "J. Edgar Thomson: Master of the Pennsylvania (Contributions in Economics and Economic History)" Praeger (October 14, 1980) p. 107-108.

¹³⁴ The New Competition: Institutions of Industrial Restructuring By M. H. Best, Harvard University Press (January 1, 1993) p. 60

¹²⁴ en.wikipedia.org/wiki/John_Edgar_Thomson

Thomson worked out the line-and staff concept as a means of integrating more effectively the functional activities of several regionally defined operating units.¹³¹

The staff consisted of executives at railroad headquarters, who had general oversight of the entire railroad. Those in the line positions directly supervised sections of the railroad. To make this more efficient, Thomson divided the railroad into divisions, each of which consisted of a certain section of track.¹³⁵

Line executives handled people and hourly decisions on traffic, while staff executives handled finance and paperwork.^{124 136}

¹³¹ The visible hand: The managerial revolution in American business By Alfred D. Chandler Belknap Press of Harvard University Press (January 1, 1993) p. 99

¹³⁵ Development of Modern Management Chapter A For Additional Information staff.jccc.net/vclark/addinfo-L.htm Johnson County Community College

¹³⁶ Chandler, Alfred D., Jr. "The Railroads: Pioneers in Modern Corporate Management". Business History Review 1965 39(1): 16-40. in JSTOR

Thomson's new organizational structure, completed by December 1857, was eventually copied all across the country.¹³⁷

It became a shining model of good corporate administration.¹²⁹

The railroads – as America's first Big Businesses – provided a model for the future manufacturing companies, that would replace geographical divisions with product-centered ones.¹²⁹

Thomson began the development of cost accounting on the railroad, which determined the cost of each operation.¹³⁵

¹³⁷ J. Edgar Thomson: Master of the Pennsylvania Railroad www.skymark.com/resources/leaders/thomson.asp

¹²⁹ The Puritan Gift: triumph, collapse and revival of an American dream, Kenneth Hopper and William Hopper, I. B. Tauris (April 3, 2007) p. 71. By permission of Ken Hopper and Will Hopper

¹³⁵ Development of Modern Management Chapter A For Additional Information staff.jccc.net/vclark/addinfo-L.htm Johnson County Community College

COST ACCOUNTING

In addition to his organization innovation, of all the organizational innovators, J. Edgar Thomson and his associates on the Pennsylvania Railroad made the most significant contributions to accounting.¹³²

Thomson's major contribution was the popularization of accounting innovations in railroad trade journals such as Henry Varnum Poor's American Railroad Journal.¹²⁷

Under Thomson, the Pennsylvania Railroad employed many talented executives, who made important management innovations of their own.¹³⁵

¹³² The visible hand: The managerial revolution in American business By Alfred D. Chandle Belknap Press of Harvard University Press (January 1, 1993) p. 109

¹²⁷ Handbooks of Management Accounting Research, Volume 2 edited by Christopher S. Chapman, Anthony G. Hopwood, Michael D. Shields p. 1074

¹³⁵ Development of Modern Management Chapter A For Additional Information staff.jccc.net/vclark/addinfo-L.htm Johnson County Community College

One of these was Thomas A. Scott.¹³⁵

As general superintendent, one of Scott's most important responsibilities was implementing Thomson's cost accounting system.¹³⁵

Scott was also to have a major influence on Andrew Carnegie, who went on to become one of the nineteenth century leading industrialists.

As head of the Pittsburgh division, Scott hired the young Andrew Carnegie.¹³⁵

Later, when Scott was promoted to general superintendent, with supervision of the entire railroad, he took Carnegie with him.¹³⁵

Scott took a special interest in mentoring aspiring railroad men, such as Andrew Carnegie; Scott taught him the basics of

¹⁴³ [en.wikipedia.org/wiki/Tom_Scott_\(PRR\)](http://en.wikipedia.org/wiki/Tom_Scott_(PRR))

¹³⁵ Development of Modern Management Chapter A For Additional Information
staff.jccc.net/vclark/addinfo-L.htm Johnson County Community College

railroading, investment, and management, and had a great impact on his later business life.¹⁴³

