# The CASPAR Artistic testbed

# A precise case from artistic production : preservation of FM Synthesis

**Jerome Barthelemy**

**Institut de Recherche et de Coordination Acoustique/Musique**

# Overview

- Context
  - Music production with digital components since the 70ies
  - CASPAR and OAIS : a formal approach
- An example
  - Diademes by M.A Dalbavie (1986)
  - The FM Synthesis problem
- Assessing authenticity
  - The composer's point of view
  - Other example of use of FM Synthesis : « Madonna of Winter and Spring » by Jonathan Harvey (1986)
- Authenticity in the CASPAR framework
  - Authenticity as a process
  - Examples of authenticity processes

# Context : current state

- IRCAM : musical production since the 70es
- Development of audio/music digital processors :
  - 4A, 4X…. (Hardware)
  - Max/MSP (Software)
  - Audiosculpt, Modaly, OpenMusic… (software)
- Musical creation using audio digital processing
  - 450 works created since 77
- Problem of preservation recognized since the middle of the 80s, but no formal approach
  - Production of documentation (from 80es to 2000 - in paper)
  - From 2002 : digital storage of documentation and digital objects : Mustica

# Context : aims and goals

- To be able to REPERFORM the works
  - Not simply record audio files !
  - To make possible interactions between human performers and digital processes :
    - Preserve the processes themselves, not the results
    - What processes?
      - Digital instruments (audio effects, like reverberation, harmonizers…)
      - Encoded in the form of « software »

# Context : CASPAR and OAIS

- OAIS : A formal approach to preservation :
  - provides the concepts needed by non-archival organizations to be effective participants in the preservation process;
  - provides a framework for the understanding and increased awareness of archival concepts needed for Long Term digital information preservation and access;
  - provides a foundation that may be expanded
- CASPAR : implements an OAIS compliant framework

# An example: Diademes by M.A. Dalbavie

- **Creation in 1986,**
- **Written for solo viola, acoustic orchestra and live electronic**
- **Live-electronic part :**
  - **1 YAMAHA TX816 : FM-Synthesis for 2 Yamaha KX88 keyboards**
  - **2 YAMAHA SPX1000 : Effects/Transformation of the viola: Harmonizer & Panning**
  - **2 YAMAHA REV5 : Effects/Transformation of the viola: Reverberation & Echo**
- **Several new performances since 1986 (the last one in 1995)**
- **No new performance since 1995 (but several attempts), due to issues related to FM synthesis component**
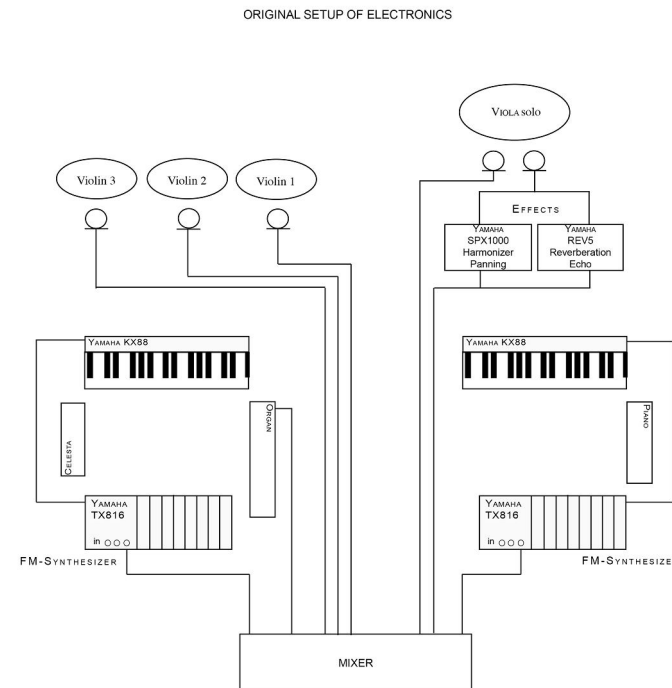
# An example: Diademes by M.A. Dalbavie

