Software 2 WS 2016 #4

Chikashi Miyama

Physical Modeling Synthese (PhM)

- Was ist PhM?

Physical Modeling Synthese (PhM)

- Was ist PhM?

- Physical Modeling (PhM) Synthesis starts from mathematical models of the physical acoustics of instrumental sound production. That is, the equations of PhM describe the mechanical and acoustic behaviour of an instrument being played.

Andere Namen

- Physical Modeling Synthese =
- Synthesis by Rule (Ferretti 1965)
- Synthesis from first principles (Weinreich 1983)
- Virtual acoustics (Yamaha 1993)

Zwei Aspekte

PhM

Wissenschaftliche Anwendung

Künstlerische Anwendung

Simulation

Kreation

Künstlerischste Anwendung

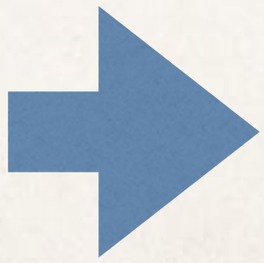
- Simulation von “phantasmagorical instruments”
- ?
- ?
- ?

Künstlerischste Anwendung

- Simulation von “phantasmagorical instruments”
- Cello mit einer dynamischen Größe
- Eine unzerbrechliche Membran einer Trommel
- ein Gong (Diameter = 30 Meter)

Efficiency of PhM

- Eigenschaft von PhM
- Because of the ***mathematical nature*** and the ***heavy computational burden*** they can impose, PhM has emerged slowly from laboratory environments to musician's studio



PhM ist nicht effizient

Efficiency of PhM

- Effiziente Methoden
- ?
- ?

Efficiency of PhM

- Effiziente Methoden
- Waveguide
- Karplus-Strong

Background

- 1894 : Lord Rayleigh *The theory of Sound*
- 1863-1900 : Helmholtz, Pynting, Thomson Tyndall Mayer, *Mathematical Models of musical instruments*
- 1922-1967: Steward, Miller, Stevens, Fant, Olson *Analog Electronic Model using Vaccum Tubes*
- 1962: Kelly, Lochbaum *Digital-based Modeling*

Background

- 1962: Kelly, Lochbaum *Digital-based Modeling*

Bicycle Built for Two (1960)

Music from Mathematics

https://www.youtube.com/watch?v=ZFUVR-clo8g

Background

- 1967-71: Hiller, Beauchamp, Ruiz *PhM synthesis Instrument*
- 1965-75: Ferretti *PhM synthesis Instrument*
- 1983: Karplus, Strong *Karplus-Strong algorithm*
- **1994: Yamaha VL1**
- **2005: Korg OASYS**

