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VIBRATION OF STEEL BAND PANS

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INTRODUCTION

The steel band originated in Trinidad and Tobago in the early 1950s, when the method of tuning discarded oil drums was developed and the resulting "pans" formed into bands which were not subject to the banning of African drums under the 1884 Peace Preservation Act. The method of making remains the same; first concave "sinking" the top of the drum, marking "grooving" of areas for individual notes, which are "ponged up" to flat facets, then "burning" over a fire of any available material (conventionally old car tyres, but gas offers better control); the note areas are individually tuned by hammering. The depth of the pan is determined by the pitches offered, which range from bass pans carrying three notes to the soprano where a pair of pans covers a complete two octave range.

In thirty years the maker's art has acquired a mythology comparable with every other instrument making mystique. Pans made from Shell oil drums washed ashore in the late 1950s are the Stradivarius of their species; drums which have never held oil are viewed with disfavour. One of the main problems facing the maker is the ammount of work which goes into preparing a pan before its quality can be assessed; only at the final stage does the maker discover whether the pan is tunable, and how stable its tuning will be. The price of pans therefore remains high (from £300 upwards - and 10 pans is a small band) because of wastage in manufacture.

Despite the price, the steel band is rapidly becoming an important vehicle for school music teaching - as well as being an art form in its own right. The problems of tuning which are notoriously present in school recorder bands are absent. Conventionally, playing is entirely by ear, so other aspects of ear training are developed rapidly and playing is not restricted to those who can read music. Primary school bands perform in public after only six months of practice.

There is therefore considerable motivation from both makers and consumers for the costs of making to be reduced. Little pressure has so far been evident for intrinsic improvements to the pans, unlike most other instruments. The "good" instrument is generally (if not exclusively) defined as one which is stable when tuned, for years at a time, rather than one possessing particular tonal qualities. However, tonal differences are identifiable in the work of different tuners, and between pans with different note layouts. The art of playing lies more in the use of the sound than in control of tone. Metallurgical investigation is required to specify suitable steel for pan making and control the initial stages of making [1]; the aim of acoustical investigation is to elucidate the tonal behaviour and the tuning mechanism. Virtually no published work is known, and although some work has been carried out at the Caribbean Industrial Research Institute, it has now ceased and details have not yet been obtained.

TUNING PROCEDURE

Note marking

The initial setting of pitch is in the marking out of each note. Marking is commonly carried out with a punch, hammered around the area; even relatively limited observations reveal a wide variety of depth of marking and the care with which the marking is taken to the edge of the pan. Areas around the perimeter are separated by a single groove; notes in the central region are separated by the two grooves, one delineating each note. The grooves are generally shallow in comparison with the thickness of metal. A fashionable innovation is the drilling of holes along the groove lines, with the aim (which is said to be desirable) of isolating the vibrating areas more effectively; the optimum separation of the holes is a matter of keen debate.

It is quite simple to deduce that the marking of areas has little to do with tone production, and only affects pitch by determining the maximum vibrating area for each note. It is possible to tune a pan without grooving, and the effective note area is outlined by the change in surface profile. The "ponged up" areas appear to be convex in the concave surface, but this is illusion and they are in fact almost flat. Regardless of the grooving, the note area is an oval with an aspect ratio of approximately 2:3 or 3:4. Playing the pan at the edge of, or outside, the oval but within the groove does not produce a pitched sound. Within the note area, use of the stick at different points emphasises different partials of the note.

Note tuning

The tuner attempts to tune the octave and the fifth in addition to the fundamental. It is common for the fifth to pose problems, and the fourth is then tuned instead. The fundamental is tuned by hammering from above and below, inside and outside the edge of the note area (not the groove); once this is correct, using an electronic tuner as standard, the other components are tuned in one operation, but descriptions of the procedure are far from clear.

The action of tuning the fundamental shifts the boundary of the note area. Hammering for tuning the other frequencies is concentrated in the central and outer region of each symmetrical quadrant, and does not significantly affect the fundamental frequency. The initial assumption was that the availability of the fifth or fourth for tuning was dependent on the aspect ratio, corresponding to simple longitudinal and cross modes of vibration. However it is the twelfth (octave and a fifth) and not the fifth which is generally present in the spectrum (figure 1). The pan available for test has paired notes an octave apart, and the resonances of other areas can add to the tone of any one note.

