

Schweizerische Musikforschende Gesellschaft Basel
03.11.2020

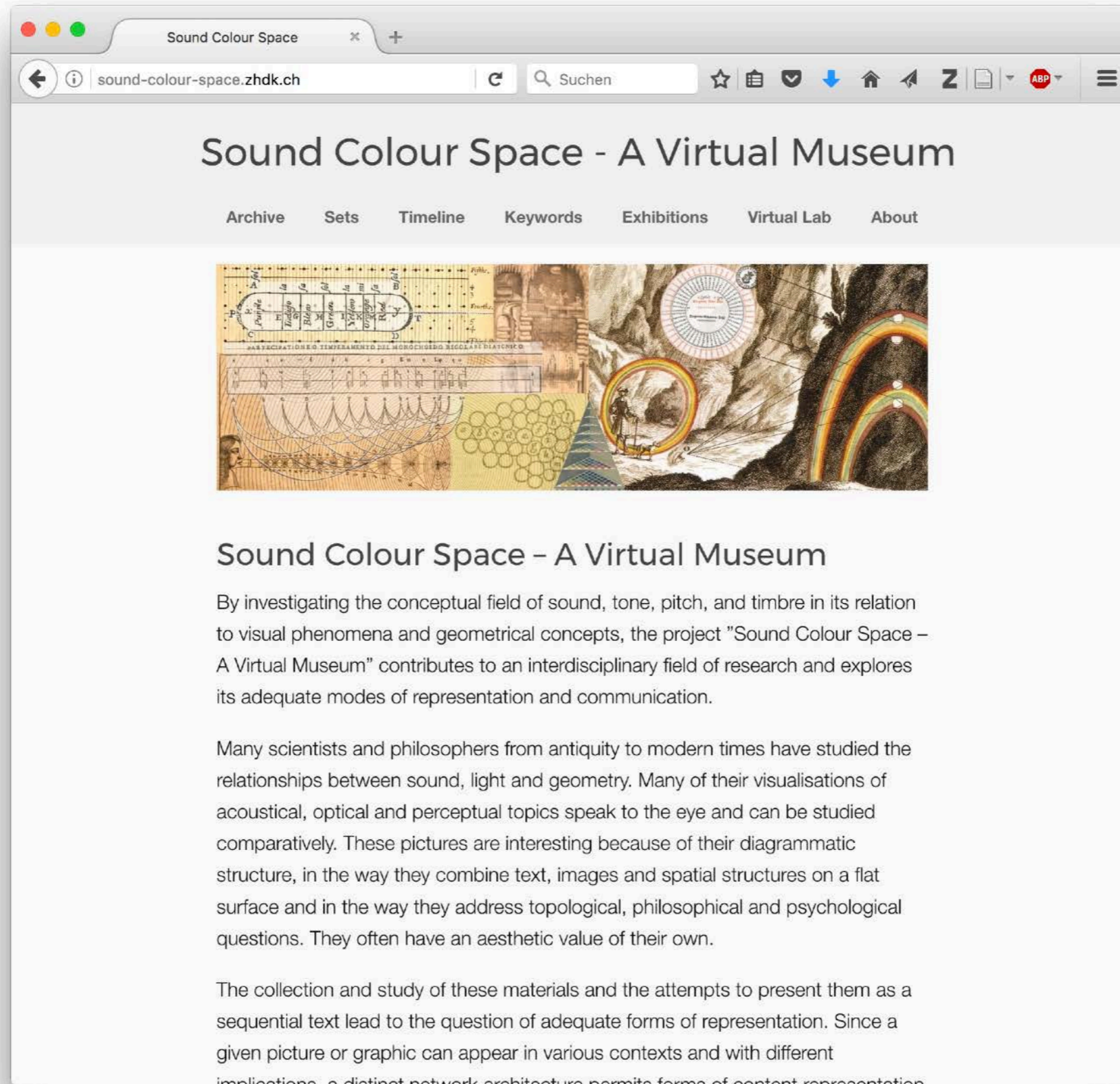
Sound Colour Space

Diagrammatische Strukturen des
Museums und
diagrammatische Arbeitsweisen
beim Aufbau des Museums

Dr. Susanne Schumacher
Vorsitzende des Digitalrats, ZHdK

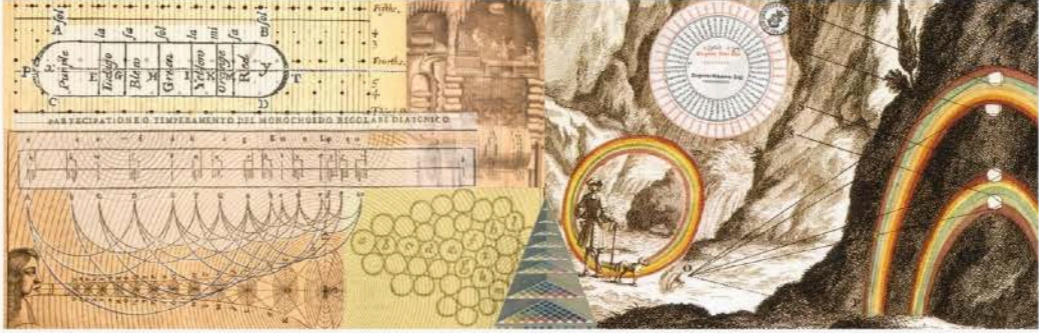
Das virtuelle Museum: sound-colour-space.zhdk.ch

Online-Publikation der Sammlung und der Analyse der historischen Diagramme



Sound Colour Space - A Virtual Museum

[Archive](#) [Sets](#) [Timeline](#) [Keywords](#) [Exhibitions](#) [Virtual Lab](#) [About](#)



Sound Colour Space – A Virtual Museum

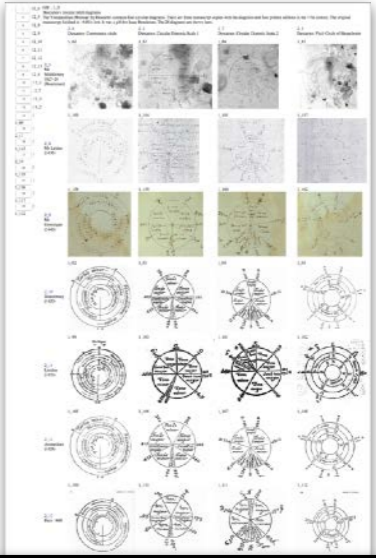
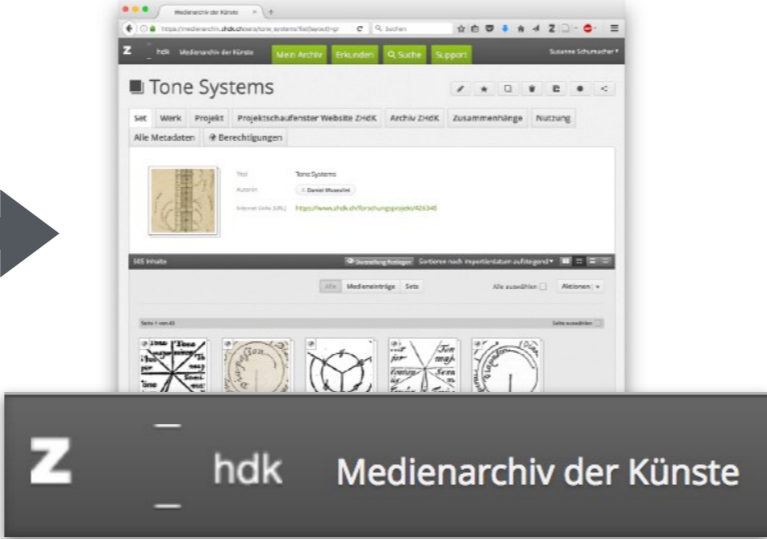
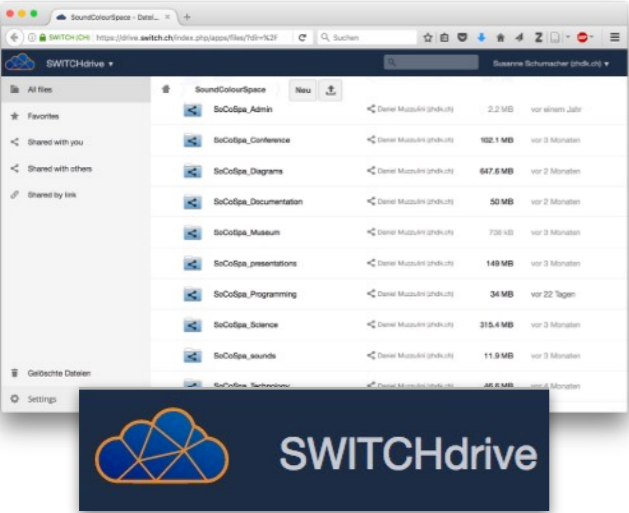
By investigating the conceptual field of sound, tone, pitch, and timbre in its relation to visual phenomena and geometrical concepts, the project "Sound Colour Space – A Virtual Museum" contributes to an interdisciplinary field of research and explores its adequate modes of representation and communication.

Many scientists and philosophers from antiquity to modern times have studied the relationships between sound, light and geometry. Many of their visualisations of acoustical, optical and perceptual topics speak to the eye and can be studied comparatively. These pictures are interesting because of their diagrammatic structure, in the way they combine text, images and spatial structures on a flat surface and in the way they address topological, philosophical and psychological questions. They often have an aesthetic value of their own.

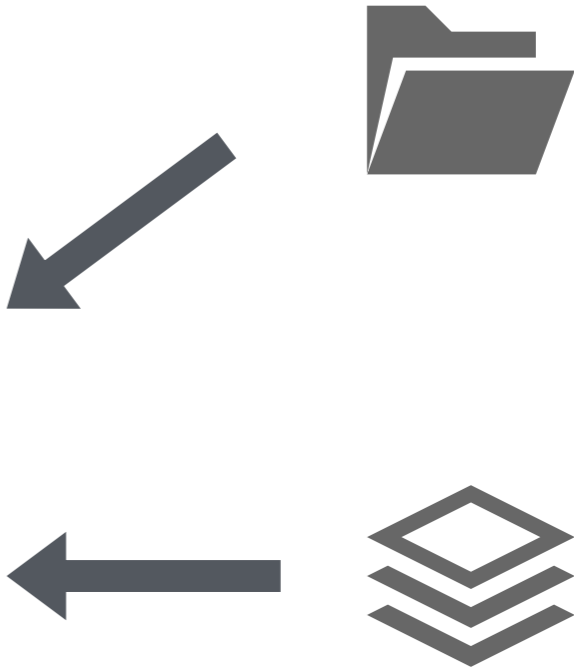
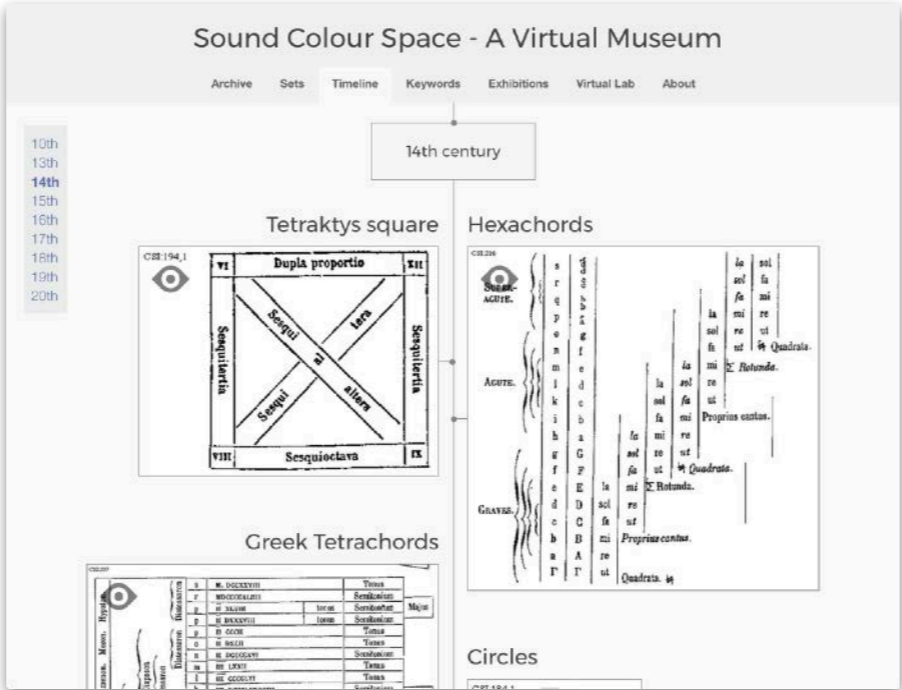
The collection and study of these materials and the attempts to present them as a sequential text lead to the question of adequate forms of representation. Since a given picture or graphic can appear in various contexts and with different implications, a distinct network architecture permits forms of content representation

