THE

PHILOSOPHY OF MANUFACTURES:

OR,

AN EXPOSITION

OF THE

SCIENTIFIC, MORAL, AND COMMERCIAL ECONOMY

OF THE

FACTORY SYSTEM

OF

Great Britain.

BY ANDREW URE, M.D., F.R.S.,

M.D., M.A.S. Lon., M. Acad. N.S. Philad.,
S. Pharm. Soc. North Germany,
&c. &c. &c.

LONDON:
CHARLES KNIGHT, LUDGATE-STREET.
MDCCXXXV.
LONDON:
Printed by WILLIAM CLOWES AND SONS,
Stamford Street.
CONTENTS.

Preface ..... vii

BOOK THE FIRST.
GENERAL PRINCIPLES OF MANUFACTURES.

CHAPTER I.
General View of Manufacturing Industry ..... 1

CHAPTER II.
Arrangement and Connexion of Manufactures ..... 55

CHAPTER III.
Topography and Statistics of the Factory System ..... 67

BOOK THE SECOND.
SCIENTIFIC ECONOMY OF THE FACTORY SYSTEM.

CHAPTER I.
Examination of the Textile Fibres,—Cotton, Wool, Flax, and Silk ..... 81

CHAPTER II.
Nature, &c. of a Cotton Factory ..... 105

CHAPTER III.
Worsted Manufacture—General Observations on Wool ..... 124

CHAPTER IV.
Nature and Operations of a Woollen-Factory.—Of the Short Wool or Cloth Manufacture ..... 160

CHAPTER V.
Nature and Operations of a Flax-Factory ..... 207
CONTENTS.

CHAPTER VI.
Nature and Operations of a Silk-Factory .... 229

BOOK THE THIRD.
MORAL ECONOMY OF THE FACTORY SYSTEM.

CHAPTER I.
Condition of our Factory Operatives, as to Personal Comforts, compared to that of other Labouring Classes; or the Quantity and Quality of their Work considered, relatively to the means of Enjoyment which it can procure.—History of the Discontents, Prejudices, and Legislation on this subject .... 277

CHAPTER II.
Health of Factory Inmates .... 374

CHAPTER III.
State of Knowledge and Religion in the Factories .... 404

BOOK THE FOURTH.

Commercial Economy of the Factory System .... 430

Note A. .... 467
" B. .... 470
" C. .... 471
" D. .... 472

APPENDIX—Relative Ages, Sexes, and Wages of Factory Workpeople .... 473
General Statistical Table of the Textile Manufactures, subject to the Factories Regulation Act .... 481

In the wages-column of table, page 373, the figures have been printed with horizontal lines, as vulgar fractions, instead of oblique lines, as shillings and pence. It should read 11s., 10s., 5s. 8d., 4s. 5d., 4s., 3s. 6d., 2s. 6d.

ERRATA.—Page 291, line 7, for "Of" read "On."
" 383, line 7, for "wires" read "wings."
PREFACE.

The present is distinguished from every preceding age by an universal ardour of enterprise in arts and manufactures. Nations convinced at length that war is always a losing game, have converted their swords and muskets into factory implements, and now contend with each other in the bloodless but still formidable strife of trade. They no longer send troops to fight on distant fields, but fabrics to drive before them those of their old adversaries in arms, and to take possession of a foreign mart. To impair the resources of a rival at home, by underselling his wares abroad, is the new belligerent system, in pursuance of which every nerve and sinew of the people are put upon the strain.

Great Britain may certainly continue to uphold her envied supremacy, sustained by her coal, iron, capital, and skill, if, acting on the Baconian axiom, "Knowledge is Power," she shall diligently promote moral and professional culture among all ranks of her productive population. Were the principles of the manufactures exactly analyzed, and expounded in a simple manner, they would diffuse a steady light to conduct the masters, managers, and operatives, in the straight
paths of improvement, and prevent them from pursuing such dangerous phantoms as flit along in the monthly patent-lists. Each department of our useful arts stands in need of a guide-book to facilitate its study, to indicate its imperfections, and to suggest the most probable means of correcting them. It is known that the manufactures of France have derived great advantage from the illustrated systems of instruction published under the auspices of its government and patriotic societies.