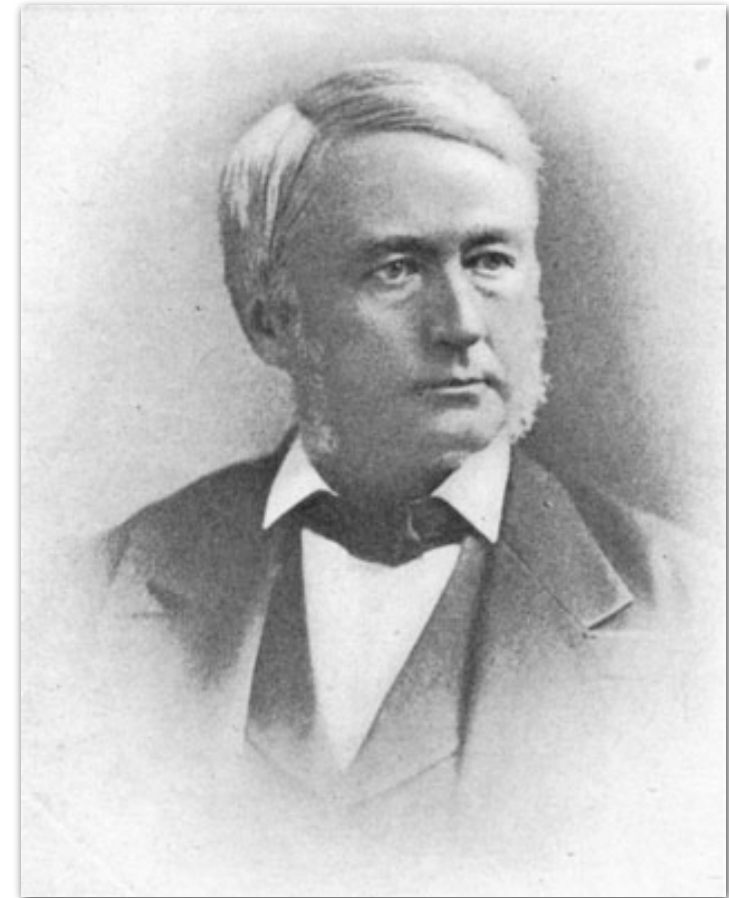


Image: **Thomas Alexander Scott** - Project Gutenberg eText 17976 From Project Gutenberg's Autobiography of Andrew Carnegie, by Andrew Carnegie
www.gutenberg.org/etext/17976
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en.wikipedia.org/wiki/File:Thomas_Alexander_Scott_-_Project_Gutenberg_eText_17976.jpg

BIG BUSINESS

Andrew Carnegie led the enormous expansion of the American steel industry in the late 19th century.¹⁴¹

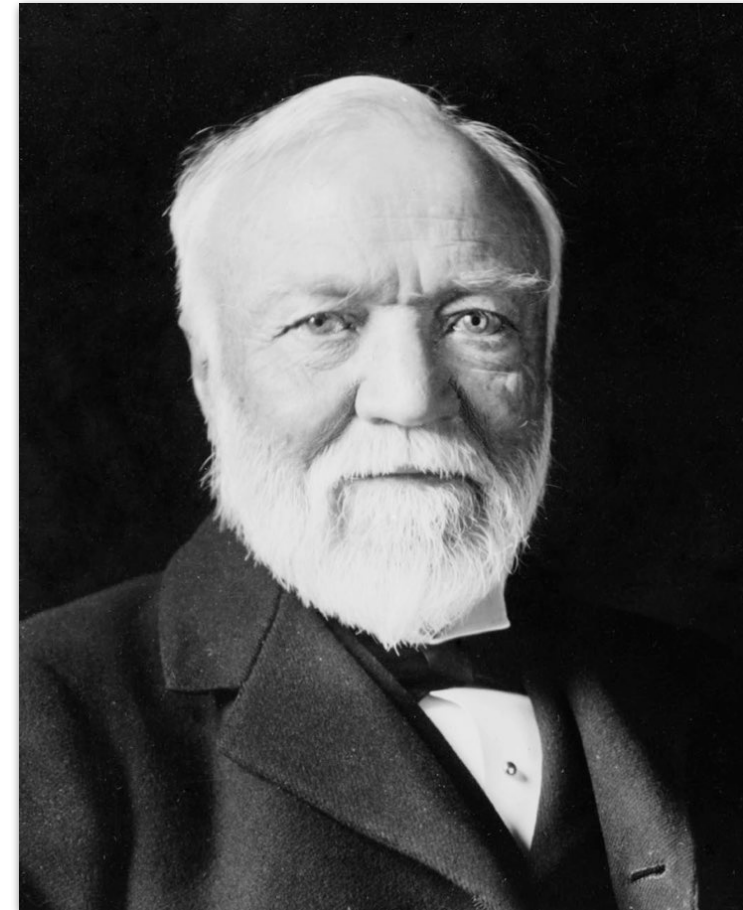
Carnegie combined his assets and those of his associates in 1892 with the launching of the Carnegie Steel Company.¹⁴¹