Zusammenspiel der beteiligten Systeme

Ablagen, Datenbanken, Code-Repositoryn, Internetseiten



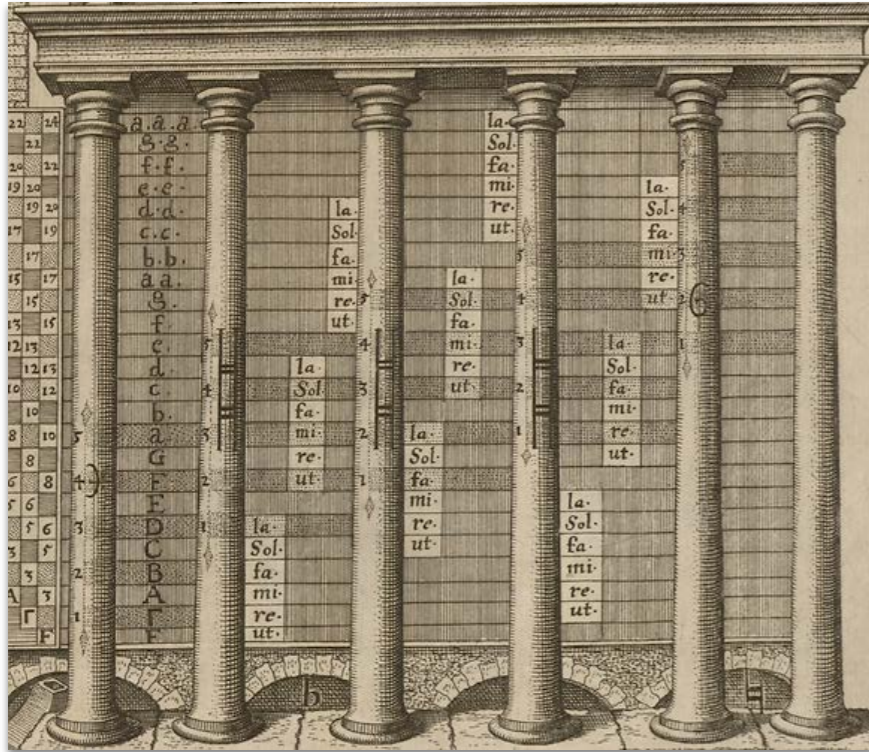
Prototyp des Museums



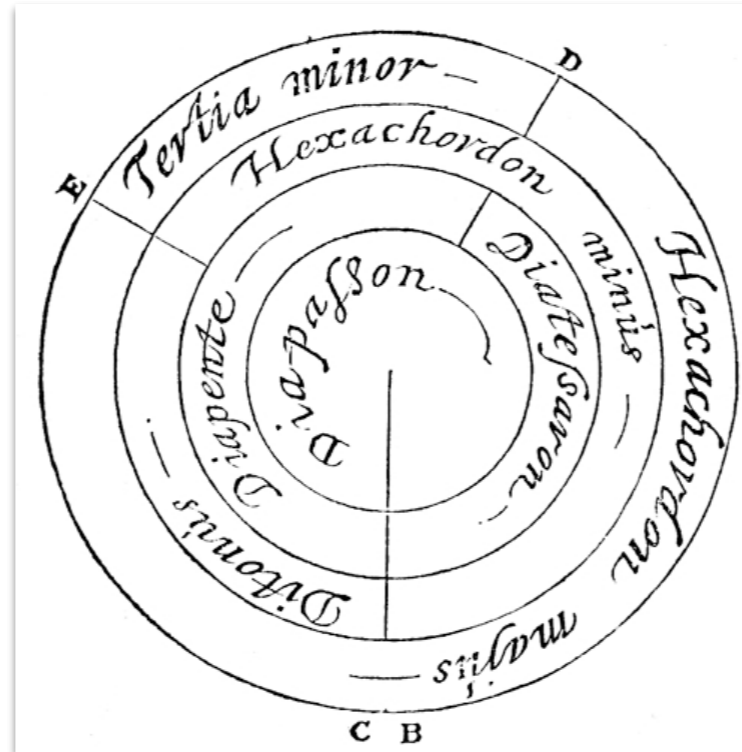
Virtuelles Museum

Gegenstände der Untersuchung

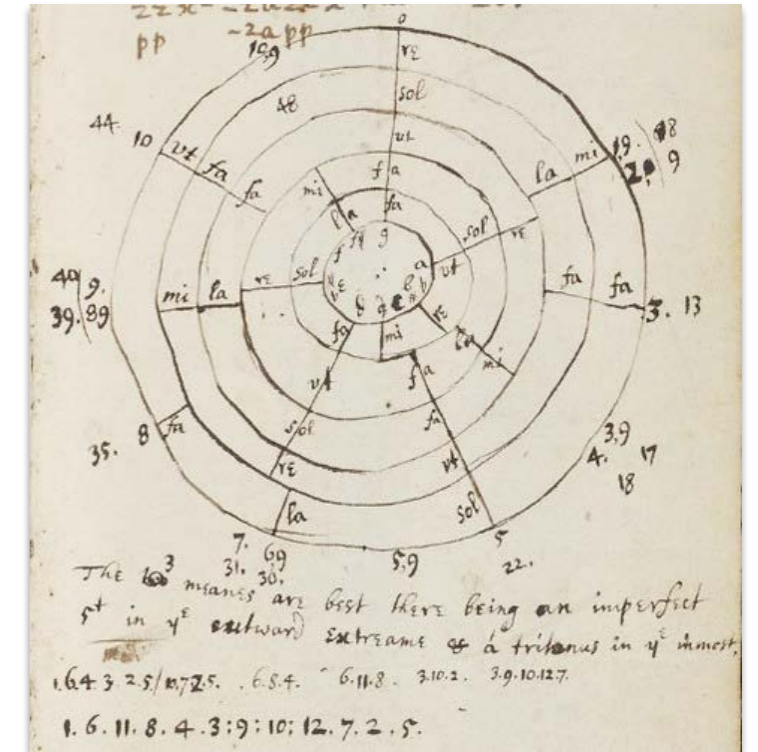
Historische Diagramme zu Ton- und Farbsystemen von Robert Fludd, René Descartes, Isaac Newton und anderen



Fludd: Hexachord, Detail aus dem *Templum Musicae*, 1624



Descartes: Consonance Circle, *Compendium Musicae*, 1656

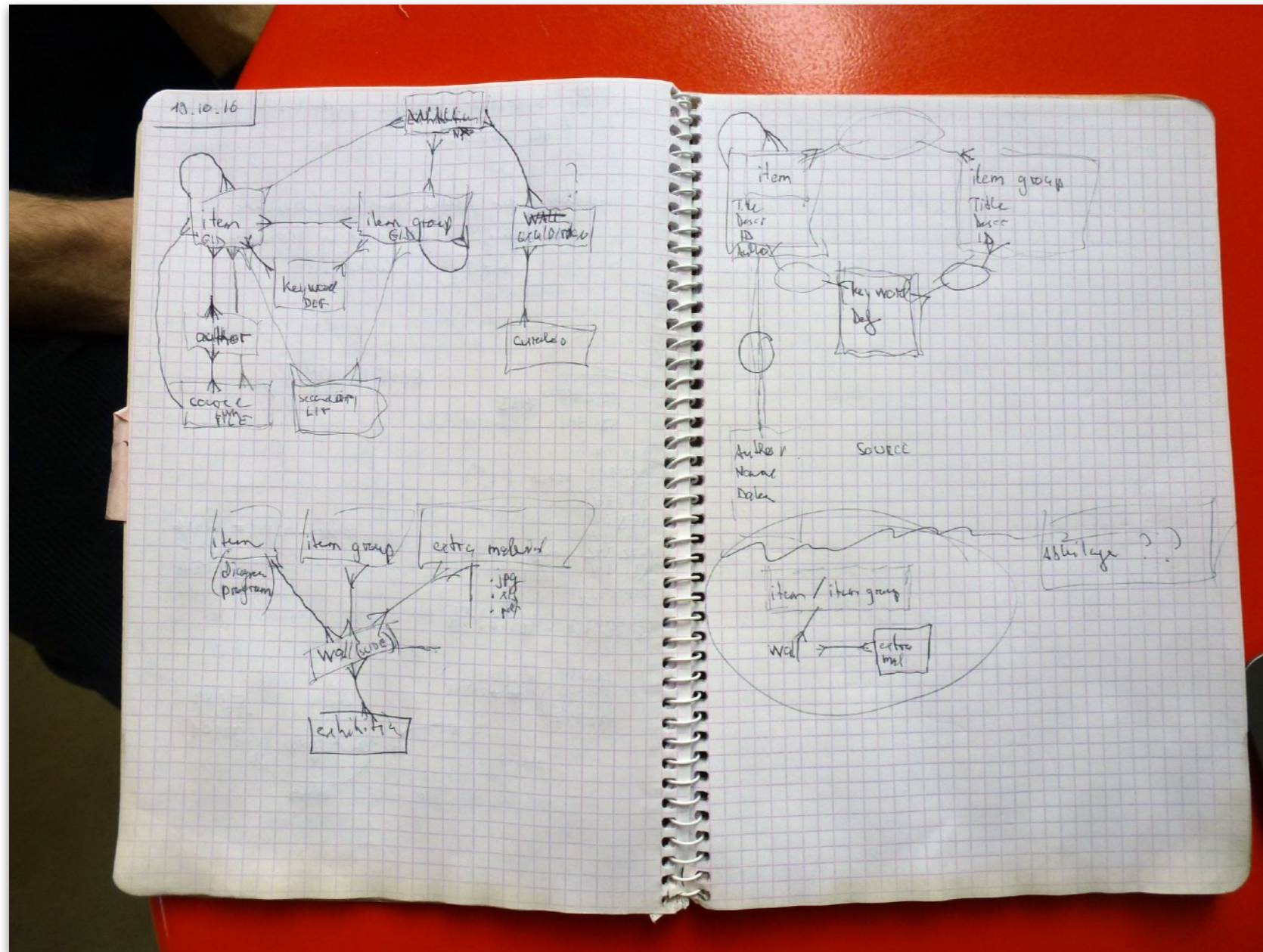


Newton: Diatonic Circles (1), *Musical Notes*, 1665

Ziel des Projekts: Analyse der historischen Diagramme und Vermittlung ihrer Bedeutung in einem Virtuellen Museum

Mit dem Datenmodell das Virtuelle Museum konzipieren

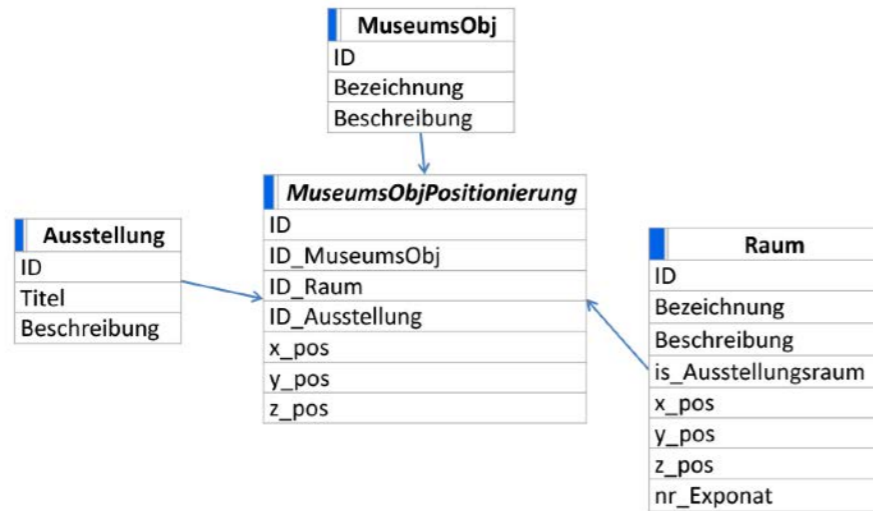
Zugeschnitten auf das Thema des Forschungsprojekts



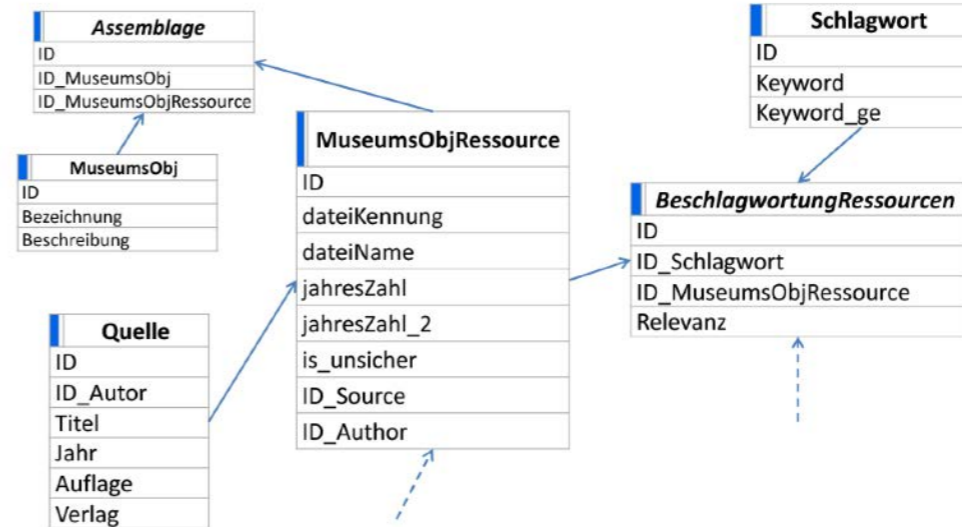
Daniel Muzzolini: Arbeiten am Datenmodell des Virtuellen Museums

Elemente des Museums und ihre Beziehung zueinander

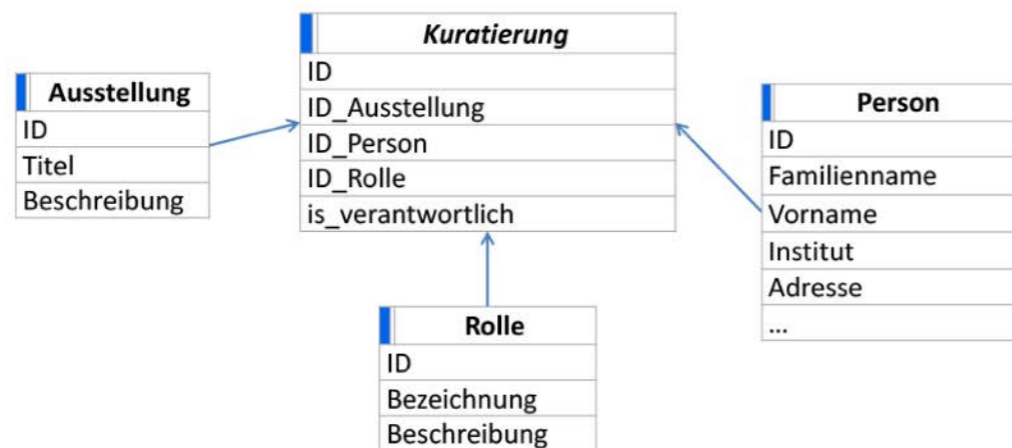
Ausstellung: Museumsobjekt-Positionierung



