

Since Ircam started, many composers came to work, and the fact is that many of them were interested in using instrument tones.

We consider that this desire of working on instrument tone came from

2 main motivations. One being to get acquainted to Electronic Music

^{While Keeping} ~~through~~ familiar references, the other, ~~is~~ ^{Being} more profound, ~~is~~ to consider the computer as a mean to investigate contemporary organology.

~~THE~~ The former cannot be applied to the german composer, York Höller~~A~~, who had already an extensive experience ~~in~~ electronic music in Cologne, but the later is certainly what was most attractive to him. He had the idea of using a selection of traditionnal orchestral instruments both on stage and on tape. The tape would developpe modes of playing which the acoustical instruments dont allow. Therefore, the electronic was considered as an extension of the stage instruments.

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The part of the work we will present today ~~is~~ involves tools previously designed for the simulation of instrumental tones. This work was pioneered by people like J.C. Risset, and developed in many different ways, using several synthesis technics, by researchers in the music and psycho-acoustics domains. We have been using tools designed in different centers such as Stanford, Colgate, Ircam by D.Wessel, Jhon Chowning Jhon Grey, Neil Rolnick, Dexter Morrill and others. These tools served as a basis for our own research. That, by the way, illustrates an important fact in the computer music field, that is the continuity of work, the ability to use, to adapt, to extend other people's work.

— SLIDE NOMENCLATURE —

FA-3

The effort has not been emphasized on the realistic aspect of the simulation of the instrument tones. We have selected instruments offering specific features. These instruments had to have sufficient quality in the approximation of the models. In fact, the piece ~~is~~ ~~associating~~ was to associate tape and orchestra, and a ~~blending~~ satisfying blending was to be insured between the 2 types of sources. Furthermore, the tape was to appear as an extension of the orchestra. There was to be a fusion between the tape and the orchestra, from which the tape had to be perceived as "UN JEU INSTRUMENTAL INOUI", something impossible to be realized on any acoustical instrument. As if there were instruments with an unheard ~~of~~ of flexibility merging from one into the other.

The work was developed at Ircam, using a Dec PDPIO computer, ~~using~~ MUSICIO ^{being} as the program for sound synthesis, Andy Moorer's reverberation program, ^{and} a digital mixing program ~~and Leyland Smith's~~ ~~Score program~~. None of these programs ~~XXXX~~ works in real time.

Scores were written using Leyland Smith's Score program. In addition, we used a real time bank of oscillators, the 4A synthesiser.

The ^{Work} was accomplished in 3 steps. First of all, the research ~~XXXX~~ period, which was spent in the evaluation of the existing tools, ~~XXXX~~ and their possible modification in relation with compositionnal expectations.

In the second period, the composer wrote the score according to the possibilities of the selected instruments as well as the orchestral score. The realisation of the tape part itself was done in the 3rd period

AN EXAMPLE OF FEATURE 1)

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~~Let's start their description with~~ the tremolo, also called quasi-periodic amplitude modulation. The tremolo feature was either built into a simulating instrument as well as an instrument by itself which was operating on already reverberated sounds. ~~XXXXXX~~
In this case the process consists of generating a sound file using the simulating instrument, ~~XX~~ reading this sound file from the storage medium, reading the samples into the modulating instrument, ~~XXXXXX~~ through the MUSICIO input module and writing a new sound file.

~~Slide BERLIOZ~~

to a serie of 34 numbers, serie which has been used extensively ~~XXXXX~~ throughout the piece as a compositionnal principle, transposed in differer scales, applied to various parameters like duration, pitch, intervals, timbres, textures. This very same serie structures the all composition. Another type of micro-intervals were the dynamic ones. They were used to provide a dynamic texture within a note. This was not induced by the score, but was introduced to create an internal life through a slow motion of the micro-intervals.

synthesis

Another treatment of the piano was the combination of several instrument models within one structure which leads to considerable modifications of the original instrument, Like in this example ~~X~~ which shows progressive transition between 2 instruments.

EX 3 no slide

→ Expansion and Compression of the
 spectra with time

Let's play now an example that wont remind of any real instrument, while preserving an instrumental aspect.

EX 4 no slide

In this example, each note receives a different timbre. It has been synthesised using the technic called wave-table synthesis which uses a wave-form obtained through analysis of real instrument tones. We have used cello wave-form taken from the ^{whole} range of the instrument. At the begining of the structure, we ^{we} used wave forms coming from the lower range of the cello, and as the structure goes on, we used wave table coming from higher and higher tones, resulting in variations of timbres going from rich to poor. An interesting fact is that the irregularity in the evolution of the timbre is a result of the natural dispersion of the formants of the ^{original} ~~natural~~ instrument.

Lets play an other example using the same imaginary instrument in a different context. This will be within its tape environment: the 4 tracks together.

