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

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By David Joyce
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- 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.
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- 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.\(^2\)\(^{49}\)\(^{50}\)

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.\(^2\)\(^{49}\)\(^{50}\)

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86 Great writers on organisations By Derek Salman Pugh, David J. Hickson, Ashgate; 3 edition (November 30, 2007) p.144.
2 en.wikipedia.org/wiki/Egyptian_pyramid_construction_techniques
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….⁴⁶⁻⁶⁷

Plato, The Republic

⁴⁶ en.wikipedia.org/wiki/Division_of_labour


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”.\(^4\)

The 14th-century Arab Muslim scholar Ibn Khaldun emphasised the importance of the division of labour in the production process, in his Muqaddimah.\(^4\)

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.\(^3\)\(^5\)

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.\(^3\)\(^5\)

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.\(^3\)\(^5\)

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\(^5\) [www.roman-empire.net/army/career.html](www.roman-empire.net/army/career.html)
Staying with Ancient Rome, Diocletian was a Roman Emperor from 284 to 305.\textsuperscript{89}

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

His answer was to divide the overall administration.\textsuperscript{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.\textsuperscript{92}

At the top, Diocletian instituted the Tetrarchy.\textsuperscript{92} The term Tetrarchy describes any form of government where power is divided among four individuals.\textsuperscript{102}
This divided the empire into two halves, East and West, each to be ruled by an Augustus (emperor).\textsuperscript{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.\textsuperscript{93}

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

Each Augustus would in turn appoint a deputy called a Caesar,\textsuperscript{92} or “junior emperors”\textsuperscript{90} (which should lessen the temptation for would-be usurpers to murder the reigning emperors, since power would automatically pass to their Caesars)\textsuperscript{95} who would act both as his ruling partner (each Caesar was assigned a quarter of the empire) and designated successor.\textsuperscript{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.\textsuperscript{92 97}

\textsuperscript{90} A quick overview of Diocletian’s Tetrarchy, Copyright 2006, Steve Niederloh, www.celatorsart.com/collect_tetrarch_start.html
\textsuperscript{92} en.wikipedia.org/wiki/Late_Roman_army
\textsuperscript{93} The Tetrarchy jaysromanhistory.com/romeweb/laterome/art5.htm
\textsuperscript{95} Tetrarchy of Diocletian www.garstang.us/emperors/tetofdiocletian.htm

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).\(^101\)

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.

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88 Notitia Title XXXIV
92 en.wikipedia.org/wiki/Late_Roman_army
98 en.wikipedia.org/wiki/Diocletian
99 Barnes, Constantine and Eusebius, 9; Rees, Diocletian and the Tetrarchy, 25–26.

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.\textsuperscript{46}

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,\textsuperscript{83} showing its existence and usefulness in Dutch shipyards.\textsuperscript{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.\textsuperscript{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.\textsuperscript{83}

\textsuperscript{46} en.wikipedia.org/wiki/Division_of_labour
\textsuperscript{83} en.wikipedia.org/wiki/William_Petty

Adam Smith first recognized how output could be increased through the use of labor division.\footnote{en.wikipedia.org/wiki/Business_process}

Adam Smith was a Scottish moral philosopher.\footnote{en.wikipedia.org/wiki/Adam_Smith}

He is cited as the “father of modern economics” and is still among the most influential thinkers in the field of economics today.\footnote{78 www.bbc.co.uk/history/scottishhistory/enlightenment/\ _features_enlightenment_enlightenment.shtml}

He was also one of the key figures of the Scottish Enlightenment.\footnote{77 www.bbc.co.uk/history/scottishhistory/enlightenment/\ _features_enlightenment_enlightenment.shtml}

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.\footnote{en.wikipedia.org/wiki/Adam_Smith}

\footnote{44 Why do we believe in economy of scale? Professor John Seddon, Managing Director Vanguard. July 2010}

\footnote{43 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\textsuperscript{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\textsuperscript{47}

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

\textsuperscript{43} en.wikipedia.org/wiki/Adam_Smith
\textsuperscript{46} en.wikipedia.org/wiki/Division_of_labour
\textsuperscript{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

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

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

45 en.wikipedia.org/wiki/Business_process
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
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. ...
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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. ...
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.”
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.\textsuperscript{45}

Following his ideas the division of labor was adopted widely.\textsuperscript{45}

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

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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{46 47}

Concerns largely ignored in today’s organisations.

