

# Haptics in Computer Music: a Paradigm Shift

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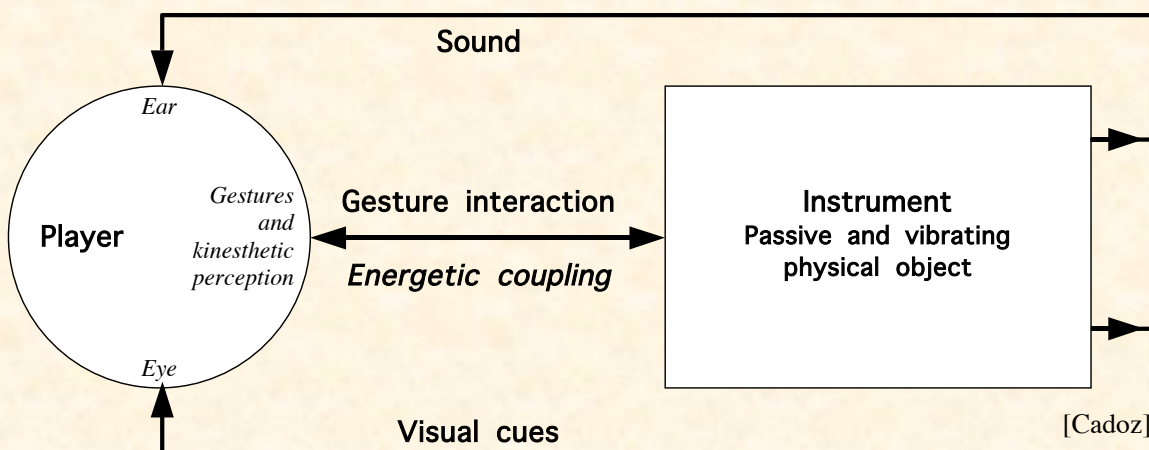
- What do **Haptics** have to do with **Music** ?
- What can we expect from **Haptic interfaces** as for **Computer Music** ?
- How can we define the differences between ‘nowadays’ digital instruments and future instruments with haptic interfaces ?

=> An historical point of view combined with a bibliographic overview <=

## A View on the Traditional *Instrumental Relation*

Observations

- The sound results from a **gesture interaction** with an **energetic coupling** between the instrument and the player
- the **energy within** the sounds comes from the **player** himself
- The **tactilo-proprio-kinesthetic feedback** is correlated with the behavior of the vibrating structure



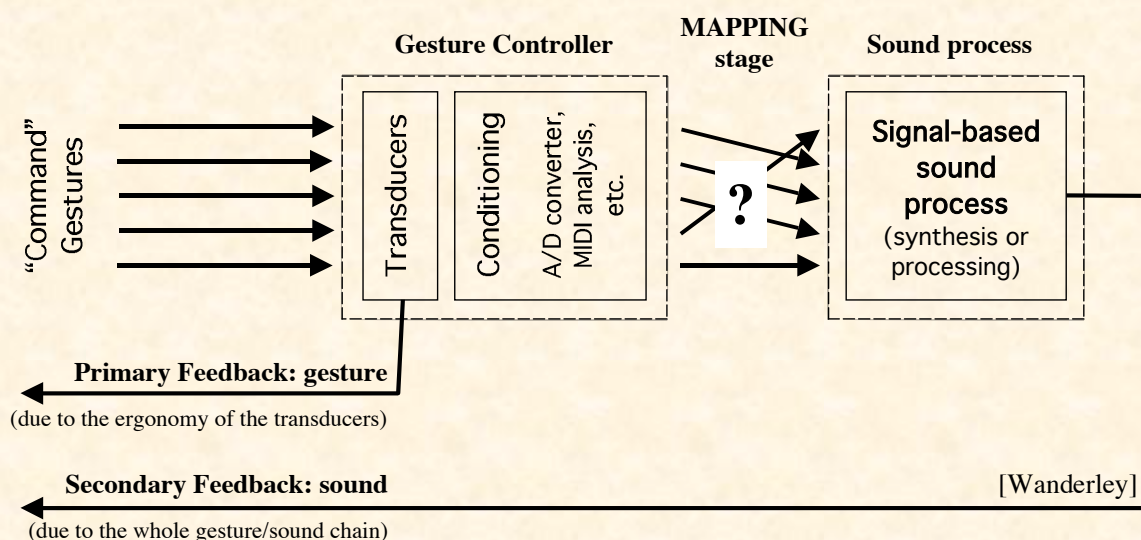
Hypothesis

- The **energetic coupling** influences **sound quality** and diversity
- It impacts the “**readability**” (or “**hearability**”) of the gestures within the sound
- It is needed for a high level of **sensitivity** and **expressivity**

# Command, Control, Mapping and Signals : Today's Concepts of "Real-Time Sound Systems "

- **Contemporary digital musical instruments exhibit three flexible components :**
  - 1) The **gesture controller(s)**, responsible of the "primary feedback" and of the category of the possible gestures
  - 2) The **signal-based real time sound processes**
  - 3) The **mapping strategy**, in charge of solving the ontological gap between the gestures and the parameters of the sound processes
- The **gestures "command" or "control" the sound processes**
- The whole system is 'interactive' : **command gestures impact sound feedbacks**

[Wanderley]



## Interests

- Musicians can adapt their gesture to musical needs by **choosing the gesture controller in a large panoply** (keyboards, mouth pads, joysticks, cameras, etc)
- Ideally, musicians can also **program the sound property to be controlled** (amplitude frequency, timbre, localization in space, etc) [Verfaillie]

