

JOHN HANDSLEY DALES

A Manual of
Mechanical Drawing

A MANUAL
OF
MECHANICAL DRAWING

BY

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INTRODUCTION

MECHANICAL DRAWING is an art and craft the importance of which in the present day it would be difficult to overestimate. It would be scarcely too much to say that, without it, civilized life as it now exists would very shortly come to a standstill. In this mechanical age it has become indispensable as part of a productive system, and has a definite commercial value. It has this position, apart from its connection with Theoretical Mechanics, as a necessary feature in economic production. Indirect methods are no longer commercially admissible; every piece of work of any importance whatever begins on paper, and on the accuracy and sufficiency of what the paper shows the efficiency of the mechanism depicted there depends.

Good mechanical drawing is in itself a powerful assistance in *design*. In addition to its primary object as an accurate representation of the ideas of the designer, it presents a practical trial of the feasibility of the collective action of the parts represented. The greater part of ordinary machine design, where rigidity and practicability are the main desiderata, is produced by the showing of the drawing only, the drawing exhibiting to the judgment of the draughtsman all those elements to which mathematical considerations are not practically applicable. No complex mechanism can be designed and produced on modern lines, with complete conformability, without the aid of high grade mechanical drawing.

Scale drawing, while primarily intended for producing representations of structures in convenient sizes for drawing, handling and storing, is equally necessary to the proportionate design of all objects, which in their natural size are too large or too small to come within the field of view of the eye at the range of clear collective vision. This is especially the case where there are little or no data for mathematical calculation.

The whole of the modern necessities of mechanical production demand accurate linear drawing, displayed and explained by conventional methods, which are common knowledge to all concerned. Collectively, these constitute an important and indispensable craft, apart from any connection with abstract science, a craft which has to be acquired by labour, care and diligence. This is most readily accomplished by making it a separate study in the early stages of Engineering training; and that period is most suitable, also, because this kind of skill is a powerful assistance to the progress of every other branch of work or study which is involved in such a training.

It should also be noted that, while special aptitude is of course always a valuable asset, it is no general substitute for the necessity of studying and practising of conventional methods and expressions, and that it is therefore necessary to go through an organized training in these.

The object of this book is the systematic cultivation of high class mechanical line making, and its application as a necessary adjunct to mechanical work production by those methods and expressions which are used and understood in the drawing offices and works of Engineering firms. To this end the early part of this work is devoted

to a rigid progressive disciplinary course, which by experience has been proved to be a direct means to the end of producing accurate drawing. Later, exercises in ordinary objects are introduced, and, finally, sets of drawings for complete machines provide training in drawing office practice.

The student is specially advised to spare no pains in attaining the highest possible skill in accuracy and finish at this stage, for the most important reason, that the most skilful junior is given the best work in an office, and that he has in consequence the best opportunities available for making progress and position in his profession.

An important feature of the system here adopted is that manipulative skill is acquired in a manner which admits of the concentration of the whole mental energy of the student on the acquirement of that skill, and entails no effort in understanding the figures themselves until after the time when he is well able to execute line drawing.

The artizan mechanic apprentice is advised to practise the exercises and system of this book from the beginning of his shop career, so that he will be able at the end of his first three years to change over to the drawing office should he desire to do so without any diminution, and probably some increase, of his apprentice wages. By reasonable industry he will thus be able to widen the outlook of his future career as well as to lay a solid foundation for high scientific attainments, and eventually be able to reap the full benefits of his work.

J. H. D.

June, 1914.

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MECHANICAL DRAWING

CHAPTER I

The scope of mechanical drawing is not necessarily confined to the delineation of machinery, as it is both useful and necessary in any branch of constructional art where accuracy is required.

The principal aim of the student of this branch of engineering craft should be absolute accuracy in position of his lines, and clear and full description by dimensions and notes of what the lines represent. Nothing at all should be left to the imagination of the workman, whose business is solely to carry out the shewing of the drawing in the materials of construction. The drawing should be measurable at every point by a scale corresponding, and the dimensioning should correspond to the drawing both locally and collectively; the dimensioning should be regarded more as a convenience in reading off sizes and distances than as any substitute for inaccuracies of drawing. The drawing should be a check on the dimensions, and the dimensions a check on the drawing.