J. P. Morgan and the attorney Elbert H. Gary founded U.S. Steel in 1901 (incorporated on February 25) by combining Andrew Carnegie's Carnegie Steel Company with Gary's Federal Steel Company and William Henry "Judge" Moore's National Steel Company^{148 149} for \$492 million (\$13.58 billion today).¹⁴⁸

It was capitalized at \$1.4 billion (\$38.63 billion today),^{148 151} making it the world's first billion-dollar corporation.^{148 150}

¹⁴¹ en.wikipedia.org/wiki/Andrew_Carnegie

¹⁴⁸ en.wikipedia.org/wiki/U.S._Steel



¹⁵⁰ US Steel library.case.edu/digitalcase/CollectionDetail.aspx?PID=ksl:ussteel#o

¹⁵¹ Steel Standing: U.S. Steel celebrates 100 years old.post-gazette.com/businessnews/20010225ussteel2.asp

¹⁴⁹ Morris, Charles R. The Tycoons: How Andrew Carnegie, John D. Rockefeller, Jay Gould, and J.P. Morgan invented the American supereconomy, H. Holt and Co., New York, 2005, pp.255-258. ISBN 0-8050-7599-2, and fundinguniverse.com/company-histories/United-States-Steel-Corporation-Company-History.http

Image: **Andrew Carnegie**, American businessman and philanthropist. Copyright 1913. Library of Congress. Public Domain
en.wikipedia.org/wiki/File:Andrew_Carnegie,_three-quarter_length_portrait,_seated,_facing_slightly_left,_1913-crop.jpg

The railroads were the first big businesses in America, and the Pennsylvania was one of the largest of them all. Carnegie learned much about management and cost control during [his] years [at PRR], and from Scott in particular.^{141 142}

Carnegie would apply the operational procedures – including, for example, detailed cost accounting – that he had absorbed at the Pennsy, and which the Pennsy had in turn learned through Poor from the Erie.¹⁴⁰

Carnegie wrote “The Secret of Business is the Management of Men” in the *World's Work* periodical in 1903, a widely read publication.

¹⁴⁰ The Puritan Gift: triumph, collapse and revival of an American dream, Kenneth Hopper and William Hopper, I. B. Tauris (April 3, 2007) p.72. By permission of Ken Hopper and Will Hopper

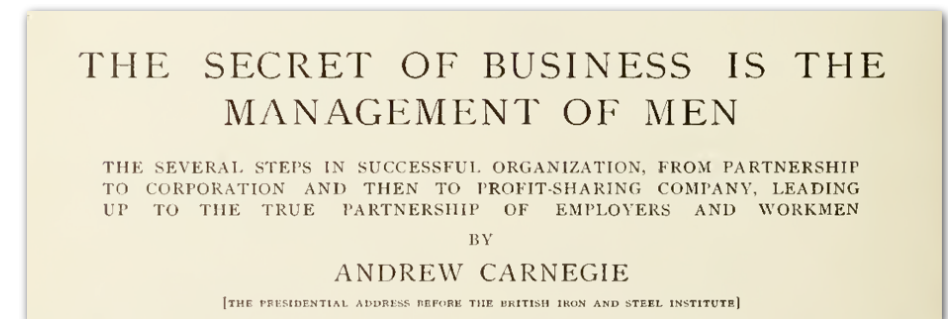
¹⁴¹ en.wikipedia.org/wiki/Andrew_Carnegie