The present volume, introductory to a series of works in more ample detail, is submitted to the public as a specimen of the manner in which the author conceives technological subjects should be discussed.

Having been employed in a public seminary for a quarter of a century, in expounding to practical men, as well as to youth, the applications of mechanical and chemical science to the arts, he felt it 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. With this view he resolved to make afresh such a survey of some of the great manufacturing establishments, to which he had liberal access, as might qualify him to discharge the task in a creditable manner. This tour of verification would have been executed at a much earlier date, so as to have enabled him, ere now, to have redeemed his pledges both publicly and pri-
vately given, but for an interruption of unexpected magnitude.

The Right Honourable the Lords of the Committee of the Privy Council for Trade and Plantations requested him, about three years ago, to undertake a series of experiments on the refining of sugar, in order to ascertain the relation of the drawbacks on exportation of refined loaves to the duties paid upon the raw article. Under an impression that these researches might be set sufficiently in train, in the space of two or three months, to lead to the desired information in the hands of experienced operatives, he undertook their arrangement; but encountered so many difficulties from the delicacy of the material operated upon, and other circumstances stated in his official report printed by order of the House of Commons, that he did not get entirely extricated from them till nearly two years were expired, nor till he had suffered considerably from anxiety of mind and bodily fatigue. Being advised by his medical friends to try the effects of travelling, with light intellectual exercise, he left London in the latter end of last summer, and spent several months in wandering through the factory districts of Lancashire, Cheshire, Derbyshire, &c., with the happiest results to his health; having everywhere experienced the utmost kindness and liberality from the mill-proprietors. Neither they, nor the great mechanical engineers who construct their buildings and machinery, use any mystery or reserve towards a visitor actuated by legitimate feelings and
principles; but, on the contrary, most readily show and explain the curiously-productive inventions which surround them.

The few individuals who betray jealousy of intelligent inspection are usually vain persons, who, having purloined a few hints from ingenious neighbours, work upon them in secret, shut out every stranger from their mill, get consequently insulated and excluded in return, and thus, receiving no external illumination, become progressively adumbrated; till, after a few years of exclusive operation, they find themselves undersold in the market, and deprived of their oldest or best customers by the inferiority of their goods. Were it not invidious, the author could point out several examples of clever people, having thus outmanœuvred themselves, in trying to steal a march upon their friends in the dark. Mystifiers of this stamp are guilty of the silly blunder of estimating their own intrinsic resources above those of all the world beside. It is, however, not more for the advantage of the kingdom, than for that of every individual manufacturer in it, to receive light from all quarters, and to cause it by reflection to irradiate the sphere around him.

In tracing the progression of the British system of industry, according to which every process peculiarly nice, and therefore liable to injury from the ignorance and waywardness of workmen, is withdrawn from handicraft control, and placed under the guidance of self-acting machinery, the author has made it
his business to study the descriptions of most of the
copyrights of that nature obtained in Great Britain,
France, and America, during the last twenty years,—
a task in which he has been assisted by Messrs.
Newton and Berry, of Chancery-lane, gentlemen de-
servedly esteemed for the soundness of the specifica-
tions which they professionally prepare for patentees.

To James Cook, Esq., of Mincing-lane, he is in-
depted for the extensive assortment of samples of raw
cotton, wool, flax, and silk, which have formed the
principal subjects of his microscopic researches upon
textile fibres, as also for much valuable information on
the statistics of trade.

Nor ought he to leave unacknowledged the polite
readiness of S. M. Phillipps, Esq., Under Secretary of
State, and of Mr. Porter, of the Board of Trade, to
aid his formation of a census of the factory population,
and his inquiries into the commerce of the kingdom.

In delivering this general Treatise on Manufacturing
Industry into the hands of the public, the author is
not unconscious of defects, both in its matter and
arrangement; for most of which, however, an apology
may be found, in the vague and contradictory opinions
entertained by experienced manufacturers on many
departments of their business. Those of his readers
who have most deeply considered the difficulties of
his undertaking will not be the least indulgent.

