CoA. Note No. 154

POST NUBES LUX

THE COLLEGE OF AERONAUTICS
CRANFIELD

TEACHING MACHINES FOR TEACHING WORK STUDY

by

H. C. Wiltshire

NOTE NO. 154

MAY, 1963

THE COLLEGE OF AERONAUTICS

CRANFIELD

Teaching machines for teaching Work Study

- by -

H.C. Wiltshire, M.Sc., M.I.Mech.E., M.I.E.E., M.B.I.M.

CORRIGENDUM

Page 3. Last paragraph, line 13 should read: 'was connected to several recorders, thus permitting group instruction'.

NOTE NO. 154

MAY, 1963.

THE COLLEGE OF AERONAUTICS

CRANFIELD

TEACHING MACHINES FOR TEACHING WORK STUDY

- by -

H.C. Wiltshire, M.Sc., M.I.Mech.E., M.I.E.E., M.B.I.M.

SUMMARY

Machines which have been used successfully for the teaching of work measurement practices are described. Although designed to shorten the period of instruction for beginners, they appear to be suitable for postgraduate students and also for management - consultant trainees.

Contents

Introduction

The function of a work study practitioner is to study the work of others, and little consideration seems to have been given to the investigation of the activities of the practitioner himself. To acquire a thorough competence in the practice of work study techniques, there seems to be no better alternative than experience in the actual working environment, but it is the author's view that, in the earlier stages, the use of particular forms of teaching machines not only shortens the time of the learning process, but also facilitates the correction of errors.

The teaching machines to be described were constructed, and used by the author, at Cranfield and relate to the teaching of work measurement, one of the most important aspects of work study. These machines were constructed in 1952, before the publications of Skinner, Goodman and Pask[1-4], and they would now be described as linear programmed machines; branching programmes[5] are not considered necessary for this particular purpose. Programming is effected by a series of films giving examples of progressive difficulty.

Standard work measurement practice

The standard practice of measuring work of a repetitive nature[6] is to divide the whole job under study into a series of elements. Throughout the study, the time of each element is measured by a stop watch and recorded. Simultaneously the performance is assessed for each element and the performance rating is recorded by the practitioner at the end of each element. The product of the elemental time and the corresponding performance rating gives the corrected or basic time of the element. With a skilled practitioner, the basic time obtained in this manner should be the same, or very approximately the same, for operators performing the same operation at different output rates.

Two teaching machines were made which were of quite different construction from each other, one for teaching accurate timing and the other for teaching rating. The principle underlying the use of two separate machines is one which is now generally accepted, viz. that the learning process can be shortened if proficiency is acquired separately in each section of the task. The subsequent combination of the two skills is then comparatively easy to achieve.

Description of machines

(A) Timing teaching machine

The accurate timing of elements in a study by the use of a flick back stop watch requires appreciable skill, particularly when the elements have to be of short duration. Furthermore, the total of all recorded element times should equal the total elapsed time of the study. A variation of not more than ± 2% is considered permissible in general study work.

The teaching machine comprises essentially a 16 millimetre film strip, moving continuously at constant speed. The film strip used was exposed black film obtained from the film manufacturers, and was quite inexpensive. On this film were marked thin white horizontal lines, spaced at varying distances. These markings were labelled, El.1, El.2, etc., to simulate the time intervals in a study. The film was driven at a constant speed by a small synchronous motor connected to the supply mains. On the vertical support, a prominent white line was marked and the learner was instructed to observe and record the time interval occurring when each of the elemental markings on the film coincided with the prominent white line on the support.

In one form of using this machine, the learners were grouped around the machine and a supervisor checked that they were fixing their attention on the white line (simulating the position of a working operator) and not looking at the watches for longer than was necessary to observe the elemental times. It was considered important, in the design of this machine, to permit the learner to see a fairly long length of film, as this more closely simulated the actual conditions where the end of an element is perceived to be gradually approaching. Any form of instantaneous flash, indicating a break point, is considered to be poor simulation.

The progress of the learner can easily be checked, as the time intervals programmed on the film are known exactly. Furthermore, the sum of the learner's stop watch recordings can be compared with the actual time taken to run through the whole length of film (representing the total elapsed time of a study). For a beginner, errors amounting to 15% of the total elapsed time were noted, which, after some practice, were reduced to 2%. In one special case, where further practice was requested, without any supervision, the error was reduced to less than 1%.

