

# Weibull Analysis Points to the Problem Location

By Chet Haibel, as demonstrated in *Practical Reliability Engineering*

One of the companies for whom I consulted last year had a vexing field issue with front panel keypads. Customers were complaining that keypads were hard to press. 136 complaints had occurred in the last five years on a product that was currently shipping at about 850 units per month. Service technicians were typically able to make customers happy by swapping out the keypad.

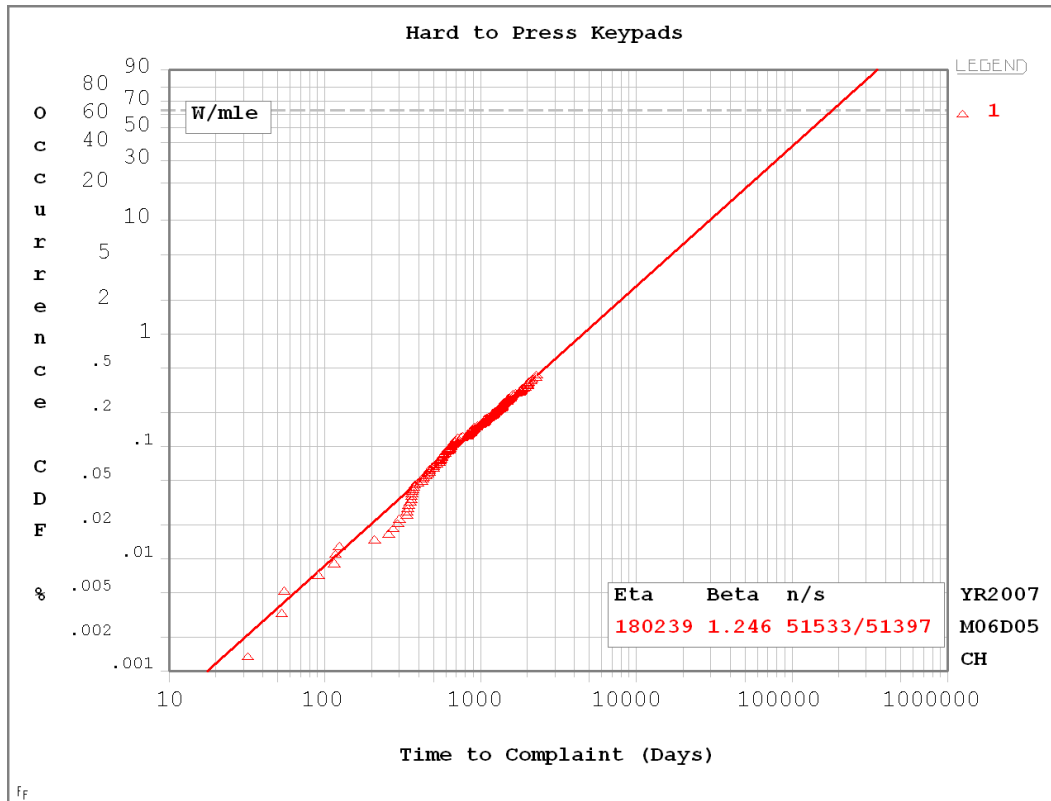
But since the keypad was only a flat panel with a flexible printed circuit board “pigtail” with no replaceable parts, the keypads were not returned to the service depot. Measurements on new keypad assemblies showed that every one tested good, requiring well less than the specified 2 pounds of pushing force to achieve less than the specified maximum resistance of the switches.

That resulted in speculation that keypads were wearing out and ought to be included in preventive maintenance and swapped out along with the rechargeable batteries every two years. However, a life test on new keypads showed that while their resistance varied quite a bit from unit-to-unit and rose somewhat with initial use, they still met specifications at a million cycles, well beyond what customers could experience.

“Failure analysis” of units pulled at various points during life test showed the silver ink redistributed itself with use, but never moved enough to cause the resistance to rise above specification. Because only 136 complaints had occurred from more than 50,000 units in the field, it was speculated that a screen could be set up in manufacturing to catch the occasional bad keypad.

I enquired about what kind of service records were being kept. To my delight I found that every field repair was recorded with the date of the complaint and the serial number of the unit. Furthermore, manufacturing records were kept for each serialized unit, including date of manufacture. Some database gurus at the company were willing to help me organize the data.

I put together an Excel spreadsheet with the age at service for each replaced keypad. I also was able to assemble, by month produced, the ages of all the units that had never had a complaint about hard to press keypads. This latter group of “suspended” units along with the failure ages of the 136 replaced keypads were entered into WinSMITH™ Weibull software to produce the following result.



The value for Beta, the Weibull slope, of 1.246 was significant, showing that while some history was being recorded in the keypads, by and large, this failure mode was randomly distributed in time.

As taught in *Practical Reliability Engineering*, Weibull Beta of 1 would be completely random in time, Weibull Beta less than about 0.8 would indicate an Early-Life failure mode that could be screened in manufacturing, and Weibull Beta greater than about 1.5 would indicate a Wear-Out failure mode, although it would take a Weibull Beta of 2 or greater to indicate preventive maintenance.

As taught in *Practical Reliability Engineering*, Weibull Beta near 1 indicates a Design Margin issue.

Armed with this knowledge, I was able to approach a design engineer at the company with confidence to enlist help in locating a marginal application having to do with these keypads. It didn't take long to find that some diodes that had been inserted on the motherboard to reduce the number of wires to the keypad were shifting the input voltage to some digital gates, degrading the voltage margin.

A slightly more complex version of the diode circuit with additional compensating diodes brought the logic threshold to the proper voltage restoring the voltage margin at the input to the digital gates. This change was implemented in a board roll to the motherboard and the "hard to push" keypad issue absolutely never happened with subsequent units.

It is my privilege and pleasure to introduce Weibull Analysis with numerous practical applications on day two of *Practical Reliability Engineering*. Consult the Hobbs Engineering website for a schedule of when this training seminar will be offered at a location convenient to you.