The body of facts distributed throughout the volume
have been most carefully verified, and will, it is pre-
sumed, bear the strictest scrutiny, though a desire to keep the volume at such a price as would bring its purchase within the reach of working-men has precluded the multiplication of notes of reference to authorities. The main portion of these, indeed, would have been to the reports of Parliamentary Committees; many great folios of which have been diligently consulted in quest of authentic information—though sometimes to little purpose—in consequence of the judgments of even honest men being strangely perverted by passion, prejudice, and self-interest.

The engravings at pages 48, 49, 120, 162, 271, 273, afford specimens of the original drawings of machines made under the author's eye, for illustrating modern manufactures; the complete series of which, when published in his forthcoming works on the cotton trade, dyeing, calico-printing, &c., will, it is hoped, constitute an interesting gallery of practical science.

London, June 18th, 1835.
PHILOSOPHY OF MANUFACTURES.

BOOK THE FIRST.

GENERAL PRINCIPLES OF MANUFACTURES.

CHAPTER I.

General View of Manufacturing Industry.

Manufacture is a word, which, in the vicissitude of language, has come to signify the reverse of its intrinsic meaning, for it now denotes every extensive product of art, which is made by machinery, with little or no aid of the human hand; so that the most perfect manufacture is that which dispenses entirely with manual labour. The philosophy of manufactures is therefore an exposition of the general principles, on which productive industry should be conducted by self-acting machines. The end of a manufacture is to modify the texture, form, or composition of natural objects by mechanical or chemical forces, acting either separately, combined, or in succession. Hence the automatic arts subservient to general commerce may be distinguished into Mechanical and Chemical, according as they modify the external form or the internal constitution of their subject matter. An indefinite variety of objects may be subjected to each system of action, but they

VOL. I.
may be all conveniently classified into animal, vegetable, and mineral.

A mechanical manufacture being commonly occupied with one substance, which it conducts through metamorphoses in regular succession, may be made nearly automatic; whereas a chemical manufacture depends on the play of delicate affinities between two or more substances, which it has to subject to heat and mixture under circumstances somewhat uncertain, and must therefore remain, to a corresponding extent, a manual operation. The best example of pure chemistry on self-acting principles which I have seen, was in a manufacture of sulphuric acid, where the sulphur being kindled and properly set in train with the nitre, atmospheric air, and water, carried on the process through a labyrinth of compartments, and supplied the requisite heat of concentration, till it brought forth a finished commercial product. The finest model of an automatic manufacture of mixed chemistry is the five-coloured calico machine, which continuously, and spontaneously, so to speak, prints beautiful webs of cloth with admirable precision and speed. It is in a cotton mill, however, that the perfection of automatic industry is to be seen; it is there that the elemental powers have been made to animate millions of complex organs, infusing into forms of wood, iron, and brass an intelligent agency. And as the philosophy of the fine arts, poetry, painting, and music may be best studied in their individual master-pieces, so may the philosophy of manufactures in this its noblest creation.

There are four distinct classes of textile fibres, cotton, wool, flax, and silk, which constitute the subjects of four, or, more correctly speaking, five distinct classes
This island is pre-eminent among civilized nations for the prodigious development of its factory wealth, and has been therefore long viewed with a jealous admiration by foreign powers. This very pre-eminence, however, has been contemplated in a very different light by many influential members of our own community, and has been even denounced by them as the certain origin of innumerable evils to the people, and of revolutionary convulsions to the state. If the affairs of the kingdom be wisely administered, I believe such allegations and fears will prove to be groundless, and to proceed more from the envy of one ancient and powerful order of the commonwealth, towards another suddenly grown into political importance than from the nature of things.

In the recent discussions concerning our factories, no circumstance is so deserving of remark, as the gross ignorance evinced by our leading legislators and economists, gentlemen well informed in other respects, relative to the nature of those stupendous manufactures which have so long provided the rulers of the kingdom with the resources of war, and a great body of the people with comfortable subsistence; which have, in fact, made this island the arbiter of many nations, and the benefactor of the globe itself.* Till this ignorance be dispelled, no sound legislation need be expected on manufacturing subjects. To effect this purpose is a principal, but not the sole aim of the present volume,

* Even the eminent statesman lately selected by his Sovereign to wield the destinies of this commercial empire—Sir Robert Peel, who derives his family consequence from the cotton trade, seems to be but little conversant with its nature and condition.—See Dr. Carbutt's observations on the subject, next page.
for it is intended also to convey specific information to the classes directly concerned in the manufactures, as well as general knowledge to the community at large, and particularly to young persons about to make the choice of a profession.