Several film strips were prepared with differently spaced markings, in such a way as to present varying degrees of difficulty in maintaining the accuracy of stop watch recordings. The machine was also fitted with a reversing switch to permit rewinding of the film. This machine is illustrated in Fig. 1.

B. <u>The rating teaching machine</u>

(a) <u>Design principles</u>

The design of the rating teaching machine was based on the following principles.

(i) Errors made during the learning process should be made clear to the learner.

(ii) Errors should be corrected by the learner.

(iii) Awareness and corrections of errors should be made as soon as possible after the errors have been made.

(iv) Progress should be capable of being recorded.

The technique of rating has been generally taught by means of motion picture films depicting industrial operation being carried out at various performance levels. A standard performance is usually included and the learner is instructed to assess the value of the various performances. After the film session has finished, the learner's assessments are compared with the programmed assessment. Usually some considerable time elapses between the assessment and the correction. With the teaching machine to be described, the corrections are made within 2 or 3 secs. of the errors being made.

(b) Description of machine

The machine comprises two individual rating boxes, and a recorder. The two rating boxes are identical in construction, one being used by the instructor and the other by the learner. Each rating box is fitted with a vertical spindle, terminating at the top in a knob and a pointer. Concentric with the spindle is fixed a scale, graduated in terms of performance ratings. The spindle is connected mechanically to a magslip which sends input currents into the recorder.

Assessments of rating are made by rotating the spindle until the pointer indicates the assessed value on the same. By turning the spindles, both learner and supervisor send input currents to the recorder. The recorder, which comprises another magslip of the hunter type, is constructed so as to record, by means of a stylus, the difference of the angular settings of the spindles. This difference is recorded on a continuously moving paper strip, and the recording equipment is so adjusted that when the angular rotations of the instructor's and learner's spindles are equal, a straight line is drawn down the centre of the moving paper strip.

The paper strip is moved continuously, and at constant speed, by a small electric motor, and the recording stylus indicates the magnitude and direction of the error made by the learner, who, by occasionally glancing down at the paper strip, immediately corrects his error, restoring the stylus recording to the centre of the paper strip. It was found advisable to shield about 2" of the paper strip from the stylus so that the learner was unable to see a change of ratings made by the instructor, until a few seconds after it had been made. This was considered necessary to obviate any tendency of the learner to cheat the machine by watching the stylus all the time instead of assessing the performance. The recordings on the paper strip give very good indications of the learner's progress. In practice, the instructor's rating box was connected to several recordings, thus permitting group instruction. A convenient feature of the equipment was the mounting of two recorders in one cabinet, a learner being seated on each side of the cabinet.

It must be pointed out that the principles used in this machine could be applied in other and less expensive forms, but the author used the equipment which was readily available at the time and which was comparatively inexpensive surplus war stock. For this reason, the next stage of making the machine fully automatic was postponed, although there should be no great difficulty in applying the appropriate rotary motion to the instructor's spindle corresponding to the changes in rating assessment as given in the motion picture films.

Group instruction using these machines is illustrated in Fig. 2. Fig. 3 illustrates a rating box, while Fig. 4 shows the paper strip recordings. The diagram of connections of the magslip and hunter is given in Fig. 5.

References

1. Skinner, B.F. The science of learning and the art of teaching. Harvard Educ. Rev., Vol. 24, pp. 86-97.

2. Skinner, B.F. Teaching machines. Science, Vol. 128, 1958, pp. 969-977.

3. Goodman, R. Programmed learning and teaching machines. E.U.P. 1962.

4. Pask, G. An approach to cybernetics. Hutchinson, 1962.

5. Crowder, N.A. Automatic tutoring by intrinsic programming. In Lumsdaine and Glaser, eds. Teaching machines and programmed learning. National Educ. Assoc. of the U.S., 1960.

