A VERSATILE AND RELIABLE PRINTING COUNTER¹

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Although printing counters have a recognized usefulness in the laboratory, there does not seem to be a flexible, economical, and reliable unit available which can be readily adapted to the operant conditioning laboratory. Units adapted by a number of commercial manufacturers of programming equipment are expensive, because of their lack of versatility. They also become unreliable after extended use. Other printing counters are prohibitively expensive because they are too highly specialized for general use in behavioral experiments.

The printing counter described here² is versatile and reliable. It has been in use 24 hr a day, six or seven days a week for 12 months without a failure. Its success is due principally to the Hewlett Packard Model 561B digital printer.

The printing counter consists of two subunits, an input counting unit and a printer contained in the same rack-mounted chassis.

The counting unit consists of 11 Durant Unipulser³ counters with their associated control and programming circuits. Each Unipulser, which supplies both a visual and electrical readout, is conservatively rated to operate at 40 pulses per sec on 24 v dc for over 100 million operations. These units accumulate the data which, on a print command, are transferred to the printer and then printed. The individual Unipulsers plug into the counting unit and are easily replaced or rotated so that wear can be equalized among counters indicating units, tens, and hundreds, *etc.* Mounted below each of the 11 Unipulsers

are four Nu-Way studs providing control of input, reset, count transfer, and overcount indication.

Grounding an input stud for at least 12 msec will advance by one count the count on the Unipulser directly above it. Since each unit operates independently, data from as many as 11 sources can be collected and recorded simultaneously as long as the total count between printing in any one channel does not exceed nine. If the count on any channel should exceed nine before a print command is received, the Unipulser will count through zero and indicate a number in multiples of 10 less than the total count received. The overcount stud provides a partial solution to this problem. When this stud is connected to the transfer stud and the Unipulser is pulsed beyond nine, the printer will record a dash indicating that at least 10 counts were received. In this way erroneously low counts will be avoided, although the experimenter will not know how many more-than-nine counts were actually received. However, for many purposes a nine point scale is satisfactory.

The count transfer stud is used to interconnect the Unipulsers so that accumulations of two, three or more digits can be recorded. By snapping a connector between the count transfer stud of one channel and the input of the next, the second channel counter advances once each time the first one goes through zero. By connecting the transfer count stud from the second to the input of a third channel, counts up to 999 can be accumulated. The count transfer stud of any channel can be connected to the input stud of any other channel, and if desirable all 11 can be interconnected, so that 11-digit numbers can be accumulated.

This printer is presently being used to record two-digit data from four different sources. Two of the remaining columns are used to in-

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²Designed to our specifications by Yewell Associates, Middletown, Connecticut.

³Durant Mfg. Co., Milwaukee 1, Wisconsin.

dicating trial number and nature of the stimulus presented. The 11th channel is not used. Many other variations are possible.

The reset stud provides for independent reset of each individual channel. Connecting this stud to ground will cause the Unipulser above it to reset at the end of each printing cycle. The channels whose reset studs are not grounded do not reset. A particular advantage of this feature is that these reset controls can be routed through the experimental programming circuit in such a way that particular channels reset only after specifically designated printing cycles, while some accumulate trial numbers, and others provide coded information specifying nature of stimulus, change of schedule of reinforcement, elapsed time, or other variables. This is especially useful when deciphering the printed data.

The printing unit is a standard Hewlett Packard Model 561B 11-channel digital recorder capable of printing rates as high as 5 per sec. On a print command the input data

are transferred from the counting units to the printer where they are stored until the printing cycle is complete. Information stored in all channels is printed each time a print command is received, since there is no provision for printing individual channels independently.

Since the print wheels move only on a print command and do not accumulate counts, their life is extended appreciably beyond that expected in conventional printing counters. During the transfer and printing cycle, which require 200 msec, the counting unit is disabled; inputs occurring during this time will not be recorded. At the end of the printing cycle, a signal is fed back to the counting units to reset any whose reset stud is at that time connected to ground.

A commercial model of the printing counter described above is manufactured by the Hewlett Packard Company at a cost of about \$2100.