Kommerzielle Produkte mit PhM

- YAMAHA VP-1

http://www.sequencer.de/syns/yamaha/VP1.html

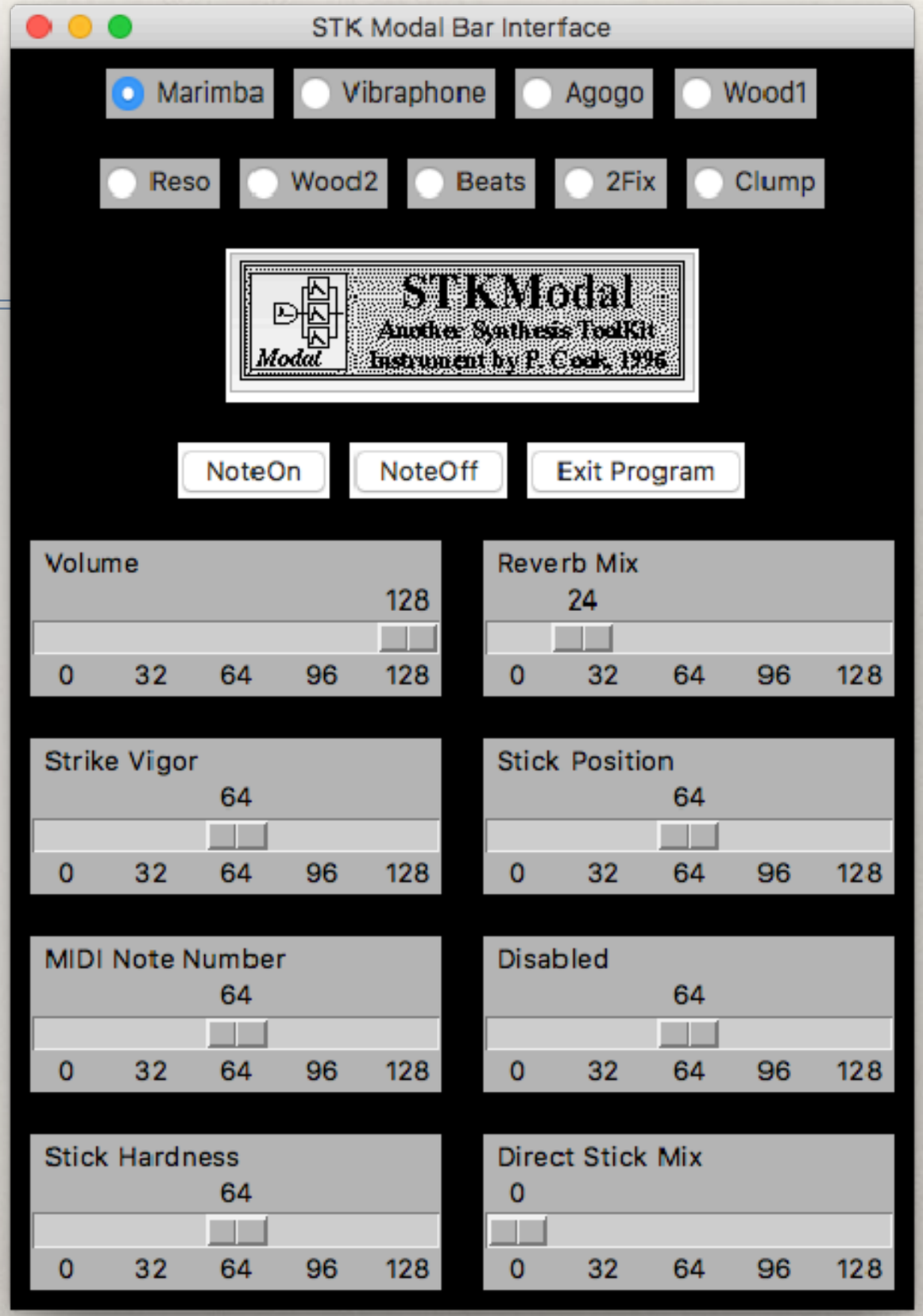
VL-7 https://www.youtube.com/watch?v=4pKOKNYbIM4

Andere Software für PhM

- IRCAM Modalys
- GENESIS
  http://www.acroe-ica.org/en/acroe/scientific-technological-research/genesis-musical-creation-and-stringed-instrument-making

OpenSource

- Synthesis Toolkit / CCRMA (https://ccrma.stanford.edu/software/stk/)



Perry Cook

Der Softwareentwickler von STK
Der Autor von “Real Sound Synthesis”
Professor, Stanford Universität
Sänger

STK Demo

Kommerzielle Produkte mit PhM

Logic Sculpture

Sculpture Demo

A fundamental Principle

- A fundamental principle of physical modeling synthesis is the interaction between an ( ) and a ( )

A fundamental Principle

- A fundamental principle of physical modeling synthesis is the interaction between an ***exciter*** and a ***resonator.***

Exciter / Resonator

- Excitation
  - An action that causes a vibration
    - e.g. Stroke of a bow, hit of a stick, a blow of air
- Resonance
  - response of the body of an instrument to the excitation
    - e.g. filter applied the excitation signal

Exciter / Resonator Interaktion

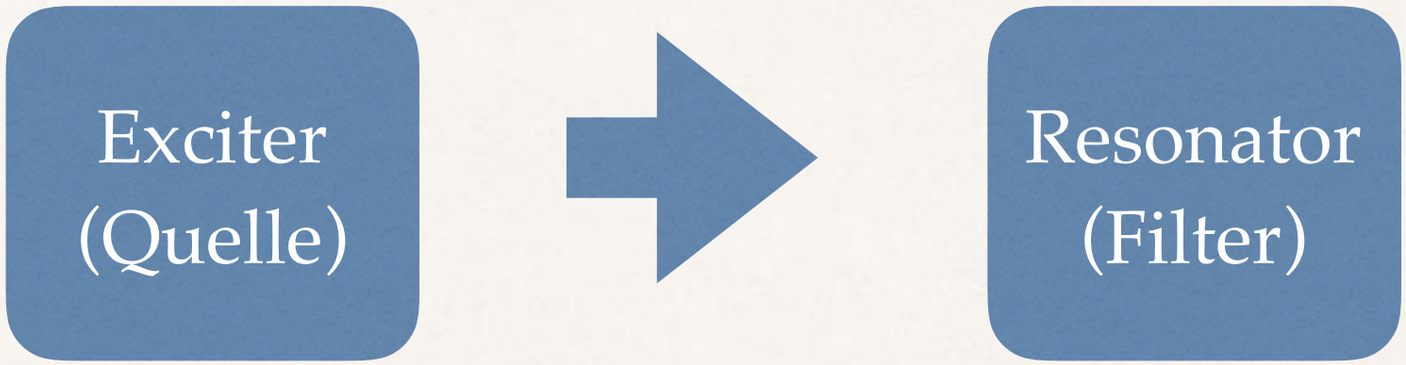
- Zwei Typen
  - (?)
  - (?)