EX 5 no slide

IT IS INTERESTING TO NOTICE THAT THE HIGH INSTANCES
COME FROM THE TRUMPET PLAYED HERE
IN A RATHER REMOTE FASHION

An other feature is the overall envelope of a musical phrase. It is rather obvious, but it becomes necessary to pay closely attention to it when synthesising musical passages. ~~XXXXXXXXXXXX~~ It concerns the dynamic modification of a music phrase. We had to respect the natural dynamic evolution of a tone, and, at the same time, apply the dynamic nuances, ~~XXXXXXXXXXXXXXXXXXXXXXXXXXXX~~ which is executed naturally by an instrumentalist. Therefore, we used an overall envelope applied to ^{the whole} ~~a~~ musical phrase. That provided also accents at the begin of notes, for instance, such as sforzando, that you will hear at the beginning of ~~the~~ next example in the string section.

This technic had the advantage to be applied to the amplitude envelope as well as to the spectrum envelope, as is permitted in FM and wave shaping synthesis, and by the additive synthesis, after the Steve MC Adam model.

~~XX~~
~~XX~~

In this example we find a number of ^{different} ~~of~~ different wind and string instrument such as flute, brass instrument, bowed and plucked ~~XXXXXXXXXXXX~~ string.

EX 6 Slide 3a, 3b

STOP AVANT TAPE/ORCHESTRA!!!!!!

In the middle of the example, we may have noticed a long glissando. This was produced by the real time bank of oscillator, the 4A machin. This cluster was using 256 oscillator, each of them reading a complex wave form obtain^y by the analysis of violin tones. The complex texture was ^{given} ~~obtained~~ by the accumulation of these elementary wave table

Providing string parfum, string wall-paper without the specific mode of playing of the violin.

The amplitude modulation ^{is} ~~was~~ used on several phrases: in the flute ostinato at the beginning, it sounds more like a flatterzung, when at the end ~~of~~ the example it is applied on the ~~XXXXXX~~ reverberated resonances of brass tones.

The trumpet-like sounds that you have heard, were synthesised by Dexter Morrill frequency modulation algorithm. The compositionnal context required a close to natural sound synthesis, to achieve the fusion with the orchestra brass section, as you will hear now with the coming example which puts together tape and orchestra in the ~~Message~~ ~~XX~~ same passage than previously *heard*

~~EX 7~~ Slide 4a ~~(9 slides)~~

~~XXXXXX interesting notice that the XXXXXXXXX like XXXXX~~

~~XXXX~~

Sometime no modification at all are applied, ~~XXXXXX~~ other than transition toward another instrument. In the coming example you will notice various wind instrument among which a ~~flute~~ ^{clarinet} is progressively transformed into a ~~clarinet~~ ^{FLUTE} tone. We will present first the tape alone, and ~~right~~ after the same thing with ~~in~~ the ~~XXXX~~ orchestra.

———— EX 8 & 9 (enchaines sans amorce) ————

———— Slide 5a, 5b ————

This principle of transition is presented in various manners in the next example, in the wind section. You will hear the transitions involving: flute, clarinet, oboe, english horn, with punctuation, from trumpet, trombon, french horn. Another feature is the use of compression and expansion of spectra. It appears in 2 manners. The flute voice, realized with the frequency modulation, uses a variation of the c/m ratio in which only the modulating frequency is moving according to the same serie. The 2nd manner involves Steve McAdam's additive synthesis instrument, built ^{for} psychoacoustic experiment ~~XXXXXX~~ on spectral fusion. The degree of inharmonicity was controlled by the serie transposed in the appropriate scale. The example will be presented in two forms, but this ^I time, with the orchestra first.

~~XXXXXX~~

———— EX 10 & 11 ———— Slide 6a, 6b

We have been taking advantage of the work of several people and the tools we have developed after them are available to any one that who expresses the desire to use them. Eventually, they will be published some day. As far as ~~our work is~~ ^{we are} concerned, the process will go on, but in a different manner. As a matter of fact, strong options have been taken at Ircam for real time ^{sound} synthesis and sound processing. Since these tools are not linked to a particular hardware, but consist of a library of general algorithms, they will be implemented on the 4X processor for real-time operations. The ~~xxxx~~ 4X has been presented here by its creator Pepino Di Giugno and his team.

This implementation will allow various kinds of parameter definitions and instruments activation. Not only will we use conventional note - list structures, but also we might think of hooking up the instruments and the compositional algorithms with real time input control devices as has been discussed yesterday by Martin de Loye. The real time response allows, as compared to non real time programs, a deeper control, that is, it becomes possible to really tune parameters with a maximum of efficiency instead of being in the usual position of trying to conceive abstract parameter values. It has always been difficult to express in absolute numbers what music conceives as subjective comparisons: musicians are used to describe or express ^{musical events by} using relational scales such as pitch. A connection between numbers and gesture will be possible by using the gestural peripherals of the 4X.

~~XXXXXXXX~~ NUMERO E SUONO
 NUMERO E GESTO

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As has been underlined by several speakers along this conference a ~~XX~~ strong characteristic of computer music is the great amount of communication and ~~XXXX~~ echangability of researches. Hopefully, this degree of communication will increase as toolssbecome shared more and more such as UNIX, for instance, and through the networks.

This will lead to rich and powerfull application and development of our field.