# *ReacTable**

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# The MTG Interactive Systems Team

- Sergi Jordà
- Alvaro Barbosa
- Gunter Geiger
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+ Xavi Rubio & Carlos Manías (final projects at ESUP)

+ New *Interactive Lab* in Ocata

# Goals of the *ReacTable**

1) Research & Development of a project that combines most of the team members' interests and know-how

   Some of these interests are (in alphabetical order):

   - Algorithmic composition
   - Collaborative creation (on and off-line) and distributed systems
   - HCI (new systems and new HCI paradigms)
   - Musical instruments design
   - Real time audio synthesis and processing architectures
   - Real time music creation (computer music improvisation)
   - Sensors and physical interfaces
   - Sound-image Interaction (*sonification* and/or audio visualization)
   - Video detection

# Goals of the *ReacTable**

2) Research & Development of a project that employs most of the MTG technologies and know-how in an “artistic” and experimental context

Some of these technologies are (in alphabetical order):

- Advanced spectral audio processing
- Audio synthesis (e.g. SALTO)
- CLAM
- Music Retrieval
- Rhythm parameterization
- Voice synthesis and processing
- ….

# Goals of the *ReacTable**

3) Creation of a state-of-the-art interactive music instrument

- Collaborative (off and on-line)
- Intuitive (cero instructions)
- Sonically challenging and interesting
- Learnable
- Suitable for complete novices (in installations)
- Suitable for pro electronic musicians (in concerts)
- Totally controllable (no random, no hidden presets…)

- Too often, *sonic installations* and *music instruments* are mutually exclusive:
  - The first are too simple and easily boring
  - The second are too complex and easily discouraging

# What does "*for novices & pros*" means?

- That a new user entering the installation is able to produce interesting and surprising, but also intuitive, results
- That in several seconds-minutes, this user is able to modify parameters, and although these results may be not 100% as expected, this user still feels a total sensation of control
- That a more skilled musician (with a reasonable knowledge of electronic music), is able to intuit all the possibilities, if not before executing them, at least immediately after (i.e. when they produce sonic results)
- That everyone is able to progress "indefinitely" in the use of this instrument

# Some *ReacTable** premises

- No manual - no instructions
- No mouse - no keyboard
- No cables - no *wearables*
- Unlimited number of users
- Users can enter/leave without announcement

Many interactive musical systems (specially hardware based) lean in a technology (types of sensing, etc.) without worrying for the sonic results

- The *ReacTable* technology has to be transparent
- Its sonic results are a fundamental component

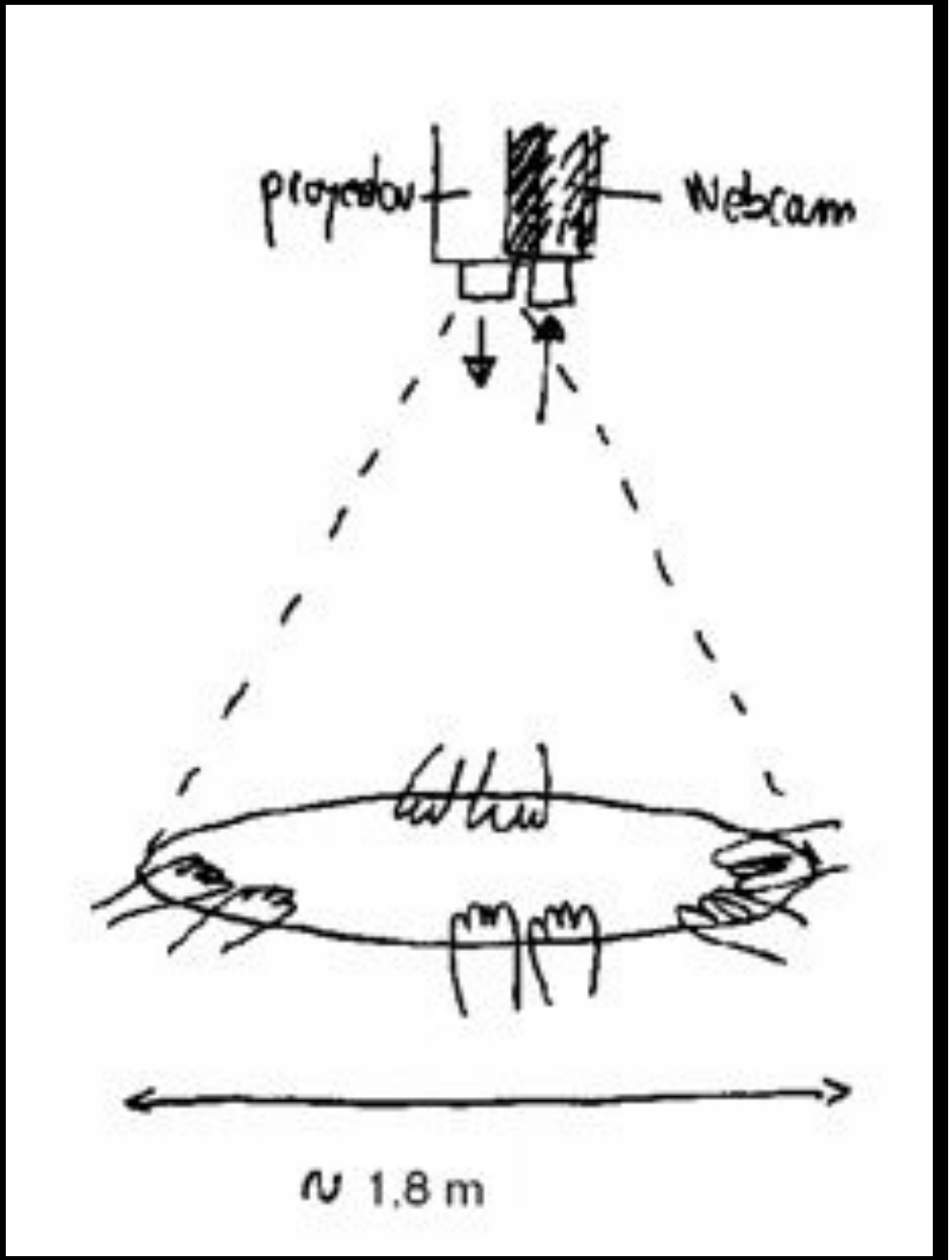
# Some inspirational models, technologies or topics

