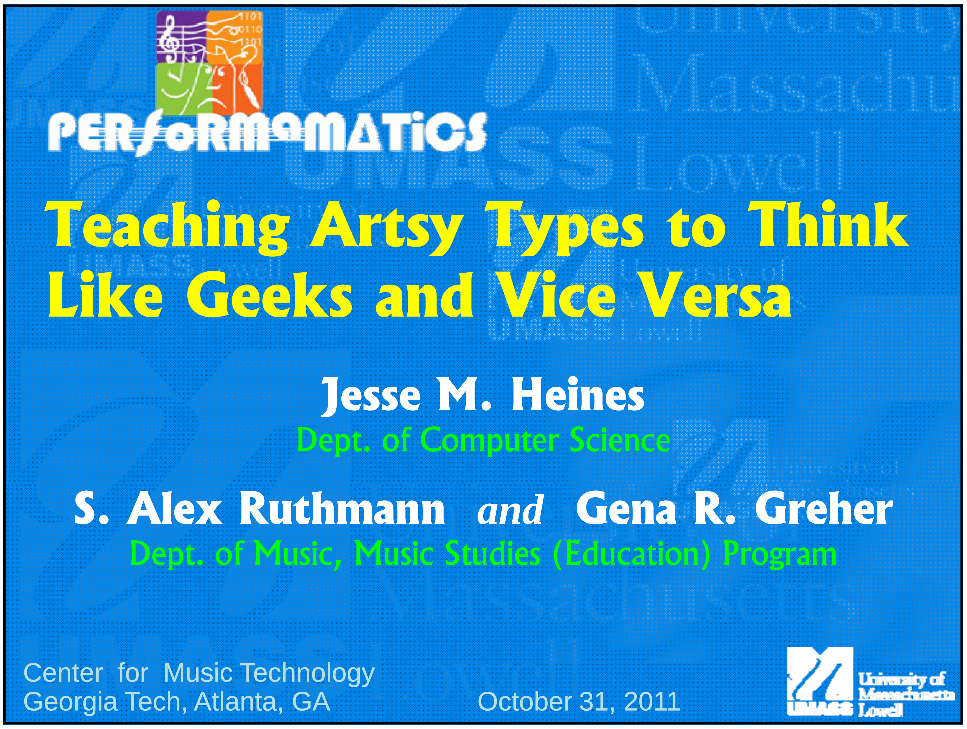


PERFORMAMATICS

Teaching Artsy Types to Think Like Geeks and Vice Versa

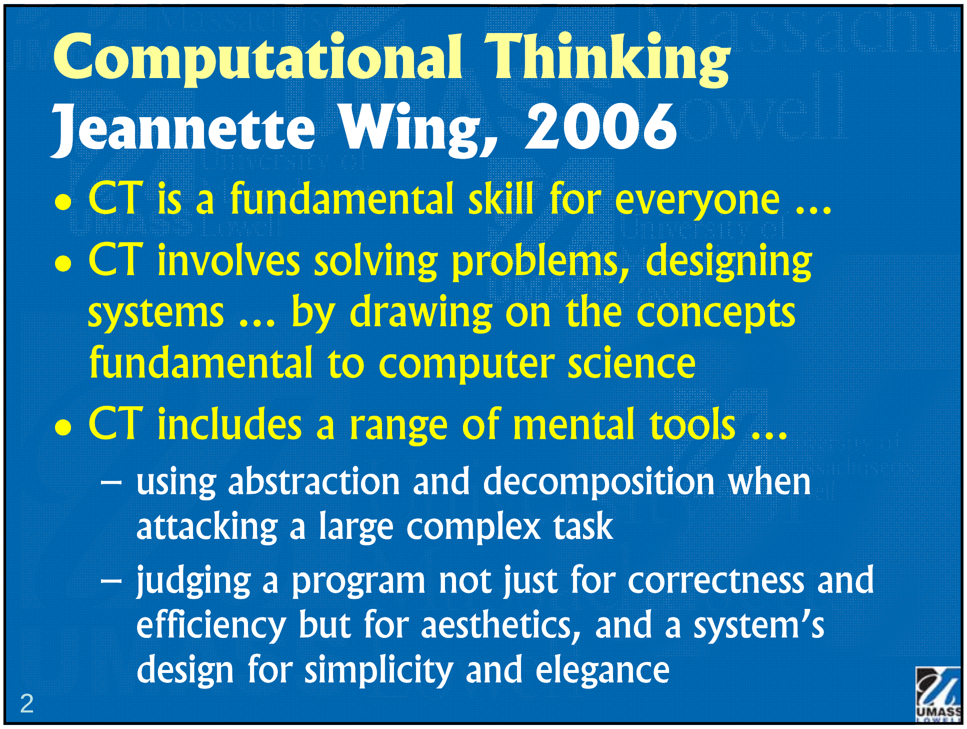
Jesse M. Heines
Dept. of Computer Science

S. Alex Ruthmann *and* **Gena R. Greher**
Dept. of Music, Music Studies (Education) Program

Center for Music Technology
Georgia Tech, Atlanta, GA

October 31, 2011

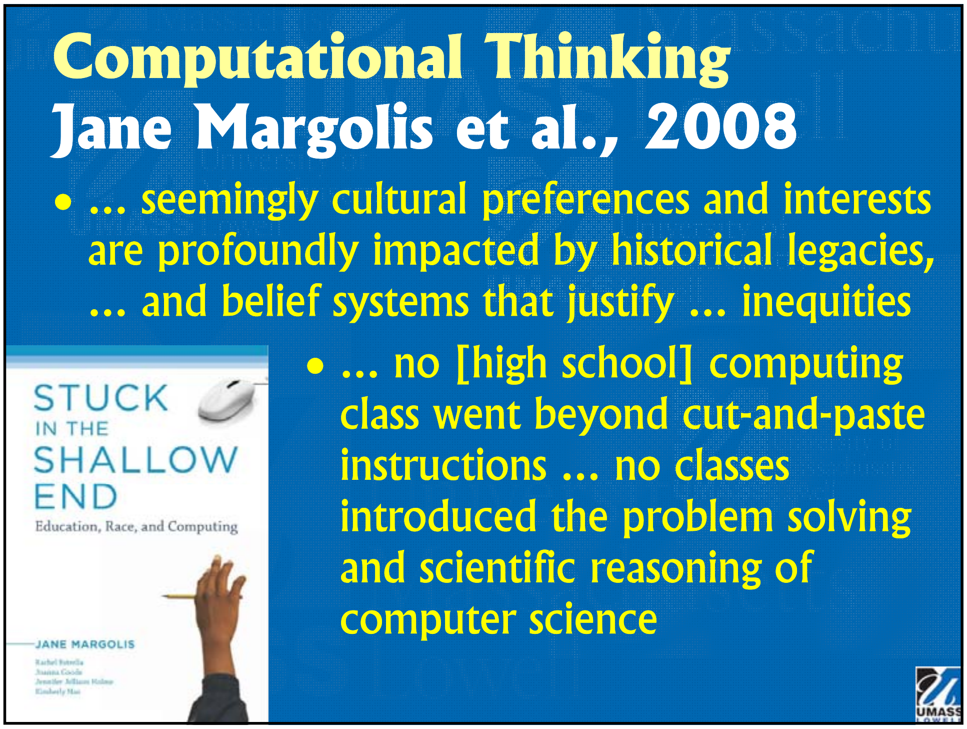
University of Massachusetts Lowell



Computational Thinking
Jeannette Wing, 2006

- CT is a fundamental skill for everyone …
- CT involves solving problems, designing systems … by drawing on the concepts fundamental to computer science
- CT includes a range of mental tools …
  - using abstraction and decomposition when attacking a large complex task
  - judging a program not just for correctness and efficiency but for aesthetics, and a system’s design for simplicity and elegance

2

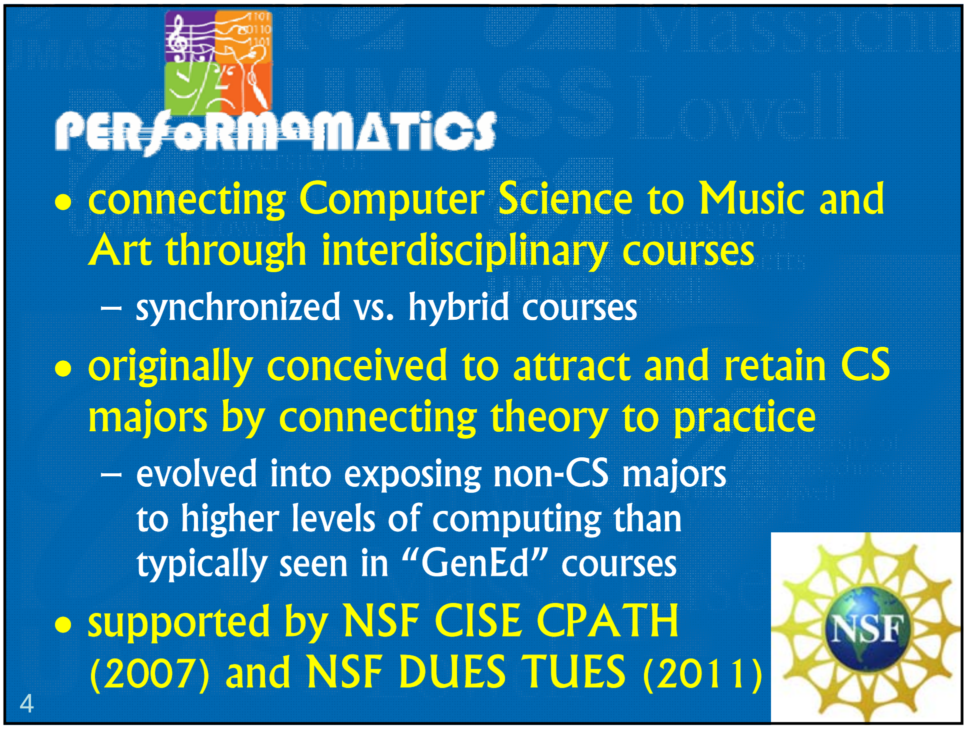


Computational Thinking
Jane Margolis et al., 2008

- … seemingly cultural preferences and interests are profoundly impacted by historical legacies, … and belief systems that justify … inequities