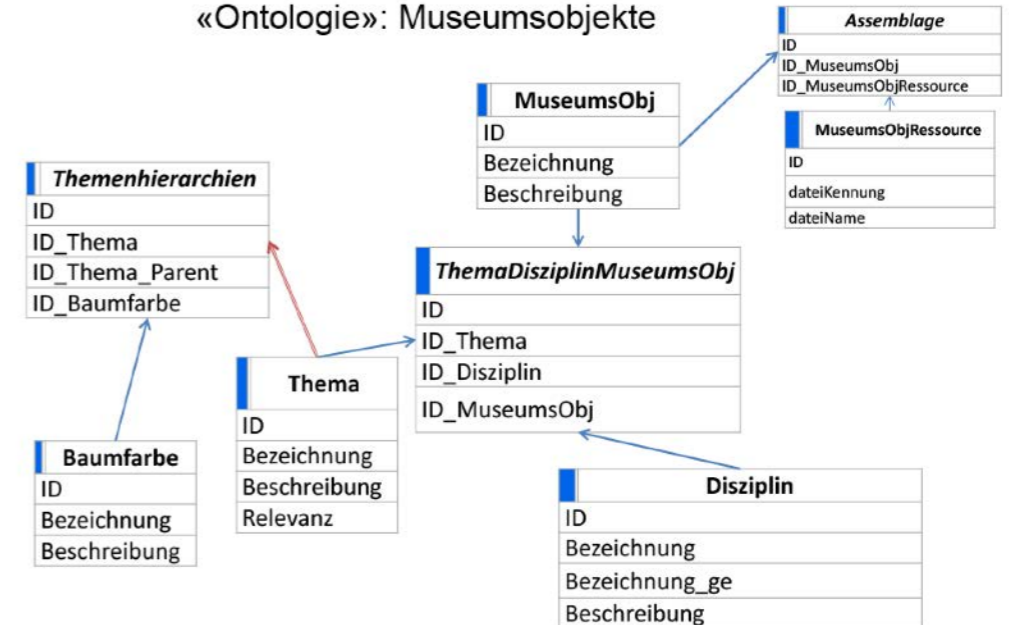
Beschlagwortung: Museumsobjekt-Ressourcen



Ausstellung: Kuratierung



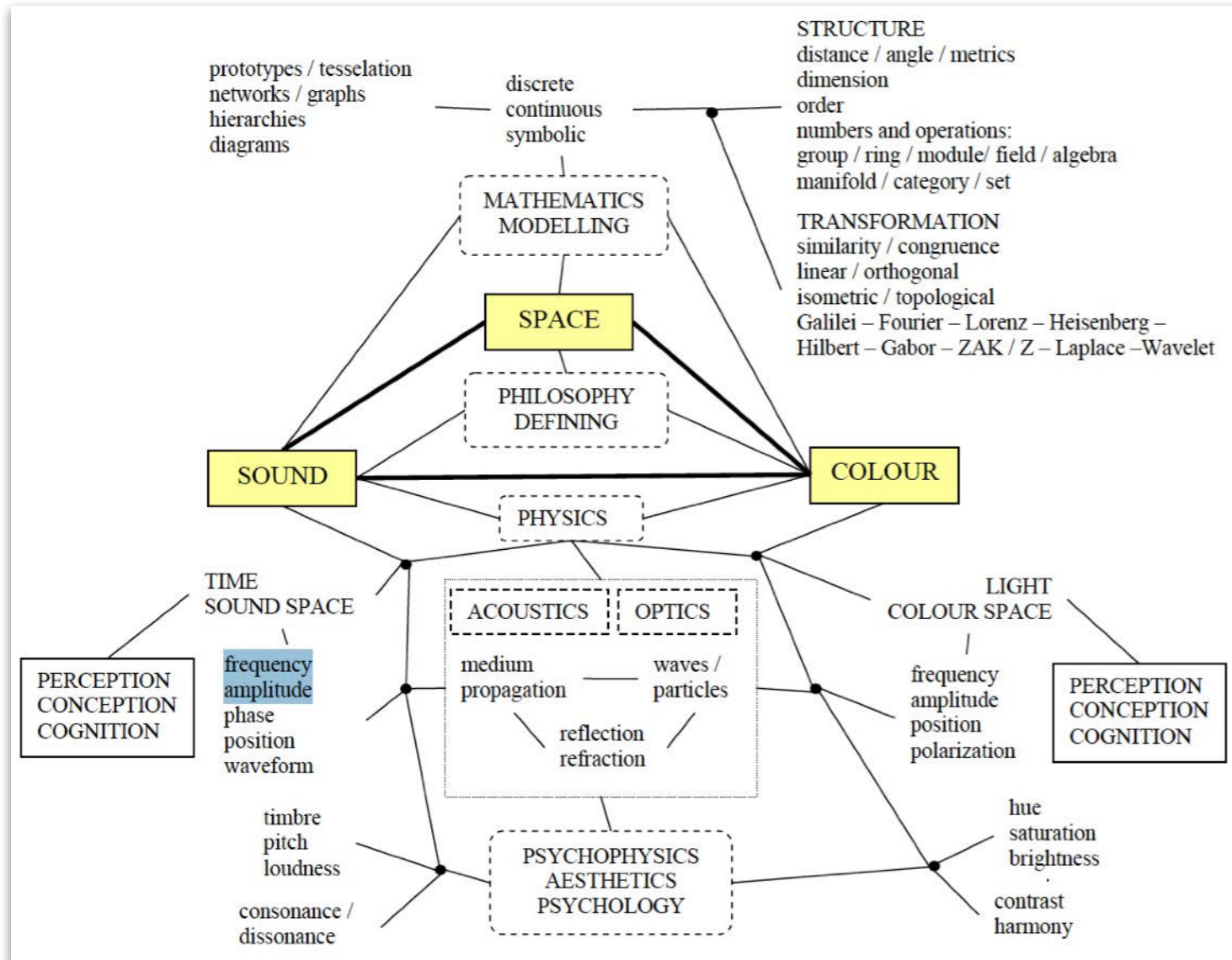
«Ontologie»: Museumsobjekte



Daniel Muzzolini und Christoph Reuter: Beziehungen der Entitäten in der Datenbank zueinander

Begriffsnetzwerk und Schlagworte

Thematische Gruppierung der Inhalte

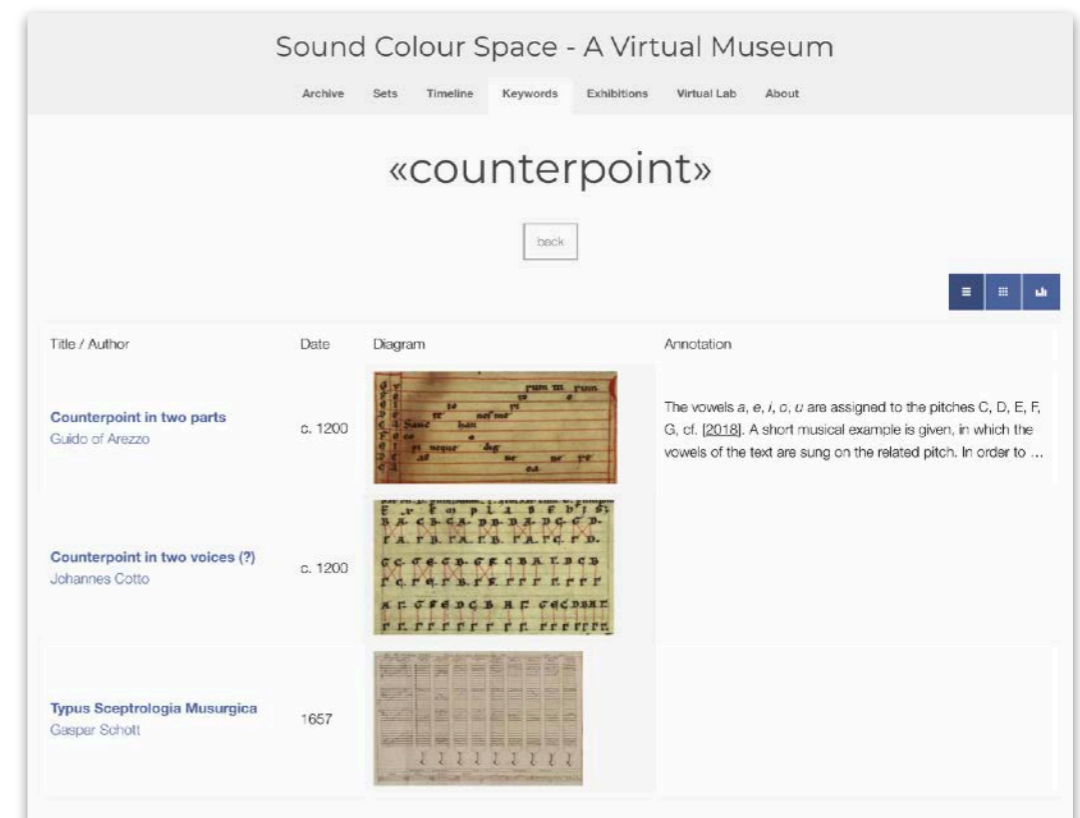
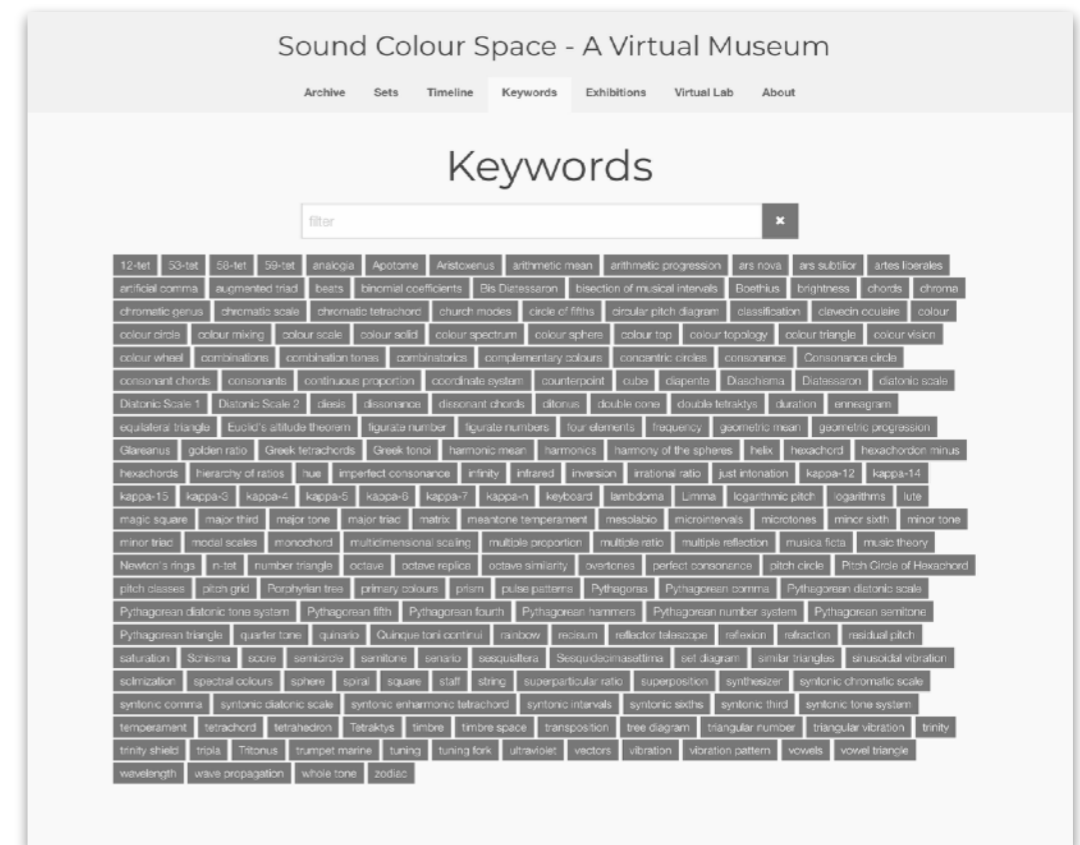
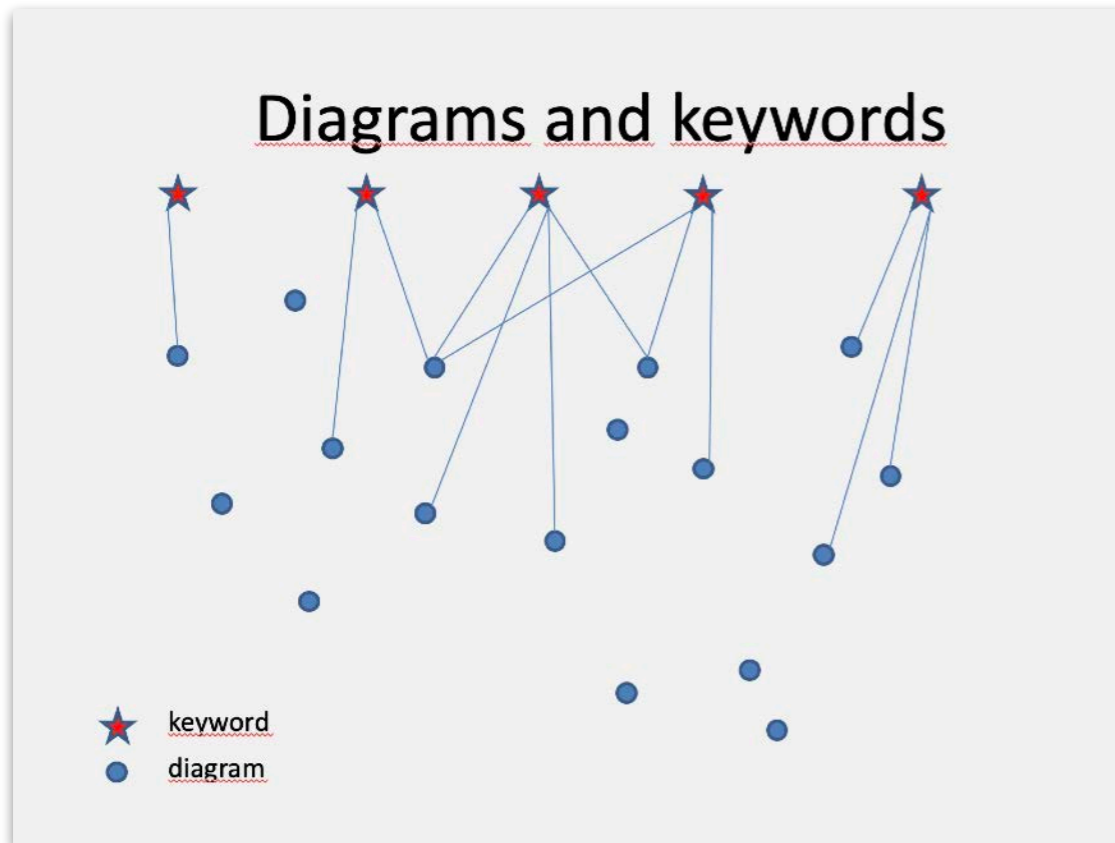


