

*Orren's Cotton Factory, Stockport.*

THE  
PHILOSOPHY OF MANUFACTURES :  
OR,  
AN EXPOSITION  
OF THE  
SCIENTIFIC, MORAL, AND COMMERCIAL ECONOMY  
OF THE  
FACTORY SYSTEM  
OF  
Great Britain.

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☞ 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 11*s.*, 10*s.*, 5*s.* 8*d.*, 4*s.* 5*d.*, 4*s.*, 3*s.* 6*d.*, 2*s.* 6*d.*

ERRATA.—Page 291, line 7, for “Of” read “On.”  
 „ 383, line 7, for “wires” read “wings.”

## P R E F A C E.

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 visiter 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 patents 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 deservedly esteemed for the soundness of the specifications which they professionally prepare for patentees.

To James Cook, Esq., of Mincing-lane, he is indebted 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.

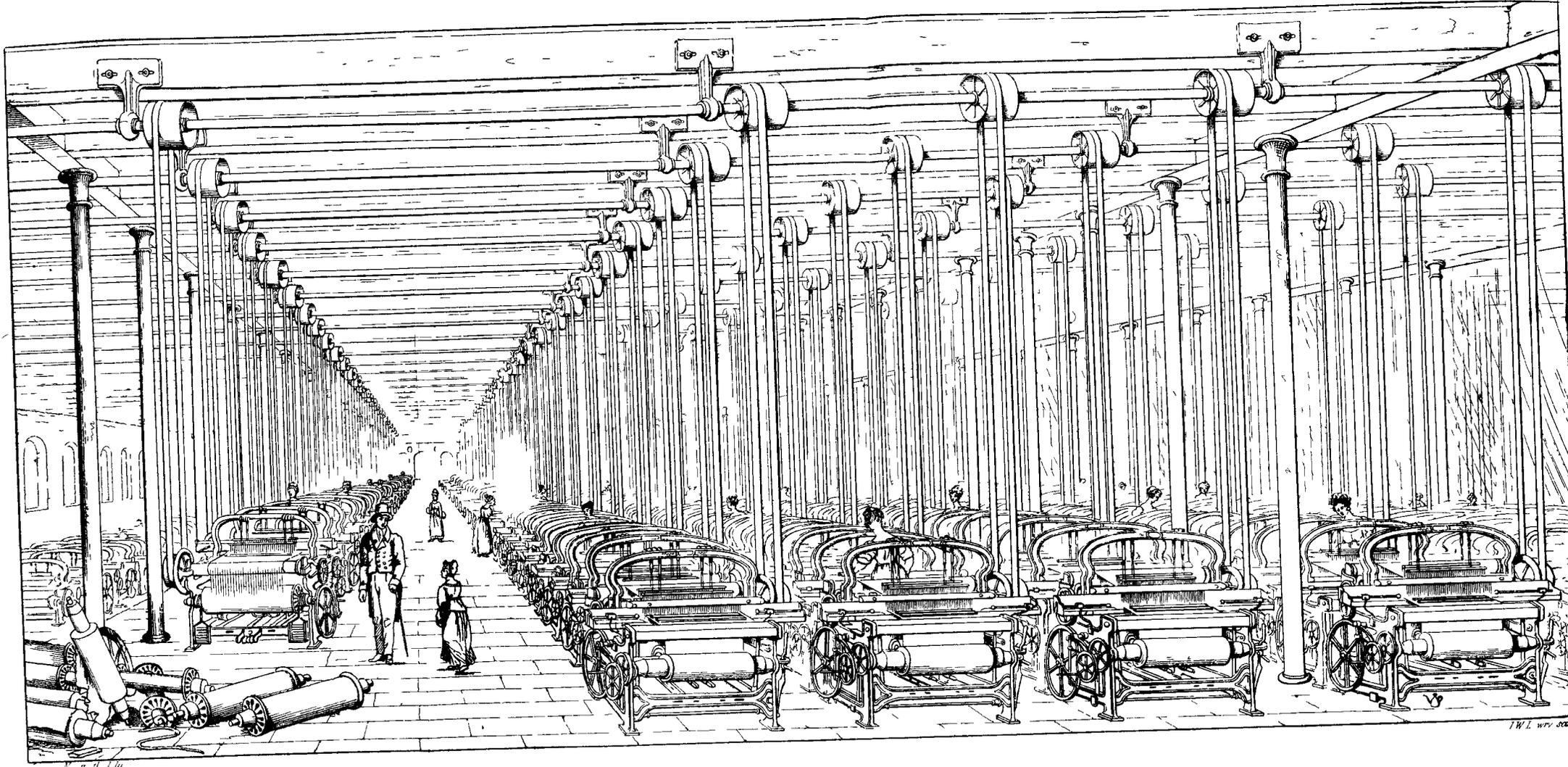
In delivering this general Treatise on Manufacturing Industry into the hands of the public, the author is not unconscious of defects, both in its matter and arrangement; for most of which, however, an apology may be found, in the vague and contradictory opinions entertained by experienced manufacturers 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.*



POWER LOOM FACTORY OF THOMAS ROBINSON ESQ<sup>R</sup>  
STOCKPORT.