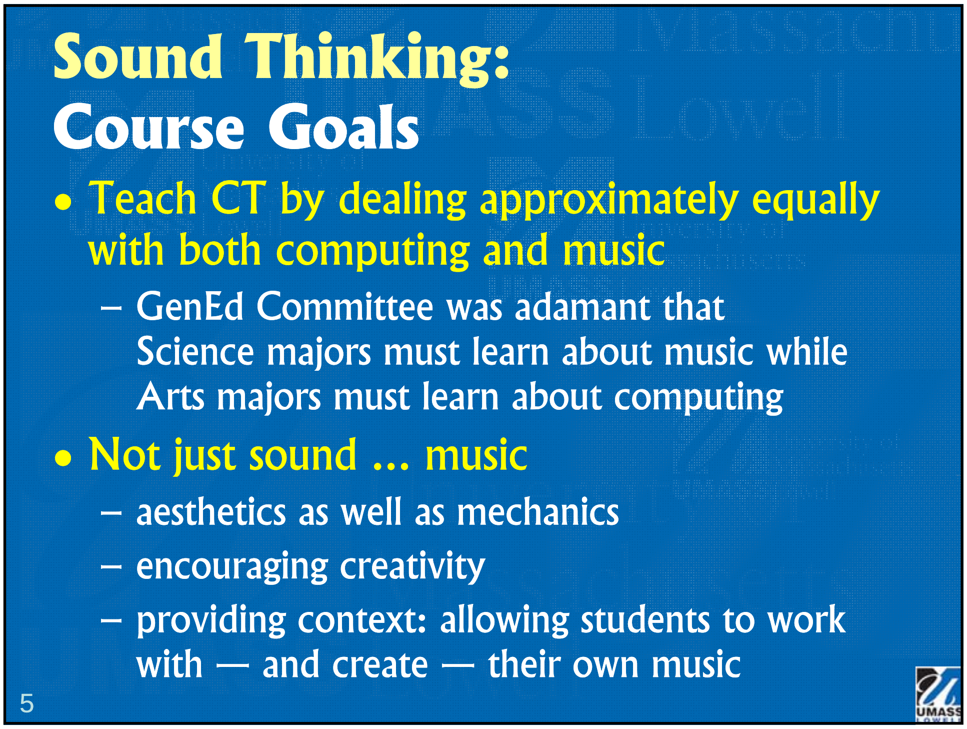
STUCK
IN THE
SHALLOW
END
Education, Race, and Computing
JANE MARGOLIS
Rachel Estrella
Joanna Goode
Jennifer Jellison Holme
Kimberly Nao
UMASS LOWELL

- … no [high school] computing class went beyond cut-and-paste instructions … no classes introduced the problem solving and scientific reasoning of computer science



Performamatics

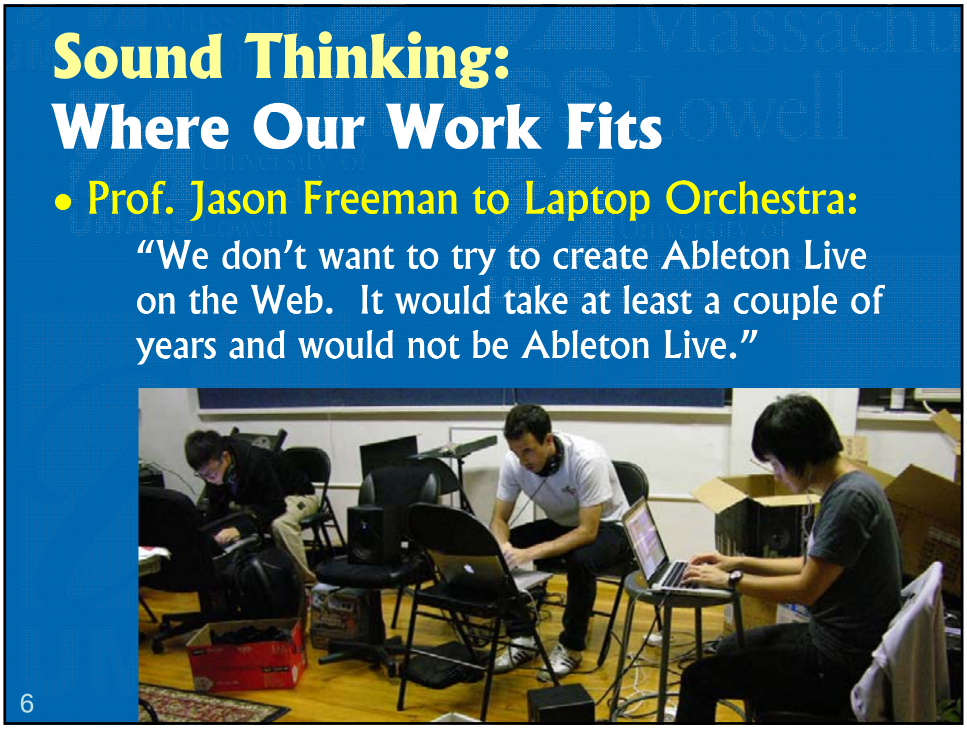
- connecting Computer Science to Music and Art through interdisciplinary courses
  - synchronized vs. hybrid courses
- originally conceived to attract and retain CS majors by connecting theory to practice
  - evolved into exposing non-CS majors to higher levels of computing than typically seen in “GenEd” courses
- supported by NSF CISE CPATH (2007) and NSF DUES TUES (2011)



Sound Thinking:
Course Goals

- Teach CT by dealing approximately equally with both computing and music
  - GenEd Committee was adamant that Science majors must learn about music while Arts majors must learn about computing
- Not just sound … music
  - aesthetics as well as mechanics
  - encouraging creativity
  - providing context: allowing students to work with — and create — their own music

5



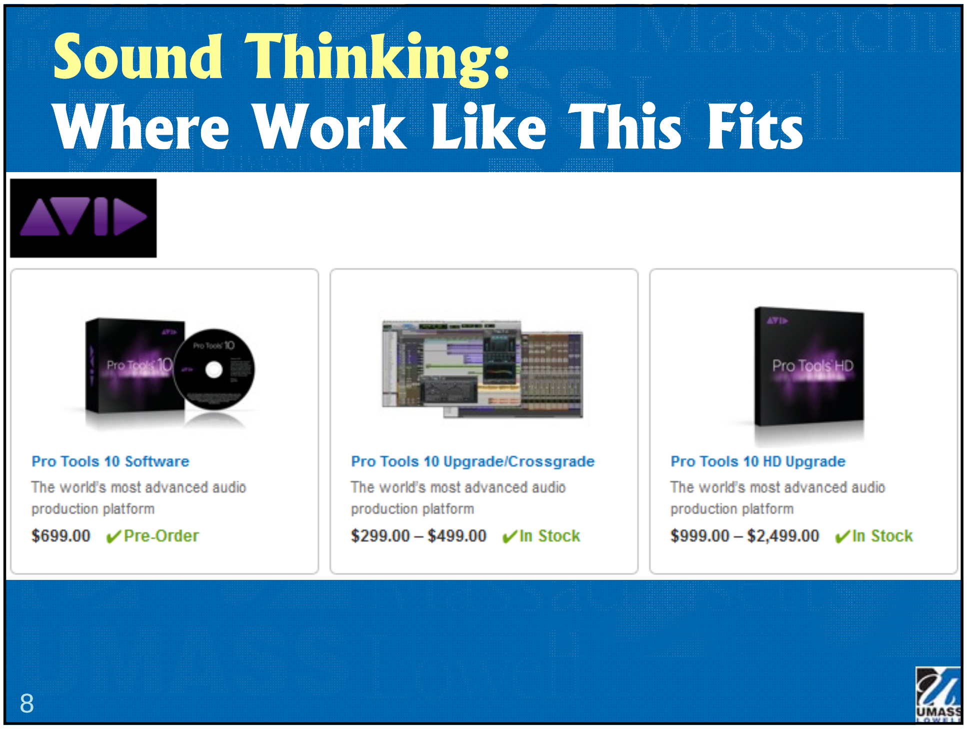
Sound Thinking:
Where Our Work Fits

- Prof. Jason Freeman to Laptop Orchestra:

  “We don’t want to try to create Ableton Live on the Web. It would take at least a couple of years and would not be Ableton Live.”

6

Sound Thinking:
Where Work Like This Fits



Sound Thinking:
Where Work Like This Fits

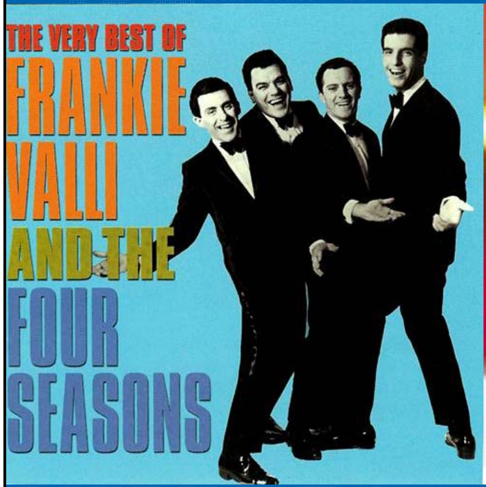
Pro Tools 10 Software
The world's most advanced audio production platform
$699.00 ✓Pre-Order

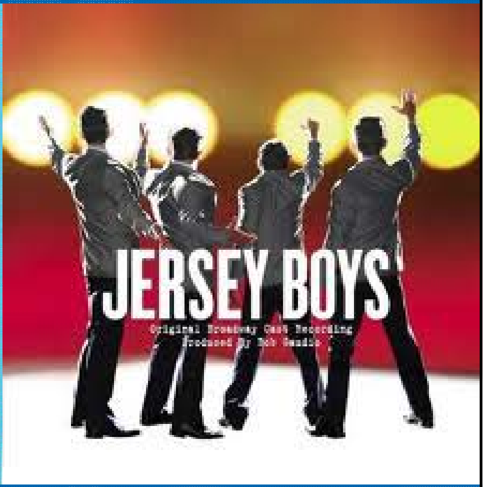
Pro Tools 10 Upgrade/Crossgrade
The world's most advanced audio production platform
$299.00 – $499.00 ✓In Stock

