

## **Design aspects of the Burroughs ET 1100 ergonomic workstation**

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**Abstract.** The Burroughs ET 1100 ergonomic workstation is a general purpose data communications system composed of a display unit and a cable-connected keyboard. It is intended for use in full-time work or continuous-use situations, therefore every effort was made to take ergonomic considerations into account. This paper describes the design process, the limitations provided to the design staff and the resulting product which was released in April 1983. A number of interacting variables needed to be balanced to ensure that one feature had not been optimized to the detriment of another. In addition to the manufacturers interest in the product it was important that it be installed properly, therefore additional measures were taken to educate users and managers about desirable environmental characteristics.

### **1. Introduction**

The Burroughs ET 1100 ergonomic workstation is a general purpose data communications system composed of a display unit and a cable-connected keyboard. It is intended for use in full-time work or continuous-use situations, therefore every effort was made to take ergonomic considerations into account.

### **2. Display characteristics**

The display technology is a cathode ray tube. The use of fairly large well-spaced characters, which when multiplied up by 25 lines and 80 columns, results in a 355 mm (14") diagonally measured display. The tube plus the electronics established most of the exterior dimensions.

The vertical dimensions were established through the goal of providing see-over criteria for a fifth percentile female properly seated at a 736 mm (29") non-adjustable worksurface. The issue here is: What does 'properly seated' mean? If the person adjusts the chair downwards to achieve a position with the feet flat on the floor then the arms will be angled upwards considerably. If the person chooses instead to favour the recommended position of placing their lower arms nearly horizontally then they will adjust the chair upwards and use a footrest. The worst case, low seat and low eye height, was chosen to arrive at a total enclosure height of 375 mm.

Next, the same dimension was considered using a 95th percentile male. In this case, a 720 mm worksurface was used since it is the European standard. The downward viewing angle becomes the limiting factor. The display is too low for a tall male when properly positioned for a short female. The addition of a 76 mm height adjustment optional feature takes the variation of eye height into account.

Tilt criteria was established by examining the range of eye heights and appropriate downward viewing angles. The display tilt range permits the screen to be no more than 10° off perpendicular to the viewing angles established by the range of eye heights. Another factor, viewing distance of 500-700 mm, was also included in the calculation. The total tilt range is from 20° back to -5° forward. The forward tilt is a glare control measure as is the 90° swivel range.

Screen background and enclosure colours are based on not exceeding a 10:1 ratio to the reflectivity of paper. Since paper reflects 70–80 per cent of the light falling on it, the colour of the screen background would be 7–8 per cent or lighter. The bezel colour reflects 15 per cent and the remainder of the enclosure is 45 per cent. The screen uses a fine-etch treatment for glare control. While this technique is not the most efficient method of reducing reflected luminance, it is, overall, the best technique available, taking normal use into account. Since the etch slightly degrades the image it is important to start with a very good-quality image.

On-off, brightness and contrast controls are located below and just behind the lower front edge. Louvers are designed to comply with all applicable safety standards.

### **3. Keyboard**

The keyboard is cable connected to the display. It complies with the German ZH1/618 standard by being 30 mm high, measured at the home row. Adjustments include 5, 10 and 15° angle settings and a four-level adjustment of the audible feedback click.

The audible feedback may be turned off if the operator wishes to rely on the tactile feedback instead. The tactile characteristic consists of a gradual increase in force to about 60 g over the first 2 mm of travel and then a rapid decrease in force. The trigger point is just beyond the peak force, so, with experience, an operator is not required to push the key to its complete distance.

The keys are smooth sided to eliminate the possibility of fingernail catching. The top of each key is a cylindrical depression to reduce the possibility of reflecting overhead lights back to the operator. Since there are several language versions of the keyboard and several keyshapes due to the stepped-sculpted configuration, it was decided to use transfer printing for the key legends instead of the more traditional double-shot moulding. This technique uses a dye with a solvent so that the marking is embedded into the plastic and cannot be worn off with use.

An optional separate numeric pad is available for either right- or left-hand use for numeric entry tasks. Enclosure colours are the same as for the display except the key colour was lightened to 25 per cent reflectivity to take into account the shadows that occur between keys.

### **4. Additional efforts/testing**

In addition to the manufacturers own product testing, the unit has been evaluated and given high marks by Professor Grandjean's laboratory at the Swiss Federal Institute of Technology at Zurich. It has also been evaluated by the major safety testing organizations such as the U.S. Underwriters Laboratories.

### **5. Marketing and user education**

The human-factors staff prepared a paper explaining the ergonomic features of the product for the sales force along with a slide and voice presentation. They also requested Professor Grandjean to prepare a booklet to be distributed by Burroughs to guide users towards good environmental situations. It is presently in the process of being prepared for printing.