

# Auto Harp

10'59

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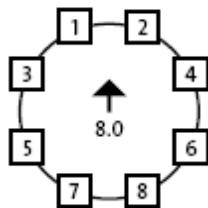
for eight-channel loudspeaker array

## Program Note

The autoharp is a smaller and simpler version of the orchestral instrument. It's usually played by strumming with a pick or finger while pressing one of a number of levers causes certain strings to be muted, leaving a chord. This results in an instrument which is very easy to play, but is also quite limited.

Auto Harp, is an attempt to extend the musicality of this simple instrument beyond its physical limitations, using a number of different electroacoustic techniques.

## Loudspeaker Arrangement



## *Auto Harp*



Fig. 1 A “Rosen” autoharp

*Auto Harp* is an eight channel acousmatic work constructed from recordings of strummed arpeggios and individual plucked strings on the autoharp shown in Figure 1. This particular type of autoharp was manufactured in the former East Germany in the 1950s and 60s and second-hand instruments are now widely and cheaply available. East German factories were not allowed to put their own factory/family name on instruments during this time and so no identifying marks appear on these instruments apart from the distinctive rose decal. Hence these instruments have come to be collectively known as “Rosen” autoharps, from the German word for roses. Autoharps are played by strumming with a pick or finger. Pressing one of a number of levers (six in this case) causes certain strings to be muted, leaving a chord. This results in an instrument which is very easy to play, but is also quite limited, as picking and muting individual notes is difficult due to the tight spacing of adjacent strings. The autoharp has therefore been predominantly used as an accompaniment instrument, particularly in American folk music.

The acousmatic piece, *Auto Harp*, is an attempt to extend the musicality of this simple instrument beyond its physical limitations. The composer Denis Smalley’s ideas of gestural surrogacy play an important part in this work as at various times the focus shifts from clearly instrumental gestures (first-order surrogacy) to static environmental textures

(second-order and remote surrogacy) created from the complex, sustained resonance which results from a strummed arpeggio through all twenty-four undampened strings of the autoharp. Various strummed arpeggios and picked sequences were recorded using both monophonic, stereo and Soundfield microphone arrangements, and these arpeggios form the basic building blocks of the entire work. These clearly instrumental passages, presented in static spatial locations, represent the first order surrogacy material, which is then abstracted to second-order and remote surrogacy using a variety of techniques. Each individual string was also recorded in isolation, and these samples are used with various algorithmic techniques to generate new sequences. Although these algorithmic passages are still clearly instrumental in origin, the rapid spatial distribution and complicated picked sequences produced are somewhat removed from the basic first order gestures produced initially from static spatial locations. More remote levels of surrogacy are attained through the use of granulation time-stretching techniques which emphasize and sustain the complex resonance of the vibrating strings. The only material which is entirely synthetic, and hence displays remote surrogacy, is the layered sine waves used in the two Franssen sections that open and close the piece.

The opening section of this work makes use of an psychoacoustical illusion, the Franssen Effect, an auditory illusion which produces large and unpredictable localization errors in human listeners. This illusion was first reported by N. V. Franssen in his 1962 thesis on stereophonic localization. In the initial experiment, two loudspeakers were arranged symmetrically in front of a single listener. A sine tone with a sharp onset transient is routed to one loudspeaker and immediately begins to exponentially decay over a fixed time period,  $t$ , while concurrently, the same signal exponentially rises in the other loudspeaker, also over the same period,  $t$ , as shown in Figure 2. Franssen found that listeners consistently localized the source signal to the initial loudspeaker, even after the signal had entirely moved to the other loudspeaker, and this illusion has since been referred to as the Franssen effect. It has since been discovered that this effect is entirely based on the inability of a listener to accurately localize a steady-state sine tone in a reverberant space. The source is first perceived at the location of the initial onset transient, and as the following steady-state sine wave provides no further reliable localization cues, the perceived source location remains unchanged, even after the real physical location of the source has moved to the other loudspeaker.

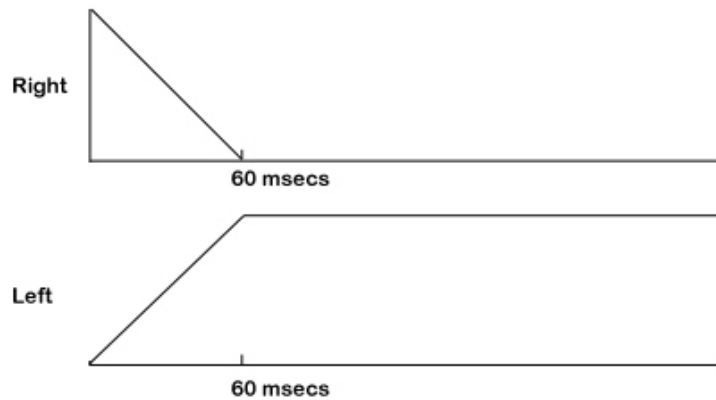


Fig. 2 Loudspeaker envelopes in *Auto Harp* Franssen section

String No.	Harmonic	Freq
1	1	261.6
2	1	261.6
3	3	392.4
4	7	457.8
5	2	523.3
6	9	294.3
7	5	327.0
8	11	359.7
9	3	392.4
10	7	457.8
11	2	523.3
12	9	294.3
13	5	327.0
14	21	343.4
15	3	392.4
16	7	457.8
17	15	490.5
18	17	278.0
19	19	310.7
20	5	327.0
21	23	376.1
22	3	392.4
23	7	457.8
24	2	523.3