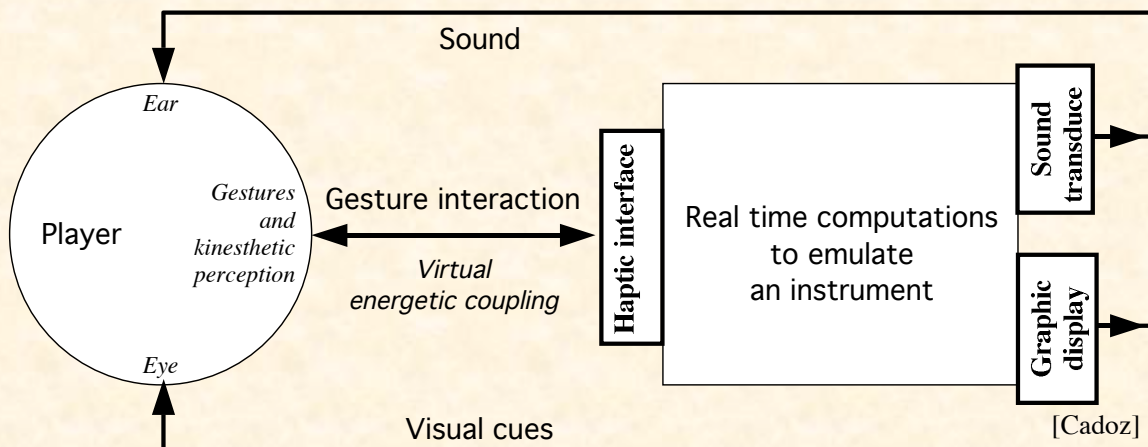
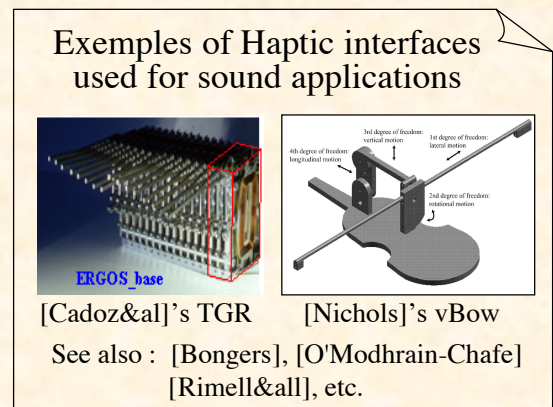
## Limitations

- This "main stream approach" **has not yet led to sound systems as expressive as traditional instrument,** though its high level of complexity and achievement
- "Control gestures", Signal and Mapping do not allow a close relationship between the player and the sound production mechanism
- They prohibit the physical interaction with energetic coupling

=> The search for expressivity may not be solved by any improvement <=>  
=> of the "gesture controllers, sound processes nor mapping strategies" <=>

# Haptic Interfaces and Sound : Promising Results

- **Haptic interfaces allow correlating the dual force and position variables**
- **They potentially make it possible to simulate a gesture interaction with a coherent energetic exchange**
- **Combined with other transducers, they allow “multisensorial simulation”** [Cadoz]
- **Various experiments have proved at least partially their relevance for expressive musical performance with digital instruments**

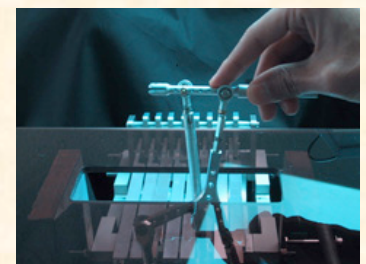


## The case study of the violin by [Florens]

- **A particularly simple physical model of the string and of the bow/string interaction**
- **The high frequency and short latency force feedback system TGR©, with a ERGOS morphologic adapter** [Florens&al], [Cadoz&al]

⇒ **Most of the relevant sound cues are easily obtained:**  
 full excitation of the string, harmonics, creaking, etc

⇒ **In the case of the violin-like instruments, the use of a high-quality haptic system is more important than the accuracy of the model**



[Florens&al]'s TGR and Ergos  
 See the video on the computer

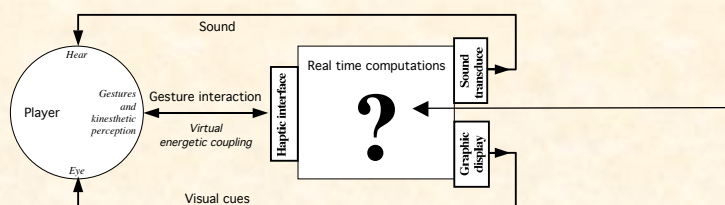
⇒ **With haptic interfaces we can expect to re-obtain** ⇐  
 ⇒ **the sensibility and the expressive possibilities offered by traditional instruments** ⇐

Experiment



# Conclusions : a Paradigm Shift

- **Haptics probably play a central role in the gesture to sound chain**  
*as it does in the gesture to vision chain [Prytherch-Jerrard]*
- **Haptic interfaces are not “better gesture controllers” !**  
They correspond with a **paradigm shift within digital instruments**  
from **“interactive musical systems” to “instrumental interaction”**  
They promise much better **expressiveness and musicality**
- **Computer music is a particularly promising field**  
for research around **haptic force-feedback interfaces**
- **However, the design and use of haptic interfaces is half the way...**  
The modelling principle should ensure **sound quality & haptic outputs**  
with an **overall physical coherence**



**Open question :**  
*which modelling principle  
for the Haptics to Sound chain ?*

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