\textsuperscript{46} en.wikipedia.org/wiki/Division_of_labour
\textsuperscript{45} en.wikipedia.org/wiki/Business_process
\textsuperscript{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

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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

202 en.wikipedia.org/wiki/Charles_Babbage
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)
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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{202, 205}


\textsuperscript{202} en.wikipedia.org/wiki/Charles_Babbage
Babbage earned a place in history as the patron saint of operations research and management science.\textsuperscript{208}

Babbage’s theories are said to have influenced the layout of the 1851 Great Exhibition.\textsuperscript{202 206}

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

Considered a “father of the computer”\textsuperscript{202 207} he has also had a profound impact on how today we design and manage work.

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.\textsuperscript{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.


\textsuperscript{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.\textsuperscript{230}

As a young adult, her mathematical talents led her to an ongoing working relationship and friendship with fellow British mathematician Charles Babbage.\textsuperscript{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,\textsuperscript{230 231} which she supplemented with an elaborate set of notes of her own, simply called Notes.\textsuperscript{230 232}

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

\textsuperscript{230} en.wikipedia.org/wiki/Ada_Lovelace

\textsuperscript{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.


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 2002\textsuperscript{234}).\textsuperscript{230}

Based on this work, Ada is now widely credited with being the first computer programmer\textsuperscript{233} and her method is recognised as the world’s first computer program.\textsuperscript{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.


\textsuperscript{230} en.wikipedia.org/wiki/Ada_Lovelace

DIVISION OF LABOUR EFFICIENCY

Continuing on 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.\(^7\)
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

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/

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

In England and Scotland in 1788, two-thirds of the workers in 143 water-powered cotton mills were described as children.\textsuperscript{25} \textsuperscript{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.\textsuperscript{200}

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

\textsuperscript{25} en.wikipedia.org/wiki/Child_labour

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

\textsuperscript{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.

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

He is frequently referred to as the father of modern personnel management.\textsuperscript{178}

In 1792\textsuperscript{180} at just twenty one, he was manager of a new, steam-powered mill\textsuperscript{179} (Bank Top Mill, Piccadilly, Manchester\textsuperscript{180}) with 500 employees.\textsuperscript{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.\textsuperscript{179}

The mill of New Lanark had been started in 1785 by David Dale and Richard Arkwright\textsuperscript{177} (whom we met in Chapter 1).
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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{177}

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.\textsuperscript{177}

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

The business was a great commercial success.\textsuperscript{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.\textsuperscript{177}

\textsuperscript{177} en.wikipedia.org/wiki/Robert_Owen

\textsuperscript{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.\textsuperscript{200}

He was a zealous supporter of the factory legislation.\textsuperscript{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.\textsuperscript{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,\textsuperscript{177, 188} but they were restricted to cotton mills.\textsuperscript{189}

However, the means of enforcing such legislation remained a serious problem.\textsuperscript{200}

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

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

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

\textsuperscript{189} robert-owen-museum.org.uk/Robert_Owen_1771_1858/factory_reform
\textsuperscript{199} Contains Parliamentary information licensed under the Open Parliament Licence v1.0. www.parliament.uk/about/living-heritage/transformingsociety/livinglearning/19thcentury/overview/earlyfactorylegislation/
\textsuperscript{177} en.wikipedia.org/wiki/Robert_Owen
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.\textsuperscript{182}

These unions were formed to address issues like child labor, 12 hour work days, safety and wages.\textsuperscript{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.\textsuperscript{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.\textsuperscript{80}

\textsuperscript{182} en.wikipedia.org/wiki/Industrial_Revolution

\textsuperscript{184} Sandrine Bardot, compensationinsider.com/the-history-of-performance-reviews-infographic/


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.  

It is seen by many as a source of organizers.

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

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27 Conversations with William Hopper

en.wikipedia.org/wiki/Sylvanus_Thayer

40 en.wikipedia.org/wiki/Sylvanus_Thayer
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

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

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

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

It was so successful in its engineering curriculum that it significantly influenced every American engineering school founded prior to the Civil War.  

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41 en.wikipedia.org/wiki/United_States_Military_Academy


Image: Thayer Statue at West Point, Date: December 2008, Source: Own work, Author: Ahodges7 en.wikipedia.org/wiki/File:Thayer_Shrine_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
Ure called on British industry to invest more in knowledge and training and to take steps to improve the welfare of workers.\textsuperscript{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.\textsuperscript{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 sounds as those that organized the mechanical works in their factories.\textsuperscript{217}

Andrew Ure included human factors into his, “The Philosophy of Manufactures”, Ure recognised the mechanical and commercial factors of manufacturing but also added a third factor that was the human factor.\textsuperscript{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.” \textsuperscript{220}
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

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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/philosophymanufouregooog
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

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

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213 Management theory By John Sheldrake p.5
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/philosophymanufouregoog
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
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.\(^\text{223}\)