- FMOL
- MAX / PD
- Augmented reality
- Computer vision

The *ReacTable** uses Comp.Vision technology and Aug.Reality paradigms, within a MAX-like architecture and FMOL-based HCI models and visual feedback

# The *ReacTable** is a reactive table ;-)

- *Computer Vision* but NOT *body motion capture*
  - Many don't like to "dance"…
  - But we all work and socialize on tables
- The table has no sensors
- The table has no graphs nor drawings
- White table + a projector & a webcam
- Webcam permanently analyzes the surface of the table
- Projector draws on the table a dynamic & interactive interface
- Interface with abstract and dynamic components and an intrinsic visual interest.
- NO buttons, sliders or menus!!!



# Some *Computer Vision* technical issues

- Retro-projection
  - Pros:
    - cleaner projection (no over hands & arms)
    - cleaner & easier installation (with mirrors?)
  - Cons: harder to project over objects (transparent *metacrilate*?)
- IR vision:
  - easier to eliminate projected background for CVision
  - only needs a IR light (on top) and a IR cam (BW cam + filter)
- Webcams, DVCams and vigilance cams
  - Vigilance cams (+ cheap analog video card) are faster (i.e. transmission without compression)
  - BW vigilance cams do not filter IR

# Interacting with the *ReacTable**

- Diverse passive objects are on the table
- Users interact with them (move, change orientation on the plane, change sides…)
- The Comp.Vision system determines:
  - Position (x,y), orientation ($\alpha$), side, type… of each object
  - Hands movements

# *ReacTable** Objects

- Objects are mainly passive (wood or plastic) with no sensors (some exceptions)
- Objects have different shapes
- Objects have different sizes (~10-30 cm)
- Some objects have different facets or sides ➔ diff. functionalities (e.g. a *dice*)
- Objects try to be intuitive at diff. levels