¹⁴² Nasaw, David, Andrew Carnegie (New York: The Penguin Press, 2006), pp. 54–59, 64–65.

¹⁸¹ The World's Work Volume 6 Publisher Garden City, N.Y. [etc.] Doubleday, Page. archive.org/details/worldsworko6gard

He would explain:

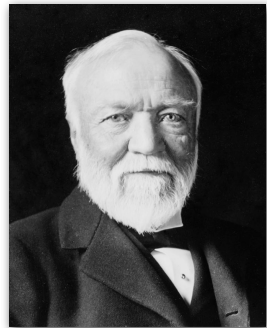
*“that perfect management in every department was needed, and that this depended on the men in charge.”*¹⁸¹



Images: *The World's Work* Volume 6 Publisher Garden City, N.Y. [etc.] Doubleday, Page. archive.org/details/worldsworko6gard

“I invite your attention, therefore, to the important question of the organization and management of that most complicated of all pieces of machinery - Man.”¹⁸¹

Andrew Carnegie, American businessman and philanthropist



At the height of his career, Carnegie was the second-richest person in the world, behind only John D. Rockefeller of Standard Oil.¹⁴¹

Image: **Andrew Carnegie**, American businessman and philanthropist. Copyright 1913. Library of Congress. Public Domain en.wikipedia.org/wiki/File:Andrew_Carnegie,_three-quarter_length_portrait,_seated,_facing_slightly_left,_1913-crop.jpg

Although he had left the Pennsylvania Railroad Company, he remained closely connected to its management, namely Thomas A. Scott and J. Edgar Thomson.¹⁴¹

Throughout his later career, he made use of his close connections to Thomson and Scott. When he built his first steel plant, he made a point of naming it after Thomson.¹⁴¹

Carnegie Mellon University in Pittsburgh was named after Carnegie, who founded the institution as the Carnegie Technical Schools.

¹⁴¹

The university has established leadership in fields such as computational finance, information systems and management.³⁷⁴

¹⁴¹ en.wikipedia.org/wiki/Andrew_Carnegie

³⁷⁴ en.wikipedia.org/wiki/Carnegie_Mellon_University

¹⁸¹ The World's Work Volume 6 Publisher Garden City, N.Y. [etc.] Doubleday, Page. archive.org/details/worldsworko6gard

— **Summary** —
Management Arises

In this chapter of our story we have seen how [eighteenth and] nineteenth century work was organized and managerial power was delegated.

30

We have seen the birth of management along with the birth of managers whose role it is to manage other managers.

It was during this time that a new sub-species of economic man—the salaried manager⁸⁷ came to be. Between 1880 and 1920, the number of professional managers in the United States grew from 161,000 to more than 1 million.¹⁵⁵

Who knows how many professional managers there are in the world today?

How many of them are still using the same methods we have seen invented thus far?

We have seen the origins of individual performance measurement, feedback on the quality of work produced by a worker and personnel management. Today this is typically achieved through a performance review or appraisal.

The roots of workplace inspection have also been discussed. In its day, workplace inspection was required to ensure the welfare of the workforce; that they were not being exploited, however, today, workplace inspection is still rife for very different reasons, which we shall explore more in our next chapter.

³⁰ Nelson, Daniel (1980) *Frederick W. Taylor and the Rise of Scientific Management* Madison Wisconsin, University of Wisconsin Press p 4

¹⁵⁵ Useem, "Entrepreneur of the Century."