# PHILOSOPHY OF MANUFACTURES.

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BOOK THE FIRST.

## GENERAL PRINCIPLES OF MANUFACTURES.

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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

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

of factories; first, the cotton factories; second, the woollen; third, the worsted; fourth, the flax, hempen, or linen; and fifth, the silk. These five factories have each peculiarities proceeding from the peculiarities of its raw material and of its fabrics; but they all possess certain family features, for they all employ torsion to convert the loose slender fibres of vegetable or animal origin into firm coherent threads, and, with the exception of silk, they all employ extension also to attenuate and equalize these threads, technically styled yarn. Even one kind of silk which occurs in entangled tufts, called floss, is spun like cotton, by the simultaneous action of stretching and twisting.

The above-named five orders of factories are, throughout this kingdom, set in motion by steam-engines or water-wheels; they all give employment to multitudes of children or adolescents; and they have therefore been subjected to certain legislative provisions, defined in the *Factories Regulation Act*, passed by Parliament on the 29th August, 1833.

It is probable that 614,200 work-people are constantly engaged within the factories of the United Kingdom: of which number 561,900 belong to England and Wales; 46,825 to Scotland; and 5,475 to Ireland.\* Fully five-tenths of them are under twenty-one years of age, and three tenths of these young persons are females. It must be remembered, however, that besides these 614,200 inmates of factories, a vast population

\* The above numbers for Scotland and Ireland are taken from Mr. Leonard Horner's excellent Report as Factory Inspector; the number for England is computed on the recognized *datum* that it is twelve times greater for the cotton trade than that of Scotland. For the last official details see the Appendix.

derives a livelihood from the manufactures of cotton, wool, flax, and silk, such as the hand-weavers, the calico-printers and dyers, the frame-work knitters, the lace-makers, lace-runners, muslin-sewers, &c. &c.

It appears from the Parliamentary Returns of 1831, that in Great Britain, out of a total population of 16,539,318 persons, there are of

Agricultural Labourers and Labour-  
ing Occupiers .....1,055,982, and of

Manufacturing Labourers .....404,317

Whence there are 1000 agricultural to 383 strictly manufacturing labourers.

Persons employed in retail trade, or  
in handicraft, as masters or work-  
men .....1,159,867

Total adult persons employed in arts  
and trades .....1,564,184, being  
about fifty per cent. more than those engaged in agri-  
culture.

The capitalists, bankers, professional  
and other educated men amount to 214,390  
Labourers non-agricultural to .....618,712

If we include in the agricultural de-  
partment, the occupiers employing  
labourers (few of whom, however,  
work), we shall have to add .....187,075  
to the above number .....1,055,057

The total sum of Agriculturists is 1,243,057, being  
only 80 per cent. of the adult males employed in manu-  
factures, arts, and trades.

When we take into account the vastly greater propor-  
tion of young persons constantly occupied with factory  
labour, than of those occupied with agricultural labour,  
we shall then be led to conclude that at least double  
the amount of personal industry is engaged in the arts,  
manufactures, and trade, to what is engaged in agricul-  
ture. Considerably upwards of one-tenth of the popu-  
lation of this island is actually employed in manu-  
factures; and probably little more than one-fifteenths  
in agriculture. This conclusion ought to lead our legis-  
lative landlords to treat the manufacturing interests  
with greater respect than they have usually been accus-  
tomed to do. If we consider, moreover, how much  
greater a mass of productive industry a male adult is  
equivalent to, in power-driven manufactures, than in  
agriculture, the balance in favour of the former will be  
greatly enhanced.

France, which has for upwards of a century and a half  
tried every scheme of public premium to become a great  
manufacturing country, has a much less proportion  
than one employed in trade for two employed in agri-  
culture. M. Charles Dupin, indeed, has been led by  
his researches into the comparative industry of France  
and of the United Kingdom, to conclude that the  
agricultural produce of our country amounted in value  
to 240 millions sterling, and that of his own to 180  
millions sterling, being the ratio of three to two;  
and that our manufacturing power is inferior to that  
of France in the proportion of sixty-three to seventy-  
two; or as seven to eight. There can be no doubt  
that his agricultural estimate underrates France, as  
much as his manufacturing estimate underrates Great  
Britain.

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-looms 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















































































































































































































































































































































































































































































