The Wearing Properties of Harpsichord Plectra

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1. Introduction

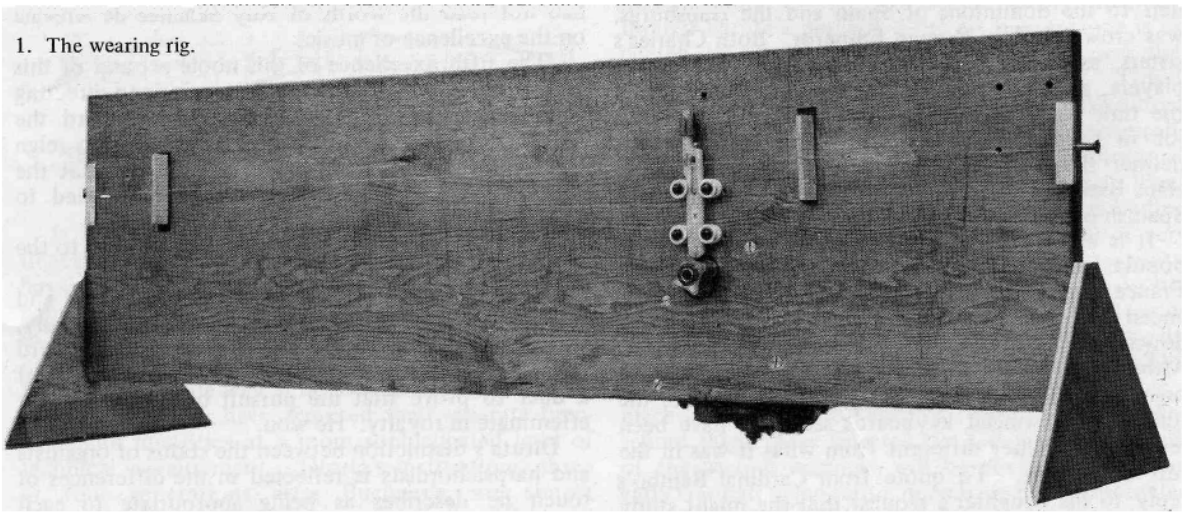
It is well known that the materials commonly used as plectra in harpsichords and similar instruments wear as the instrument is played; the purpose of this brief communication is to present the results of some wearing experiments on different plectra.

Three different materials were experimented upon, (a) quill, (b) leather and (c) Delrin. The last of these is a polymeric substance which is being used more and more in modern harpsichords. Its usefulness lies in the fact that it can be injection-moulded to any required shape and it is thus admirably suited to modern mass-production techniques. Neither of the other two materials is as easy to utilise as they both have to be cut to size.

All three types of plectra produce their own distinctive sound. Quill produces the brightest sound with the sound produced by Delrin a close second. Which sound is the most pleasing is, of course, a complicated subjective issue outside the scope of this work. However, consistency of any particular sound is certainly desirable and it was for this reason that not only overall lifetimes but also consistency of sound over this time were examined.

2. Initial Experiment

To examine overall lifetimes, a special wearing rig was constructed which is shown in Fig. 1. The specially-shaped jack runs between P.T.F.E. guides and it is made to go up and down by the cam which is attached to a gramophone motor mounted on the back of the rig. When in operation, the string is plucked approximately 25,400 times per hour. To convert this figure to an equivalent number of years' wear on a harpsichord, the following assumptions were made.



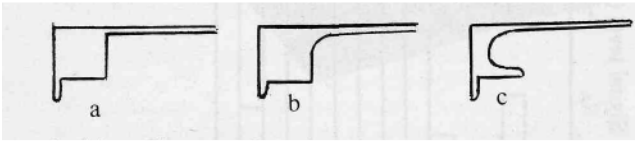
1. The wearing rig.

(i) For a standard piece of music, approximately 500 notes are played each minute.
(ii) These will be mainly spread over the middle two octaves.
(iii) During a year, an instrument will be played 1 hour a day for 300 days.

From these assumptions, which must be approximate, one can say that 14 hours on the test rig is equivalent to one year's standard playing time.

The Delrin plectra, as originally supplied by Robert Morley & Co., Ltd. were as shown in Fig. 2 (a). The main body of the plectrum is made cuboid so that it fits into a special holding in the jack. The results which were obtained for a selection of these plectra are 10, 33, $5^1/2$, 16, 24 (still unbroken), $8V_2$, 27 (still unbroken) and 5 hours. From these figures, the mean life of a standard Delrin plectrum is 16 hours with a standard deviation of 10 hours. This corresponds to an actual lifetime of approximately one year.