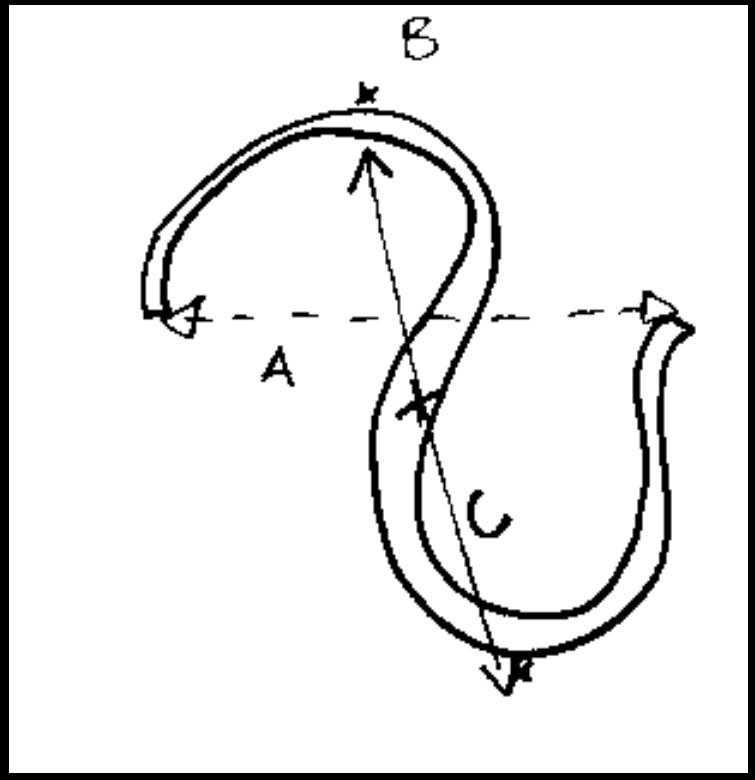
  (e.g. a *comb* is only intuitive for those who know what a *comb filter* is!)
- Projection interacts with the objects (drawing figures on top, auras around…)

NB. These pictures are only illustrative. Most *ReacTable** objects will be custom made

# More about Objects

- Some objects can have variable shapes (e.g. a flexible plastic tube) for continuous multi-parametrical control

- Some objects can have more complex drawings for discrete parametric control. In this case, drawings should suggest their functionality (e.g. a plastic or wood passive keyboard – everyone knows what they're for…)




# Active Objects?

- Some objects may have sensors (e.g. tap or pressure sensors)
- In that case, they should use wireless transmission (no cables!)

- Examples:
  - The “Hand” object is designed to be tapped with the fingers
  - The “Mallet” object can tap on anything

# Objects' Functionality

- May depend on:
  - The object itself
  - Its orientation, side (icons), relative position (related to the background)…
  - Its context, neighbors…
  - Color?
  - Hands (that manipulate them)?
- Objects are intuitive but an interactive projected help is not discarded

# O.K. we know there **are** objects, but what should we do with them?

- Like MAX or PD, *ReacTable** has 2 types of streams: control & audio
- Some objects have
  - generic control outputs: *e.g. the flexible tube*
  - fixed control outputs: *e.g. the wood keyboard* (pitch)
  - audio outputs: *e.g. a sound generator*
  - control inputs: *e.g. a sound generator*
  - audio inputs: *e.g. a filter*
- Objects can have dif. inputs & dif. outputs:

  *e.g. a filter has several control inputs, one audio input and one audio output*

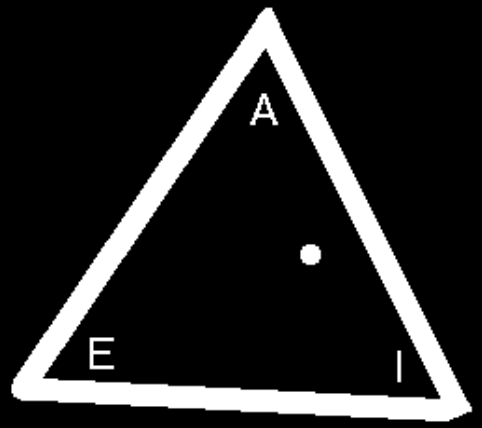
# Some objects that generate control output

- Dif. kinds of LFOs
- Chaos generators
- Dif. algorithmic comp. methods
- Harmonizers* (could also be designed at audio level) and other control filters or control processors
- Etc.

# Some objects that generate audio output

- Basic oscillators
  - The 6 sides of a dice can be used for 6 different oscillators (sine, square, saw, triangle, random and pulse)
- Complex synthesizers (SALTO, voice, etc.)

  (in the figure, a vowel interpolator, courtesy of J.Bonada)
- Sampler players
- Etc.




They have only control inputs.