Daniel Muzzolini: Begriffliche Strukturierung des Themenfeldes. Netzdiagramm der Beziehung der Begriffe untereinander und kurze Erläuterung der Schlagworte

	(tuned in the ratio 6:5) and an octave (in the ratio 2:1), equal to 648:625
Greek tetrachords	
harmony of the spheres	
Hertz	unit to measure frequency, number of periods per second
hexachord	part of a diatonic scale with six notes covering a major sixth
<u>Hexachordon duris</u>	the hexachord G-A-B-C-D-E
<u>Hexachordon mollis</u>	the hexachord F-G-A-Bb-C-D
<u>Hexachordon naturalis</u>	the hexachord C-D-E-F-G-A
interval	
<u>ionian</u>	
irrational number	number that cannot be expressed as fraction, number with infinite aperiodic decimal representation
just intonation	
kappa-n	a graph with n-nodes where all pairs of nodes are connected by an edge
lesser diesis	difference between an octave (in the ratio 2:1) and three justly tuned major thirds (tuned in the ratio 5:4), equal to 128:125 or about 41.06 cents
<u>limma</u>	the diatonic Pythagorean semitone (256:243)
logarithmic scale	
logos	Greek word for ratio, rational number
lute	
<u>lydian</u>	
mean tone temperament	tuning where the major third 5:4 is divided into two equal tones
<u>Mese</u>	
<u>mixolydian</u>	
monochord	instrument with a single string used for performing acoustical experiments
multiple proportion	ratio of the form n:1
n-edo	division of the octave into n equal intervals
<u>Nete hyperbolaion</u>	
n-tet	division of the octave into n equal intervals
<u>Numeri Sonori</u>	
octave	interval with the ratio 2:1
<u>ottonario</u>	the set of the first eighth numbers 1, 2, 3, 4, 5, 6, 7, 8
perfect major triad	triad with the proportion 4:5:6
perfect minor triad	triad with the proportion 10:12:15
<u>phrygian</u>	
pitch	
proportion	
Pythagorean chromatic semitone	interval of the ratio 2187:2048
Pythagorean comma	interval with the ratio 531,441:524,288, six tones (9:8) minus an octave (2:1)
Pythagorean diatonic semitone	interval of the ratio 256:243
Pythagorean fifth	
Pythagorean hammers	
<u>Pythaorean major third</u>	interval with the ratio 81:64 consisting of two equal tones (9:8)
<u>quinario</u>	the set of the first five numbers 1, 2, 3, 4, 5
ratio	pair of two numbers
relatively prime	integer numbers without a common divisor <u>gerater</u> than 1

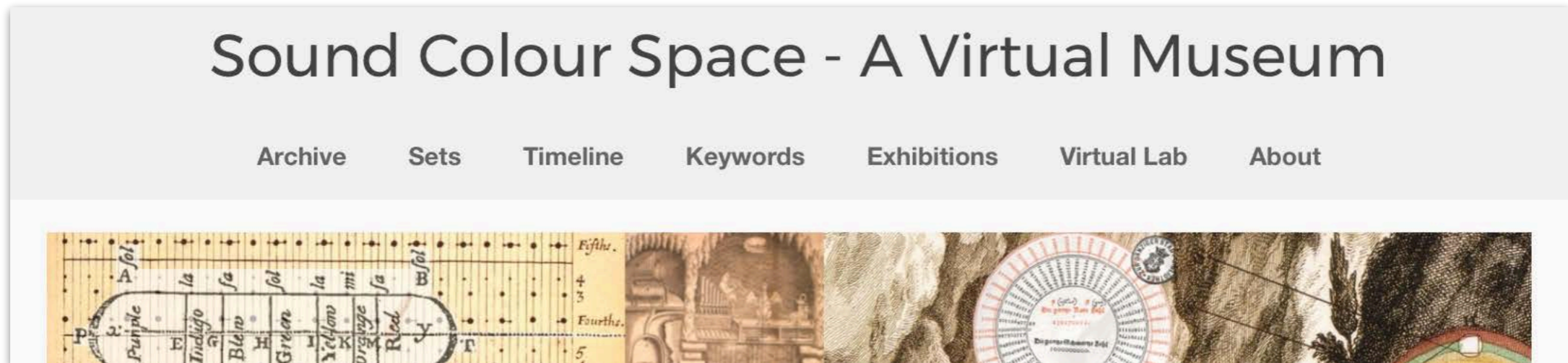
Funktionen von Schlagworten aus Sicht der BesucherInnen

Zugang zu den Inhalten via Schlagworten

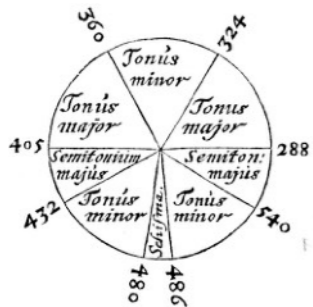


Daniel Muzzolini: Funktion der Schlagworte als eine Form des Zugangs zur Sammlung der historischen Diagramme.
oben: schematische Darstellung
rechts: Screenshots aus dem Virtuellen Museum

(Re)präsentationsformen der historischen Diagramme

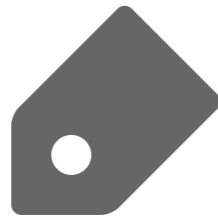


Quellen



digitalisierte Diagramme aus historischen Traktaten

Metadaten



Autoren, Titel, Datierungen, Erscheinungsorte

Texte



Annotationen, Schlagworte, Definitionen

Anordnungen



Bild-Text- und Bild-Bild-Tableaus, lineare Rezeption

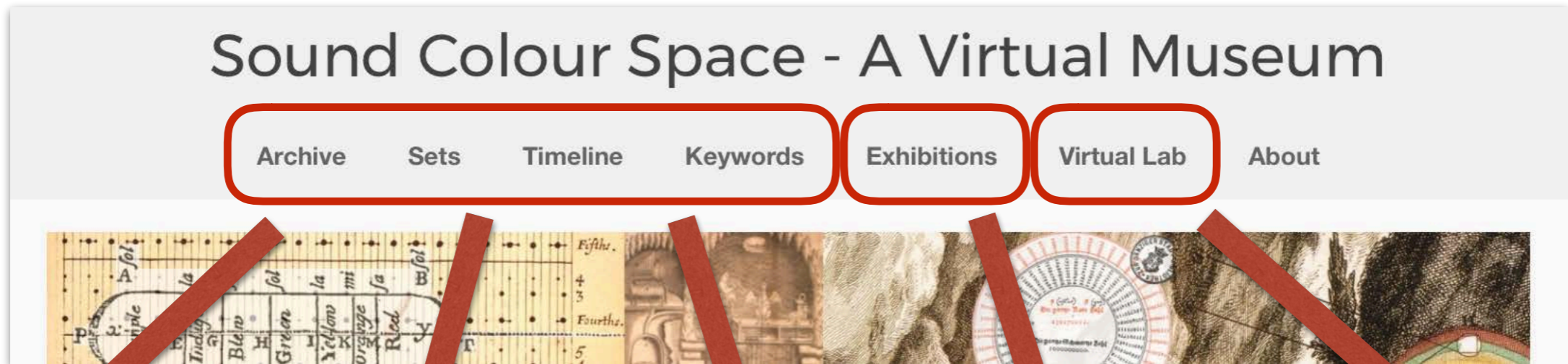
Interaktionen



programmierte Diagramme, interaktive Tonsysteme

An jeweilige Vermittlungsform angepasste Datenorganisation

Zugriff auf verschiedene Repositorien und Ablagen



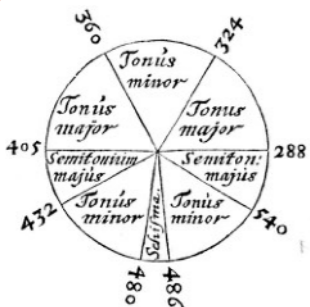
Quellen

Metadaten

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digitalisierte
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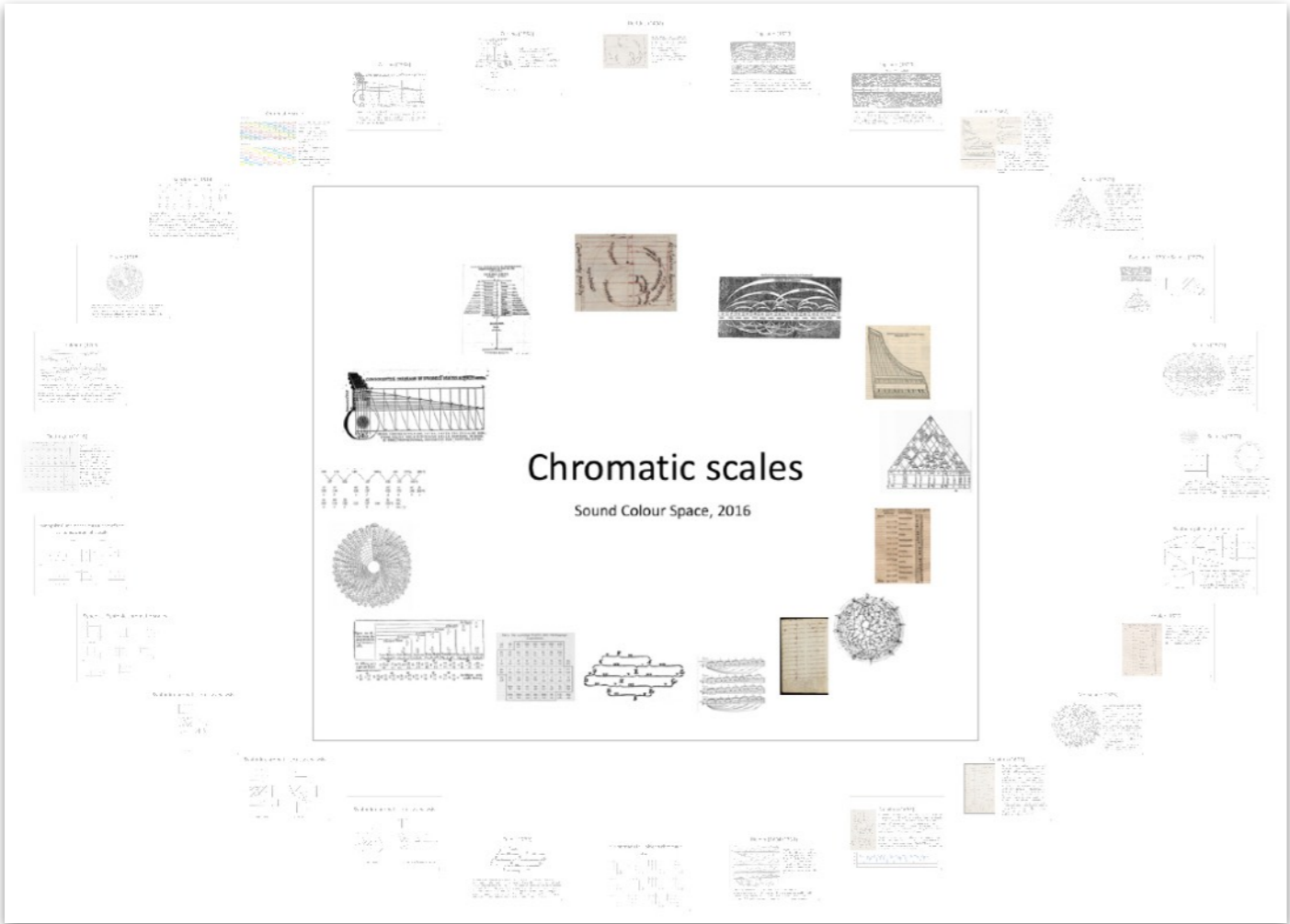


Bild-Text- und
Bild-Bild-
Tableaus,
lineare
Rezeption



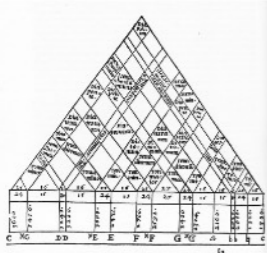
programmierte
Diagramme,
interaktive
Tonsysteme

Format der virtuellen Ausstellungen



Raimund Vogtenhuber:
 Bewegbare Anordnungen von
 Tableaus und Diagrammen im
 Internet-Browser. «Eingespielt»
 sind Inhalte von Dirmoser und
 Muzzolini.

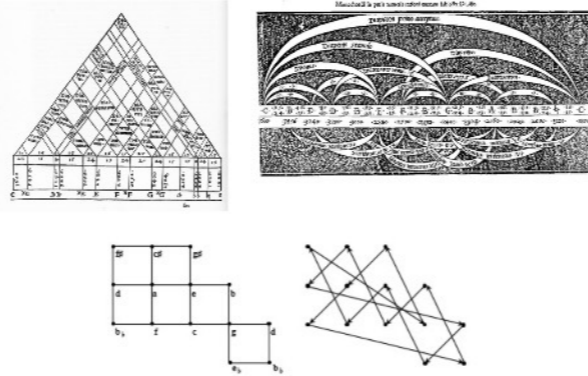
Francisco Salinas (1577)



Chromatic scale of 14 pitch classes per octave. There are two ambiguous pitches D and b. #E should be read as Eb: it is a chromatic semitone (25:24) lower than E. There are five regular chromatic semitones 25:24 and six regular diatonic semitones 16:15, the ratio of f#-g however is 27:25 instead. The scale is a subset of Salina's scale of 24 pitch classes [46]. The larger intervals of the scale are analysed in a triangle, which substitutes Boethius's system of arcs and uses fewer lines to label the same number of relationships. The names of the intervals can be found directly below the point of intersection of the related oblique lines.