Pro Tools 10 HD Upgrade
The world's most advanced audio production platform
$999.00 – $2,499.00 ✓In Stock

8

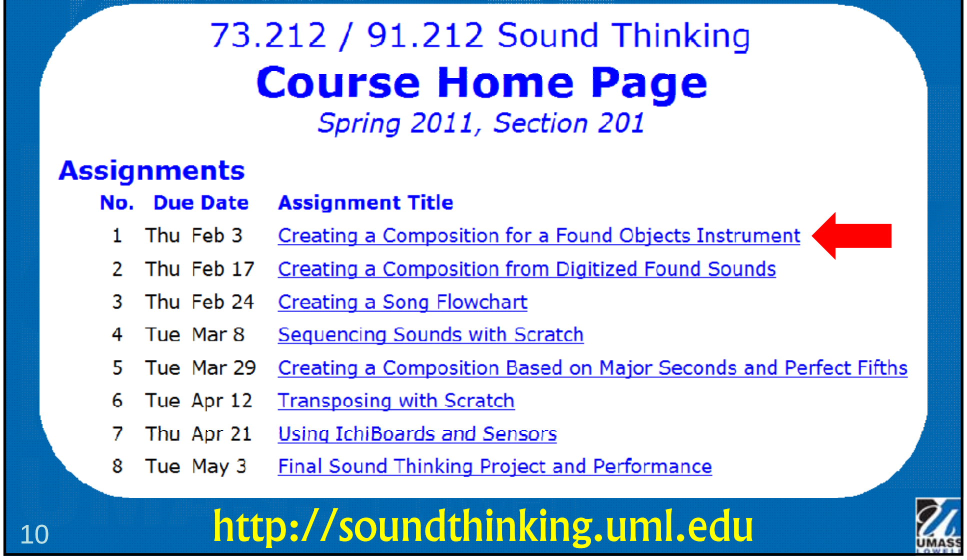
Sound Thinking:
Where Work Like This Fits





9 Audio 1 Audio 2 Stop Sound

Sound Thinking:
What Do Students Do?



73.212 / 91.212 Sound Thinking

Course Home Page

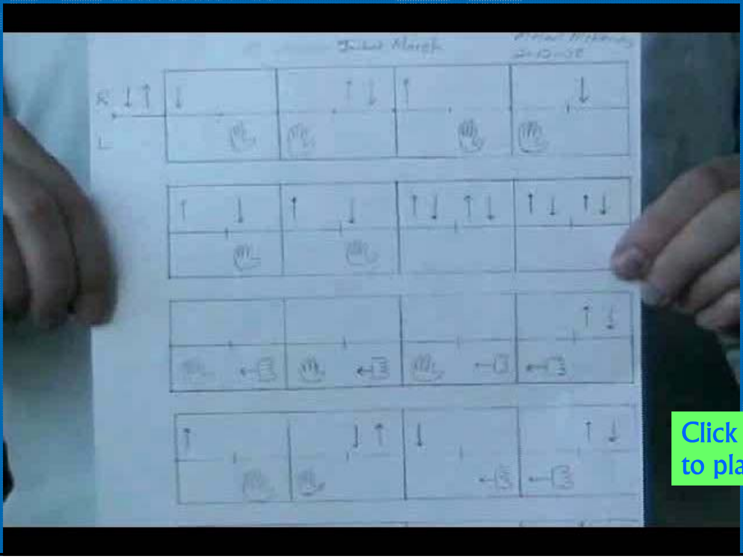
Spring 2011, Section 201

Assignments

No.	Due Date	Assignment Title
1	Thu Feb 3	Creating a Composition for a Found Objects Instrument
2	Thu Feb 17	Creating a Composition from Digitized Found Sounds
3	Thu Feb 24	Creating a Song Flowchart
4	Tue Mar 8	Sequencing Sounds with Scratch
5	Tue Mar 29	Creating a Composition Based on Major Seconds and Perfect Fifths
6	Tue Apr 12	Transposing with Scratch
7	Thu Apr 21	Using IchiBoards and Sensors
8	Tue May 3	Final Sound Thinking Project and Performance

10 http://soundthinking.uml.edu

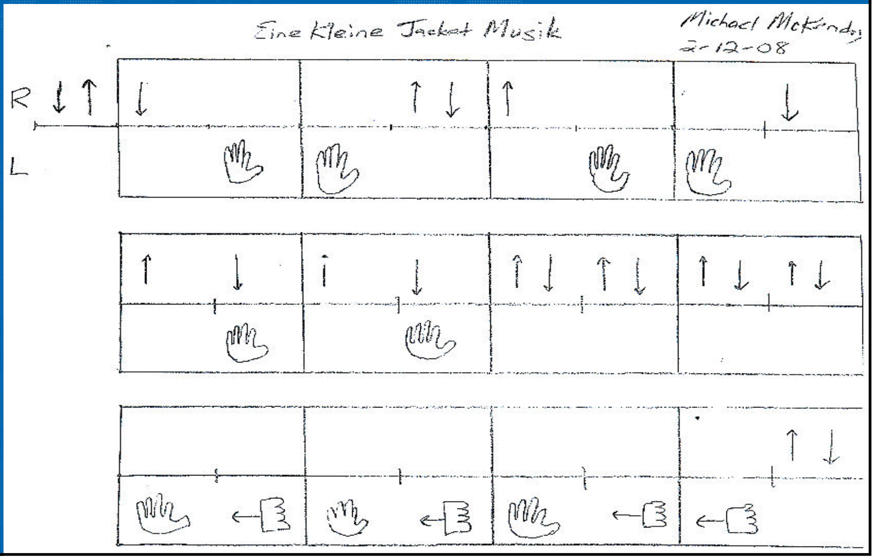
Mike's Found Instrument:
His Jacket



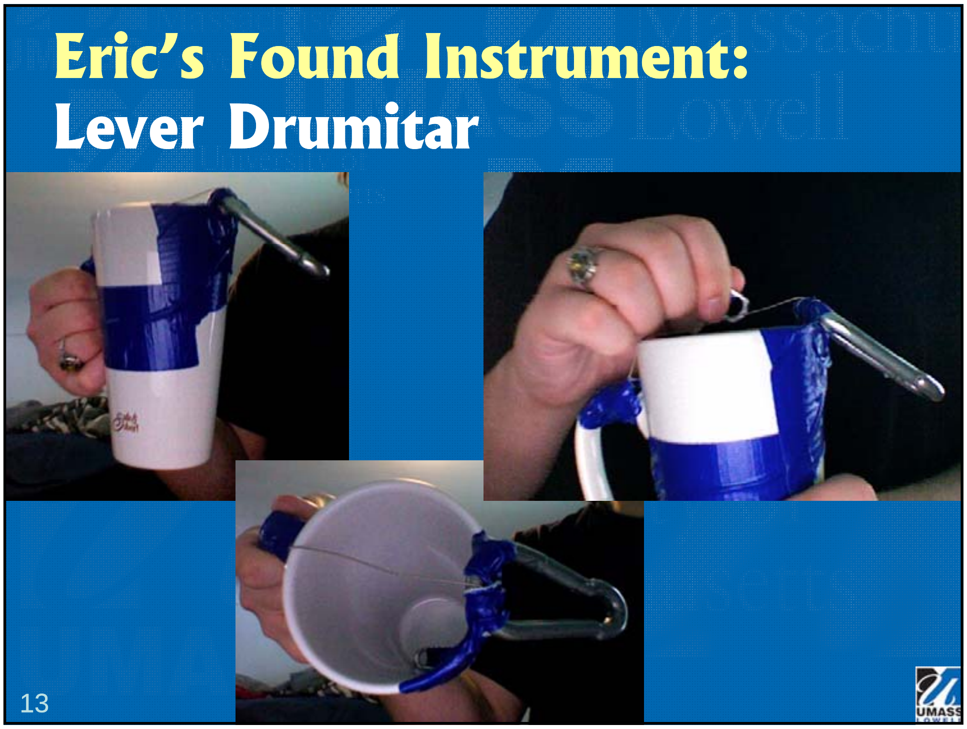
Click picture to play video

11

Mike's Notation for His "Eine Kleine Jacket Musik"