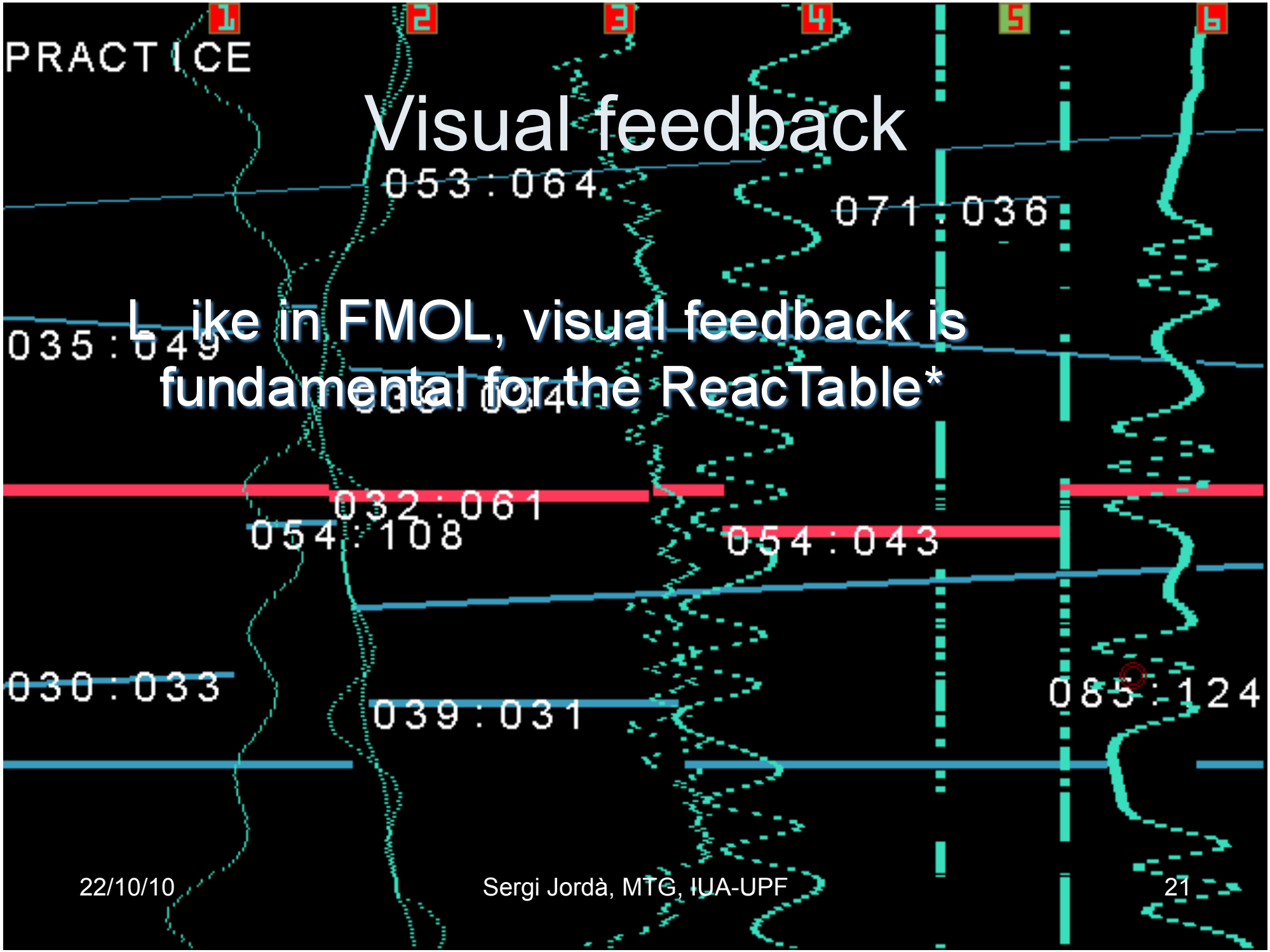
# Some objects that process audio

- Filters, EQs…
- Reverbs, delays…
- Compressors, expanders…
- Gates (some with multiple outputs, for spectral delays etc.)
- Multipliers or audio interconnectors (objects with several audio inputs) for FM, Ring, etc…
- Granulators
- Etc.

They have control and audio inputs and audio outputs

# Some other miscellaneous objects

- Some objects can convert audio into control
  - Envelope followers
  - FFTs
  - Etc.
- Preset recorders & sequencers (the first work without time)
- Quantizers
- Sync Clocks
- Percussion pads
- Toy keyboards
- Soft mallets (can hit other objects to synchronize, adjust tempos…)
- Etc.