It was noticed, however, that in all cases where the plectrum broke, the breaking point was at the junction of the actual plectrum to the main body. For this reason, a new shape of plectrum was designed with a 1 mm. radius as shown in Fig. 2 (b). The results of the tests on modified plectra are 39, 20, 57, 39, 60, 42, 37 and 30 hours, giving a mean of 41 hours with a standard deviation of 12 hours. This corresponds to an actual lifetime of 3 years*.



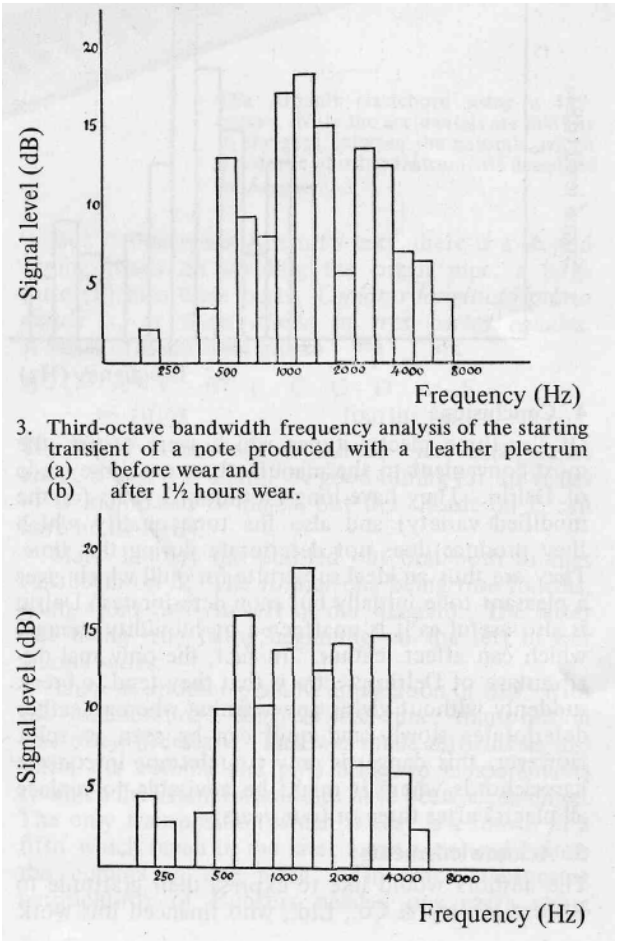
2. (a) Diagram of section through the original Delrin plectrum.
(b) Diagram of section through the modified Delrin plectrum.
(c) Diagram of section through subsequently modified Delrin plectrum.

3. Further Experiments

For analysis of changes in the starting transient due to wear of the plectrum, a Briiel and Kjaer real-time third-octave analyser, model 3347, was used. The analyser is fitted with 30 third-octave filters which cover the audio range. Each filter output is displayed as a vertical bar on a cathode-ray tube with horizontal lines giving a dB scale reference. The analyser can be set to record and retain the whole of one note from an instrument and the display then represents to an approximation necessitated by the limited frequency resolution of the analyser, the relative amplitudes of the frequencies in the transient. Actually each bar can represent a single harmonic of any note only as far as the fifth harmonic. Any bar above this frequency will represent a combination of two or more different harmonics. The analyser is thus not suitable for detailed analysis of all harmonics of a note but is suitable for comparison tests of the form which were undertaken.