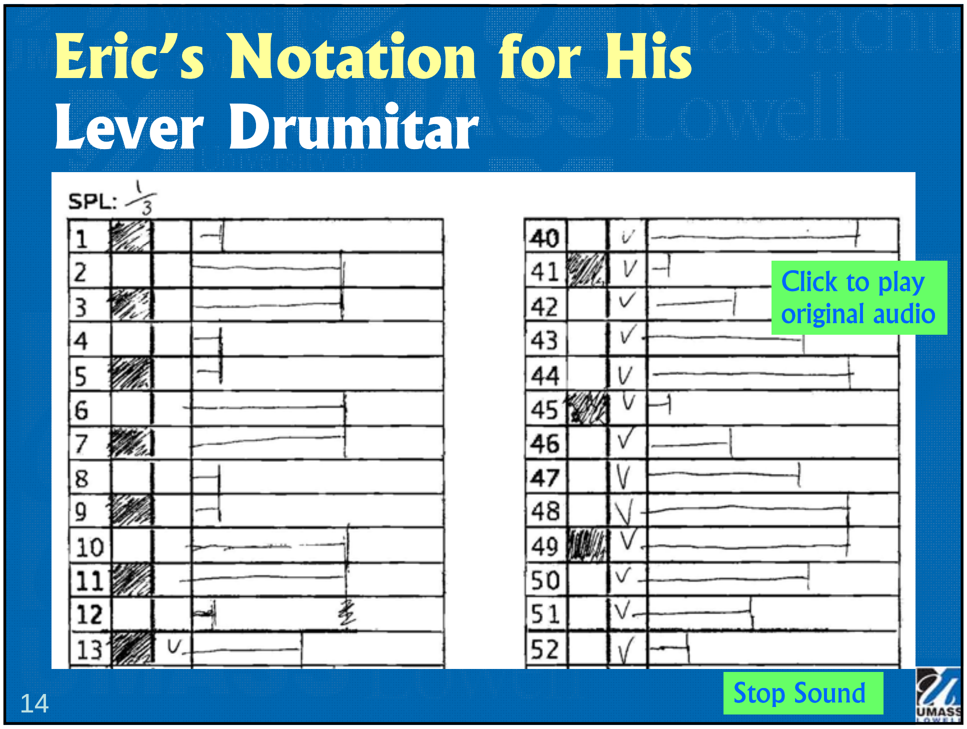


12



Eric’s Found Instrument:
Lever Drumitar

13

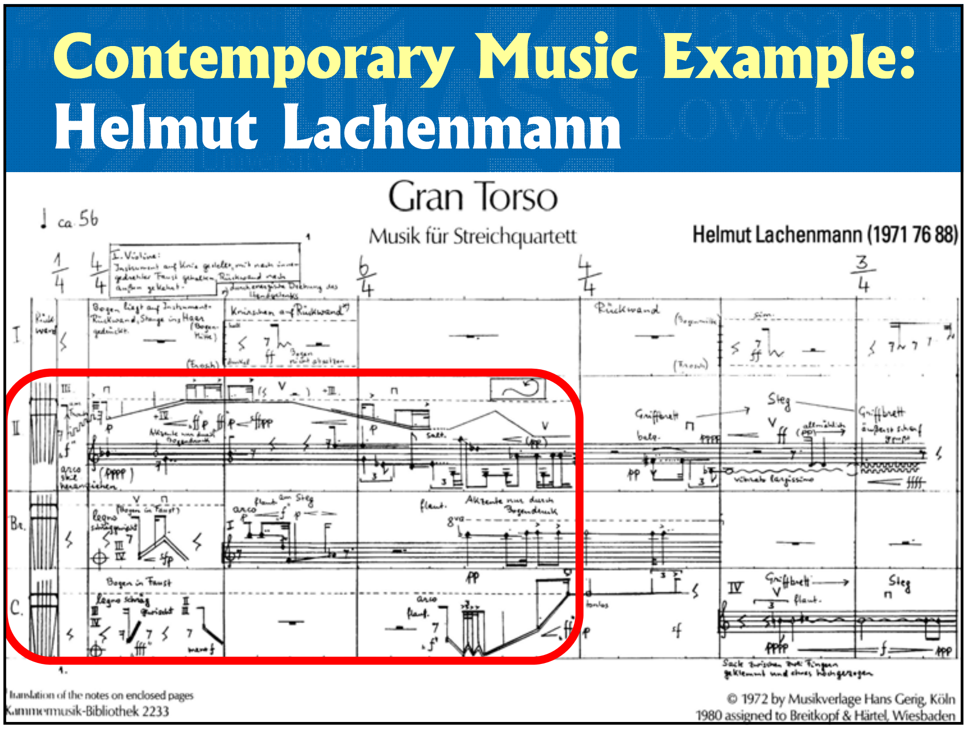


Eric’s Notation for His
Lever Drumitar

Click to play original audio

Stop Sound

14



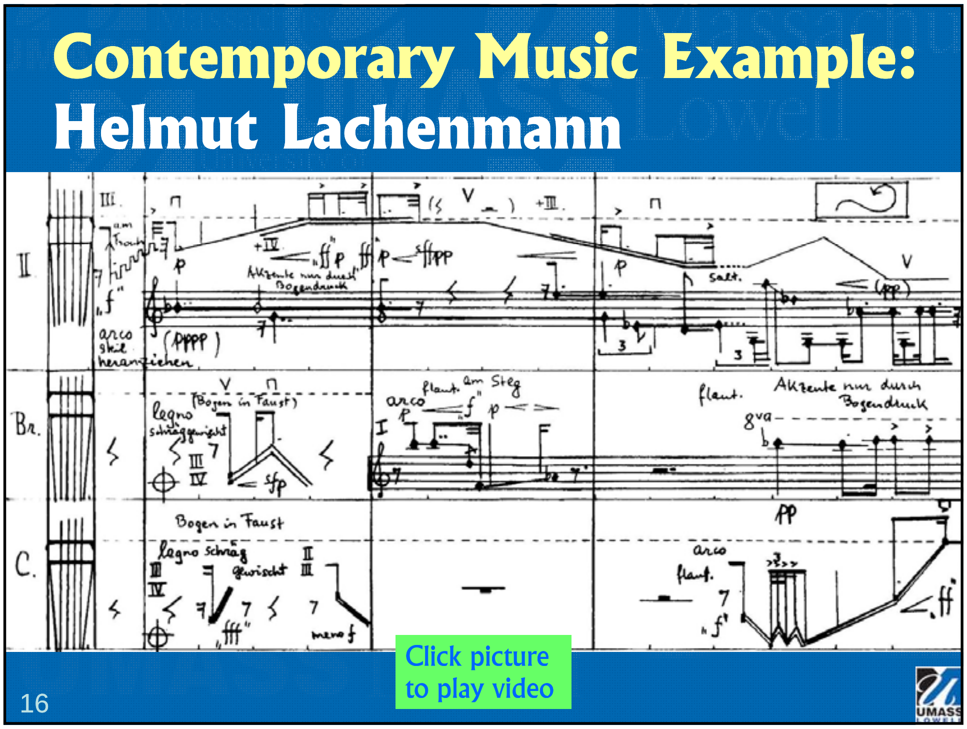
Contemporary Music Example: Helmut Lachenmann

Gran Torso

Musik für Streichquartett

Helmut Lachenmann (1971 76 88)

Translation of the notes on enclosed pages
Kammermusik-Bibliothek 2233



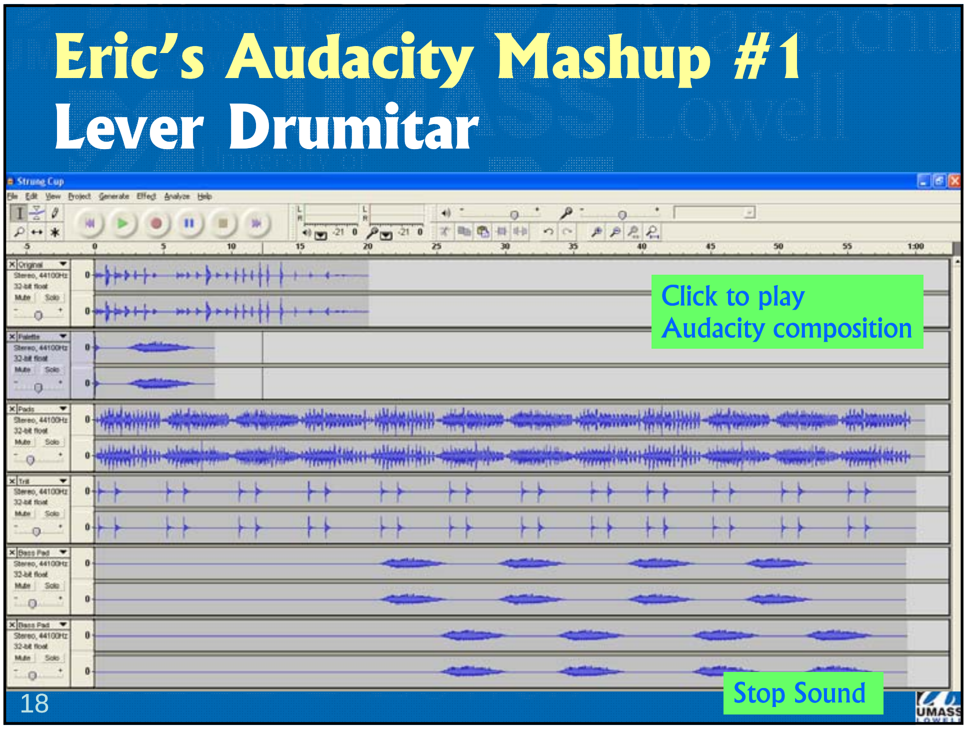
Contemporary Music Example: Helmut Lachenmann