- A new performance is foreseen at the end of this year (December - New York)

- Necessary to port (and ensure the good performance of live electronics part)

- Most important criteria of « good performance »: Authenticity

# An example: Diademes by M.A. Dalbavie

- **Live-electronic part :**
  - –1 YAMAHA TX816 : FM-Synthesis for 2 Yamaha KX88 keyboards
  - –2 YAMAHA SPX1000 : Effects/Transformation of the viola: Harmonizer & Panning
  - –2 YAMAHA REV5 : Effects/Transformation of the viola: Reverberation & Echo

ORIGINAL SETUP OF ELECTRONICS

VIOLA solo

Violin 3   Violin 2   Violin 1

EFFECTS

Yamaha SPX1000 Harmonizer Panning   Yamaha REV5 Reverberation Echo

YAMAHA KX88   YAMAHA KX88

ORGAN   PIANO

CELESTA

YAMAHA TX816   YAMAHA TX816

in ○○○   in ○○○

FM-SYNTHESIZER   FM-SYNTHESIZER

MIXER

# An example: Diademes by M.A. Dalbavie

•**FM Synthesis :**

– Modulation of a waveform by another waveform (both in the audio range)

– Original implementation by Yamaha (under patent)

– Results in « complex » sounds, not produceable by another means

# FM Synthesis issue

- Since 1995 (patent expiration), hardware not maintained
- Several tries to port or emulate FM Synthesis on different systems
- Previous attempts software emulation :
  - By Ipke Starke, November 1998
  - By Colin Yates, December 2001
- Attempts not satisfying for the composer
- Approach chosen in 2008:
  - Record each FM Synthesis sound on the original hardware (fortunately available) according to thge limited set of parameters in use in Diademes

# FM Synthesis issue

- Comparison with other works using the same hardware :
  - « Madonna of Winter and Spring » by Jonathan Harvey (also 1986)
  - Porting realized in 2006 using emulation by Native Instruments (not done in Ircam)

- Two different forms of emulation :
  - Diademes : recording of original sounds, and use of a software sampler
  - Madonna of Winter and Spring : FM Synthesis emulation

# Other issues

- For harmonizer, panning, reverberation and echo :
  - Preference given to a modern effect
- A porting has been realized
  - According to the composer, he prefer in this case the modern effects.

# FM Synthesis issue

- Different point of views
  - Composer (different point of views according to each « unique » vision)
  - Scientist : model (modulation of a waveform with another waveform)
  - Software developer : algorithm
  - Issue : how to cope with these different point of views, regarding « authenticity »?

# Authenticity in CASPAR

- Authenticity is a process (Mariella Guercio, University Urbino)
- CASPAR defines Authenticity Protocols (AP)
  - Each one composed of several steps (AS)
- Must be executed at different steps according to the lifecycle of the object (access, migration…)
  - Each execution is composed of different execution steps (ASE)
  - The overall result should lead to an evaluation of the authenticity
- Defined accordingly to a Designated Community

# Considerations on Authenticity (1)

- Need to attach different AP to different steps of the lifecycle. Example:
  - AP1 <-> Migration of component
  - AP2 <-> Maintenance
- Different AP for context
  - Dependent on the work in which is used (example of FMSynthesis)
  - Dependent from the point of view of community
    - Developers
    - Musical assistant
    - Curators

# Considerations on Authenticity (2)

- End users unable to create « Authenticity protocols » from scratch
  - Different roles for curator and musical assistant
- Need to have templates and customization
  - Curator creates templates
  - Musical assistant customize
- An example of an authenticity protocol template, for an audio processing effect migration (AFX1 -> AFX2):
  - Provide sound samples in input (SI1.. SOn)
  - Provide sound samples in output (SO1 .. SOn)
  - Apply AFX2 to SI1..Sin (get SO2..SOn)
  - Compare SO1..Son with SO2..Son according to features F1..Fn