6. Currie, R.M. Work study. Pitman, 1959. pp. 113-141.

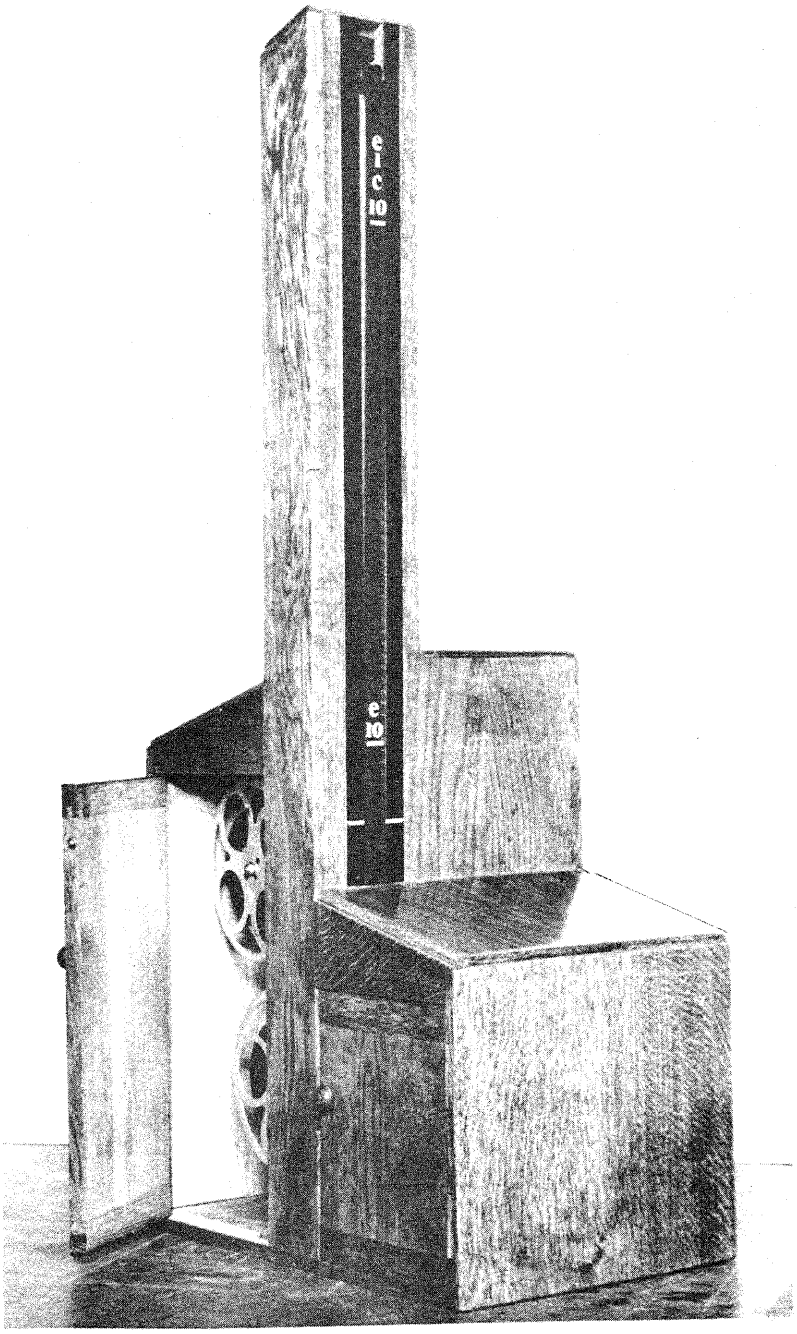

FIG. 1