Exciter / Resonator Interaktion

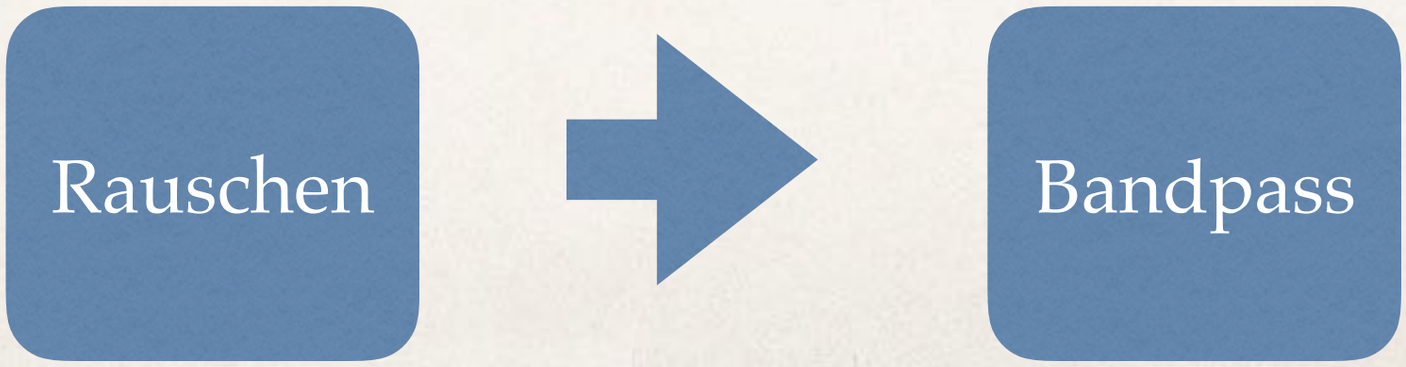
- Zwei Typen
  - decoupled (or feedforward)
  - coupled (or feedback)