In 1819, Dupin was appointed as a management professor in Paris. His writings on various aspects of management were well known throughout France.\(^\text{210}\)

He wrote extensively on industry, work, and the welfare of workers.\(^\text{226}\)

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.\(^\text{226}\)

He formally tried to structurise the subject matter of management.\(^\text{216}\)

He began teaching factory management in France in 1819.\(^\text{228}\)

Supposedly, by 1826 his materials on management had been presented in 100 French cities to more than 5,000 workers and supervisors.\(^\text{227}\)

Dupin emphasized worker welfare and the need for integrity and accountability in management.\(^\text{229}\)

\(^{210}\) 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

\(^{229}\) 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

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
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.\textsuperscript{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.\textsuperscript{107}

\textsuperscript{106} en.wikipedia.org/wiki/Organizational_chart

\textsuperscript{107} en.wikipedia.org/wiki/Figurative_system_of_human_knowledge

The tree was a taxonomy of human knowledge, inspired by Francis Bacon’s The Advancement of Learning.\textsuperscript{107}

The three main branches of knowledge in the tree are:

“Memory”/History,
“Reason”/Philosophy, and
“Imagination”/Poetry.\textsuperscript{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.

\textsuperscript{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/encyclopdieoudoualem 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.\(^{13}\)

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.\(^{13}\)

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\(^{120}\) puttincolegoneotherickshaw.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

The Scottish-American engineer Daniel McCallum (1815–1878) is credited for creating the first organizational charts of American business\textsuperscript{108} around 1854.\textsuperscript{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.\textsuperscript{122} 112

In 1854, Daniel McCallum (a railroad engineer\textsuperscript{122}) took charge of the operations of the New York and Erie Railroad\textsuperscript{110} as the General Superintendent.\textsuperscript{122}

\textsuperscript{106} en.wikipedia.org/wiki/Organizational_chart


\textsuperscript{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.

\textsuperscript{112} "The cases of Daniel McCallum and Gustavus Swift" 1 July 2008

\textsuperscript{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.\textsuperscript{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.\textsuperscript{111}

Faced with the railroad’s financial strain and productivity slumps due to a lack of sufficient management, McCallum split management responsibility between the superintendents by having each manage a certain number of employees within his department.\textsuperscript{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.\textsuperscript{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.\textsuperscript{113}

\textsuperscript{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.

\textsuperscript{103} Charting History History of Organizational Charts www.orgchart.net/wiki/Charting_History


\textsuperscript{112} “The cases of Daniel McCallum and Gustavus Swift” 1 July 2008

Coordinating activities between these two branches, the superintendents managed both the fixed depots and the rolling stock that moved between them.\textsuperscript{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 information\textsuperscript{117} throughout the operation.

He first divided the line into four geographical regions and appointed divisional superintendents who were made responsible for the day-to-day movement of trains and traffic and the upkeep of roadbeds and buildings within their domains.\textsuperscript{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.\textsuperscript{121}

A mixed departmental-division structure was thus created.\textsuperscript{121}

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

www.mckinseyquarterly.com/Big_data_in_the_age_of_the_telegraph_3064

\textsuperscript{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

\textsuperscript{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.

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

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

McCallum’s charts included lines connecting the superintendents to the subordinates, while keeping them structured within each separate division.\footnote{103}

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

\footnote{103} Charting History History of Organizational Charts www.orgchart.net/wiki/Charting_History


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.\textsuperscript{116}

You can see the board of directors at the bottom of this exquisite tree.\textsuperscript{118}
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 complied 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.”

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"Many of the Lemures are also employed at Weitchpee. At some Stations the Agent at Weitchpee seems to be the Master."

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[Note: The diagram is a representation of the organizational structure of the New York and Erie Railroad as of September 1855. It shows the average number of employees in each class, engaged in the Operating Department of the Road, and indicates the powers and duties of each individual and to whom they are subject. The explanation highlights the concentration of power in the Board of Directors, who delegate authority to the President as the executive officer, who directly controls the officers shown on the diagram.]
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.”