⁸⁷ Business historian Alfred D. Chandler, Jr., quoted in Jerry Useem, "Entrepreneur of the Century," Inc. (20th Anniversary Issue, 1999): 159–174

We have explored the roots of labour division and specialisation, resulting in, at that time, increased output and less training (process could be written, and people could learn one skill, and learn to do that skill well, they no longer had to learn everything).

We have also seen the rise of assigning only high-skill tasks to high-cost workers.

Karl Marx argued that the source of the productivity of the factory system was exactly the combination of the division of labour with machinery, building on Adam Smith, Babbage and Ure.^{239 202}

Today division of labour, specialisation, separating out activities into simple standard tasks carried out by less skilled workers thus giving greater consistency and lower unit costs¹ is still the norm.

We have discussed the beginnings of line and staff separation, differing levels of authority and accountability, division of clearly specified responsibility and duties, multiple levels of top-down hierarchy, an organisational line of command, and the classic org chart.

We have also seen how these evolved into geographical and product centered divisions, departments and operating units. This is still the norm; today's organisations are functionally dominated.

²³⁹ Ákos Róna-Tas (1997). *The Great Surprise of the Small Transformation: The Demise of Communism and the Rise of the Private Sector of Hungary*. University of Michigan Press. p. 20. ISBN 978-0-472-10795-7. Retrieved 27 April 2013.

²⁰² en.wikipedia.org/wiki/Charles_Babbage

Alfred Chandler in his 1977 book “The Visible Hand” describes a hierarchy of responsibility and control being introduced in response to a train crash in the United States in 1841. The idea was to prevent train crashes by controlling operations through the division of responsibilities and authority, with reporting and checks.

These ideas are enshrined in an organisation chart.¹ Today, we think of hierarchical organisational charts describing responsibilities and controls as normal.¹

“Organizational charts are like a blame flow; rule makers, controllers, enforcers, losers²⁴²”

Claudio Perrone @agilesensei

However, in contrast, how few levels are really needed is shown by the example of the oldest, largest, and most successful organization of the West, the Catholic Church.¹¹⁹

There is only one level of authority and responsibility between the Pope and the lowliest parish priest; the bishop.¹¹⁹

Yet today, very few organisations have that few layers in their structure.

¹ 540-A brief history of Western management thought, Copyright © Vanguard Consulting Limited

¹¹⁹ Management Task, Responsibilities, Practices, Peter F. Drucker, HarperBusiness (April 14, 1993) p. 547

²⁴² www.slideshare.net/cperrone/a3-kaizen-heres-how

We have seen the rise of engineering academies and management education based upon “best practice”. Management education is big business. How much of what is taught in management schools and the prevailing management literature is still based on industrial thinking?

The origins of accurate systems of reporting, weekly reports for the hierarchy, and cost accounting have also been discussed.

Cost accounting we will explore more in this book when we look at the roots of budgeting.

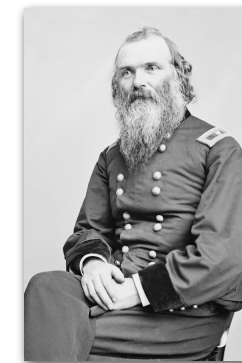
It is not uncommon today to see reports serving the hierarchy, as McCallum described all those years ago:

²³⁶ Photocopy of an 1855 organizational diagram of the New York and Erie Railroad. Original in the collections of the Library of Congress. - Erie Railway, New Jersey, New York, Pennsylvania, Deposit, Broome County, NY Repository: Library of Congress Prints and Photographs Division Washington, D.C. 20540 USA hdl.loc.gov/loc.pnp/pp.print www.loc.gov/pictures/item/ny1255.photos.122186p/

“Each individual holds himself responsible only to his immediate superior.