The blessings which physico-mechanical science has bestowed on society, and the means it has still in store for ameliorating the lot of mankind, have been too little dwelt upon; while, on the other hand, it has been accused of lending itself to the rich capitalists as an instrument for harassing the poor, and of exacting from the operative an accelerated rate of work. It has been said, for example, that the steam-engine now drives the power-loom with such velocity as to urge on their attendant weavers at the same rapid pace; but that the hand-weaver, not being subjected to this restless agent, can throw his shuttle and move his treddles at his convenience. There is, however, this difference in the two cases, that in the factory, every member of the loom is so adjusted, that the driving force leaves the attendant nearly nothing at all to do, certainly no muscular fatigue to sustain, while it procures for him good, unfailing wages, besides a healthy workshop gratis: whereas the non-factory weaver, having everything to execute by muscular exertion, finds the labour irksome, makes in consequence innumerable short pauses, separately of little account, but great when added together; earns therefore proportionally low wages, while he loses his health by poor diet and the dampness of his hovel. Dr. Carbutt of Manchester says, "With regard to Sir Robert Peel's assertion a few evenings ago, that the hand-loom weavers are mostly small farmers, nothing can be a greater mistake; they live, or rather they just keep life
together, in the most miserable manner, in the cellars
and garrets of the town, working sixteen or eighteen
hours for the merest pittance.”

The constant aim and effect of scientific improve-
ment in manufactures are philanthropic, as they tend to
relieve the workmen either from niceties of adjustment
which exhaust his mind and fatigue his eyes, or from
painful repetition of effort which distort or wear out
his frame. At every step of each manufacturing pro-
cess described in this volume, the humanity of science
will be manifest. New illustrations of this truth ap-
pear almost every day, of which a remarkable one has
just come to my knowledge. In the woollen-cloth trade
there is a process between carding and spinning the
wool, called *slubbing*, which converts the spongy rolls,
turned off from the cards, into a continuous length of
fine porous cord. Now, though carding and spinning
lie within the domain of automatic science, yet slub-
bbing is a handicraft operation, depending on the skill
of the slubber, and participating therefore in all his
irregularities. If he be a steady, temperate man, he
will conduct his business regularly, without needing to
harass his juvenile assistants, who join together the
series of card rolls, and thus feed his machine; but if
he be addicted to liquor, and passionate, he has it in
his power to exercise a fearful despotism over the
young pieceners, in violation of the proprietor’s benevo-
ment regulations. This class of operatives, who, though
inmates of factories, are not, properly speaking, factory
workers, being independent of the moving power, have
been the principal source of the obloquy so unsparingly

* Letter of 3rd of May, 1833, to Dr. Hawkins in his Medical Report,
cast on the cotton and other factories, in which no such capricious practices or cruelties exist. The wool slubber, when behind hand with his work, after a visit to the beer-shop, resumes his task with violence, and drives his machine at a speed beyond the power of the pieceners to accompany; and if he finds them deficient in the least point, he does not hesitate to lift up the long wooden rod from his slubbing-frame, called a billy-roller, and beat them unmercifully. I rejoice to find that science now promises to rescue this branch of the business from handicraft caprice, and to place it, like the rest, under the safeguard of automatic mechanism. The details of this recent invention will be given in describing the woollen manufacture.