Click picture to play video

16

http://www.jackquartet.com

17

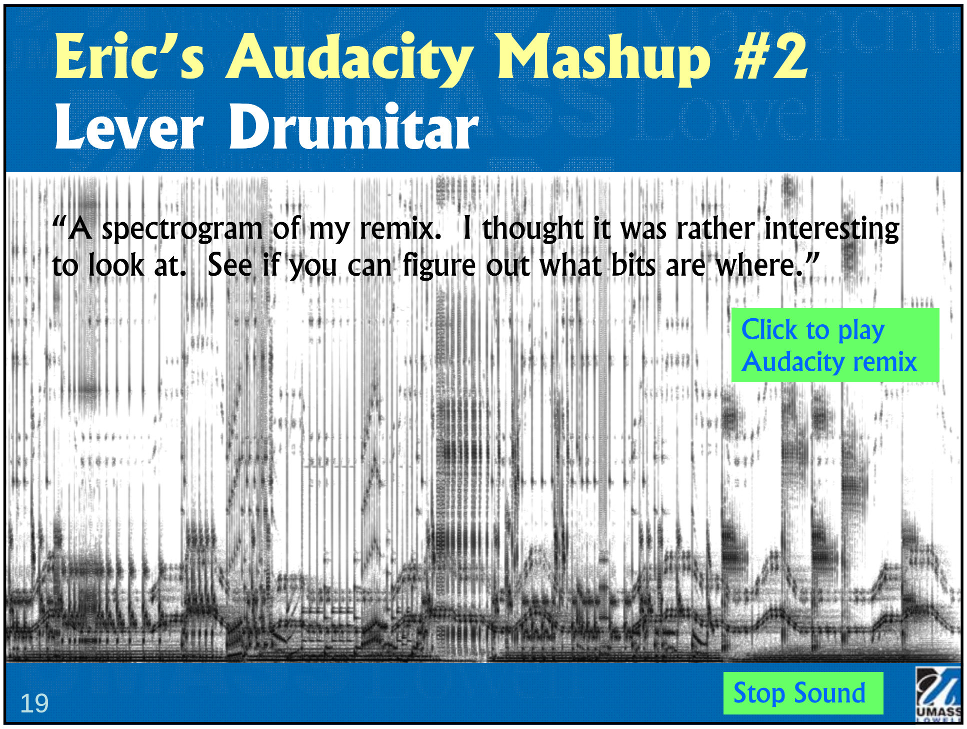


Eric's Audacity Mashup #1
Lever Drumitar

Click to play
Audacity composition

Stop Sound

18

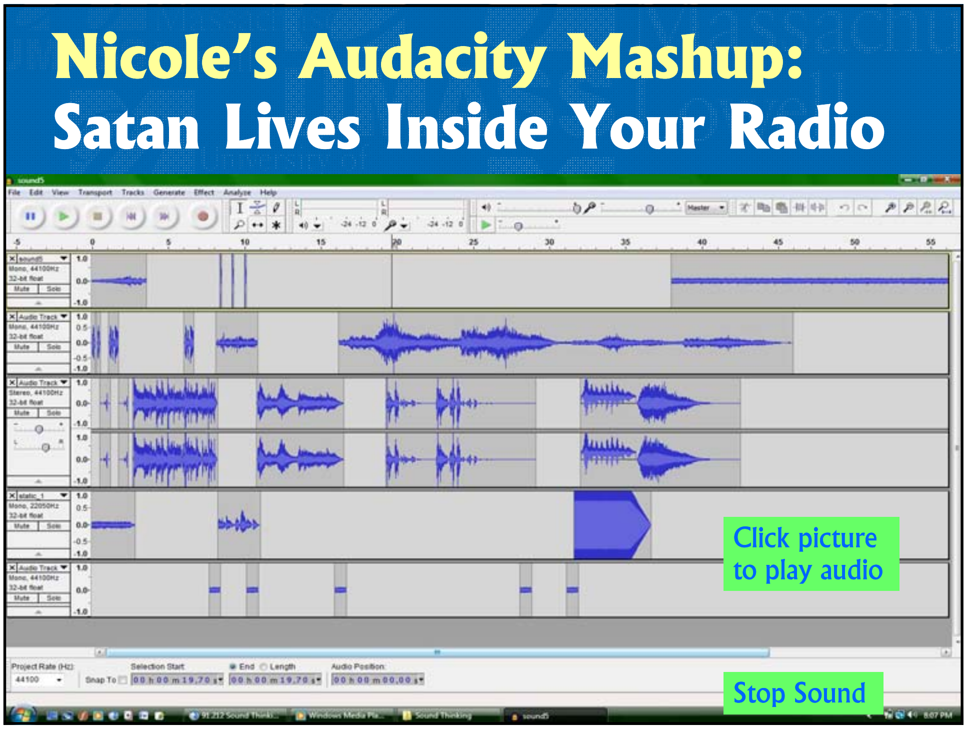


Eric's Audacity Mashup #2
Lever Drumitar

"A spectrogram of my remix. I thought it was rather interesting to look at. See if you can figure out what bits are where."

Click to play Audacity remix

Stop Sound



Nicole's Audacity Mashup:
Satan Lives Inside Your Radio

Project Rate (Hz): 44100

Snap To □

Selection Start: 00 h 00 m 19,70 s

● End ○ Length: 00 h 00 m 19,70 s

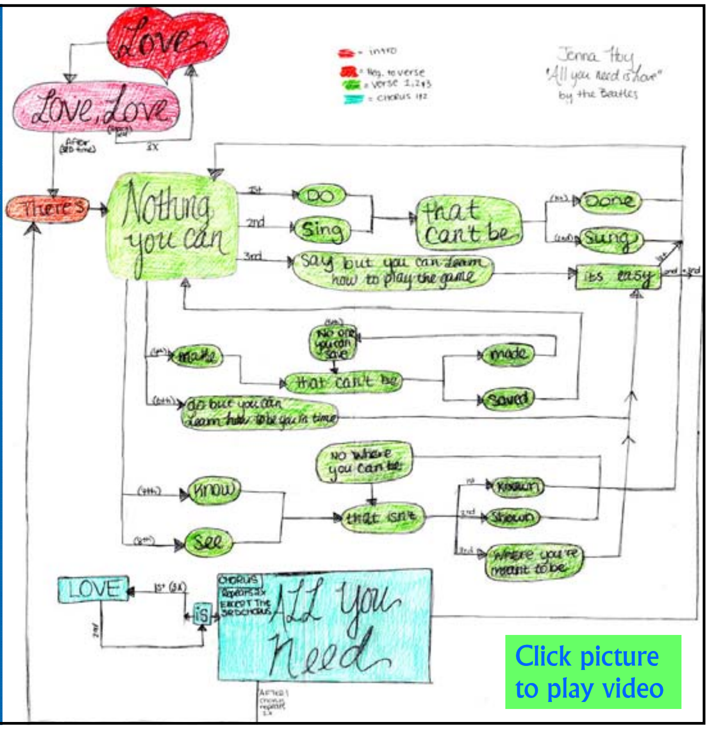
Audio Position: 00 h 00 m 00,00 s

Click picture to play audio

Stop Sound

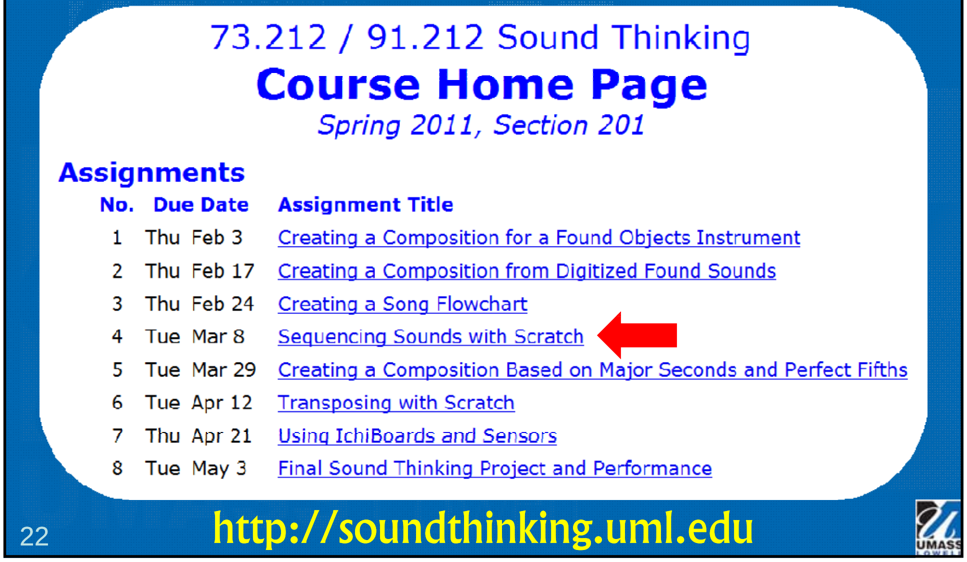
Jenna's Flow-chart: All You Need Is Love

inspired by Jeannie Harrell



Click picture to play video

Sound Thinking: From Editing to Coding



73.212 / 91.212 Sound Thinking

Course Home Page

Spring 2011, Section 201

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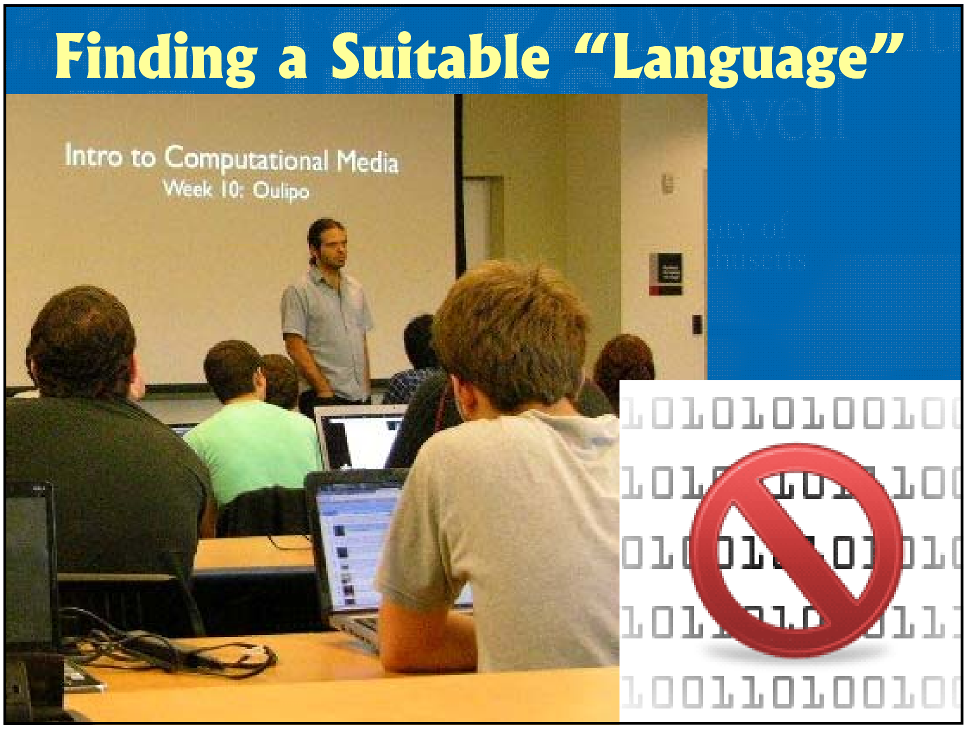
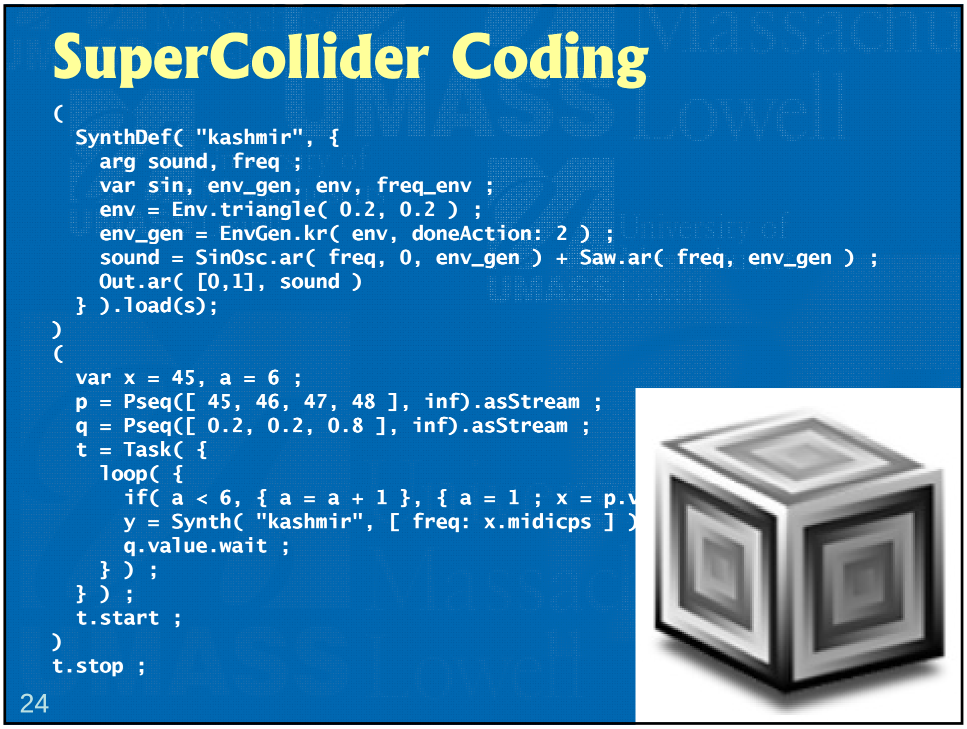
http://soundthinking.uml.edu