Communication from subordinates can reach the Heads of Departments only by passing up regularly through the same gradations.”²³⁶

Daniel McCallum General Superintendent of the New York and Erie Railroad



¹ 540-A brief history of Western management thought, Copyright © Vanguard Consulting Limited

Image: **Daniel McCallum**. Taken prior to 1878, Author Original uploader was Instinct at en.wikipedia. Later version(s) were uploaded by Anetode at en.wikipedia. PD-US en.wikipedia.org/wiki/File:Daniel_Craig_McCallum_image.jpg

— **Footnote** —
Early Beginnings and
Management Arises

Industrial thinking is alive and well today, through our organisations, government and educational institutions we have educated managers to think in ways that are sub-optimal.³⁵

Focusing on our educational institutions, in addition to our first chapters I have also added a link to a talk below by Sir Ken Robinson entitled “Changing Education Paradigms”, in which he will talk about how today’s systems of education are modeled in the image of industrialism; production lines, standardisation, functionalisation, specialisation, batches and inspection, the roots of which we have discussed so far.

You can see the Sir Ken Robinson talk overleaf.

Watch video www.youtube.com/watch?v=zDZFcDGpL4U

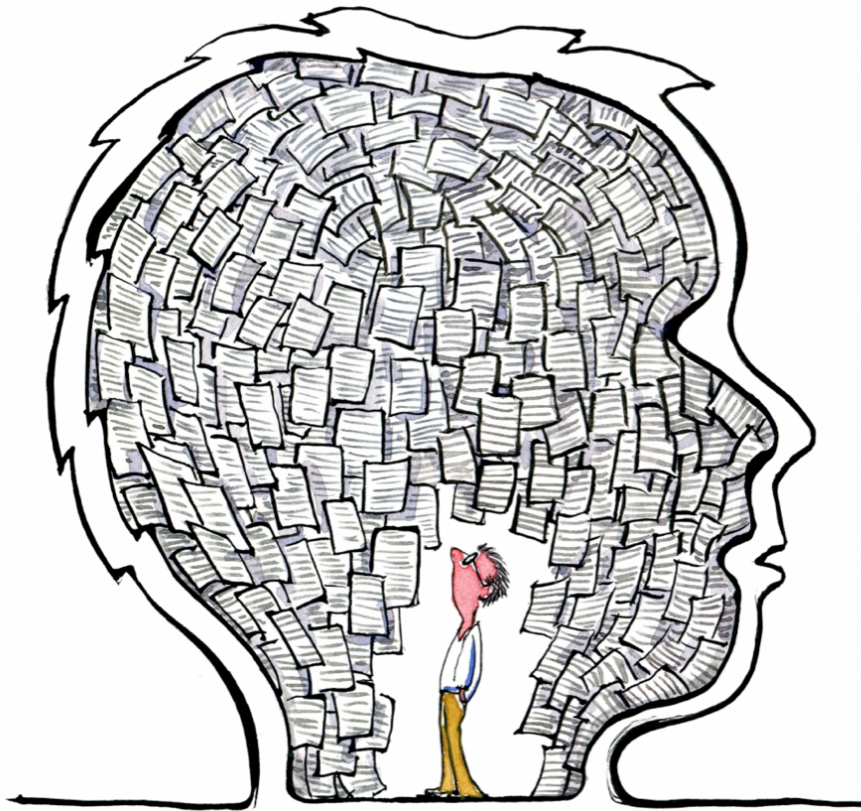


Design and Management — Concepts —

- The Organisation, Top Down Hierarchy, Hierarchical Responsibilities, and the Organisation Chart.
- Division of Labour, Line Executives and Staff.
- Decentralisation and Division of Responsibilities, Operating Units and the Departmental Divisional Structure.
- Specialization and Functionalisation.
- Working Hours, Child Labour, Unions and Workplace Inspection.
- Personnel Management.
- Management Reporting and Real Time Data.
- Cost Accounting.
- The Salaried Manager, Management Schools, Textbooks and Manuals.
- Standardisation of Tasks, High-Skill Tasks to High-Cost Workers, and Quality of Output.

In our next chapter we will look at the rise of Management as a “science”.