The processes that may be employed, to give to portions of inert matter, precise movements resembling those of organized beings, are innumerable, as they consist of an indefinite number and variety of cords, pulleys, toothed-wheels, nails, screws, levers, inclined-planes, as well as agencies of air, water, fire, light, &c., combined in endless modes to produce a desired effect. Ingenuity has been long exercised on such combinations, chiefly for public amusement or mystification, without any object of utility. In ancient times the statue of Memnon was celebrated for emitting harmonious sounds at sun-rise, and acted probably by concealed organ-pipes. The flying pigeon of Archytas was more manifestly an automatic mechanism, as it performed all the motions of an animal; and likewise the Android of Albert the Great, which opened a door when any one knocked, and muttered certain sounds, as if speaking to the visitor. The brass heads, or conversible busts of Abbé Mical, were probably a simple
silk so long ago as 1749; one for doubling and twisting it in 1751; a tapestry loom in 1758; another for winding silk in 1770; a machine for laminating stuffs in 1757, and a plan of mounting silk-mills in 1776. There can be no doubt as to the value of these inventions, as they were described with merited eulogiums in the above named years by the Academy of Paris. In 1776 he published an account of the Indian mode of weaving fine muslins in the wet state, showing that his attention had been turned likewise to the cotton trade.

The term Factory, in technology, designates the combined operation of many orders of work-people, adult and young, in tending with assiduous skill a system of productive machines continuously impelled by a central power. This definition includes such organizations as cotton-mills, flax-mills, silk-mills, woollen-mills, and certain engineering works; but it excludes those in which the mechanisms do not form a connected series, nor are dependent on one prime mover. Of the latter class, examples occur in iron-works, dye-works, soap-works, brass-foundries, &c. Some authors, indeed, have comprehended under the title factory, all extensive establishments wherein a number of people co-operate towards a common purpose of art; and would therefore rank breweries, distilleries, as well as the workshops of carpenters, turners, cooperers, &c., under the factory system. But I conceive that this title, in its strictest sense, involves the idea of a vast automatou, composed of various mechanical and intellectual organs, acting in uninterrupted concert for the production of a common object, all of them being subordinated to a self-regulated moving
force. If the marshalling of human beings in systematic order for the execution of any technical enterprise were allowed to constitute a factory, this term might embrace every department of civil and military engineering; a latitude of application quite inadmissible.

In its precise acceptance, the Factory system is of recent origin, and may claim England for its birthplace. The mills for throwing silk, or making organzine, which were mounted centuries ago in several of the Italian states, and furtively transferred to this country by Sir Thomas Lombe in 1718, contained indeed certain elements of a factory, and probably suggested some hints of those grander and more complex combinations of self-acting machines, which were first embodied half a century later in our cotton manufacture by Richard Arkwright, assisted by gentlemen of Derby, well acquainted with its celebrated silk establishment. But the spinning of an entangled flock of fibres into a smooth thread, which constitutes the main operation with cotton, is in silk superfluous; being already performed by the unerring instinct of a worm, which leaves to human art the simple task of doubling and twisting its regular filaments. The apparatus requisite for this purpose is more elementary, and calls for few of those gradations of machinery which are needed in the carding, drawing, roving, and spinning processes of a cotton-mill.

When the first water-frames for spinning cotton were erected at Cromford, in the romantic valley of the Derwent, about sixty years ago, mankind were little aware of the mighty revolution which the new system of labour was destined by Providence to achieve, not only in the structure of British society, but in the for-
tunes of the world at large. Arkwright alone had the sagacity to discern, and the boldness to predict in glowing language, how vastly productive human industry would become, when no longer proportioned in its results to muscular effort, which is by its nature fitful and capricious, but when made to consist in the task of guiding the work of mechanical fingers and arms, regularly impelled with great velocity by some indefatigable physical power. What his judgment so clearly led him to perceive, his energy of will enabled him to realize with such rapidity and success, as would have done honour to the most influential individuals, but were truly wonderful in that obscure and indigent artisan. The main difficulty did not, to my apprehension, lie so much in the invention of a proper self-acting mechanism for drawing out and twisting cotton into a continuous thread, as in the distribution of the different members of the apparatus into one co-operative body, in impelling each organ with its appropriate delicacy and speed, and above all, in training human beings to renounce their desultory habits of work, and to identify themselves with the unvarying regularity of the complex automaton. To devise and administer a successful code of factory discipline, suited to the necessities of factory diligence, was the Herculean enterprise, the noble achievement of Arkwright. Even at the present day, when the system is perfectly organized, and its labour lightened to the utmost, it is found nearly impossible to convert persons past the age of puberty, whether drawn from rural or from handicraft occupations, into useful factory hands. After struggling for a while to conquer their listless or restive habits, they either renounce the employment sponta-
neously, or are dismissed by the overlookers on account of inattention.