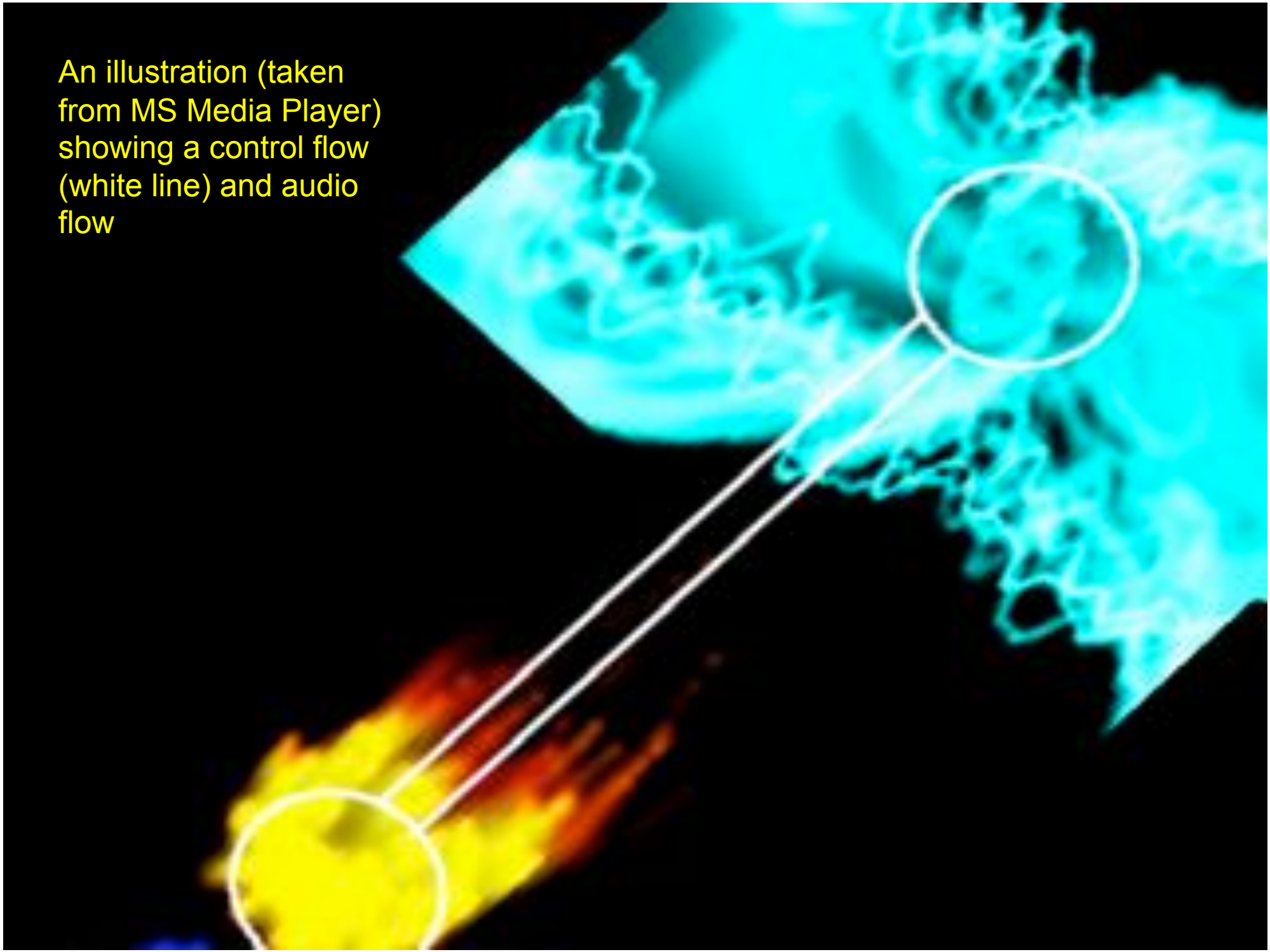

# Visual feedback

Like in FMOL, visual feedback is fundamental for the ReacTable*

# Visual feedback

- When a control flow is established between two objects, a thick straight line is drawn between them, showing direction, rate, intensity…(control flow lines are simple)
- LFOs and other macrotemporal values will be seen as blinking animations projected on top of the objects, showing frequency and shape (e.g. square vs. sinusoidal) (problem with retroprojection)

- Audio flow lines are *organic* and complex
  - Macrotemporal audio variations (vibratos, tremolos, rhythms…) will modify the shapes of this lines (in Bézier-like style)
  - While the contents of these shapes (colors, intensities…) may be vaguely spectral


An illustration (taken from MS Media Player) showing a control flow (white line) and audio flow

# Intuition & Usability

Unlike MAX (or PD), the *ReacTable** has to work “by default”.