Exciter / Resonator Interaktion

- Decoupled

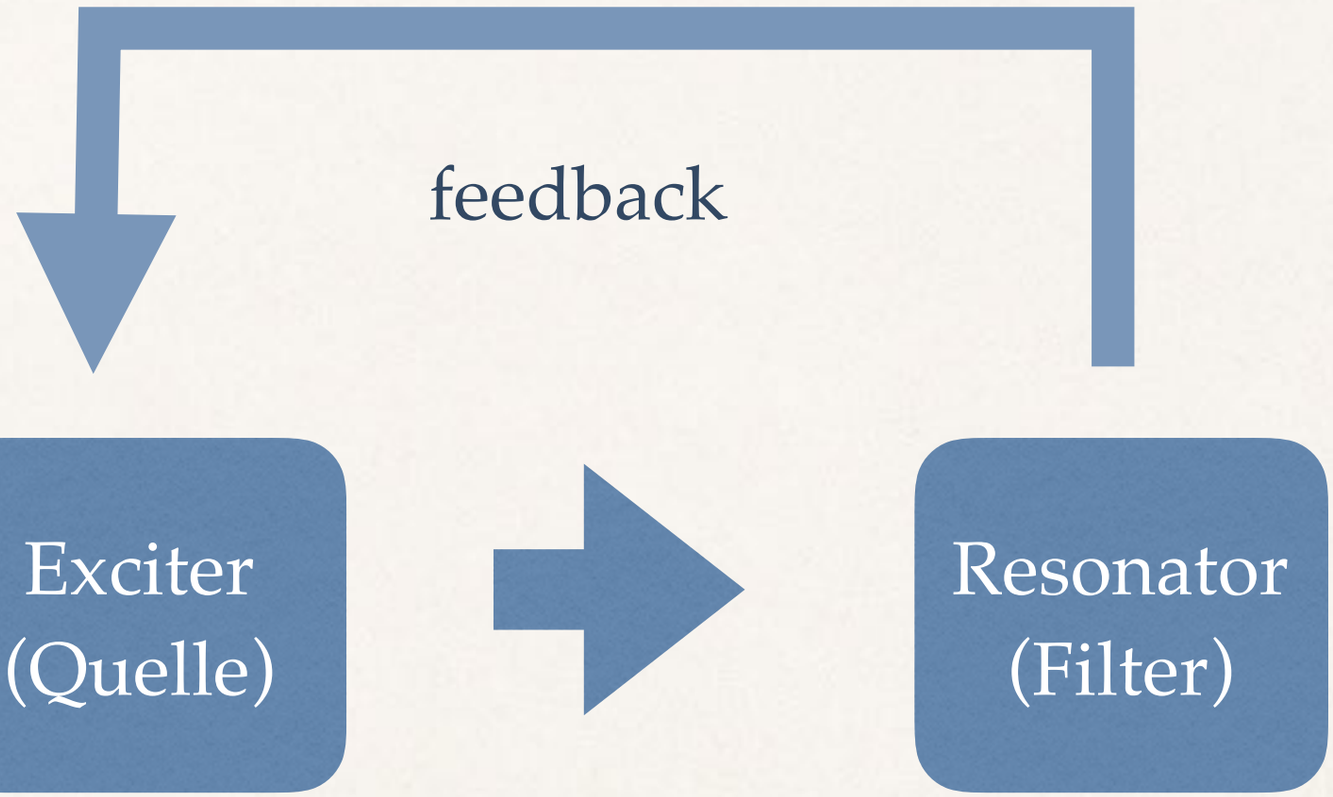


z.B. Subtraktive Synthese



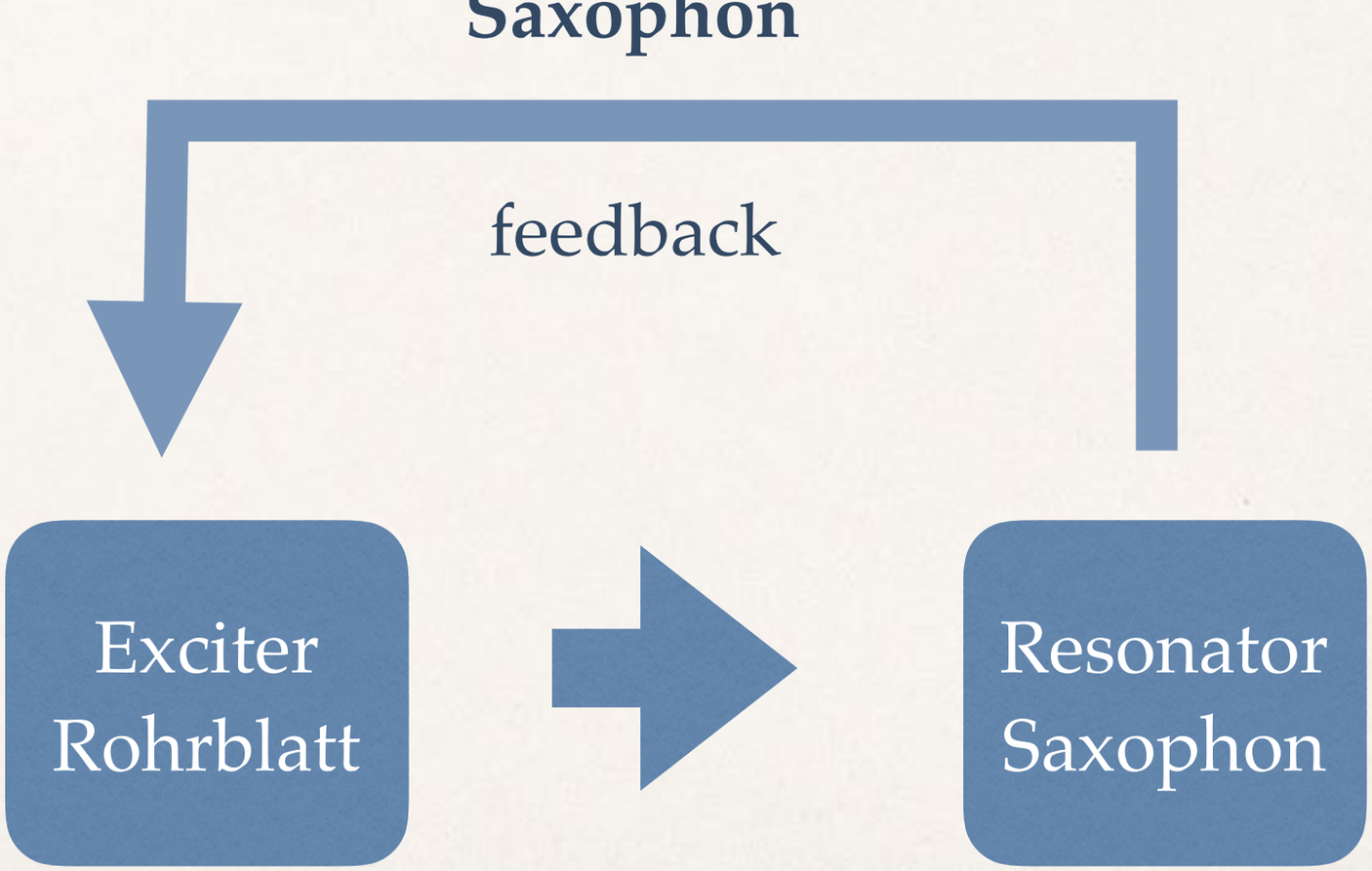
Exciter / Resonator Interaktion

- Coupled

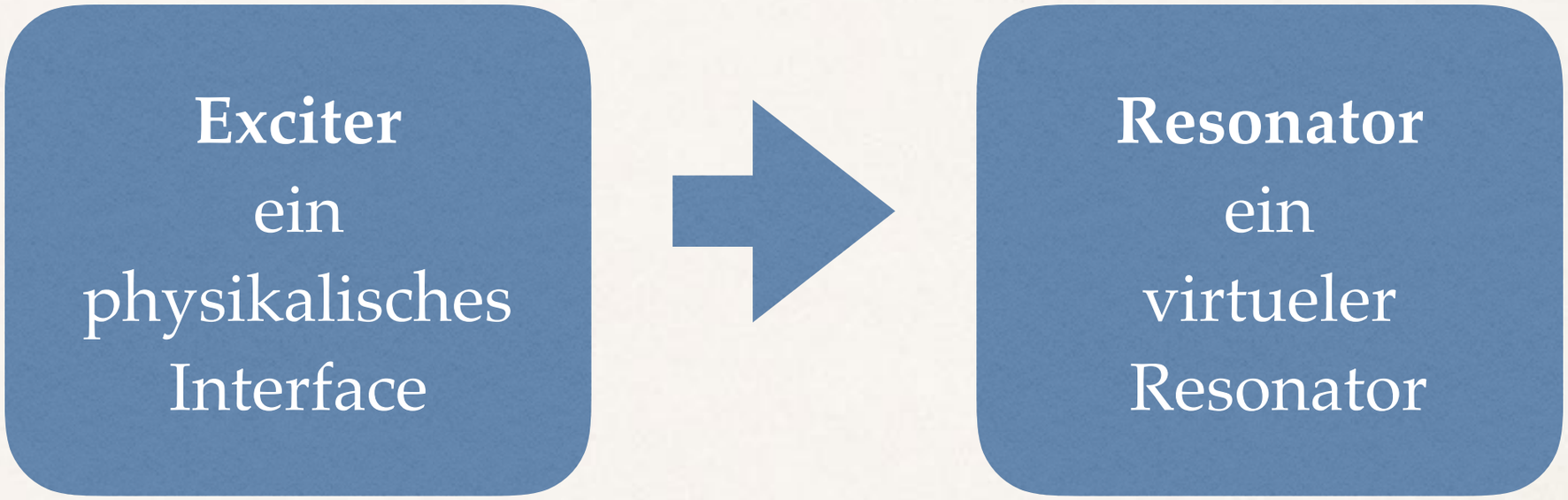


Exciter / Resonator Interaktion

- Coupled



Input Controller



In some implementations of PhM synthesis, the excitation comes from an input device (or performance controller) played by a performer

Florens and Luciani 1984 / Cook 1992

Yamaha WX5

Breath Controller

https://www.youtube.com/watch?v=DJJHsh9uBCs

Classical PhM Methodology

1. Definition
Dimension
Mass
Elasticity

3. Excitation
Coupling

5. Filtering

2. Limitation
Boundary Condition

4. Impedance

Modal Synthese

Modal Synthesis

- Was ist Modal Synthesis ?

Modal Synthesis

- Was ist Modal Synthesis ?