If the factory Briareus could have been created by mechanical genius alone, it should have come into being thirty years sooner; for upwards of ninety years have now elapsed since John Wyatt, of Birmingham, not only invented the series of fluted rollers, (the spinning fingers usually ascribed to Arkwright,) but obtained a patent for the invention, and erected "a spinning engine without hands" in his native town. The details of this remarkable circumstance, recently snatched from oblivion, will be given in our Treatise on the Cotton Manufactures. Wyatt was a man of good education, in a respectable walk of life, much esteemed by his superiors, and therefore favourably placed, in a mechanical point of view, for maturing his admirable scheme. But he was of a gentle and passive spirit, little qualified to cope with the hardships of a new manufacturing enterprise. It required, in fact, a man of a Napoleon nerve and ambition, to subdue the refractory tempers of work-people accustomed to irregular paroxysms of diligence, and to urge on his multifarious and intricate constructions in the face of prejudice, passion, and envy. Such was Arkwright, who, suffering nothing to stay or turn aside his progress, arrived gloriously at the goal, and has for ever affixed his name to a great era in the annals of mankind, an era which has laid open unbounded prospects of wealth and comfort to the industrious, however much they may have been occasionally clouded by ignorance and folly.

Prior to this period, manufactures were everywhere feeble and fluctuating in their development; shooting forth luxuriantly for a season, and again
withering almost to the roots, like annual plants. Their perennial growth now began in England, and attracted capital in copious streams to irrigate the rich domains of industry. When this new career commenced, about the year 1770, the annual consumption of cotton in British manufactures was under four millions of pounds weight, and that of the whole of Christendom was probably not more than ten millions. Last year the consumption in Great Britain and Ireland was about two hundred and seventy millions of pounds, and that of Europe and the United States together four hundred and eighty millions. This prodigious increase is, without doubt, almost entirely due to the factory system founded and upreared by the intrepid native of Preston. If then this system be not merely an inevitable step in the social progression of the world, but the one which gives a commanding station and influence to the people who most resolutely take it, it does not become any man, far less a denizen of this favoured land, to vilify the author of a benefaction, which, wisely administered, may become the best temporal gift of Providence to the poor, a blessing destined to mitigate, and in some measure to repeal, the primeval curse pronounced on the labour of man, "in the sweat of thy face shalt thou eat bread." Arkwright well deserves to live in honoured remembrance among those ancient master-spirits, who persuaded their roaming companions to exchange the precarious toils of the chase, for the settled comforts of agriculture.

In my recent tour, continued during several months, through the manufacturing districts, I have seen tens of thousands of old, young, and middle-aged of both sexes, many of them too feeble to get their daily bread
by any of the former modes of industry, earning abundant food, raiment, and domestic accommodation, without perspiring at a single pore, screened meanwhile from the summer's sun and the winter's frost, in apartments more airy and salubrious than those of the metropolis, in which our legislative and fashionable aristocracies assemble. In those spacious halls * the benignant power of steam summons around him his myriads of willing menials, and assigns to each the regulated task, substituting for painful muscular effort on their part, the energies of his own gigantic arm, and demanding in return only attention and dexterity to correct such little aberrations as casually occur in his workmanship. The gentle docility of this moving force qualifies it for impelling the tiny bobbins of the lace-machine with a precision and speed inimitable by the most dexterous hands, directed by the sharpest eyes. Hence, under its auspices, and in obedience to Arkwright's polity, magnificent edifices, surpassing far in number, value, usefulness, and ingenuity of construction, the boasted monuments of Asiatic, Egyptian, and Roman despotism, have, within the short period of fifty years, risen up in this kingdom, to show to what extent, capital, industry, and science may augment the resources of a state, while they meliorate the condition of its citizens. Such is the factory system, replete with prodigies in mechanics and political economy, which promises, in its future growth, to become the great minister of civilization to the terraqueous globe, enabling this country, as its heart, to diffuse along with its commerce, the life-blood of science and religion to myriads

* See the engraving at the end of the volume.
of people still lying "in the region and shadow of death."

