How to Mend a Broken ~~Heart~~ Key

Martin Hepperle, 7 September 2015

Once Upon a Time

In the good old times, the keys of Hewlett-Packard's high quality calculators featured rotary hinges close to the bottom edge of each key, providing a unique and very accurate key motion. Also, these keys were almost indestructible. However, they had to be manufactured and assembled individually, leading to high production costs.

Nowadays the keyboard of most Hewlett-Packard calculators consists of a single injection molded key carrier frame complete with thin bars connecting each key to the frame. These two bars attach to the bottom of each key and try to mimic the rotary motion. This design principle had been introduced with the HP 48 calculator family.

Keys with rotary hinges can be seen on some calculators. For example on the HP 12c the blue and orange secondary function keys are manufactured separately due to their color.

Houston, we have got a Problem!

While the rotary hinges cannot break under normal circumstances, the molded hinge bars are doomed to break after hopefully many happy operations due to age. Each key press bends the small bar until it throws up its hands in despair and succumbs to fatigue. Sometimes the small bars break early e.g. when the calculator is dropped, stored improperly or when a user simply exerts too much force on the keys. Sometimes only one bar breaks, leaving the key in a sad tilted position, sometimes both bars break so that the key is rattling around in its homestead or, god forbid, may even get lost in outer space.

There is no easy way to repair broken hinges. If the keyboard carrier were available as a spare part this would be no big deal. Alas this is not the case and the calculator ends in the scrap or, if he is lucky, in the spare parts box.

How I Did It

I tried the following method to fix a broken key on an *HP 12c Platinum* calculator. There are chances that this is not durable and may not work for your purposes, so read and decide by yourself. It is just my story and it was a success so far.

Obviously, the calculator had to be dismantled first. This involved removing the rubber feet, and the four screws hidden below as well as the solitary screw in the

battery compartment. In addition to the screws there are four thin plastic latches on the sides of the case. These can be depressed by running a fingernail or a thin plastic or smooth, polished metal blade along the separation grove between the upper and lower case shells.

Then the heads of several plastic rivets had to be removed by rotating a 4 mm or so drill bit by hand. I tried to avoid scraping the printed circuit board. Next the main printed circuit board was lifted out of the calculator. Luckily the display is fixed to the PCB so that we do not have to deal with flexible connections.
After removing the thin soft plastic ("rubber") sheet I lifted the keyboard carrier frame out of the upper case. I was careful not to break the frame or another one of the rather thin key hinges.

To prepare the repair it is advisable to use some acetone and/or some fine sandpaper or a needle file to prepare the surface of the neighboring frame struts (to the left and right of the broken key, see Figure 1) and the cavity in the key cap for later gluing.

The broken key was then fixed in its original position using small droplets of liquid plastic cement (e. g. from *Revell*). This will not provide a strong connection and serves just to keep the key in position for the repair. You could also stick the keyboard and the broken key cap on a wide band of self-adhesive tape. Another, more dangerous option could be to use a soldering iron (or a hand-held 3D printer with ABS filament) to temporarily weld the broken bars together. Also modeling clay may be a means to create a fixture. No matter which method you chose, the key should be where it belongs and should stay in this place while the next steps are undertaken. Make sure that its face is in plane with his siblings.

In order to provide a stronger connection I developed the idea to replace the wimpy plastic bars by a rock solid steel suspension system (a.k.a. piano wire). The springs should have an exposed torsional region, which provides flexibility in addition to the short region acting under bending loads.

For this purpose I took a thin helical spring (about 0.25 mm wire diameter) out of my "you-never-know-when-you-might-need-it" box and straightened it, leaving the eyes at the ends intact. The spring wire was cut and bent so that the eyes reside down at the bottom of the hollow key cap. The spring wire then passes up, over the original plastic bar, moves a short distance to the side and then curves back on the frame between the keys.
This required quite some fiddling with pliers and tweezers. Another useful tool could be a magnification glass or even a microscope (you wanted to buy that USB microscope anyway, didn't you?). Without any force the wire should lie as flat on the plastic frame as possible.

After the wires had been prepared, they were tacked to the frame using a tiny drop of super glue. This was just to hold them in position and to allow for crosschecking before the application of the final glue.