The motion of a complicated system having many moving parts may always be regarded as compounded from simpler motions, called ***modes****, all going on at once.*

Alternative to mass-spring paradigm

von Calvet, Laurens, Adriens 1990

Substructure

Jede Komponente hat einen eigenen Modus

Modus

Geige

Modes of Vibration

Excitation

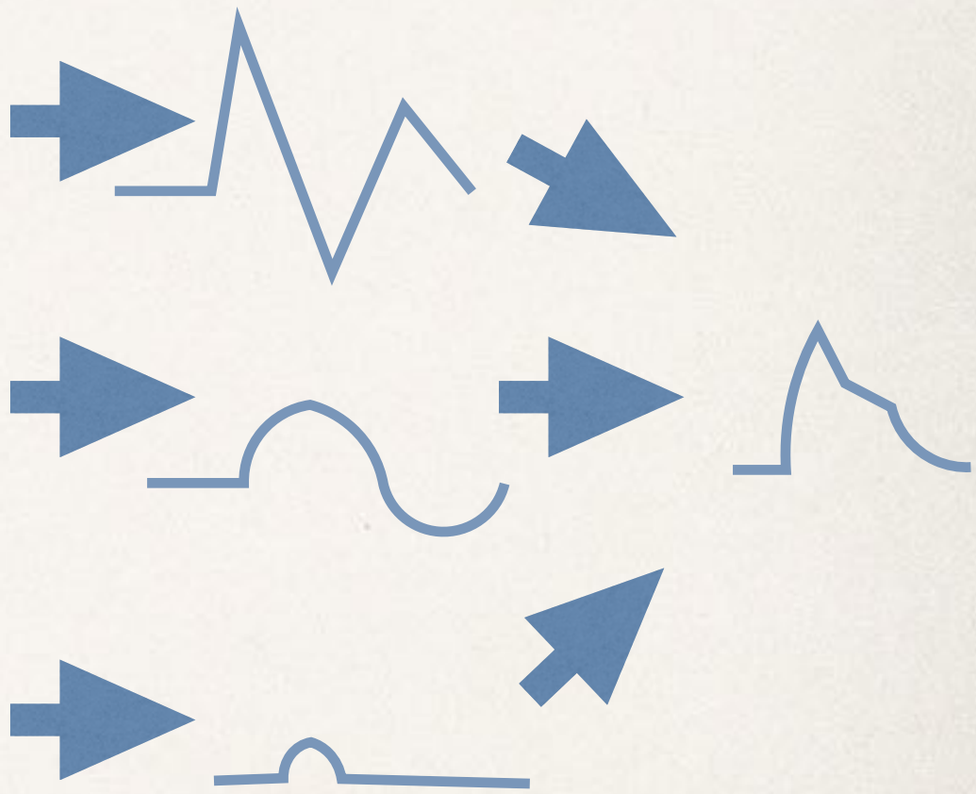
Saiten

Decke

Steg

…

Modal Data



Unterbau
(Substructure)

Modal Synthesis

- Was ist der größte Vorteil der Modalsynthese?

Modal Synthesis

- Was ist der größte Vorteil der Modalsynthese?

- *well-defined methodology for analysis of modes of vibration already exists, due to its many industrial applications*

Als **mathematische Formeln** oder **Daten**

Implementation von Adrien

- Was ist der größte Vorteil der Modalsynthese?