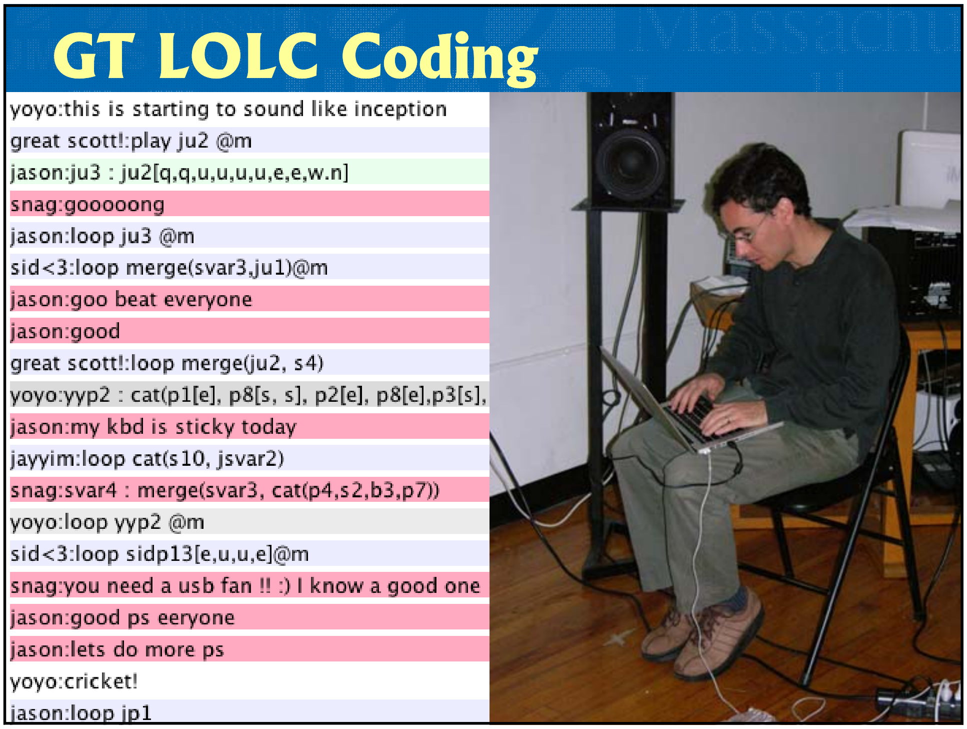
Finding a Suitable "Language"



SuperCollider Coding

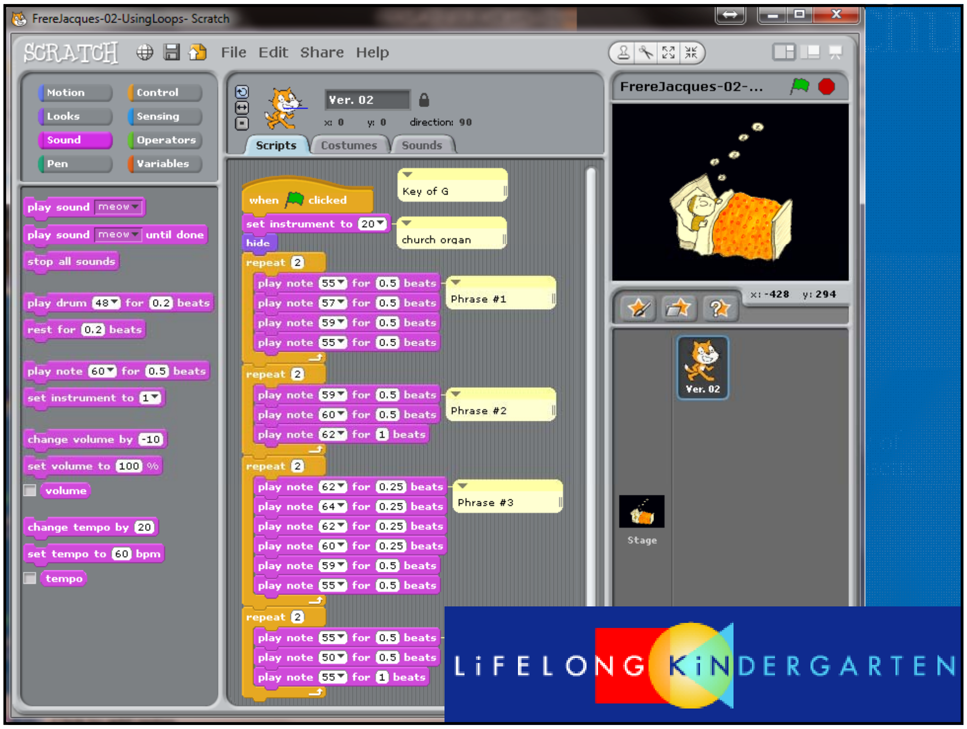
```
(
  SynthDef( "kashmir", {
    arg sound, freq ;
    var sin, env_gen, env, freq_env ;
    env = Env.triangle( 0.2, 0.2 ) ;
    env_gen = EnvGen.kr( env, doneAction: 2 ) ;
    sound = SinOsc.ar( freq, 0, env_gen ) + Saw.ar( freq, env_gen ) ;
    Out.ar( [0,1], sound )
  } ).load(s);
)
(
  var x = 45, a = 6 ;
  p = Pseq([ 45, 46, 47, 48 ], inf).asStream ;
  q = Pseq([ 0.2, 0.2, 0.8 ], inf).asStream ;
  t = Task( {
    loop( {
      if( a < 6, { a = a + 1 }, { a = 1 ; x = p.v
      y = Synth( "kashmir", [ freq: x.midicps ] )
      q.value.wait ;
    } ) ;
  } ) ;
  t.start ;
)
t.stop ;
```

24



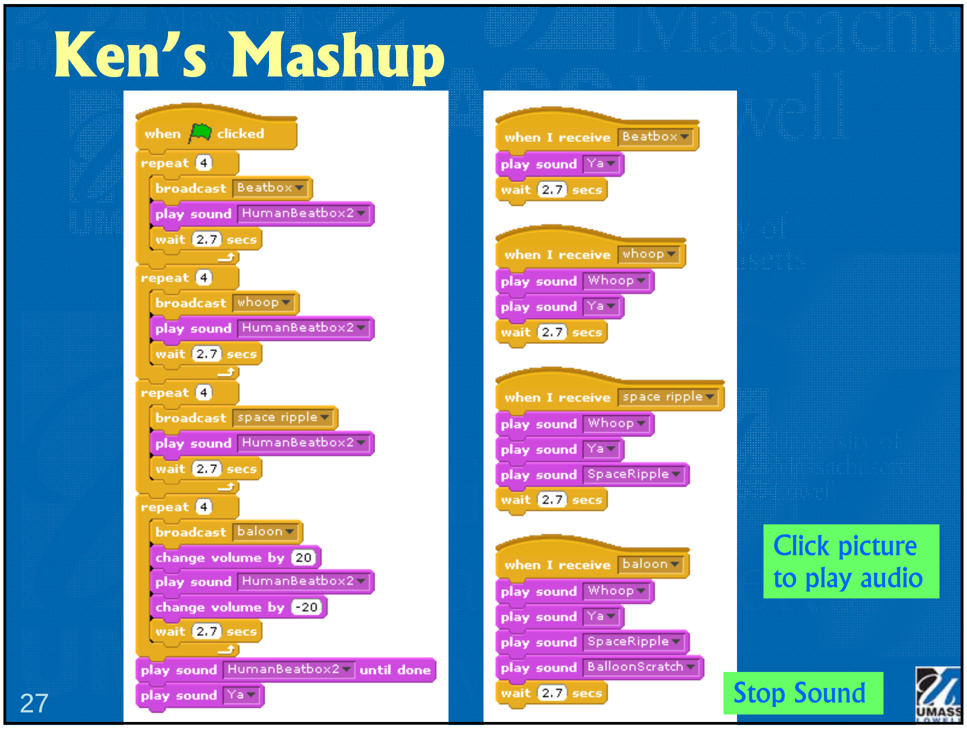
GT LOLC Coding

yoyo:this is starting to sound like inception
great scott!:play ju2 @m
jason:ju3 : ju2[q,q,u,u,u,u,e,e,w.n]
snag:gooooong
jason:loop ju3 @m
sid<3:loop merge(svar3,ju1)@m
jason:goo beat everyone
jason:good
great scott!:loop merge(ju2, s4)
yoyo:yyp2 : cat(p1[e], p8[s, s], p2[e], p8[e],p3[s],
jason:my kbd is sticky today
jayyim:loop cat(s10, jsvar2)
snag:svar4 : merge(svar3, cat(p4,s2,b3,p7))
yoyo:loop yyp2 @m
sid<3:loop sidp13[e,u,u,e]@m
snag:you need a usb fan !! :) I know a good one
jason:good ps eeryone
jason:lets do more ps
yoyo:cricket!
jason:loop jp1