Table 1 *Auto Harp* tuning scheme

The introductory section of *Auto Harp* uses the loudspeaker amplitude envelope shown in Figure 2 in conjunction with twenty-four sine tones which correspond to the twenty-four strings of the autoharp. Each string is tuned to a different harmonic (octave adjusted) of the lowest note (C 261.6Hz) as shown in Table 1. Each harmonic is adjusted so it falls within a two octave range. This spectral tuning produces a complex resonance with

very little beating due to the close harmonic relationship between each string. Each sine tone onset is presented in sequence from the four loudspeakers to the right, moving from front to back, and is shifted to the matching loudspeaker on the left using a transition time  $t$  of 60ms. After all twenty-four sine tones have been introduced, reversed recordings of each individual string are gradually introduced at the same real spatial locations as the associated sine tone, and the entire sequence builds to a sharp crescendo. The overall effect of this sequence is to delay and disguise the movement of the layered sine tones from right to left, as the initial onsets are clearly localized to the right, while the final reversed autoharps recording clearly crescendo on the left side. Localization during the middle steady-state section will therefore vary depending on the acoustical environment, the individual listener and the associated strength of the Franssen effect, introducing an element of variability in a composition for fixed media.

The overall structure of *Auto Harp* is marked on the waveform of a monophonic reduction of the eight-channel work in Figure 3. The crescendo which marks the end of the initial Franssen section is articulated with a spatial sweep from front to back on the left side of the array. This is immediately responded too by a sweep through each individual note in a corresponding spatial motion from back right to front right. The entire Play section which follows uses this type of spatial dialogue between static arpeggio recordings and dynamic, algorithmic sequences. In each case, a recorded arpeggio (mono, stereo or b-format) produces an algorithmic response, which is constructed from the individual string recordings, pitch shifted up an octave. The spectromorphological profile of each recorded arpeggio was carefully applied to the algorithmic response by matching the duration of each sequence.

The next section is introduced by a mono recording of the plucked sequence which functions as the main melodic theme. The theme is presented four times in this section, initially as the performed sequence in the original mono recording. This is followed by a sequenced recreation of the theme using the individually recorded strings which are spread across the front pair of loudspeakers. The final two iterations of the theme use both the original progression, and various sequenced progressions which are distributed across each of the four loudspeaker pairs. In this case, the sequenced progressions are also transposed to harmonize with the initial progression. A granulated time-stretched version of this progression is also introduced in this section, shifting the focus away from the highly

gestural material which has dominated up to this point. The spatial distribution and dynamic of this drone alters in response to the instrumental gestures and at times the drone itself displays strong spatial gestures. This is evident in the crescendo that ends this section, and also at 3'48, when the diffuse drones builds and then suddenly collapses to low frequency drone statically positioned in the front loudspeaker pair.

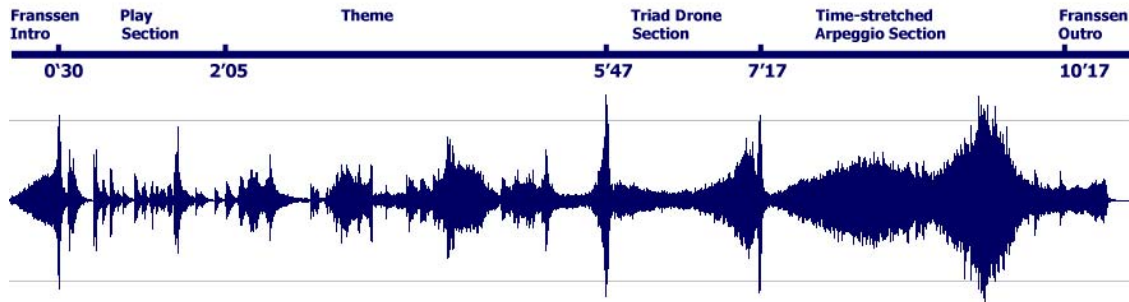


Fig. 3 Monophonic reduction of *Auto Harp* indicating section durations

The *Triad Drone* section is the first to move away completely from the highly gestural arpeggios and sequences which dominated the opening half of this piece. The first harmonies which are not contained within the tuning system shown earlier are also introduced in this section. Multiple stereo channels of a spectrally rich drone were constructed from a recorded arpeggio which was time-stretched using the *granule* opcode in the Csound processing language. Two of these decorrelated stereo channels quickly begin a slow upward glissando before eventually settling at two pitches to form the triad drone which gives this section its name. The two pitch-shifted drones were tuned by ear to produce a relatively consonant yet unusually pitched harmony. The tuning of these two new drones corresponds approximately to the fifth and ninth harmonics of the original root note.

The penultimate section is, as its name suggests, primarily constructed from a time-stretched arpeggio constructed using a granulation algorithm in Max MSP. The resulting drone quickly separates into a dense cloud of clicks created from the initial plucking action and a thick, mid-frequency drone created from the resonance of the instrument. This spatially diffuse sequence decays slowly and then builds again to a final crescendo which is punctuated by occasional unprocessed arpeggios. The piece ends with a reversal of the

initial Franssen section, as the drone fades into associated sine tones which collapse spatially in the same way as they appeared.