When Adam Smith wrote his immortal elements of economics, automatic machinery being hardly known, he was properly led to regard the division of labour as the grand principle of manufacturing improvement; and he showed, in the example of pin-making, how each handicraftsman, being thereby enabled to perfect himself by practice in one point, became a quicker and cheaper workman. In each branch of manufacture he saw that some parts were, on that principle, of easy execution, like the cutting of pin wires into uniform lengths, and some were comparatively difficult, like the formation and fixation of their heads; and therefore he concluded that to each a workman of appropriate value and cost was naturally assigned. This appropriation forms the very essence of the division of labour, and has been constantly made since the origin of society. The ploughman, with powerful hand and skilful eye, has been always hired at high wages to form the furrow, and the ploughboy at low wages, to lead the team. But what was in Dr. Smith's time a topic of useful illustration, cannot now be used without risk of misleading the public mind as to the right principle of manufacturing industry. In fact, the division, or rather adaptation of labour to the different talents of men, is little thought of in factory employment. On the contrary, wherever a process requires peculiar dexterity and steadiness of hand, it is withdrawn as soon as possible from the cunning workman, who is prone to irregularities of many kinds, and it is placed in charge of a peculiar mechanism, so self-regulating, that a child may superintend it. Thus,—to
take an example from the spinning of cotton—the first operation in delicacy and importance, is that of laying the fibres truly parallel in the spongy slivers, and the next is that of drawing these out into slender spongy cords, called rovings, with the least possible twist; both being perfectly uniform throughout their total length. To execute either of these processes tolerably by a hand-wheel, would require a degree of skill not to be met with in one artisan out of a hundred. But fine yarn could not be made in factory-spinning except by taking these steps, nor was it ever made by machinery till Arkwright's sagacity contrived them. Moderately good yarn may be spun indeed on the hand-wheel without any drawings at all, and with even indifferent rovings, because the thread, under the two-fold action of twisting and extension, has a tendency to equalize itself.

The principle of the factory system then is, to substitute mechanical science for hand skill, and the partition of a process into its essential constituents, for the division or graduation of labour among artisans. On the handicraft plan, labour more or less skilled, was usually the most expensive element of production—*Materiam superabat opus*; but on the automatic plan, skilled labour gets progressively superseded, and will, eventually, be replaced by mere overlookers of machines.

By the infirmity of human nature it happens, that the more skilful the workman, the more self-willed and intractable he is apt to become, and, of course, the less fit a component of a mechanical system, in which, by occasional irregularities, he may do great damage to the whole. The grand object therefore of the modern manufacturer is, through the union of capital and
science, to reduce the task of his work-people to the exercise of vigilance and dexterity,—faculties, when concentrated to one process, speedily brought to perfection in the young. In the infancy of mechanical engineering, a machine-factory displayed the division of labour in manifold gradations—the file, the drill, the lathe, having each its different workmen in the order of skill: but the dexterous hands of the filer and driller are now superseded by the planing, the key-groove cutting, and the drilling-machines; and those of the iron and brass turners, by the self-acting slide-lathe. Mr. Anthony Strutt, who conducts the mechanical department of the great cotton factories of Belper and Milford, has so thoroughly departed from the old routine of the schools, that he will employ no man who has learned his craft by regular apprenticeship; but in contempt, as it were, of the division of labour principle, he sets a ploughboy to turn a shaft of perhaps several tons weight, and never has reason to repent his preference, because he infuses into the turning apparatus a precision of action, equal, if not superior, to the skill of the most experienced journeyman.

An eminent mechanician in Manchester told me, that he does not choose to make any steam-engines at present, because with his existing means, he would need to resort to the old principle of the division of labour, so fruitful of jealousies and strikes among workmen; but he intends to prosecute that branch of business whenever he has prepared suitable arrangements on the equalization of labour, or automatic plan. On the graduation system, a man must serve an apprenticeship of many years before his hand and eye become skilled enough for certain mechanical feats;