FrereJacques-02-UsingLoops- Scratch

```
when [flag] clicked          Key of G
set instrument to 20         church organ
hide
repeat 2
    play note 55 for 0.5 beats    Phrase #1
    play note 57 for 0.5 beats
    play note 59 for 0.5 beats
    play note 55 for 0.5 beats
repeat 2
    play note 59 for 0.5 beats    Phrase #2
    play note 60 for 0.5 beats
    play note 62 for 1 beats
repeat 2
    play note 62 for 0.25 beats   Phrase #3
    play note 64 for 0.25 beats
    play note 62 for 0.25 beats
    play note 60 for 0.25 beats
    play note 59 for 0.5 beats
    play note 55 for 0.5 beats
repeat 2
    play note 55 for 0.5 beats
    play note 50 for 0.5 beats
    play note 55 for 1 beats
```



Ken's Mashup

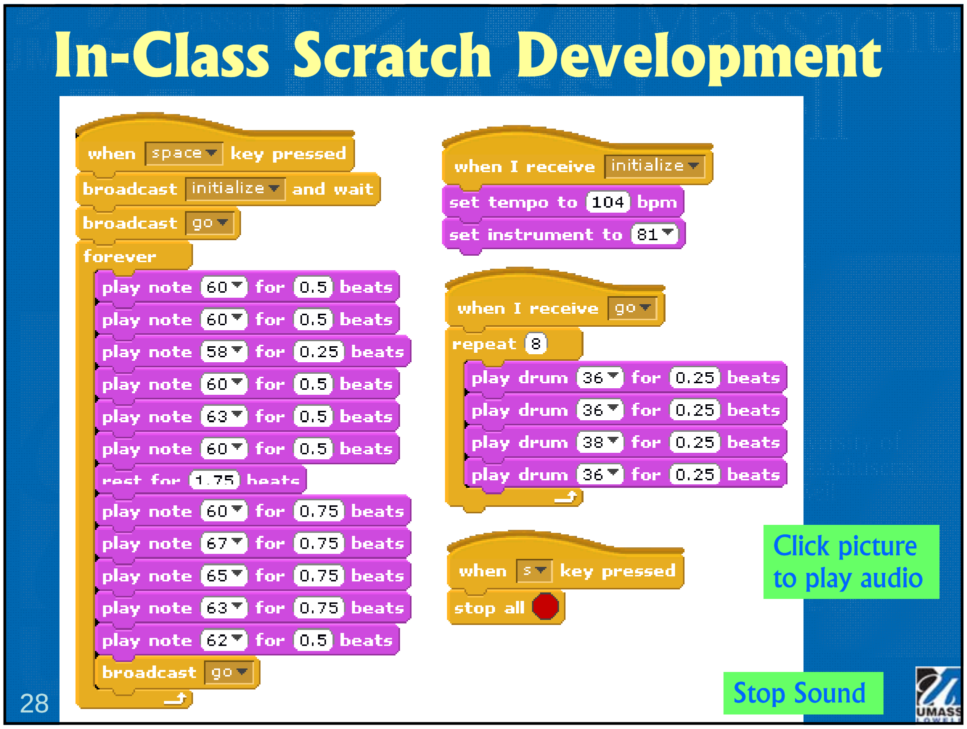
```
when [flag] clicked
repeat 4
    broadcast Beatbox
    play sound HumanBeatbox2
    wait 2.7 secs
repeat 4
    broadcast whoop
    play sound HumanBeatbox2
    wait 2.7 secs
repeat 4
    broadcast space ripple
    play sound HumanBeatbox2
    wait 2.7 secs
repeat 4
    broadcast baloon
    change volume by 20
    play sound HumanBeatbox2
    change volume by -20
    wait 2.7 secs
play sound HumanBeatbox2 until done
play sound Ya
```

```
when I receive Beatbox
play sound Ya
wait 2.7 secs

when I receive whoop
play sound Whoop
play sound Ya
wait 2.7 secs

when I receive space ripple
play sound Whoop
play sound Ya
play sound SpaceRipple
wait 2.7 secs

when I receive baloon
play sound Whoop
play sound Ya
play sound SpaceRipple
play sound BalloonScratch
wait 2.7 secs
```



In-Class Scratch Development

```
when space key pressed
broadcast initialize and wait
broadcast go
forever
    play note 60 for 0.5 beats
    play note 60 for 0.5 beats
    play note 58 for 0.25 beats
    play note 60 for 0.5 beats
    play note 63 for 0.5 beats
    play note 60 for 0.5 beats
    rest for 1.75 beats
    play note 60 for 0.75 beats
    play note 67 for 0.75 beats
    play note 65 for 0.75 beats
    play note 63 for 0.75 beats
    play note 62 for 0.5 beats
    broadcast go
```

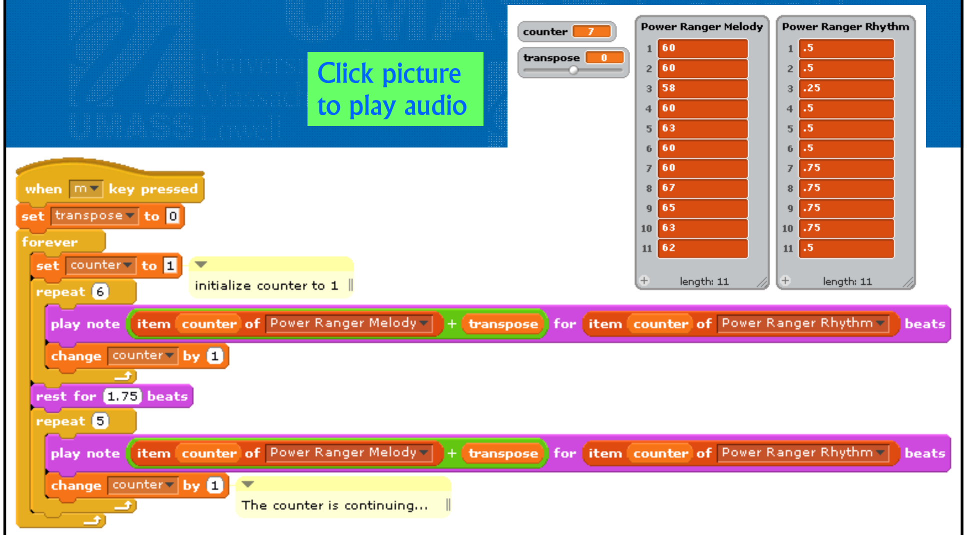
```
when I receive initialize
set tempo to 104 bpm
set instrument to 81

when I receive go
repeat 8
    play drum 36 for 0.25 beats
    play drum 36 for 0.25 beats
    play drum 38 for 0.25 beats
    play drum 36 for 0.25 beats

when s key pressed
stop all
```

In-Class Scratch Development

Click picture to play audio



counter	7
transpose	0

	Power Ranger Melody
1	60
2	60
3	58
4	60
5	63
6	60
7	60
8	67
9	65
10	63
11	62
	length: 11

	Power Ranger Rhythm
1	.5
2	.5
3	.25
4	.5
5	.5
6	.5
7	.75
8	.75
9	.75
10	.75
11	.5
	length: 11

```
when m key pressed
set transpose to 0
forever
    set counter to 1          initialize counter to 1
    repeat 6
        play note (item counter of Power Ranger Melody + transpose) for (item counter of Power Ranger Rhythm) beats
        change counter by 1
    rest for 1.75 beats
    repeat 5
        play note (item counter of Power Ranger Melody + transpose) for (item counter of Power Ranger Rhythm) beats
        change counter by 1          The counter is continuing...
```

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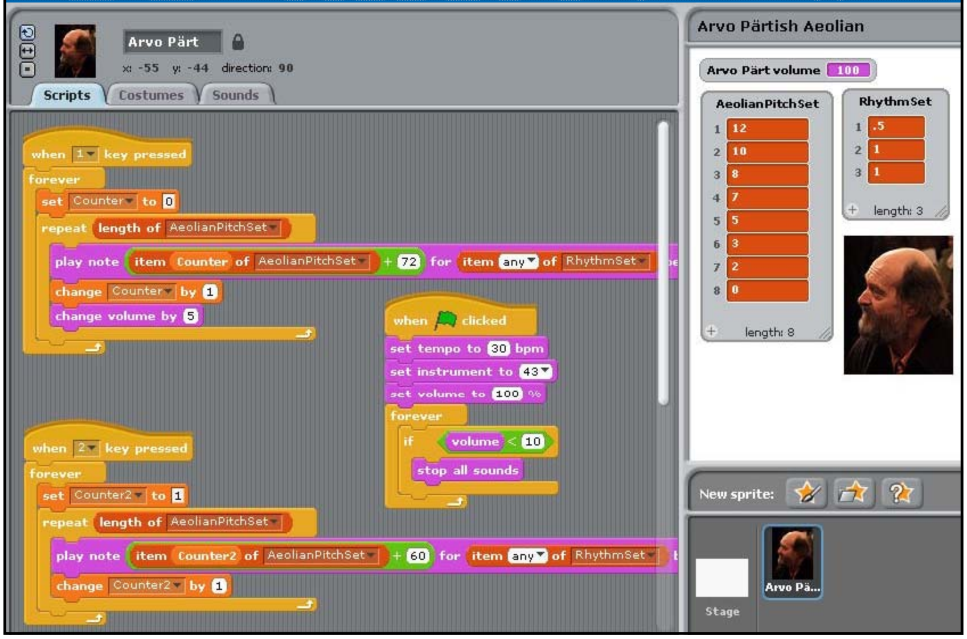
Stop Sound