For the attainment of that manipulative exactness which is needed, all the apparatus and implements

which are used should be of the best quality obtainable and of such patterns and make as will make the production of exact work a possibility, with ordinary care and commercial expedition. Patterns which are difficult to handle, or which require both hands instead of one for adjustment in working, or in any way are less convenient than such things can be made, are quite inadmissible and are not in any circumstances to be used, as they are eventually a handicap on the draughtsman's means of getting a living, and are dear at any price. Inferior implements tend to produce bad habits in manipulation which are difficult to get rid of when once acquired. The apparatus and instruments are the tools of his craft, and the cost of the best is a negligible item in the value of the work which is produced by their use. No man in competition can afford to work under any heavier handicap than his competitor.

All mechanical drawings, or nearly all, contain work of a great variety of difficulty, some parts being relatively easy to the beginner, and other parts of a degree of difficulty sufficient to tax the skill of an accomplished draughtsman. This variety has always prevented the student from making any satisfactory progress in his work of copying drawings of mechanical objects for practice for a considerable length of time, as nothing collectively passable could be done until the more difficult minutiae were mastered; and these occurring only seldom in the figures, and therefore affording relatively little practice, a very large amount of waste labour has had to be expended in repetitions under the old system of teaching before sufficient proficiency for practical purposes could be attained. In order to get over these difficulties and expedite the rate of progress in the early stages of

study, the author some years ago devised a series of progressive exercises in the use of scales and instruments which have invariably shortened the time for acquiring manipulative skill, from twelve months to three months, and in cases of exceptional aptitude to even much less than the latter time. This is a very important matter in many ways. The saving of time is great, and especially valuable at a student's time of life; but the saving of patience and avoiding of vexatious and repeated failures to execute the more difficult parts of an ordinary object drawing, and thus repeatedly wasting the whole, are perhaps even more important. Many students under the old system have given up the attempt to become good draughtsmen, and many more have lapsed into loose ways of finish which have never left them.

LINE EXERCISES.

The Exercises, which form part of this work, are arranged to give a large amount of practice in each stage on small sheets of paper, so that those containing irremediable "slips" can be destroyed and a fresh start made without much loss of either time, patience, or material. They develop a sufficient skill for object drawing before such work is attempted, and at the same time a skill in the minutiae which is altogether superior to that which is usually acquired under the old system. Also these exercises entail no mental effort in the understanding of the figures, and so leave the whole mental energy available for concentration on the manipulation. This is important, and adds to the rate of progress in skill. The repetitions also provide opportunity for the student to "experiment" with the instruments, and so to find out what they will do and what they will not do. The teacher's

work in the opening stages of this study is very much less than under the old system, as the simple use of the scale and an examination of the quality of the lines are all that it is necessary for him to do while work on the exercises is going on, and he can consequently give efficient supervision to larger classes.

CHAPTER II

APPARATUS AND MATERIALS FOR DRAWING

DRAWING BOARD.

Among the apparatus and instruments which are employed in mechanical drawing, the drawing-board is the first to be considered. This is a perfectly rectangular board, made of the best yellow pine, about 1 inch in thickness. It is grooved at the back and stayed with oak or mahogany cross-pieces or clamps for preventing skellering or twisting from damp and changes of temperature, which would spoil the flatness of the working side. The sizes are such as are required for the paper drawn upon; but in drawing offices the most common size in use is that which corresponds with the "double elephant" size of paper, which is 40 inches long by 27 inches wide, the boards being made 42 inches by 28 inches. This size is as large as the draughtsman can reach over comfortably, but in some offices 60 by 30-inch boards are used. For special purposes some are even larger.

Wherever there is room for its use, it is advisable that all drawing practice should be done on the regular