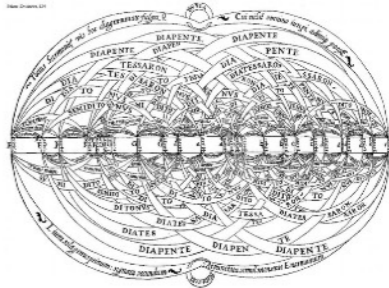
overview
 title
 back
 forward

Fogliano (1529) / Salinas (1577)



overview
 title
 back
 forward

Salinas (1577)



Chromatic scale of 24 pitch classes per octave. The indicated string lengths admit its interpretation in terms of Pythagorean fifths (3:2) and syntonic major thirds (5:4). There are four different pitches for F#/Gb and four different pitches for A#/Bb. In the realisation in the 53-tet tuning the distance between neighboured pitches varies from 1 to 3 units.

Exponate in virtuellen Ausstellungen

Descartes's tone system

mollis naturalis
duris

c d e f g a b h c

Hexachord:
Descartes
Fludd

- major tone 9 : 8
- minor tone 10 : 9
- semitone 16 : 15
- minor third 6 : 5
- semitone Pyth. 256 : 243

Descartes's diatonic scale

c d e f g a h c

- major tone 9 : 8
- minor tone 10 : 9
- semitone 16 : 15

1650 (1618)

Transformations underlying Descartes's diagrams

$\log_2()$

$360^\circ \cdot \text{mod}_1()$

Newton's diatonic scales

ut re mi fa sol la fa ut
g a b c d e f g
g a bb c d e f g
sol la fa sol la mi fa sol

- major tone 9 : 8
- minor tone 10 : 9
- semitone 16 : 15

1665

1675/1704

9 units (53-tet)
8 units (53-tet)
5 units (53-tet)

Newton – tuning problem

- col 1: ratio just intonation
- col 2: string length just intonation
- col 5: string length 12-tempered intonation
- col 3 = $\log_{10}(\text{col 2})$
C: $\log_{10}(540)=2.73239$
- col 4 = $\log_{10}(\text{col 5})$
C: $\log_{10}(539.39056)=2.73190$
- Common difference in col 4:
 $2.85733-2.83225=0.025086$
- col 6: interval size of just intonation in terms of 12-tempered semitones:
G-C: $(2.857332-2.732393)/0.025086=4.9804$, i.e., 4.98 12-t semitones

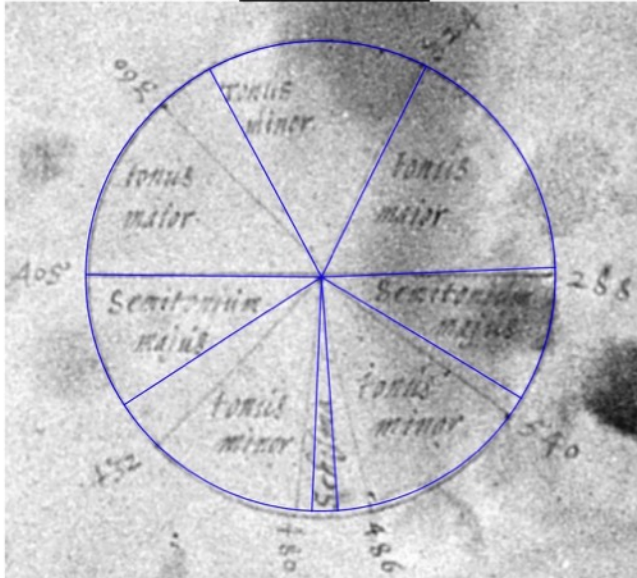
Newton – tuning problem

Daniel Muzzolini: Erläuterung der Themen der einzelnen Diagrammen mit Hilfe von eigenen Diagrammen oder Notationen

Sonifikation der historischen Diagramme

Descartes - Diatonic Scale

Descartes 1628, MS_Middelburg freq: 671.6



Settings

Template

visibility show hide (Keyboard: F H)

center set (Keyboard: -ctrl-)

move left up right down (Keyboard: A W S Y)

rotate left right (Keyboard: Q E)

scale decrease enlarge (Keyboard: 8 9)

moving speed fast slow (Keyboard: -shift-)

Sound

Sound on off (Keyboard: -enter- -escape-)

Base-Frequency:

Oscillator

Choose type: hold

volume:

attack:

decay:

sustain-level:

release:

Master

volume:

compressor off

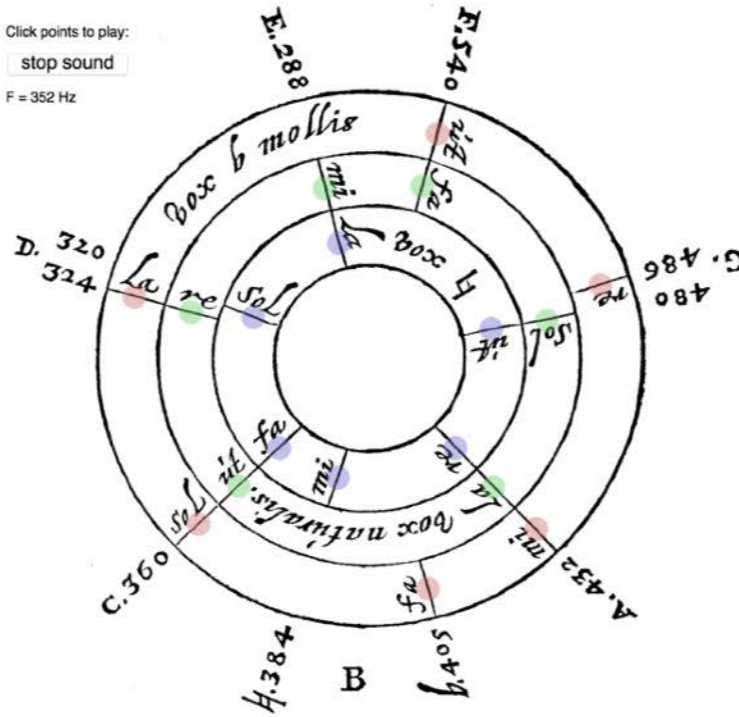
Daniel Muzzolini: Mathematische Rekonstruktion der diatonischen Skala bei Descartes. Interaktives Vergleichen mit den historischen Diagrammen und hörbar Machen der Theorie.

Raimund Vogtenhuber: Sonifizierung des Diagramms zu Hexachorden bei Descartes.

Descartes Hexachord Circles

Click points to play:

 F = 352 Hz



Sound Settings

Oscillator

Choose type: hold

volume:

attack:

decay:

sustain:

release:

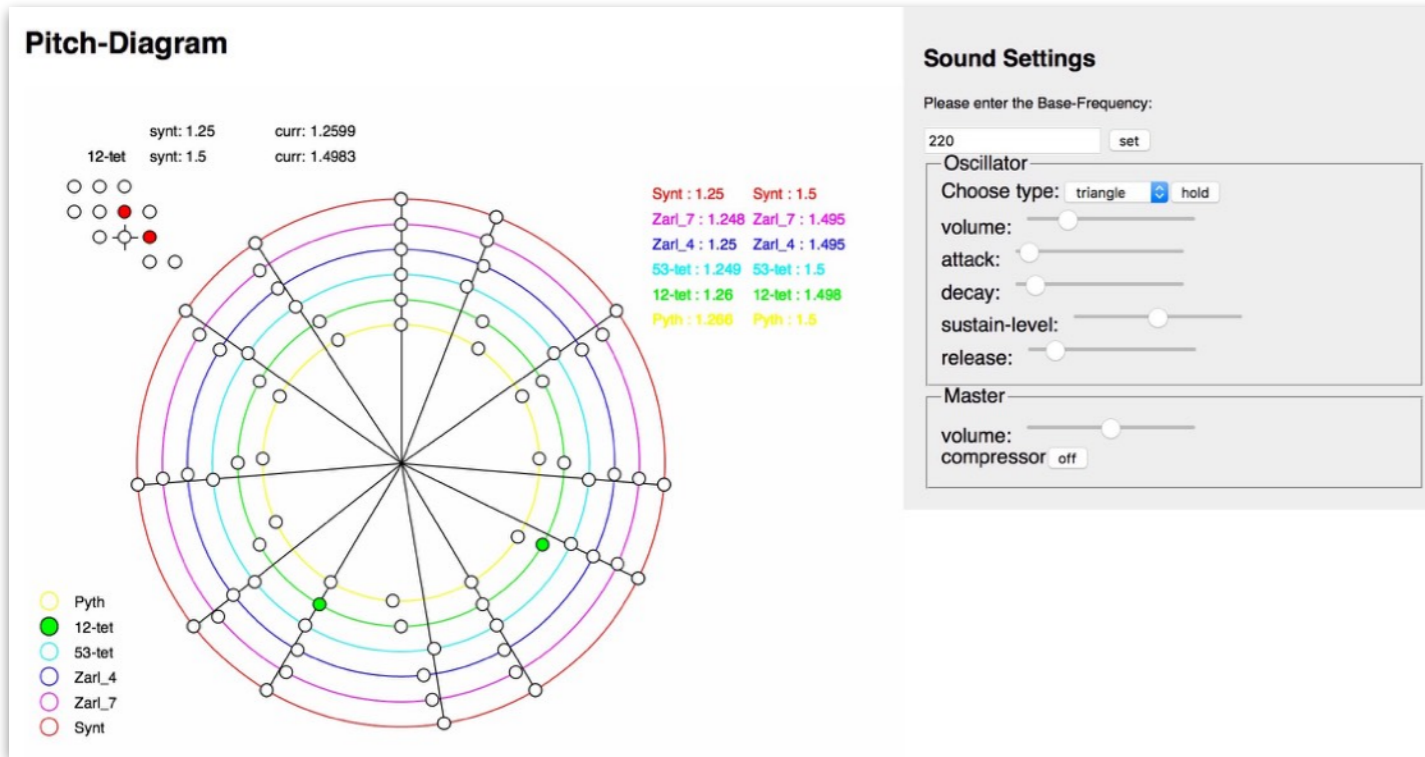
Master

volume:

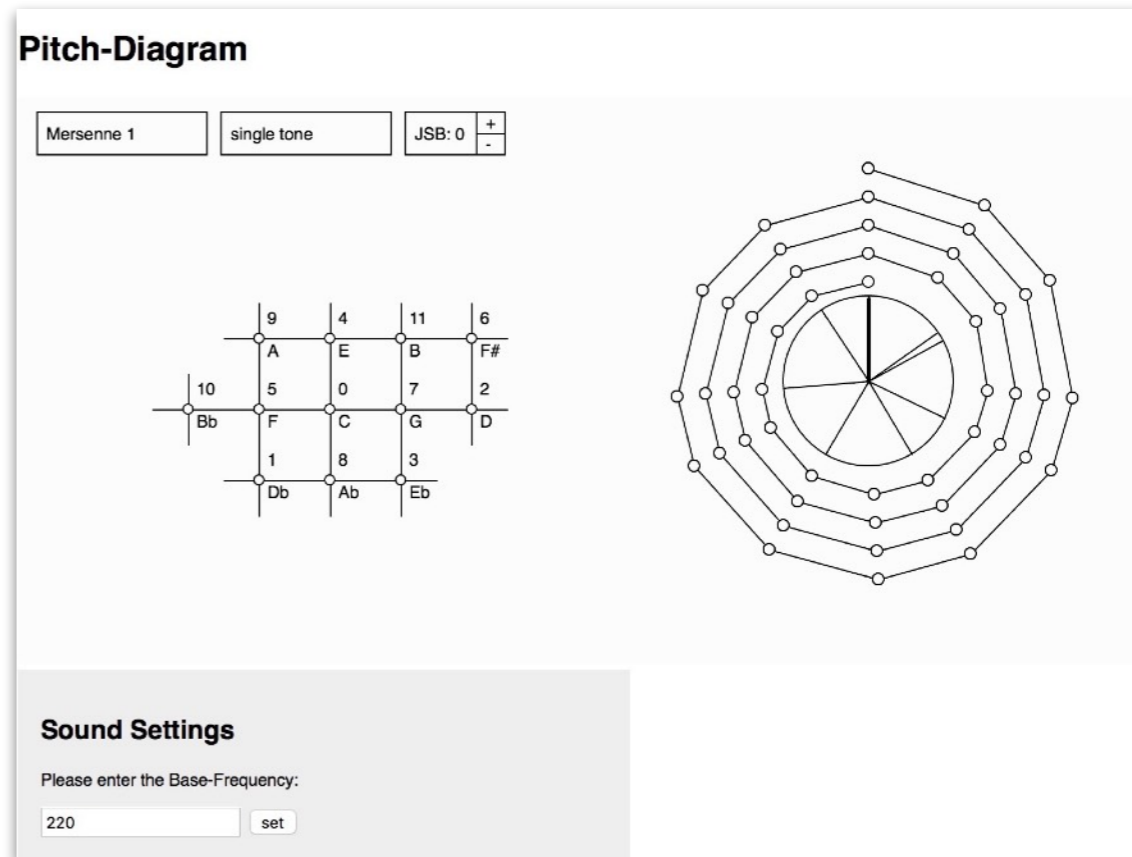
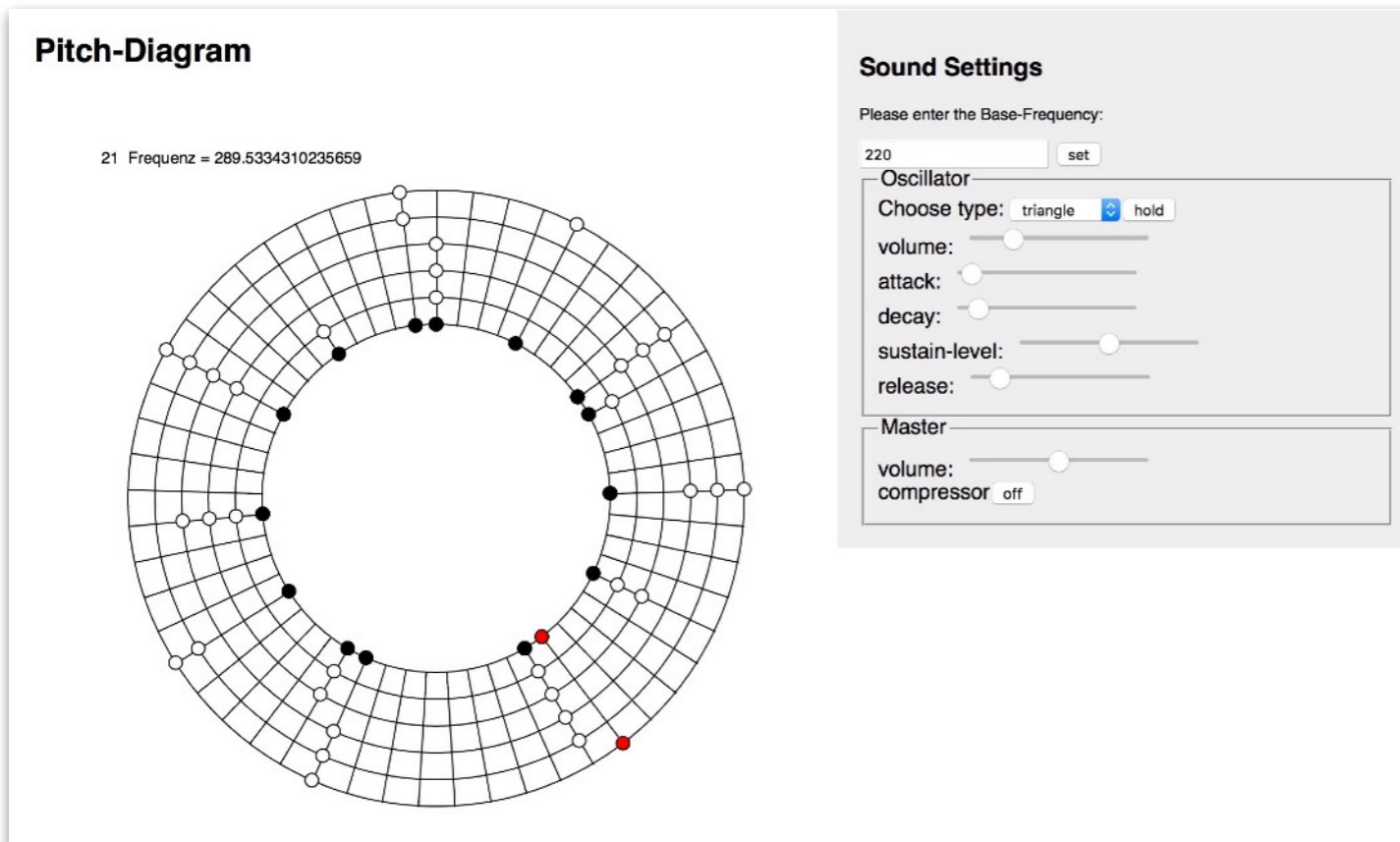
compressor off