After a visual inspection, the wires were glued to the frame using *Henkel Pattex Stabilit Express*, a Methacrylate-based two component glue, suitable also for ABS plastics. This glue becomes very hard, almost brittle. The glue was applied to the key cap, almost filling it and safely embedding the coiled ends of each spring. The horizontal legs of the springs were left without glue to provide a rotary action. Avoid excessive glue on the frame. I made sure that the pin which pushed on the key contact was not contaminated by glue. While the calculator is dismantled it might also be a good idea to check these thin pins for integrity. If necessary, they could be reinforced by glue, thin plastic ribs.

If everything looks fine, test the key motion, reassemble and enjoy.

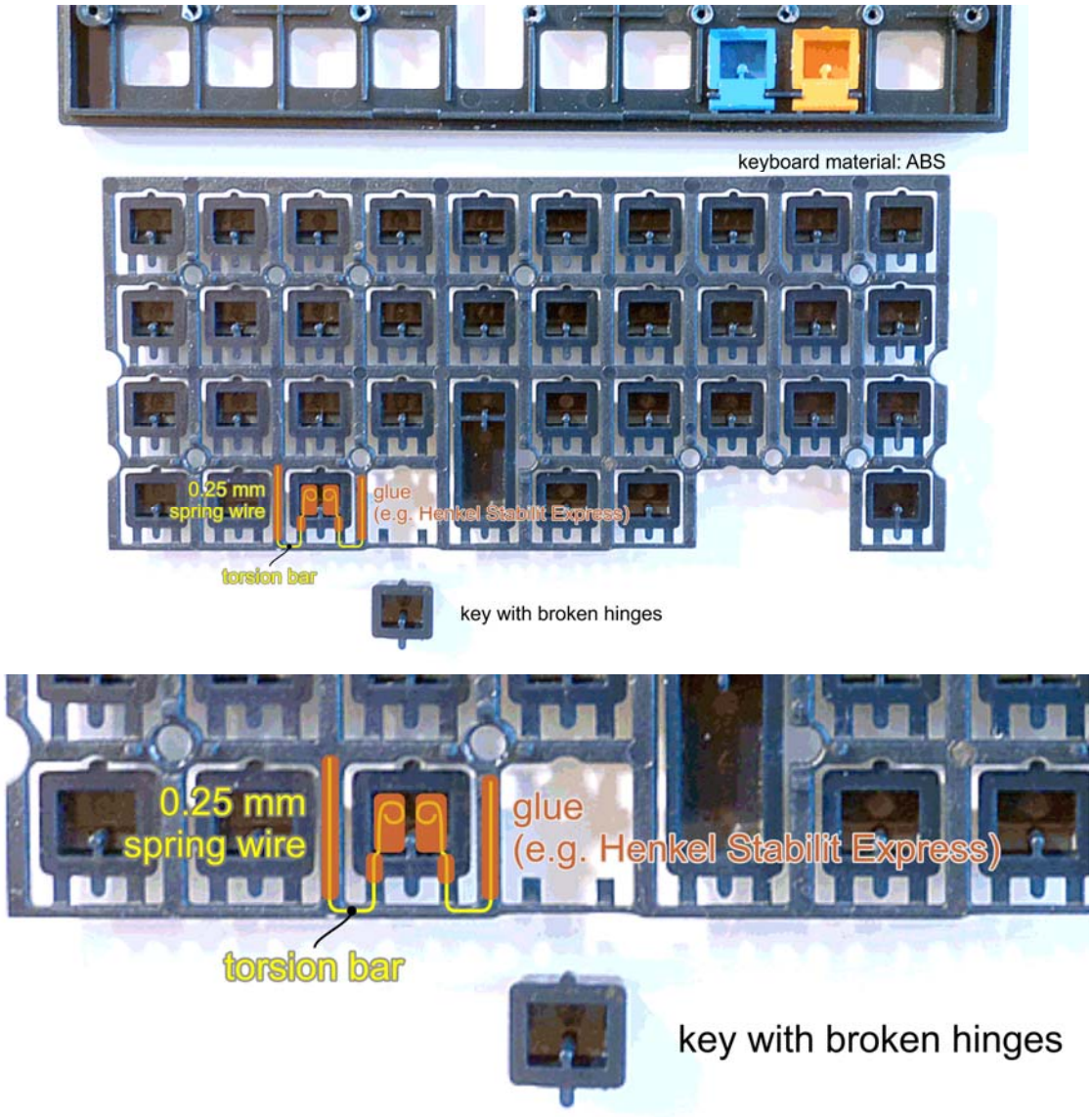

Figure 1 Keyboard with a completely broken key. For illustration purposes, the repair is drawn on the neighboring key. The yellow part of the spring wires is exposed and free to bend and twist, the remaining parts are embedded in the glue.