# Software tools for creating line drawings on a CRT

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A software package that can be used for the generation of line drawings on CRTs is discussed. The pictures obtained are stored as sets of coordinates of line segments. Complex pictures consist of sets of subpictures. In this way, pictures, or parts of pictures, can be easily manipulated (e.g., rotated, translated, scaled) and can be displayed on different types of display systems.

Many experiments in cognitive psychology make use of pictorial representations of objects. Traditionally, experiments using pictures have been carried out with slides and a projection tachistoscope or with drawings and a mirror tachistoscope. Both of these methods have some serious handicaps. First, because mechanical shutters are used in the projectors, the timing of events is often not accurate. Second, because one is usually limited in the number of channels, the sequence of events must be very simple. For instance, with a traditional three-channel projection or mirror tachistoscope, a relatively simple stimulus sequence that consists of a fixation point, a picture, a masking stimulus, and another picture is impossible. Third, especially in the case of the projection tachistoscope, it is difficult to present pictures foveally.

In order to resolve these limitations, we developed software to show pictorial stimuli on a CRT. In this report we present a software package that enables users to draw pictures on a CRT screen with a light pen. These pictures can be saved as a set of coordinates of line segments.

The pictures can then be used in experiments in which tachistoscopes would traditionally be used. Some advantages (depending on the actual display system used) are: multiple copies of one or more figures in one presentation, scaling, translation, rotation, motion by repeated translation, and mirror transformations. Presentation rates will depend upon the actual display unit used in the experiments. For instance, a Vector General CRT, in use in our laboratory, displays the truck (see Figure 1) with a refresh time of 3 msec and the zebra with a refresh time of 8 msec; for a DEC VS-11, these refresh times are 9 and 24 msec, respectively. The display unit used does not have to be of the same type as the

unit on which the pictures were drawn. Therefore, even if one does not have the right apparatus to draw the pictures, as long as it is possible to draw them somewhere, one can use the coordinates with any CRT that is fast enough to do the job.

The software package described here is written in FORTRAN IV and makes use of the DECgraphic-11 FORTRAN graphics package for the VS60 and VT11 graphic display subsystems, usable in the RT-11, RSX-11M, RSX-11D, and IAS operating systems. By making use of the overlay capability of these operating systems, the complete package fits in 32K of a PDP-11/10 minicomputer. The layout of our drawing package is as follows (options appear in capitals). The basic operation involves the DRAWing of a line segment on a CRT with a light pen. Optionally, the package provides the possibility of keyboard entry. Keyboard entry is very useful in cases in which simple figures (such as triangles or rectangles) have to be drawn with great precision. These line segments can subsequently be FILTERed, to get curved lines (first dividing them into a number of STEPS), COPYed, MOVEd across the screen, or ERASEd from the screen. Special subroutines provide for a GRID on the screen (to facilitate drawing) and for the drawing of CIRCLEs. Further operations allow WRITing of a figure to a storage device, or READing from it.

The actual working of the program is as follows. On the screen of the CRT, a menu area displaying all options is created. The user indicates which option he/she will use by pointing the light pen at this specific option. This option can be terminated by typing a completion code on the keyboard or by pushing a button on a push-button device. Within the drawing option, a figure consisting of up to 50 lines can be drawn. This figure then can be subdivided into a larger number of smaller line segments, with lengths that can be determined by the step-size routine. This allows the use of a simple filter routine to produce curved lines. The different parameters (i.e., the lengths of the line segments and the magnitude of the filtering) are

determined by a special subroutine that allows for the "reading" of different values from the screen by means of the light pen. After this figure, a new figure can be drawn, with the old one still visible, if desired. After being drawn, this new figure can be submitted to one of the options available, and is finally stored as a new subpicture in a picture file. In this way, a complex picture can be built up from a large number of subpictures. These subpictures are identified in the picture file by the addition of a large constant number to the first pair of coordinates of each subpicture. Thus, this picture file is nothing but a series of pairs of coordinates, with some of them reaching a value that discriminates them from the rest. Because this layout provides for easy identification of the different subpictures, the alteration of parts of an already existing picture is rather simple. In this software package, the total picture is displayed on the screen, and identification of a certain subpicture is accomplished by touching this subpicture with the tip of the light pen, after which this subpicture is displayed in flash mode. This subpicture can then be submitted to the various options, and can eventually be saved again in the picture file. In this way, the manipulation of the different subpictures becomes independent of the sequence in which they were drawn. A further advantage, especially when it comes to displaying a complex figure on a CRT, is that this layout makes it very easy to manipulate variables such as intensity and line type for the different subpictures separately.

The software, in its present form, makes it possible to draw pictures that contain up to 1,000 line segments.

In Figure 1, three examples of pictures drawn with this software are presented.

The photographs were taken from a Vector General fast CRT. The quality of the pictures depends on both the resolution of the system on which the pictures are drawn and the resolution of the system on which the pictures are finally displayed. Of course, it helps to draw the figures as large as possible, so that they can be scaled down in size for the actual presentation. Minor flaws in the line drawings are covered up in this way.

To summarize, the advantages of our software package seem to be twofold. First, the package makes it relatively easy to draw pictures. Second, because of the fact that a complex picture consists of a number of easily identifiable subpictures, the package makes it very easy to manipulate parts of pictures, both in drawing and displaying, while leaving the remaining picture unimpaired. Especially because of this last property, the software package compares favorably with packages that use other drawing devices, such as digitizers and x-y tablets.