Currently playing:

Rendering von interaktiven Diagrammen

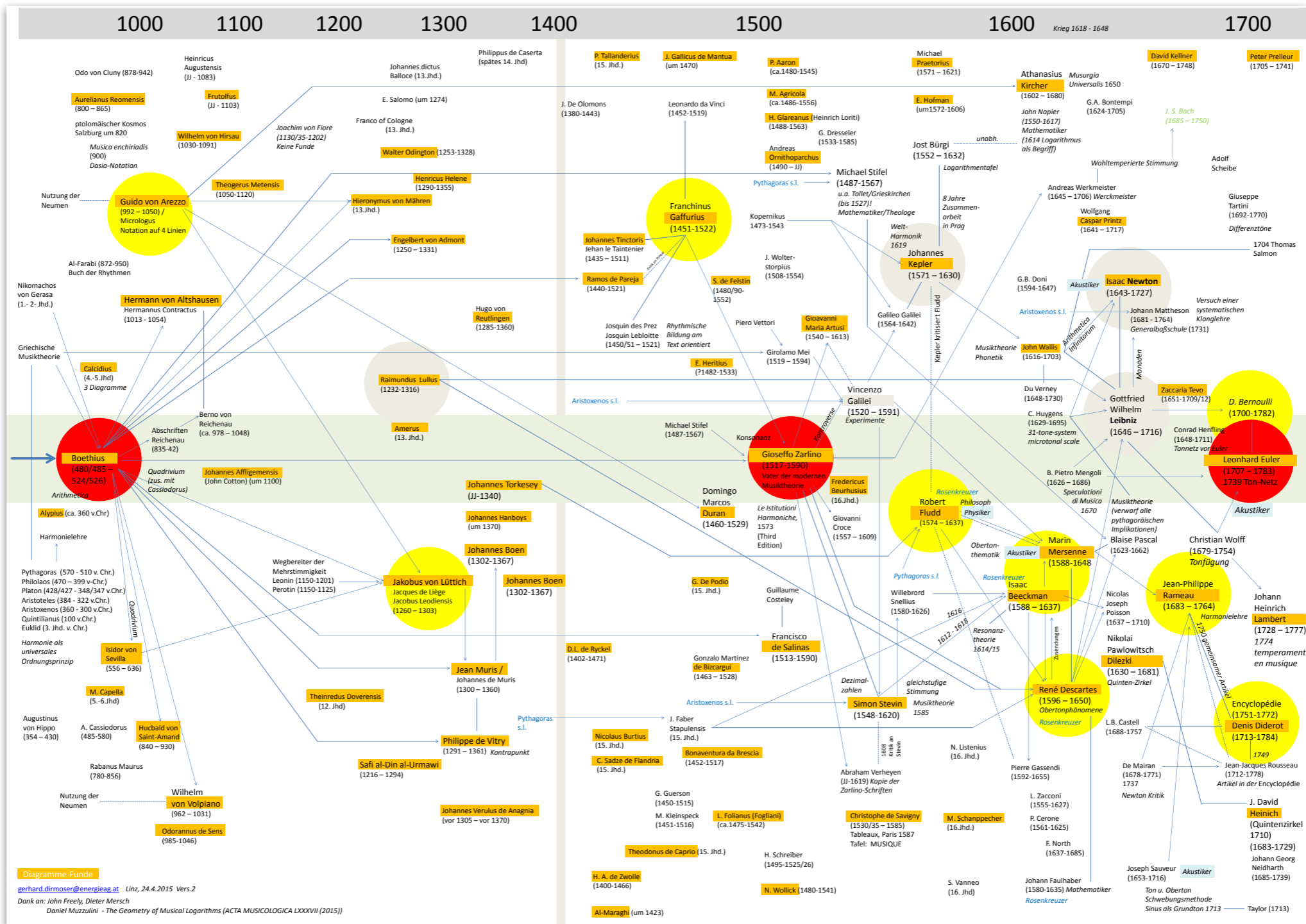


Daniel Muzzolini: Interaktive Pitch Diagramme berechnen verschiedene historische Tonhöensysteme und machen deren Tonschritte hör- und sogar vergleichbar.



Entwicklungslinien und Bezüge verstehen

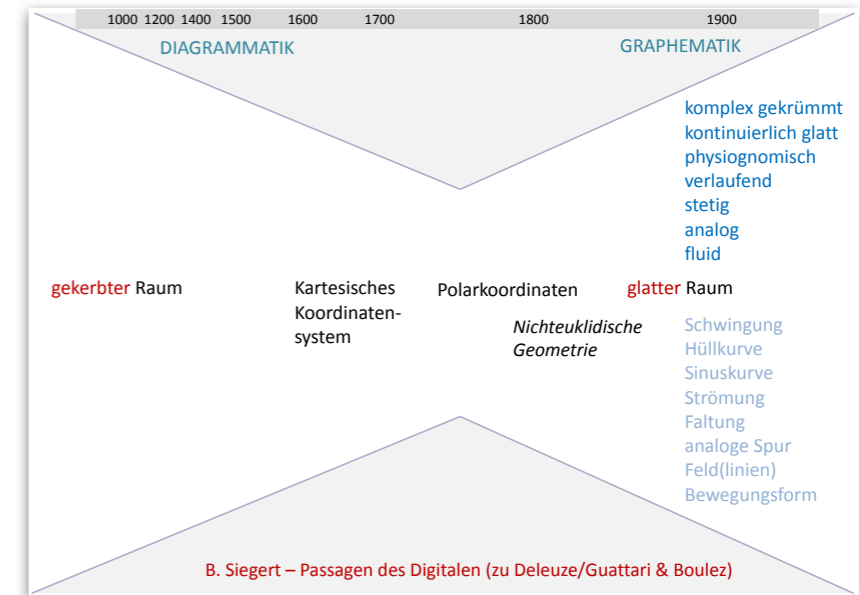
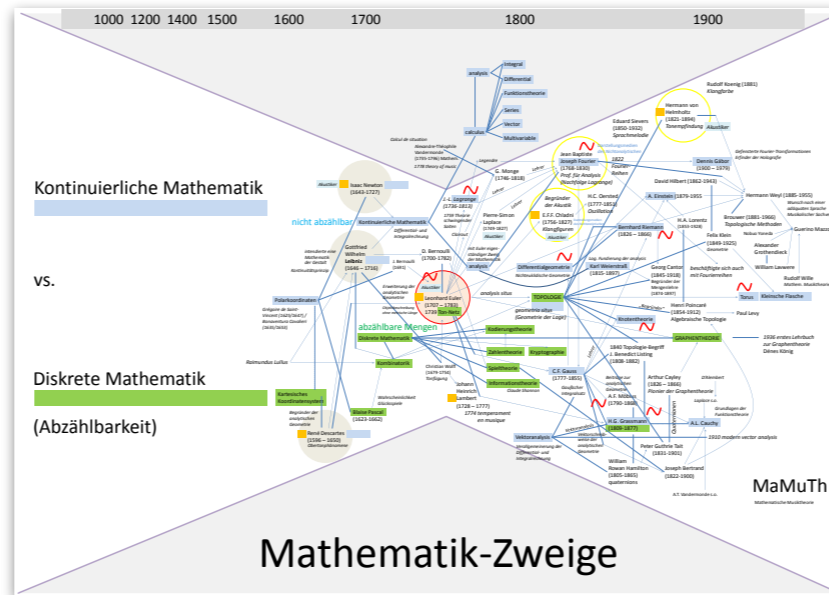
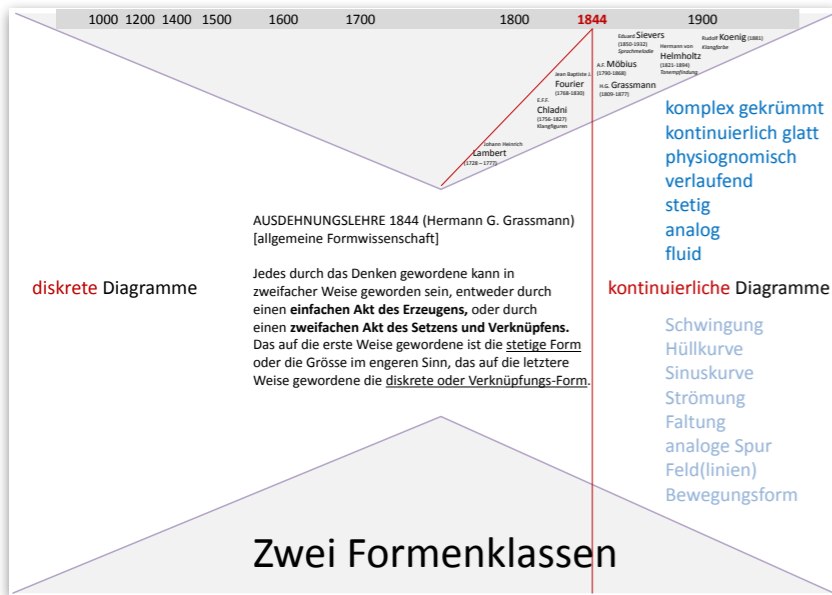
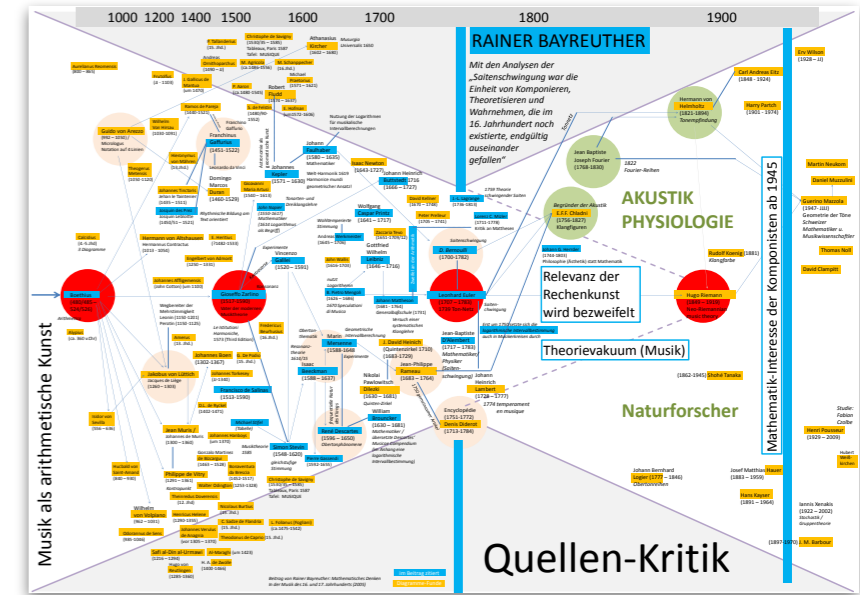
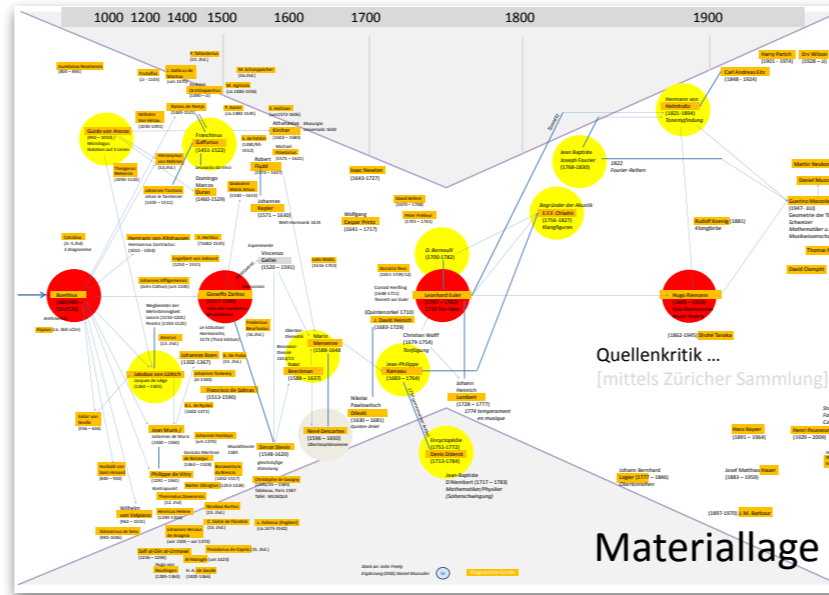
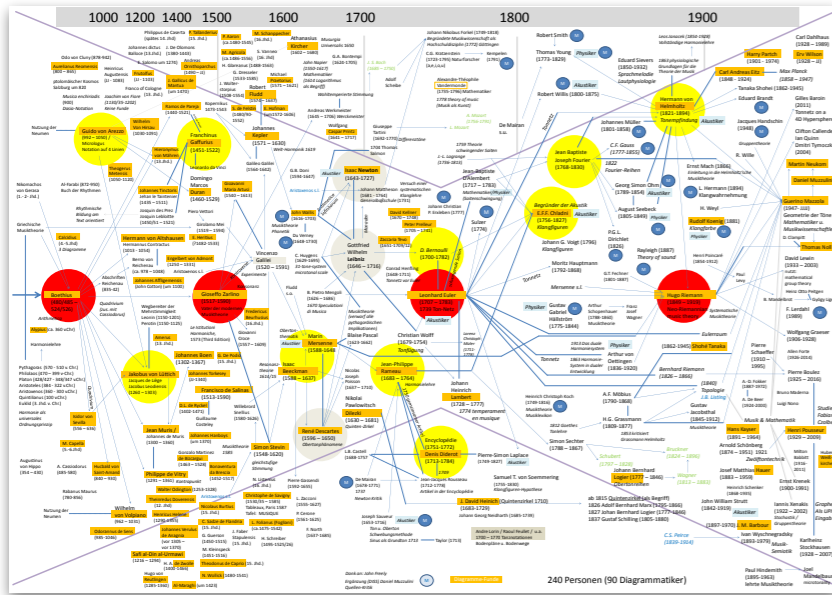
Zeitstrahl mit Einordnung der wichtigen Autoren