# Authenticity protocol #1

- Case : maintenance (audio file)
  - Compute fixity
  - Verify provenance

# Authenticity protocol #2

- Case : migration of audio file, from format f1 to format f2
- AS1 - before migration : verify semantics (is it an audio file) ?
  - Yes : continue
  - No : failure - apply another protocol suitable to the right semantics
- AS2 - verify file not compressed
  - Yes : continue
  - No : uncompress (or return to analog!)
- AS3 - before migration : verify availability of source sampling rate and sampling size in target format f2
  - Yes : continue
  - No : failure - apply another protocol
- AS4 - after migration : compute fixity of sample size and sample rate
  - Yes : continue
  - No : failure - apply another protocol
- AS5 - after migration : compute fixity of Pulse Code Modulation from audio files
  - Yes : continue
  - No : failure - apply another protocol

| Audio file? | → | Failure - apply another protocol |
| Compression? | → | Decompress |
| Sample rate? Sample size? | → | Failure - apply another protocol |
| Migration | | |
| Fixity sample rate & sample size | → | Failure - apply another protocol |
| Fixity PCM | → | Failure - apply another protocol |
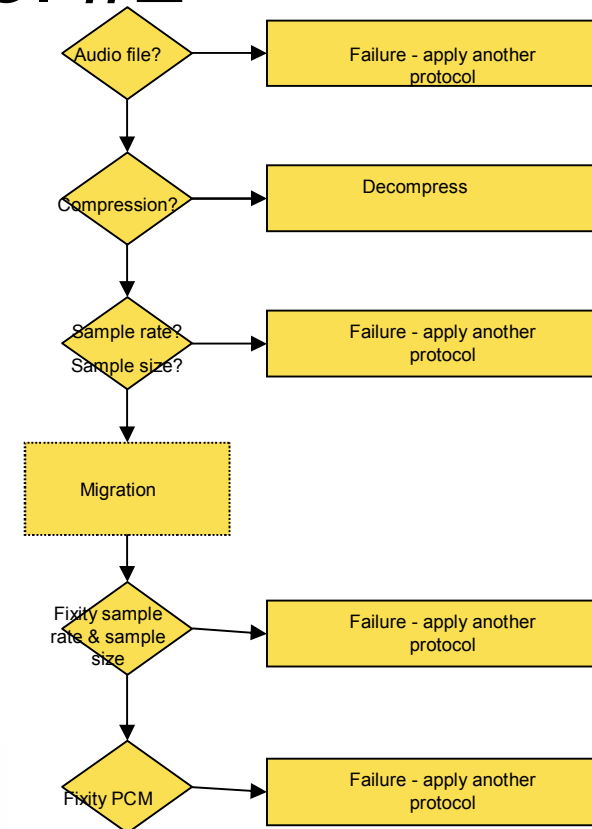
# Authenticity protocol #3

- Case : migration of an audio effect (AFX1 -> AFX2)
  - Ingest phase (AP1):
    - AS1 : Define a list of audio samples in input (using predefined audio samples 1khz sinusoid…)
    - AS2 : Apply to them the audio effect AFX1, and store the output audio samples
    - AS3 : Define the comparison features (with range) that are to be validated when executing AP2
  - Migration phase (AP2) :
    - AS1 : Apply to input audio files the migrated audio effect AFX2 and store the results
    - AS2 : Compare the audio samples resulting from AFX2 to those resulting from AFX1, according to features defined in AP1

# Conclusion

- From Mustica to MustiCASPAR:
    - Management of the archive lifecycle :
        - Support of Ingest and Access based on Representation Information
        - Support of Provenance, Context
        - Support of notifications (unavailability of components, changes in the knowledge…)
        - Support of Authenticity
    - Conforms to standards:
        - CIDOC-CRM (RDF) for Description
        - XFDU for packaging
        - OAIS…