## AVAILABILITY

A listing of the drawing package, along with a more elaborate description of its functions, and a listing of a display program that shows how complex pictures can be displayed can be obtained free of charge from the authors. Furthermore, we have drawn at this moment 142 figures with our drawing program. These figures are partly based on the pictures designed by Snodgrass and
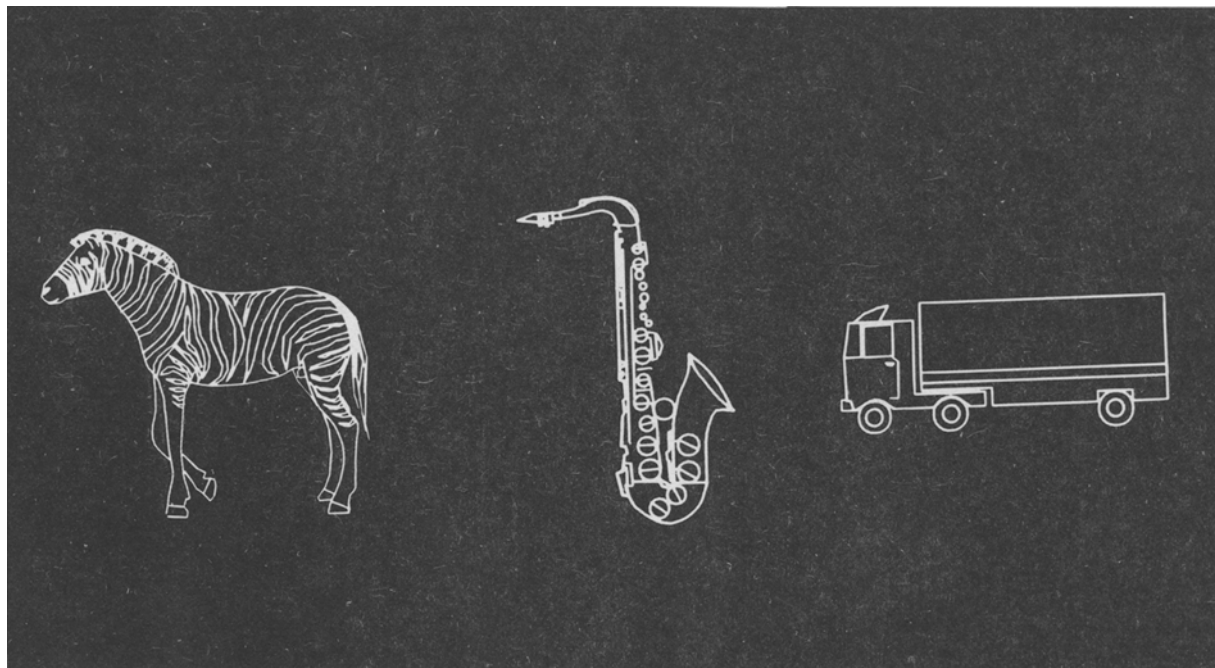


Figure 1. Three examples of pictures that were drawn with lightpen and keyboard.

Vanderwart (1980) (although not exact copies), supplemented by figures designed in this laboratory. These figures (see Appendix for available pictures) can be obtained at cost as sets of coordinates on floppy disk (RT-11 V4 or RSX-11 M format) or as a list of coordinates on paper. These coordinates can, of course, be transformed to any other coordinate system. Send requests to G. Glazenborg, Subf. Psychologie, Hooigracht 15, 2312 KM Leiden, The Netherlands.

## REFERENCE

SNODGRASS, J. G., & VANDERWART, M. A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory*, 1980, 6, 174-215.

### Appendix
### List of Currently Available Pictures

| | | | |
|---|---|---|---|
| accordion | desk | light bulb | smoothing iron |
| alarm clock | door handle | lips | snake |
| apple | drawing pin | lobster | sock |
| arm | dresser | lolly | stapler |
| axe | drum | moon | stool |
| ball | ear | nail | stove |
| balloon | envelope | necklace | suitcase |
| banana | eye | needle | sunflower |
| banjo | finger | nose | sword |

| | | | |
|---|---|---|---|
| baseball bat | fishing net | orange | swordfish |
| basket | fishing rod | padlock | syringe |
| bean | fist | paper clip | table |
| boomerang | flag | parasol | television |
| boot | float | pear | tennis ball |
| bottle | flute | pedal bin | tennis racket |
| brush | foil | pen | thumb |
| button | fork | pencil | toaster |
| cake | french bread | penguin | toffee |
| candle | frying pan | perforator | tomato |
| carrot | garbage can | piano | torch |
| celery | guitar | pincers | traffic sign |
| chair | gull | pipe | trousers |
| cherry | harp | pot | truck |
| chisel | hat | pudding | trumpet |
| church | hockey stick | revolver | tulip |
| cigar | hoe | rolling pin | turtle |
| cigarette | hourglass | rope | typewriter |
| clarinet | house | saw | vacuum cleaner |
| clock | ice-cream cone | saxophone | washing machine |
| clothes peg | kettle | scorpion | watering can |
| coat hanger | kite | screwdriver | wineglass |
| compass | lamp | sea horse | worm |
| couch | leaf | shark | zebra |
| cup | leg | shaving brush | zeppelin |
| daffodil | lemon | shopping bag | |
| dagger | lettuce | skipping rope | |