MOSAIC

- Software für Modalsynthese

von Jean-Marie Adrien / Joseph Morrison

Modalys

http://support.ircam.fr/docs/Modalys/3.4.0/co/Introduction.html

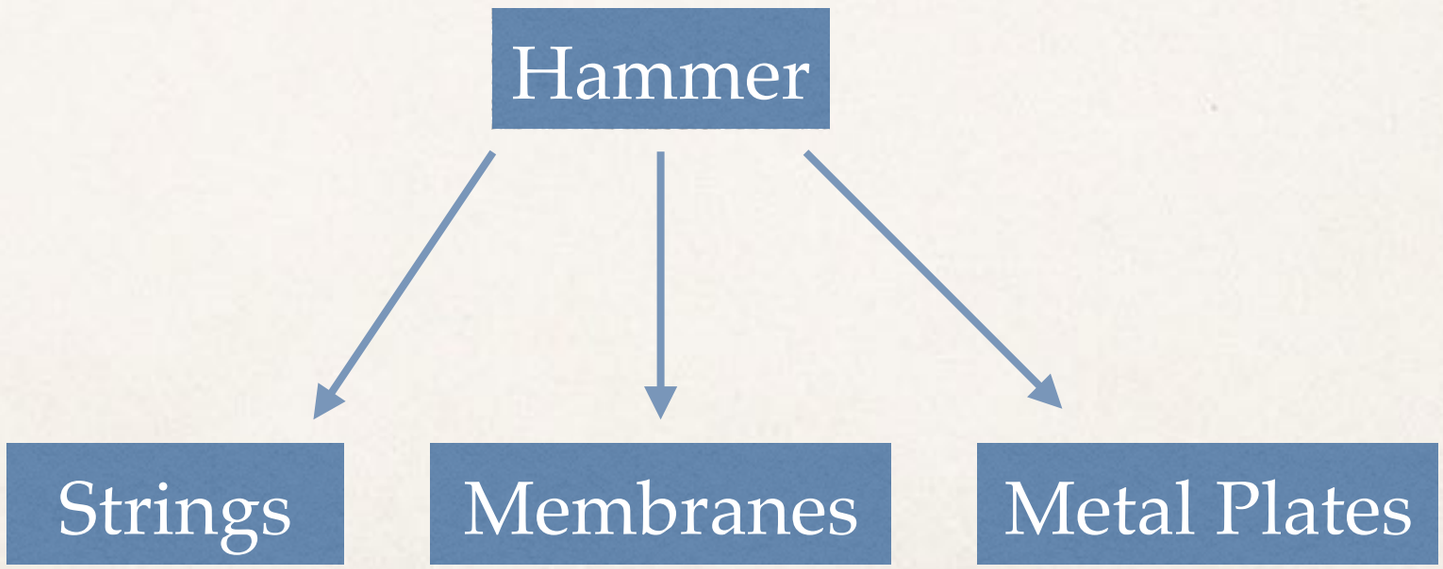
Beispiel MOSAIC / Modalys

Object

Strings | Air Columns | Metal Plates | Membranes | Violin Bridge

Exciter

Bow | Hammer | Plectrum



Beispiel MOSAIC / Modalys