Gerhard Dirmoser: Graphischer Überblick zu Personen aus der Geschichte der Musikdiagrammatologie und ihre Beziehungen untereinander

Daten nach verschiedenen Gesichtspunkten analysieren

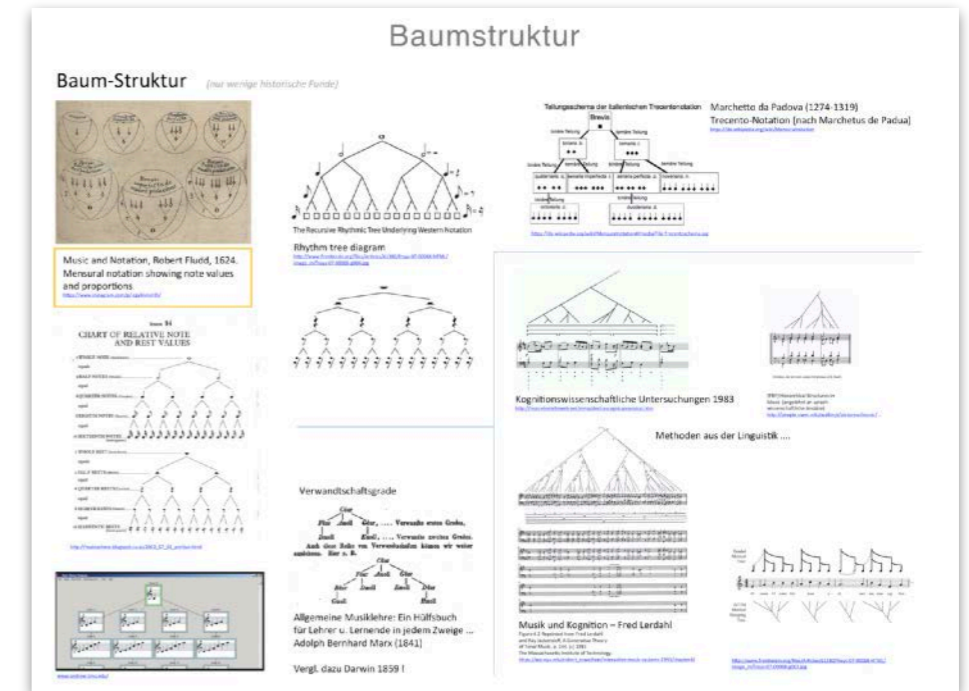
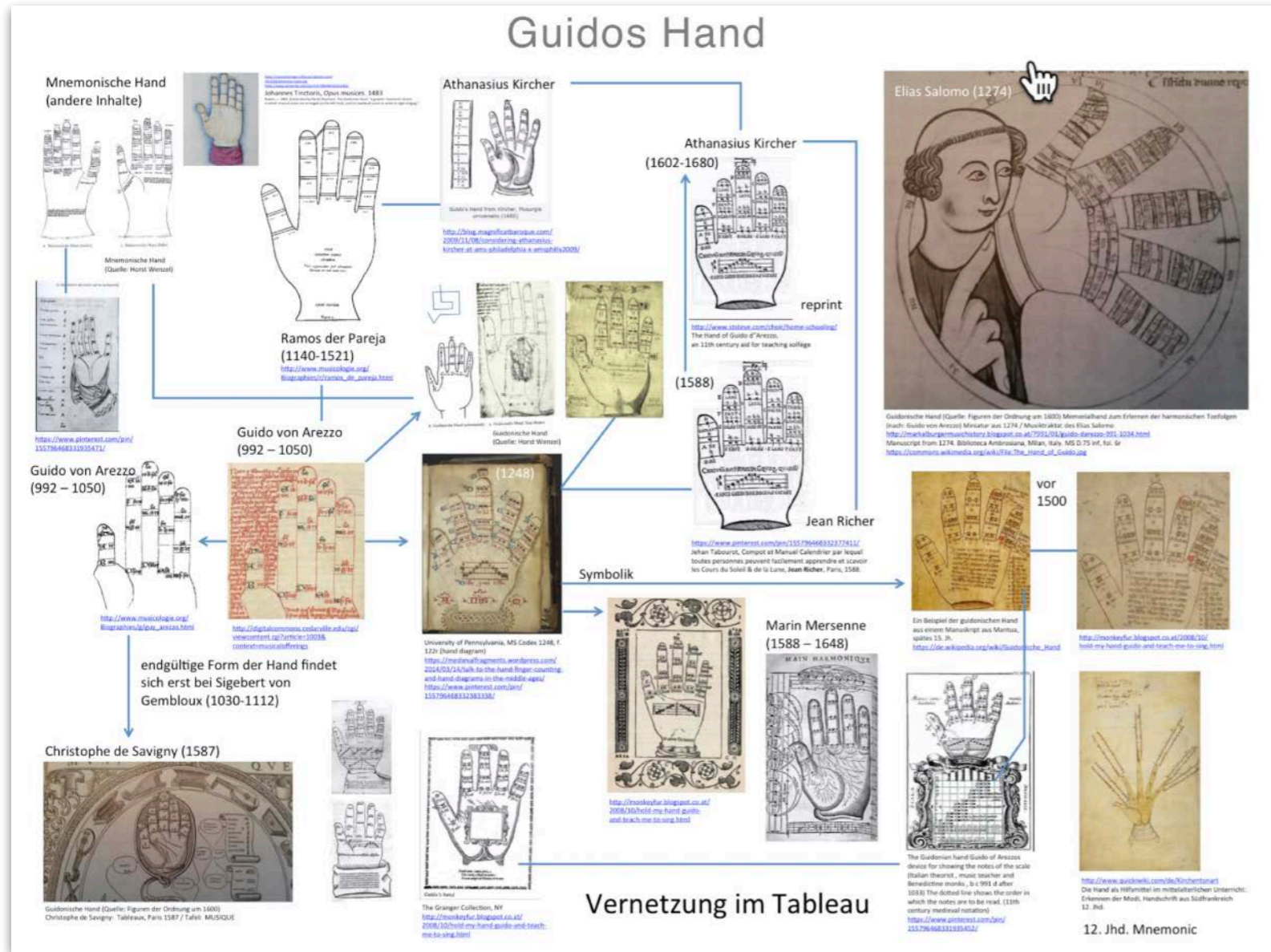
Zeitstrahl mit Einordnung der wichtigen Autoren



Gerhard Dirmoser: Sichtbar Machen von Aspekten der Geschichte der Musikdiagrammatologie

B. Siegert – Passagen des Digitalen (zu Deleuze/Guattari & Boulez)

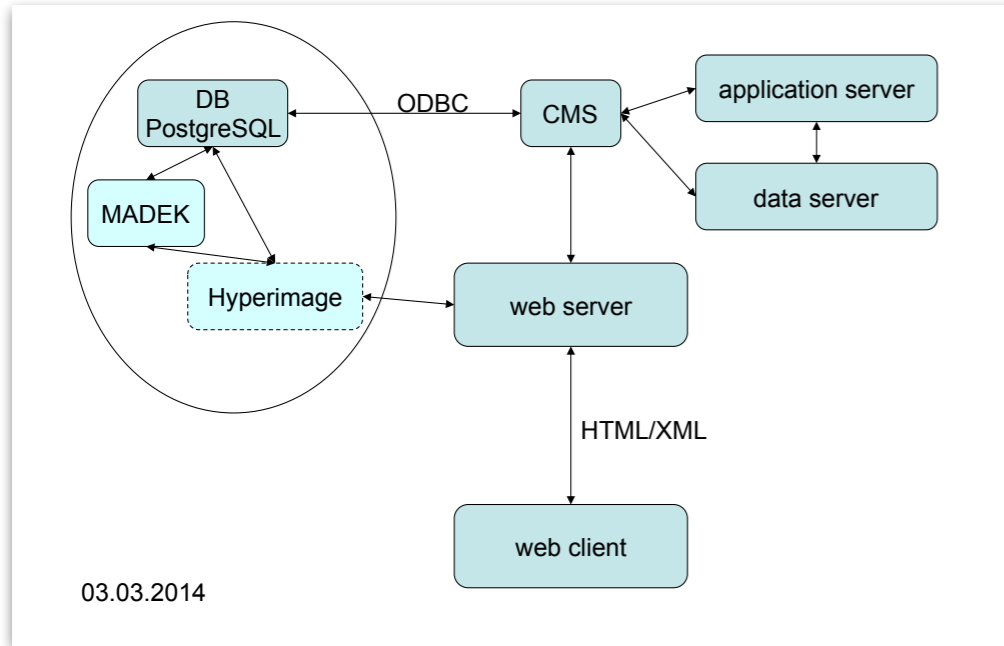
Anordnungen der Quellen zu grossen Tabeleaus



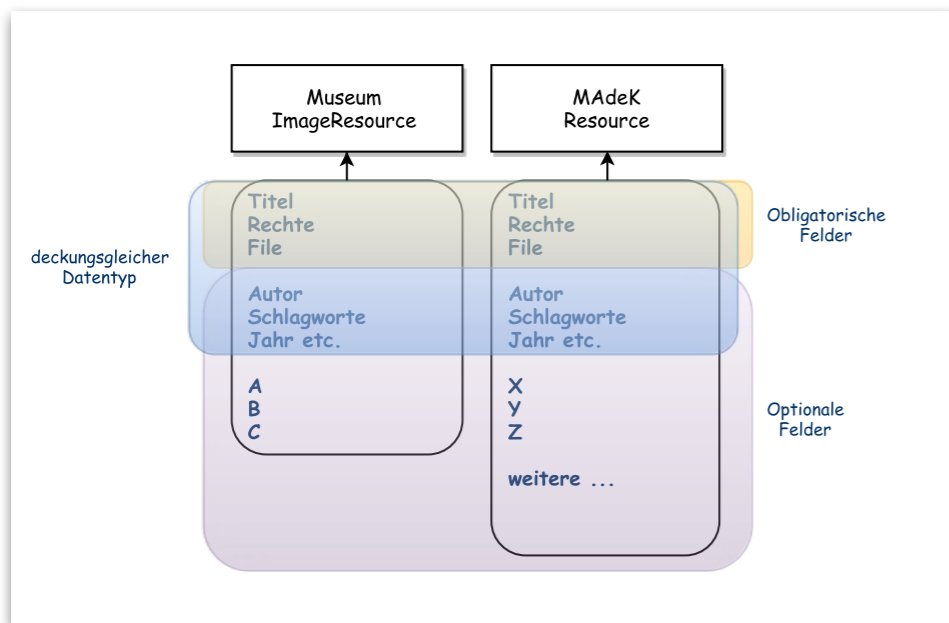
Gerhard Dirmoser: Darstellungsformen vergleichen und Themen identifizieren