The philosophy is: “*Any gesture has to produce audible results*” & “*Try always to avoid frustration*”

Here are some laws:

- Objects are not active until they are touched
- If on start-up, a user activates an object that doesn’t sound, the closest audio object is automatically linked to it (and the link is visualized)
- Active objects have a dynamic visual *aura*
- Moving an object on the table can change the relations with the other objects (although relations can also be “fixed”, e.g. by touching two objects with the two hands – fixed links are shown with a thicker line or a dif. color)

- The system has also some “intelligence”:
  - Chooses what are the best parameters to control in any case (a control object can be adimensional)
  - Suggests (by blinking objects, not to be confused with LFOs) interesting objects to use in a given configuration

# Other possible ways of interacting 1/3

- Manual Interaction
  - Hands can modify audio flow, without the need of touching other objects.
  - In that case, audio flow behaves like a river which can be reconducted.
  - Useful for bringing audio through other processors
- Voice Control – voice processing
  - MTG is famous for its voice applications (e.g. ELVIS…).
  - Separation between control (extract params. from voice) and processing (use audio from voice) is not clear but both aspects are interesting.
  - Small microphones can be attached to the table for this purpose

# Other possible ways of interacting 2/3

- Pattern recognition & Music Retrieval by whistling
  - MTG has a deep knowledge in songs & patterns recognition.
  - Whistling is easily distinguishable from singing or talking
  - Whistling could be used for retrieving melodic patterns stored as MIDI data
- Collective Table tapping
  - Table tapping is slightly different from using the TAP objects
  - It can be a collective phenomena, and therefore less precise
  - The table could have contact microphones or *piezoelectric* sensors
  - Analysis of the collective rhythmic structures (another MTG highlight) can be done

# Other possible ways of interacting 3/3

- Moving Objects
  - Toy cars, bouncing balls…
- Unidentified Objects
  - It seems natural that after some minutes, people will start stressing the system in dif. ways, like placing personnel objects into the table.
  - Although it is no possible to prevent all objects that people may use, some of them could be detected (cigarette packets, mobile phones, keys, pens…), and a “funny” functionality could be added to them (e.g. mobiles could generate pitch in a “mobile-fashion”)

# Final considerations

- The project will start as soon as we enter Ocata, where a prototype table will be built in the Interactive Lab
- Expected duration: < 2 years
- Some technologies involved
  - CLAM
  - EyesWeb
  - OpenGL (?), Cg (NVidia's C for graphics) (?)

# Suggestions are welcome

- For a diff. project name (*ReacTable** ?)
- For other MTG technology “licensing”
- For detecting apparent pitfalls, errors or impossibilities
- For imaginative and radical new ideas !!!

# Some of the team related publications and additional information (1/2)


- Barbosa, A. 2001. "Instruments and temporal control in the context of musical communication and technology" - *Proceedings of Olhares de Outono Workshop on new trends in Digital Arts* – Porto 2001, Portugal.
- Barbosa, A.; Kaltenbrunner, M. 2002. "Public Sound Objects: A shared musical space on the web" - *Proceedings of International Conference on Web Delivering of Music 2002* - Darmstadt, Germany, published by the IEEE Computer Society Press.
- Barbosa, A. 2002. "Overview and conclusions of the Music Interfaces Panel Session at the MOSART Workshop (Barcelona, December 2001)". *Reference Documentation from the MOSART Workshop on Current Research Directions in Computer Music2001* - Barcelona, Spain. Published by the MOSART IHP Network in 2002 at http://www.iua.upf.es/mtg/mosart/.
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- Jordà, S. and T. Aguilar. 1998. “A graphical and net oriented approach to interactive sonic composition and real-time synthesis for low cost computer systems.” *Proceedings of COST G6 Conference on Digital Audio Effects*, pp. 207-210, Institut Universitari de l’Audiovisual, Barcelona.
- Jordà, S. 1999. “Faust music On Line: An Approach to Real-Time Collective Composition on the Internet.” *Leonardo Music Journal*, 9: 5-12.

# Some of the team related publications and additional information (2/2)


- Jordá, S. and A. Barbosa. 2001. “Computer Supported Cooperative Music: Overview of research work and projects at the Audiovisual Institute - UPF.” *Proceedings of the 2001 Workshop on Current Research Directions in Computer Music.* Barcelona: MOSART, pp. 92-96.
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