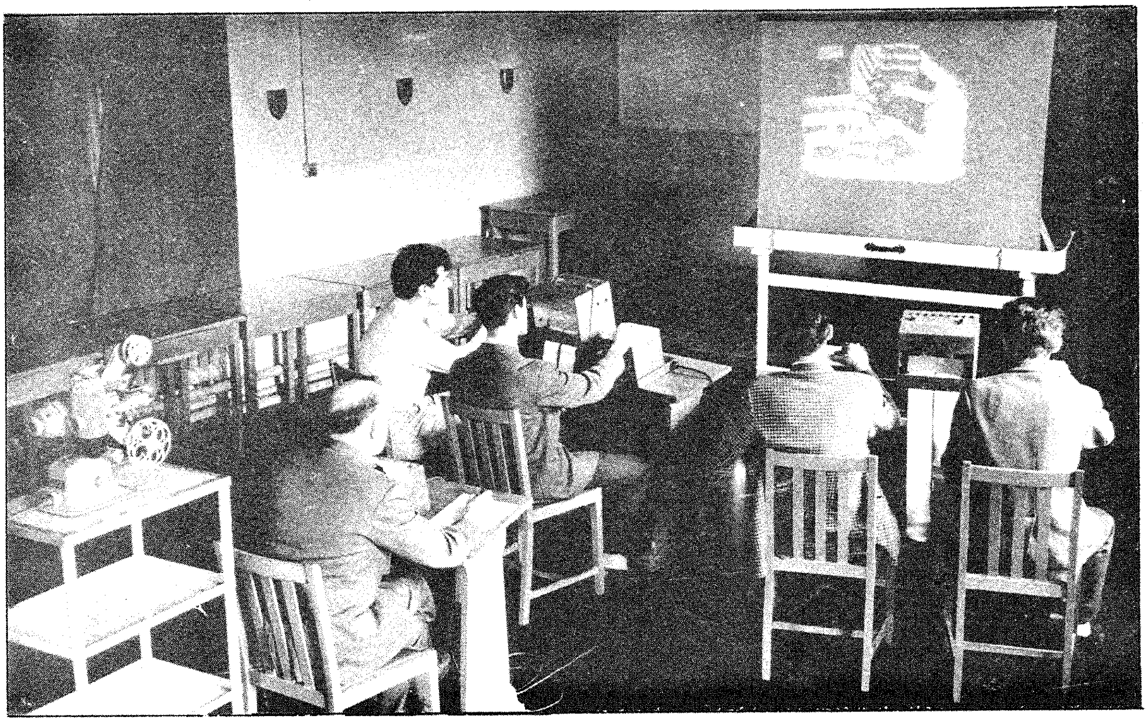

FIG. 2.

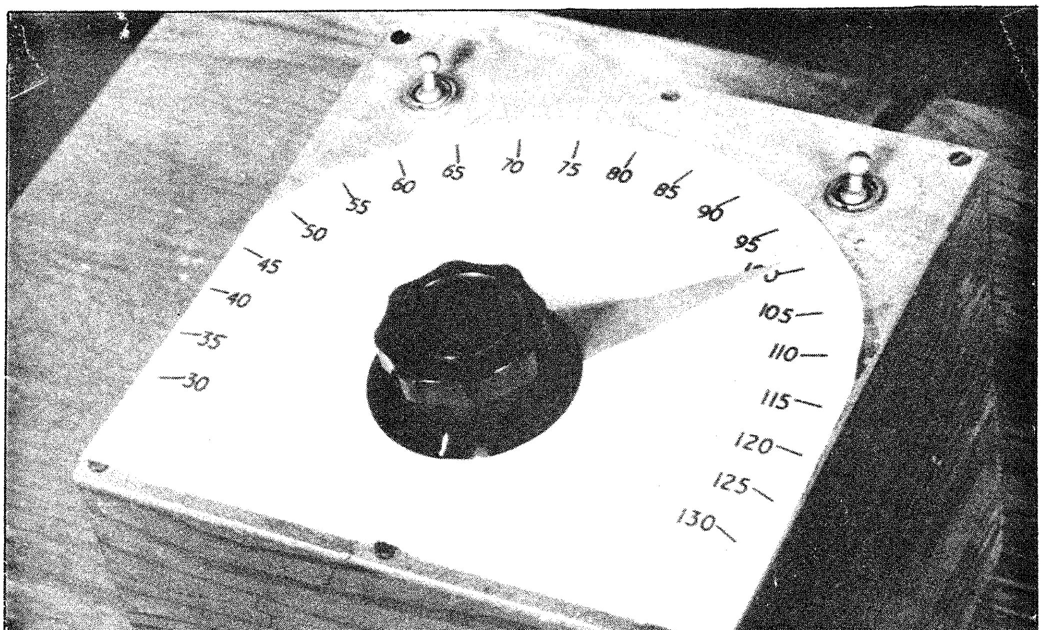

FIG. 3.