Chapter Two: Management Arises



By David Joyce

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Part of w:Charles Babbage's Difference Engine No. 1, as assembled in 1833, exhibited 1862, and later in the South Kensington Museum. Date: 1853, Author: Woodcut after a drawing by Benjamin Herschel Babbage
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Depicted person: **Ada King, Countess of Lovelace**, Artist: Alfred Edward Chalon (1780–1860), Date: 1840, Medium: watercolor, Dimensions: 250 mm x 183 mm, Current location: Science Museum Science & Society Picture Library, Accession number: Inventory number 1995-0796 (see on gallery's website) Image No. 10312035, Source/Photographer: www.fathom.com Public Domain en.wikipedia.org/wiki/File:Ada_lovelace.jpg

Shoemaker, 1535, vlrch (Ulrich) fürnpach (Fürnpach; Fürnbach) , schuster (Schuster) Transkription und weitere Informationen siehe www.nuernberger-hausbuecher.de/75-Amb-2-317-154-r/data Date, 1535,
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Photographer: Hine, Lewis Wickes Flashlight **photo of children on night shift going to work at 6 PM** on a cold dark December night. Work shift lasts all night, 12 hours. They do not come out again until 6:00 AM
Child workers on their way to a night shift at Whitnel Cottton Mills. North Carolina, USA 1908. NMFF.003473 Date: 26 January 2011, 11:25:00 Source: Flickr: NMFF.003473 Author: Preus museum CC 2.0 en.wikipedia.org/wiki/File:Child_Labor_in_United_States_1908,_12_hour_night_shifts.jpg

Children working in a mill in Macon, Georgia, 1909. Author Lewis Hine. This image is available from the United States Library of Congress's Prints and Photographs division under the digital ID nclc.01581
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Robert Owen 1771-1858. de: Robert Owen 1771-1858. Date: 1845, Source: painting of John Cranch 1845, Author: John Cranch, Permission (Reusing this file)

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Children working in a mill in Macon, Georgia, 1909. Author Lewis Hine. This image is available from the United States Library of Congress's Prints and Photographs division under the digital ID nclc.01581

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Portrait of **Sylvanus Thayer** by en:Robert W. Weir photo of portrait originally found at domain usma.edu. PD-ART

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Portrait of **Andrew Ure** (1778 - 1857), American chemist. Engraving, original size 15.9×11.3 cm. Date: 19th century, Source: www.sil.si.edu/digitalcollections/hst/scientific-identity/fullsize/SIL14-U001-02a.jpg

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Charles Dupin, Julien-Leopold Boilly (1896-1874), Date: 1820, Medium: lithograph

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Carrollton, Louisiana (later annexed into the city of New Orleans). **View of New Orleans and Carrollton Railroad locomotive in front of the Carrollton Hotel.** Date: 16 December 1835

Source: Drawing by C. Rothaas dated 16 December 1835 in the New Orleans Notorial Archives, Book 91, Folio 10, via book "The Saint Charles Streetcar or the history of The New Orleans and Carrollton Railroad" by James Guilbeau, The Louisiana Landmarks Society, 3rd edition, 1992. Author: C. Rothaas. PD-Art PD-OLD. en.wikipedia.org/wiki/File:CarrolltonTrain1835.jpg

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Daniel McCallum. Taken prior to 1878, Author Original uploader was Instinct at en.wikipedia. Later version(s) were uploaded by Anetode at en.wikipedia. PD-US en.wikipedia.org/wiki/File:Daniel_Craig_McCallum_image.jpg

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Andrew Carnegie, American businessman and philanthropist. Copyright 1913. Library of Congress. Public Domain en.wikipedia.org/wiki/File:Andrew_Carnegie,_three-quarter_length_portrait,_seated,_facing_slightly_left,_1913-crop.jpg

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Plato
Xenophon
Ibn Khaldun
Diocletian
Maximinus
Sir William Petty
Adam Smith
Charles Babbage
Ada Lovelace
Robert Owen
Brevet Brigadier General Sylvanus Thayer
President James Madison
James Monroe
Andrew Ure
Charles Dupin
Jean le Rond d'Alembert
Denis Diderot
Francis Bacon
Daniel McCallum
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John Poor

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