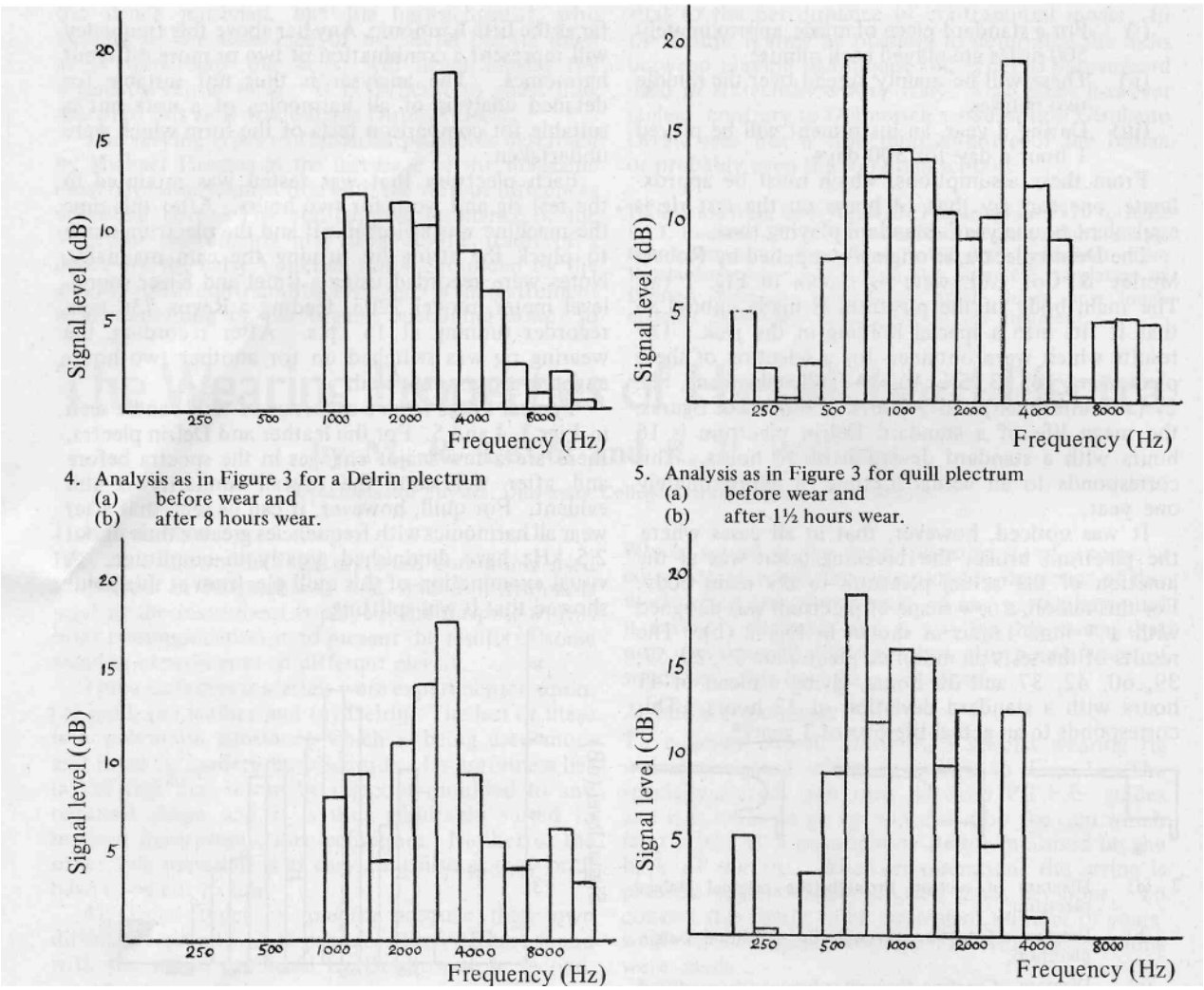
Each plectrum that was tested was mounted in the test rig and worn for two hours. After this time the machine was switched off and the plectrum made to pluck the string by turning the cam manually. Notes were recorded using a Bru'el and Kjaer sound-level meter, model 2203, feeding a Revox 736 tape recorder running at 15 i.p.s. After recording, the wearing rig was switched on for another two hours and the process repeated.

Typical traces from a sequence of tests can be seen in Figs 3, 4 and 5. For the leather and Delrin plectra, there are a few major changes in the spectra before and after wear but the overall similarity is still evident. For quill, however, it can be seen that after wear all harmonics with frequencies greater than about 2.5 kHz have diminished greatly in amplitude. A visual examination of this quill plectrum at this point showed that it was splitting.



3. Third-octave bandwidth frequency analysis of the starting transient of a note produced with a leather plectrum
(a) before wear and
(b) after 1½ hours wear.

* Since the work described in this communication was completed, Robert Morley & Co., Ltd. designed another plectrum illustrated in Fig. 2c. Two such plectra were worn as described in section 2 and both were unbroken (and visually perfect) after 175 hours wear.



4. Analysis as in Figure 3 for a Delrin plectrum
(a) before wear and
(b) after 8 hours wear.

5. Analysis as in Figure 3 for quill plectrum
(a) before wear and
(b) after 1½ hours wear.

4. Conclusions

Of the three plectra types which were tested, the most convenient to the manufacturer are those made of Delrin. They have long lifetimes (3 years for the modified variety) and also the tone quality which they produce does not deteriorate during this time. They are thus an ideal substitute for quill which gives a pleasant tone initially but soon deteriorates. Delrin is also useful as it is unaffected by humidity changes which can affect leather. In fact, the only real disadvantage of Delrin plectra is that they tend to break suddenly without giving any warning whereas leather deteriorates slowly and quill can be seen to split. However, this danger is only troublesome in concert harpsichords where it might be advisable to replace all plectra after three or four years.

5. Acknowledgments

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