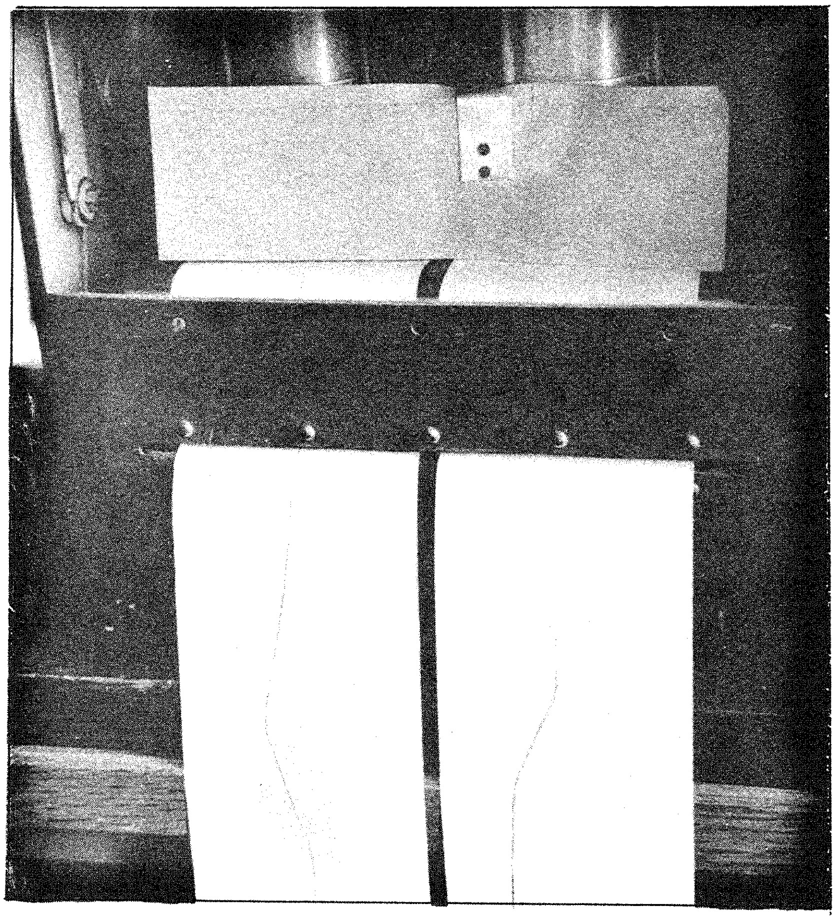

FIG. 4.

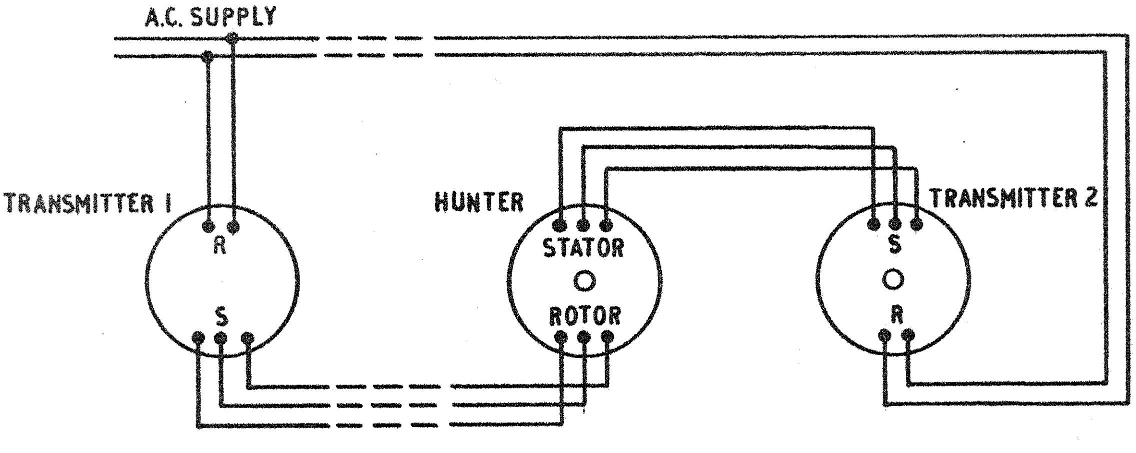

DIAGRAM OF CONNECTIONS OF MAGSLIPS

FIG. 5.