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 attempt to compile comprehensive information about the financial and operational state of U.S. railroad companies.¹³⁸¹³⁹

¹³⁸ en.wikipedia.org/wiki/Henry_Varnum_Poor

Image: American railroad journal 1881 Volume 54 www.archive.org/details/historyrailroad00poorgoog
Henry Varnum Poor was a financial analyst\textsuperscript{138} and later established H.V. and H.W. Poor Co. with his son, Henry William, which published annual updated versions of his book.\textsuperscript{138 139}

Standard & Poor’s, the financial research and analysis bellwether, traces its history back to this publication.\textsuperscript{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).\textsuperscript{114}

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

Alfred Chandler, Professor of business history, Harvard\textsuperscript{240}, 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.\textsuperscript{187}

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

\textsuperscript{138} en.wikipedia.org/wiki/Henry_Varnum_Poor
\textsuperscript{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
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.\textsuperscript{135}

He divided the managers into staff and line positions.\textsuperscript{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.\textsuperscript{123}
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.\textsuperscript{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,\textsuperscript{123} in the Allegheny Mountains of western Pennsylvania, which opened in 1854.\textsuperscript{124} It was an engineering marvel and the accomplishment for which Thomson is remembered by most persons.\textsuperscript{123}

\textsuperscript{124} en.wikipedia.org/wiki/John_Edgar_Thomson
\textsuperscript{126} Ward, James A. "Power and Accountability on the Pennsylvania Railroad, 1846-1878." Business History Review 1975 49(1): 37-59. in JSTOR

John Edgar Thomson was an American civil engineer and industrialist.\textsuperscript{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.\textsuperscript{124}

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.\textsuperscript{124}

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.\textsuperscript{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.\textsuperscript{130}

His organization manual for the Pennsylvania Railroad\textsuperscript{128} issued in December 1857, would contain many of the Scots-American’s words and phrases.\textsuperscript{129}

\textsuperscript{124} en.wikipedia.org/wiki/John_Edgar_Thomson
\textsuperscript{127} Handbooks of Management Accounting Research, Volume 2 edited by Christopher S. Chapman, Anthony G. Hopwood, Michael D. Shields p. 1074
\textsuperscript{128} Organizational Studies. Vol. I, Modes of Management p. 88
\textsuperscript{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
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.\textsuperscript{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.\textsuperscript{134}

He devised a decentralized system based on geographical districts\textsuperscript{124} much as Dioceses had done before.

Thomson worked out the line-and staff concept as a means of integrating more effectively the functional activities of several regionally defined operating units.\textsuperscript{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.\textsuperscript{135}

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

\begin{thebibliography}{99}
\bibitem{134} The New Competition: Institutions of Industrial Restructuring By M. H. Best, Harvard University Press (January 1, 1993) p. 60
\bibitem{124} en.wikipedia.org/wiki/John_Edgar_Thomson
\bibitem{135} Development of Modern Management Chapter A For Additional Information staff.jccc.net/vclark/addinfo-L.htm Johnson County Community College
\end{thebibliography}
Thomson’s new organizational structure, completed by December 1857, was eventually copied all across the country.\textsuperscript{137}

It became a shining model of good corporate administration.\textsuperscript{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.\textsuperscript{129}

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

\textbf{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.\textsuperscript{132}

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

Under Thomson, the Pennsylvania Railroad employed many talented executives, who made important management innovations of their own.\textsuperscript{135}
One of these was Thomas A. Scott.\footnote{en.wikipedia.org/wiki/Tom_Scott_(PRR)}

As general superintendent, one of Scott’s most important responsibilities was implementing Thomson’s cost accounting system.\footnote{Development of Modern Management Chapter A For Additional Information staff.jccc.net/vclark/addinfo-L.htm Johnson County Community College}

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.\footnote{www.gutenberg.org/etext/17976}

Later, when Scott was promoted to general superintendent, with supervision of the entire railroad, he took Carnegie with him.\footnote{en.wikipedia.org/wiki/Thomas_Alexander_Scott-Project_Gutenberg_eText_17976.jpg}

Scott took a special interest in mentoring aspiring railroad men, such as Andrew Carnegie; Scott taught him the basics of railroading, investment, and management, and had a great impact on his later business life.\footnote{143}
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


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#0
151 Steel Standing: U.S. Steel celebrates 100 years old.post-gazette.com/businessnews/20010225ussteel2.asp
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.\textsuperscript{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.\textsuperscript{140}

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

\textsuperscript{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
\textsuperscript{141} en.wikipedia.org/wiki/Andrew_Carnegie
\textsuperscript{181} The World’s Work Volume 6 Publisher Garden City, N.Y. [etc.] Doubleday, Page. archive.org/details/worldswork06gard

He would explain:

“that perfect management in every department was needed, and that this depended on the men in charge.”\textsuperscript{181}
“...I invite your attention, therefore, to the important question of the organization and management of that most complicated of all pieces of machinery - Man.”

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. 

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

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.

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

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

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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/worldswork06gard
— 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 manager 87 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.

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155 Useem, “Entrepreneur of the Century.”

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 actives into simple standard tasks carried out by less skilled workers thus giving greater consistency and lower unit costs 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.


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

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.
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:

> 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

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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
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.\textsuperscript{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”.
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