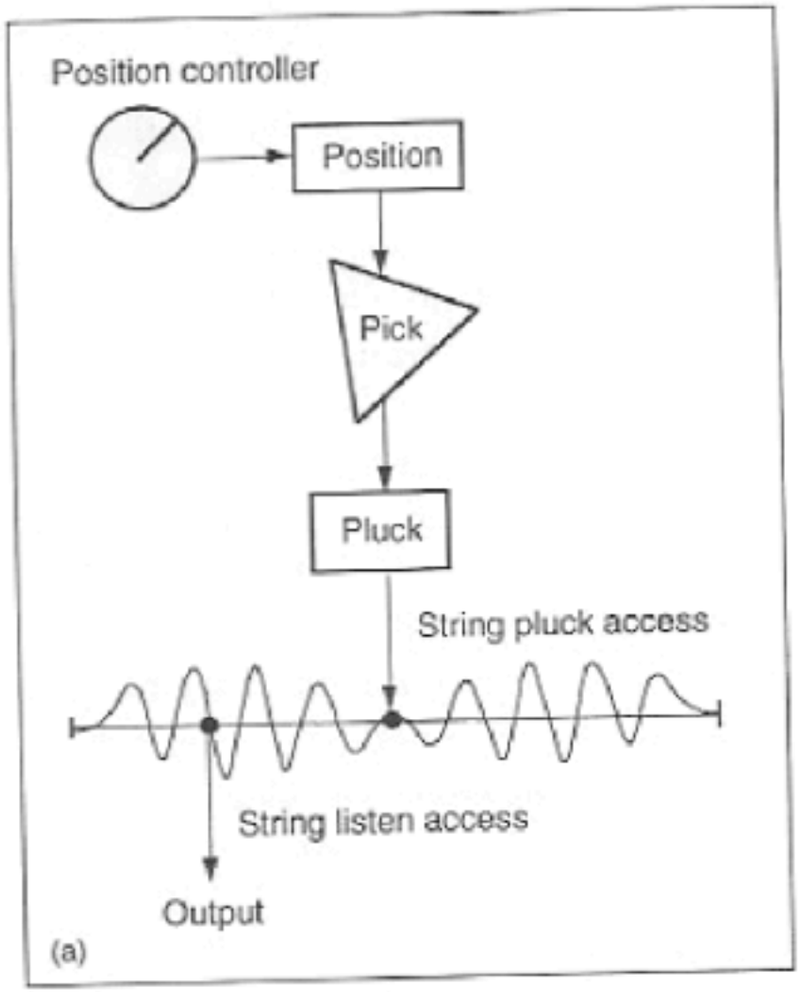
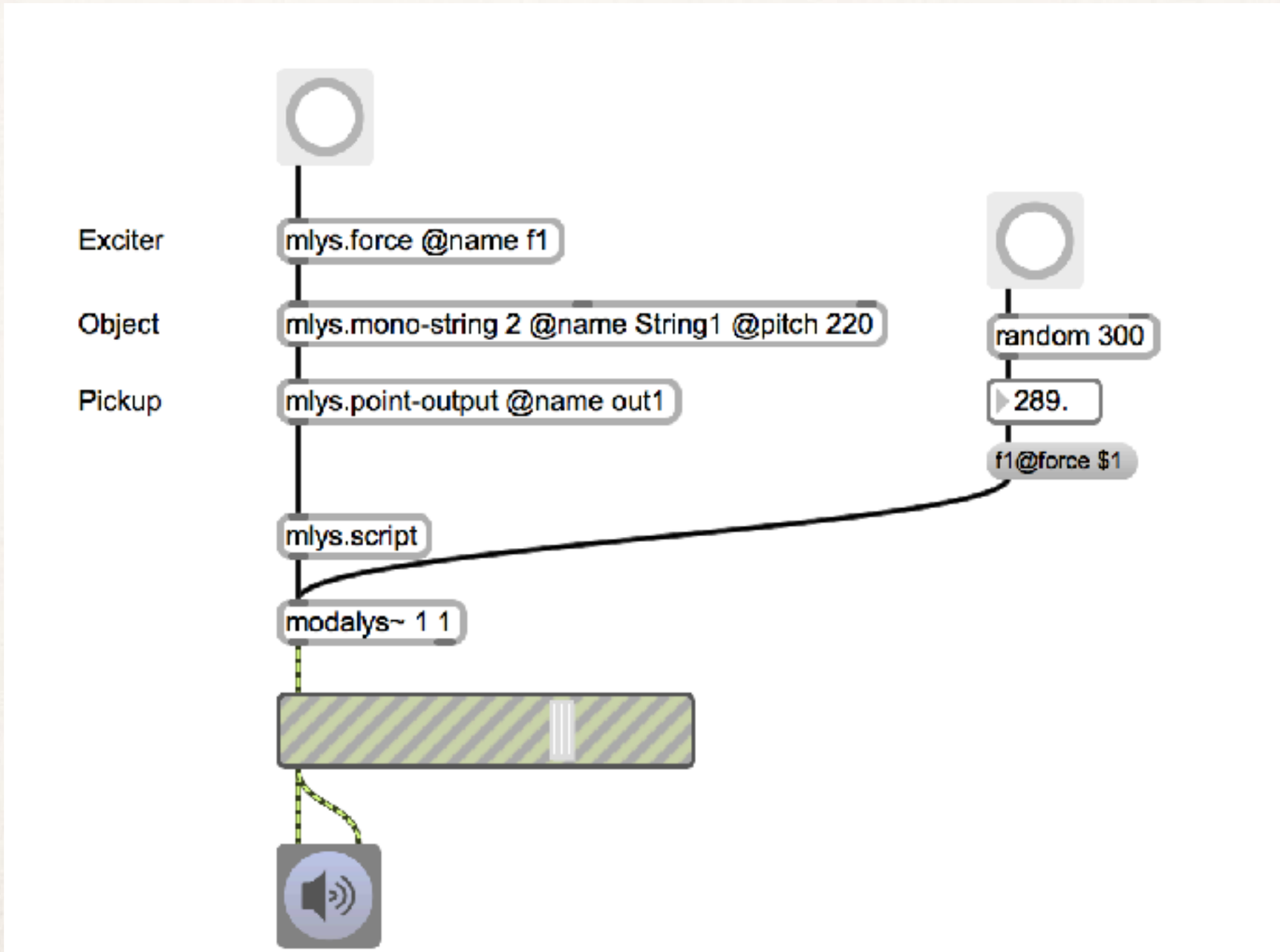


Figure 7.3 Plucked string simulated by the MOSAIC program. (*a*) Graphical resentation. (*b*) MOSAIC code corresponding to (*a*). Lines beginning with a sem lon are comments. See the text for an explanation of the code.

Experiment in Max



Designing Sound

Andy Farnell

Designing Sound

MIT Press