Interaction of note areas

The sound of a single note can be heard to change in its duration, with the high frequency components growing relative to the fundamental. The significance of this for the tone of the pan is debateable; its musical use is in moving melody and harmony, with sustain provided by drum roll or tremolo action when required, so that the time history of each note is not heard directly.

If each note area behaves as if isolated, the change should be due to frequency dependent effects of decay and radiation, whereas if the areas interact significantly, the growth of the higher harmonics in a low note would be characteristic of weak coupling with the note areas an octave higher. That interaction does occur can be both heard, and seen in the spectrum, by damping other areas than the note sounded; the effect of low notes on higher is greater than that of high notes on lower, although both occur.

The spectrum of the note A 220 Hz shows a large component around A 880 Hz, with a split peak. For the A, only, the test pan has three note areas (A 220 Hz, A 440 Hz and A 880 Hz). The scope for production of difference tones at multiples of 220 Hz is therefore considerable. Investigation of the time history of this particular note by Jim Woodhouse shows beats of 10 - 15 dB amplitude and about 5 Hz frequency in the 880 Hz component, and slower beating in the 440 Hz component.

The tuning of note areas, and initial tone generation for each note, appears to be governed by each note area independently; however the overall sound is influenced by interaction with other note areas.

CONTINUING WORK

Initial tests have provoked more questions than they have answered. Systematic investigations of the modal vibration patterns of single note areas and transfer functions of vibration between note areas are in progress, to assist in understanding the tuning procedure.

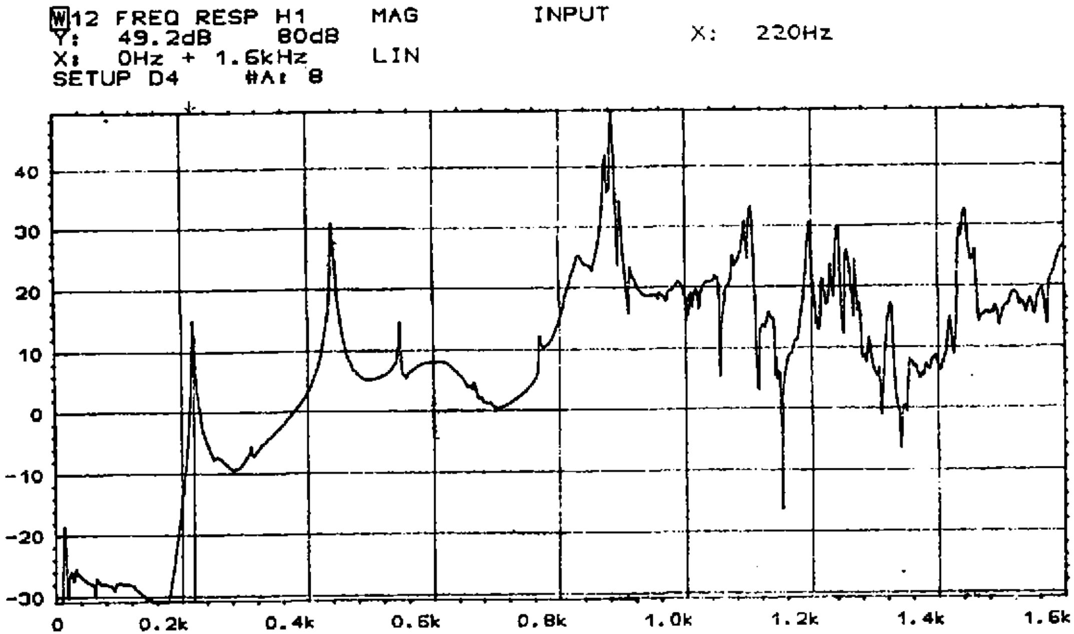

Figure 1: Spectrum of note A 220 Hz, soprano pan.

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REFERENCE

1. C.Y. Barlow. "A metallurgical investigation of steel for pans". Internal project report, 1986.