

# Packaging the Pocket Calculator

*The industrial design of the HP-35 was of primary importance, often taking precedence over electrical considerations.*

**By Edward T. Liljenwall**

**T**HE INDUSTRIAL DESIGN OF THE HP-35 was unusual not only for Hewlett-Packard, but for the electronics industry in general. Usually, the mechanical and electrical components of a product are determined before the exterior is designed. The HP-35 took the opposite approach.

Since the calculator was to be pocket-sized, size was the overriding constraint on the design. In addition to size three other parameters were established. The calculator would have thirty to thirty-five keys, contain two or three batteries, and have a twelve-to-fifteen-digit LED display.

The industrial design began with an investigation of keyboard, packaging, and overall shape concepts. Several basic form factors were studied using sketches and simple three-dimensional models. The models were particularly valuable at this stage of development. They allowed a good evaluation of the shapes and sizes being considered.

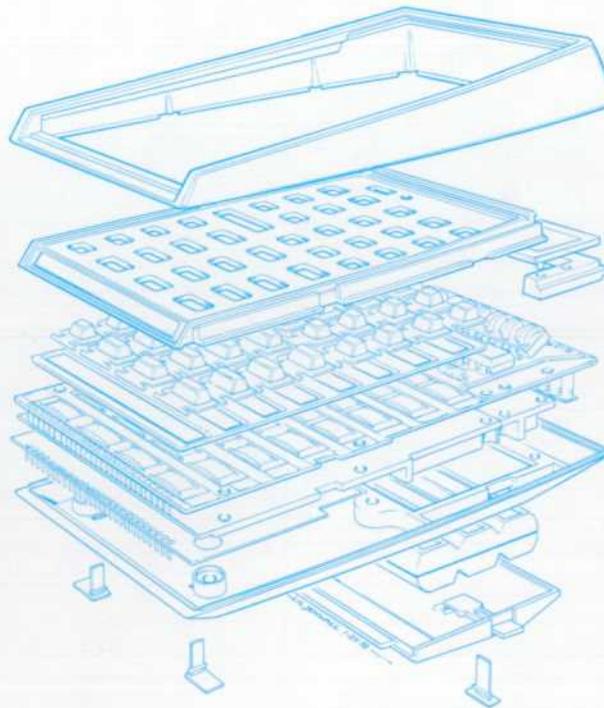
Once the preferred direction had been established a detailed model was built. The model was well accepted and approval was given to develop the concept into a reality.

Only a general idea of the electronic design was

known at this point. Designing and packaging all necessary electrical and mechanical components into the tiny product became a tremendous challenge for electrical, mechanical, and industrial designers alike.

From a human-engineering standpoint, the keyboard was the most critical area of the design. The problem was to place thirty-five keys in an area approximately 2½ inches by 4½ inches and retain the ability to operate the keys without striking more than one at a time. It became apparent that the industry standard of ¾-inch center-to-center key spacing could not be maintained. A successful compromise was to use 11/16-inch center-to-center spacing for the numeric keys, and ½-inch spacing for all others. This was made possible by reducing the size of each key, thereby increasing the space between the keys.

The keys are divided into groups according to functions. The groups are separated by size, value contrast, color, and placement of nomenclature. The numeric keys, which are most frequently used, are larger and have the strongest value contrast. They have their nomenclature directly on the keys. The next group of keys accord-



ing to frequency of use are identified by their blue color. The ENTER↑ key and arithmetic keys are separated within this group by placement of nomenclature on the keys. The less frequently used keys have the least value contrast, and the nomenclature is placed on the panel just above the key.

The keys have an over-center or snap feel when they are pressed. This comes from special spring contact developed by HP. The electrical and mechanical parts of the keyboard are less than 1/8 inch high.

The spring contacts are mounted on a printed-circuit board along with several other components including the fifteen-digit LED display. The display is tilted toward the operator for optimum viewing.

A second printed-circuit board carries the majority of the electronic components. The two boards are attached by a series of pin connectors.

The external package was developed from a human-engineering approach, with aesthetic appeal of major importance. The sculptural wedge shape permits the calculator to be comfortably held in the palm of one hand. It also allows the product to slide easily into a pocket. The keyboard and display slope upwards for a better viewing angle in desk-top use. The sculptural sides visually break up the total mass of the package. The top half of the case is highlighted while the bottom half is in shadow. This gives the product the appearance that it is thinner than it actually is. The product appears to be floating when viewed from a normal operating position in desk-top use. The use of textures that complement each other contribute significantly to the overall finesse and appearance. The texture on the case provides a non-slip surface, important when the calculator is being hand-held.

Viewed from the bottom, the calculator retains a clean appearance. There are no exposed screws or other fastening devices. This is aesthetically important to a product that is hand-held and viewed from all sides.

The polyvinyl-chloride feet prevent the calculator from sliding during desk-top use. The rear feet also serve as the battery-door latches, aiding in the overall cleanness of the product.

The HP-35 couldn't have been developed without an outstanding working relationship between laboratory, industrial design, manufacturing, and tooling. Everyone involved in the project shared a common desire to retain the original size and shape, and many innovative engineering concepts resulted. Many of the problems encountered during development could have been easily solved by using more conventional methods, but the result would have

been a larger package. Now that the calculator is a reality, everyone feels that the extra efforts required were worthwhile. 

## SPECIFICATIONS

### HP-35 Pocket Calculator

#### FUNCTIONS:

ARITHMETIC: Add, Subtract, Multiply, Divide and Square Root.  
TRIGONOMETRIC: Sin x, Cos x, Tan x, Arc Sin x, Arc Cos x, Arc Tan x.  
LOGARITHMIC: Log<sub>10</sub> x, Log<sub>e</sub> x, and e<sup>x</sup>.  
OTHER FUNCTIONS: x<sup>y</sup>, 1/x, π and data storage and positioning keys.

#### SPEED OF OPERATION (typical):

Add, Subtract	60 milliseconds
Multiply, Divide	100 milliseconds
Square Root	110 milliseconds
Logarithmic & Exponential	200 milliseconds
x <sup>y</sup>	400 milliseconds
Trigonometric	500 milliseconds

#### POWER:

ac: 115 or 230 V ±10%, 50 to 60 Hz, 5 watts.  
Battery: 500 mW derived from Nickel-Cadmium rechargeable Battery Pack.

#### WEIGHT:

Calculator: 9 oz., Recharger: 5 oz.  
Shipping weight: approx. 2 lbs.

#### TEMPERATURE RANGE:

OPERATING: 0°C to 40°C (32°F to 104°F).  
STORAGE: -40°C to +55°C (-40°F to 131°F).

**PRICE IN USA:** \$395, including battery pack, 115/230 V adapter/recharger, carrying case, travel case, name tags, operating manual. Note: At press time, orders for the HP-35 have exceeded expectations to such an extent that a waiting list has been established. Deliveries should improve in the next few weeks.

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#### Edward T. Liljenwall

Ed Liljenwall, industrial designer of the HP-35 Pocket Calculator, is a 1967 graduate of the Art Center College of Design in Los Angeles. He holds a BS degree in industrial design. Ed joined HP's corporate industrial design group in 1960 after two and one-half years as an automotive designer. As a result of his work on the HP-35, he's filed for several design patents. Away from HP, Ed likes to ski or water-ski, and is currently putting another hobby, woodworking, to good use in redecorating his home.