Zusammenspiel der Systeme

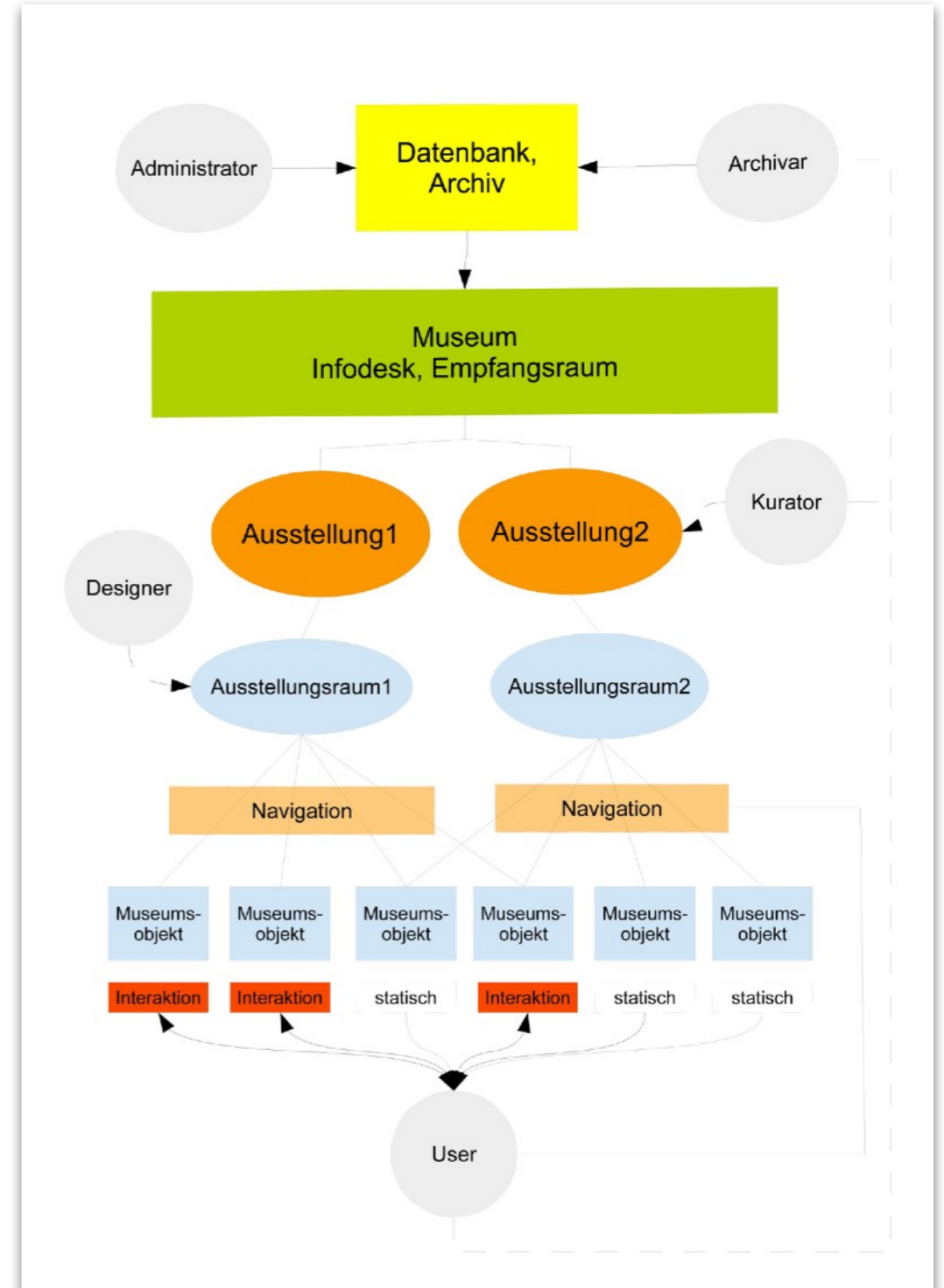
Auf der Seite der Datenorganisation und auf der Seite der Nutzer



Daniel Muzzolini: Überlegungen zur Software-Architektur



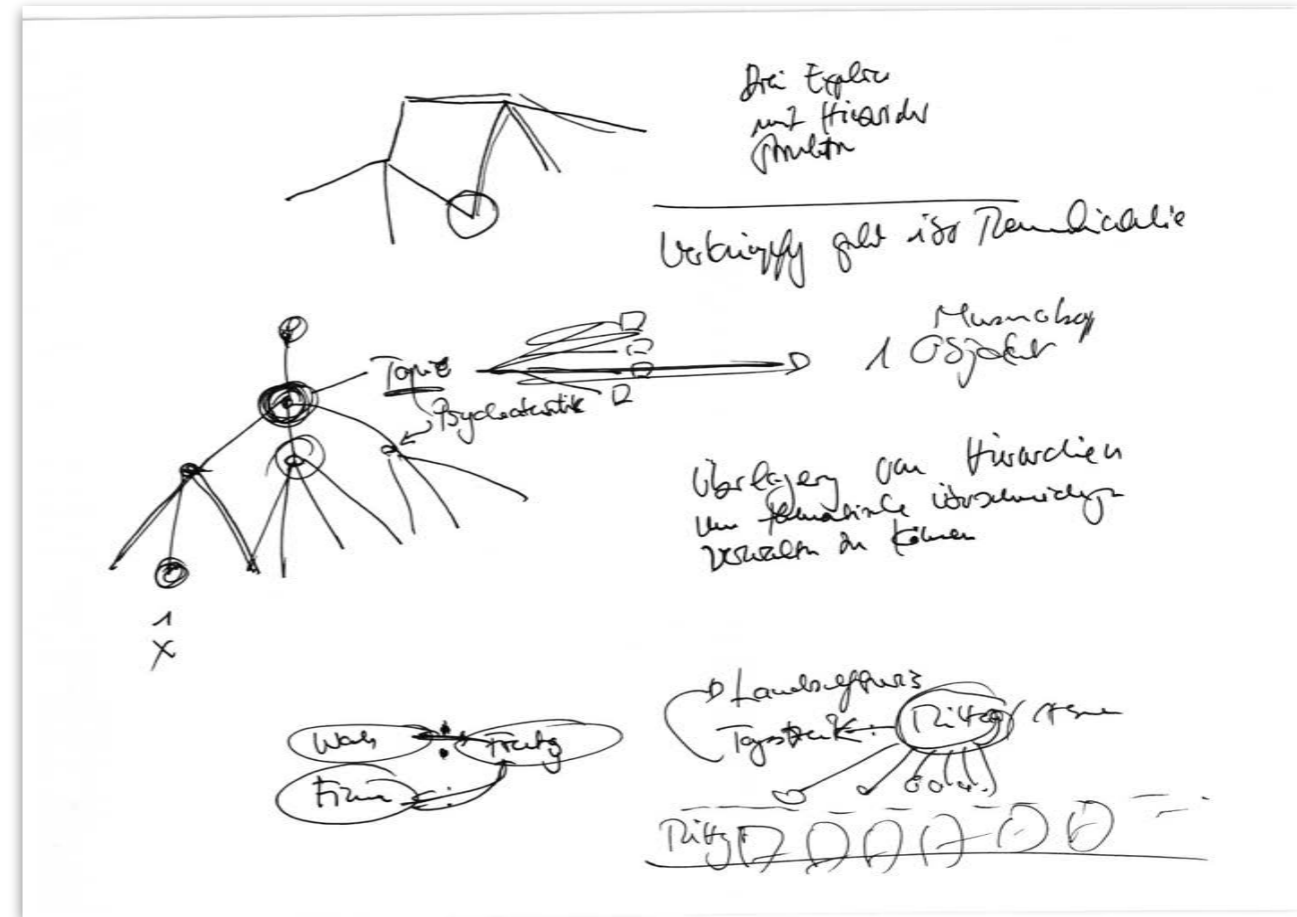
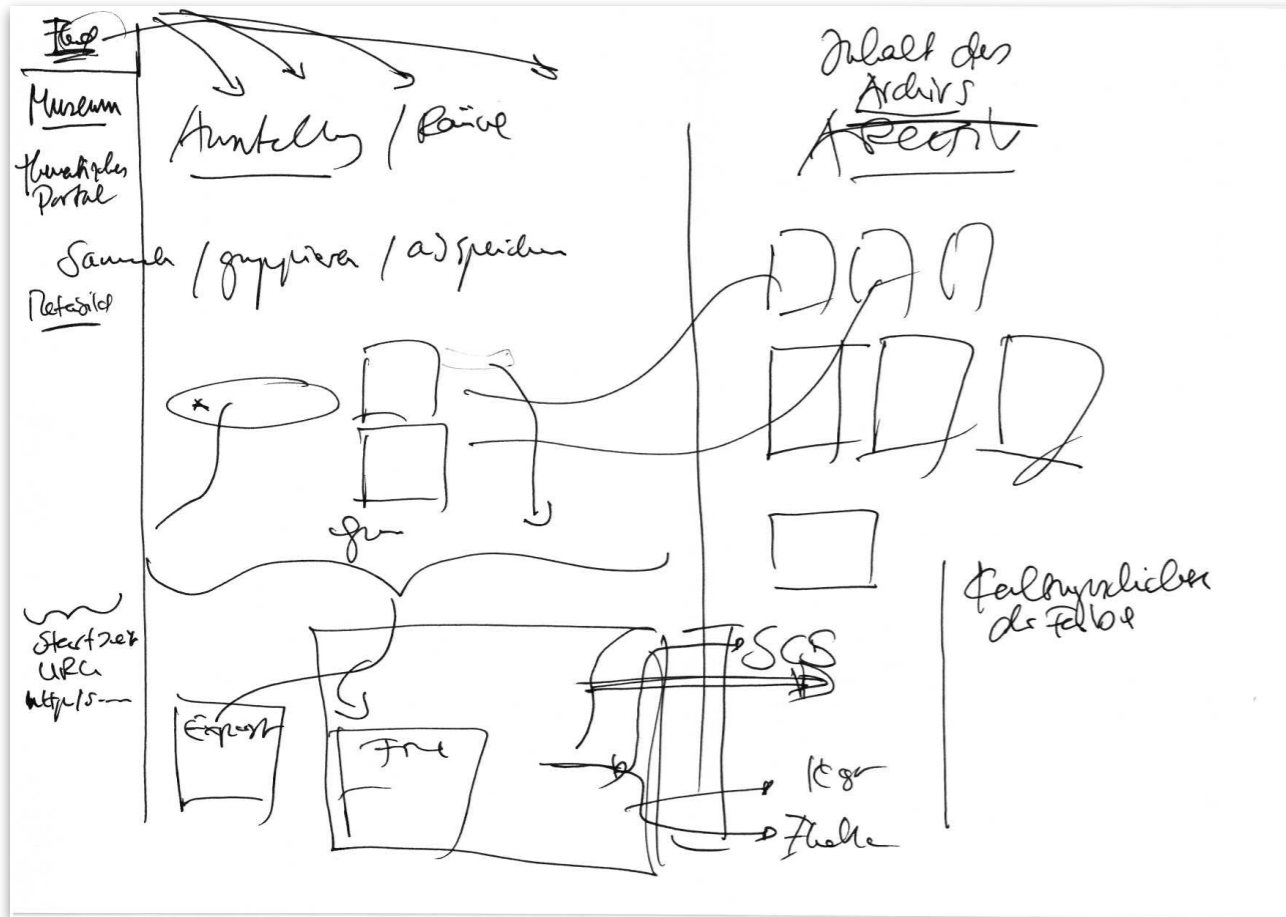
Christoph Stähli: Zusammenspiel der Datenquellen



Raimund Vogtenhuber: Funktionsdiagramm des Virtuellen Museums

Beziehungen zwischen Datenmodell und Vermittlungsformen

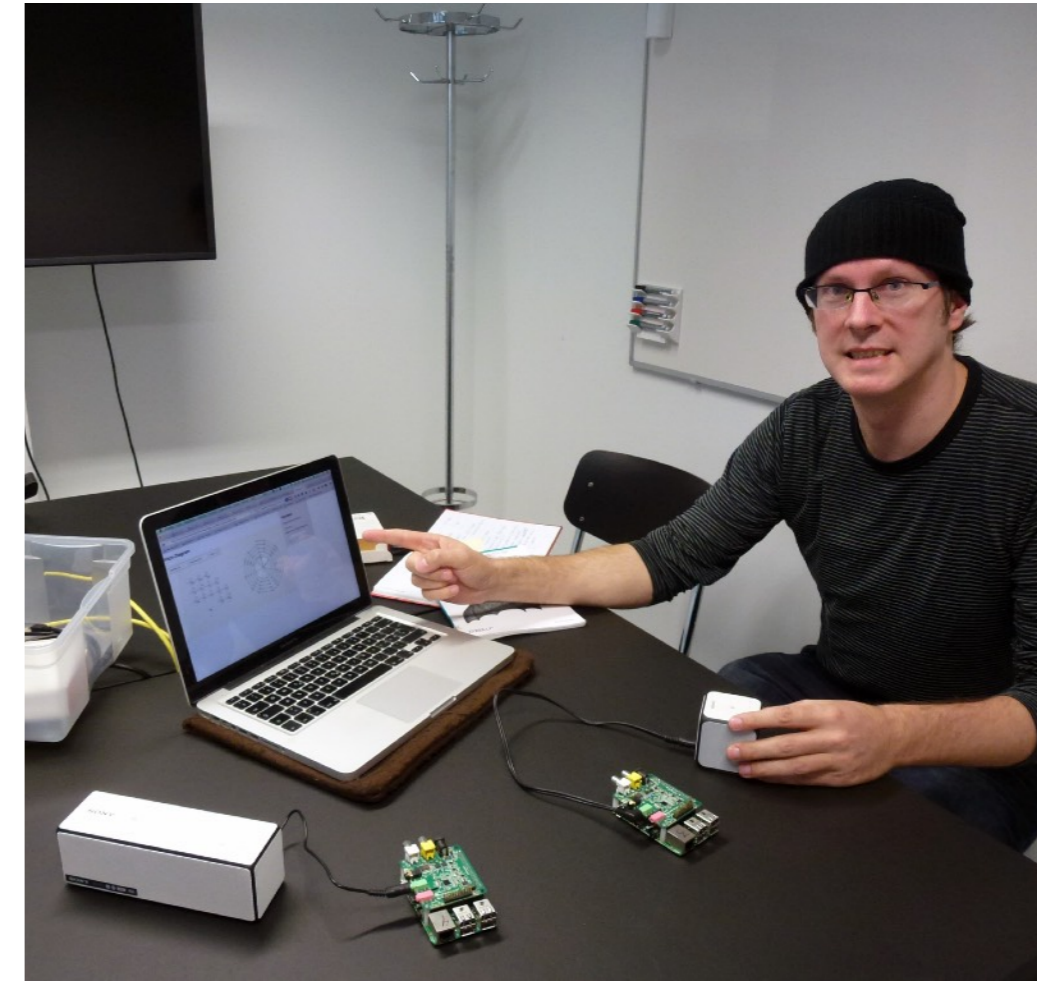
Wechselseitige Abhängigkeit – schrittweise Annäherung



Susanne Schumacher: «Mitzeichnungen» bei Gesprächen zu Konzept und Modell des Virtuellen Museums

Denken und Verstehen beim «Diagraphieren»

Diagramme zeichnen, basteln, erklären, programmieren, künstlerisch interpretieren



Jeroen Visser und Raimund Vogtenhuber