Live Coding with Scratch



Arvo Pärt

x: -55 y: -44 direction: 90

```
when 1 key pressed
forever
    set Counter to 0
    repeat (length of AeolianPitchSet)
        play note (item Counter of AeolianPitchSet + 72) for (item any of RhythmSet) be
        change Counter by 1
        change volume by 5

when 2 key pressed
forever
    set Counter2 to 1
    repeat (length of AeolianPitchSet)
        play note (item Counter2 of AeolianPitchSet + 60) for (item any of RhythmSet) b
        change Counter2 by 1

when [flag] clicked
set tempo to 30 bpm
set instrument to 43
set volume to 100 %
forever
    if volume < 10
        stop all sounds
```

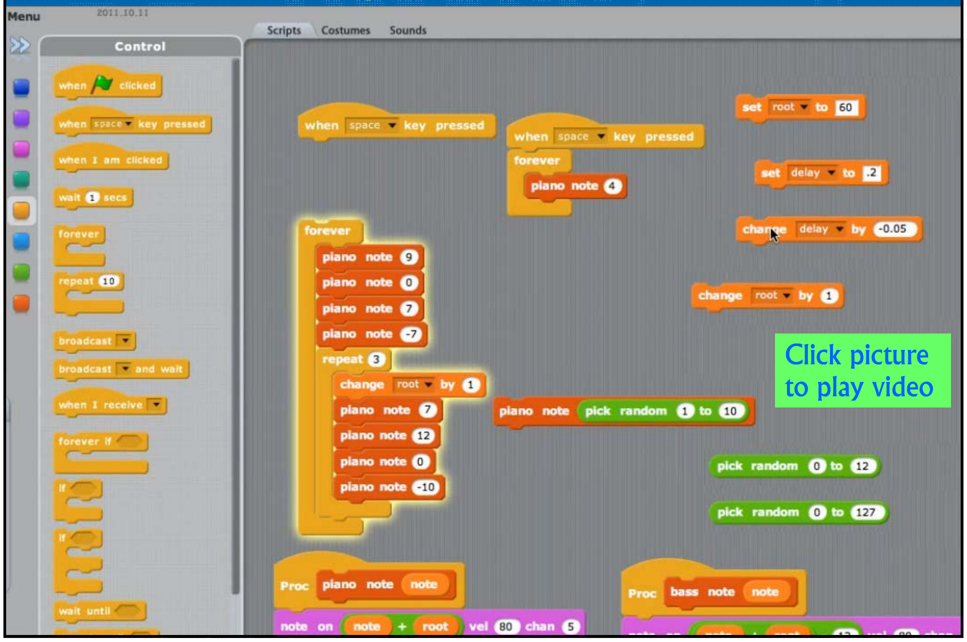
Arvo Pärtish Aeolian

Arvo Pärt volume	100

	AeolianPitchSet
1	12
2	10
3	8
4	7
5	5
6	3
7	2
8	0
	length: 8

	RhythmSet
1	.5
2	1
3	1
	length: 3

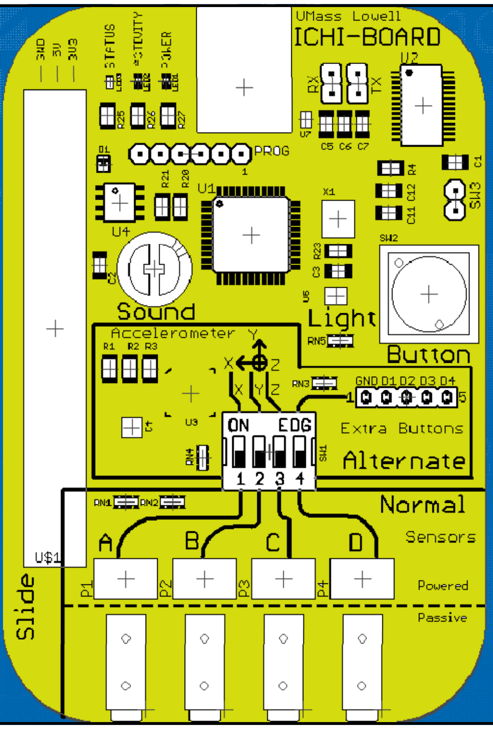
Live Coding with MidiScratch2



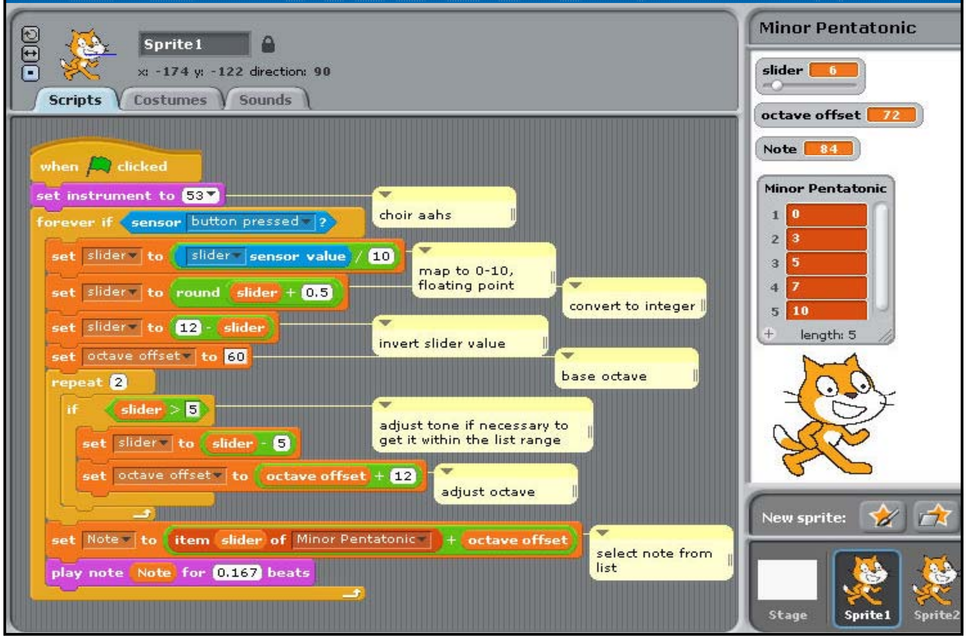
```
when space key pressed

when space key pressed
forever
    piano note 4

forever
    piano note 9
    piano note 0
    piano note 7
    piano note -7
    repeat 3
        change root by 1
        piano note 7
        piano note 12
        piano note 0
        piano note -10

set root to 60
set delay to .2
change delay by -0.05
change root by 1
piano note pick random 1 to 10
pick random 0 to 12
pick random 0 to 127

Proc piano note note
note on note + root vel 80 chan 5

Proc bass note note
```

Click picture to play video

IchiBoard Instrument



IchiBoard Instrument



```
when ⚑ clicked
set instrument to 53
forever if sensor button pressed ?
    set slider to (slider sensor value / 10)
    set slider to round (slider + 0.5)
    set slider to 12 - slider
    set octave offset to 60
    repeat 2
        if slider > 5
            set slider to slider - 5
            set octave offset to octave offset + 12
    set Note to item slider of Minor Pentatonic + octave offset
    play note Note for 0.167 beats
```

choir aahs

map to 0-10, floating point

convert to integer

invert slider value

base octave

adjust tone if necessary to get it within the list range

adjust octave

select note from list

Minor Pentatonic

slider 6

octave offset 72

Note 84

Minor Pentatonic

1	0
2	3
3	5
4	7
5	10

length: 5

Jeremy & Nicole IchiBoard Duet

Click picture to play video

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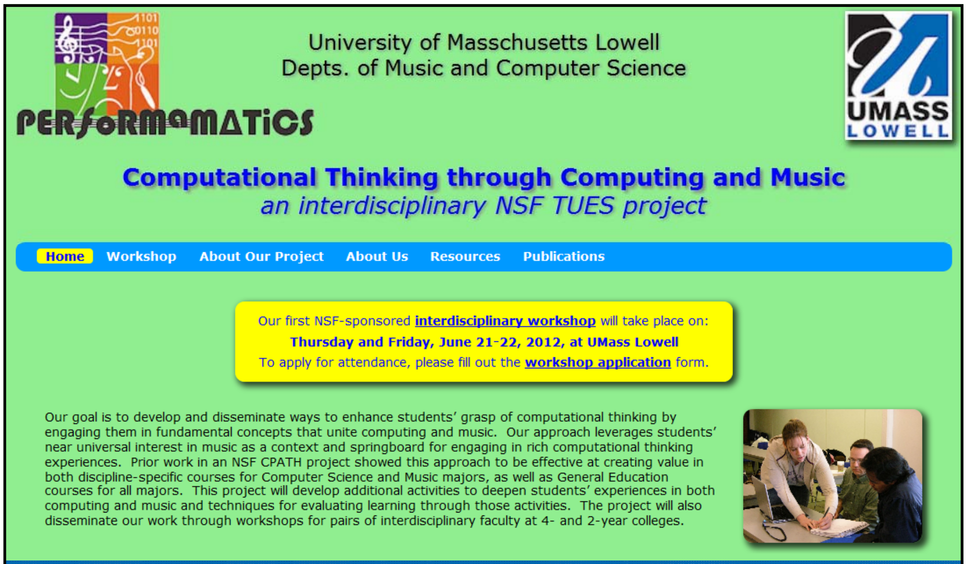

PERfoRMaMATiCS

University of Masschusetts Lowell
Depts. of Music and Computer Science

UMASS LOWELL

Computational Thinking through Computing and Music
an interdisciplinary NSF TUES project

Our first NSF-sponsored **interdisciplinary workshop** will take place on:
Thursday and Friday, June 21-22, 2012, at UMass Lowell
To apply for attendance, please fill out the **workshop application** form.

Our goal is to develop and disseminate ways to enhance students' grasp of computational thinking by engaging them in fundamental concepts that unite computing and music. Our approach leverages students' near universal interest in music as a context and springboard for engaging in rich computational thinking experiences. Prior work in an NSF CPATH project showed this approach to be effective at creating value in both discipline-specific courses for Computer Science and Music majors, as well as General Education courses for all majors. This project will develop additional activities to deepen students' experiences in both computing and music and techniques for evaluating learning through those activities. The project will also disseminate our work through workshops for pairs of interdisciplinary faculty at 4- and 2-year colleges.

www.performamatics.org

NSF-Sponsored Workshop Interdisciplinary Teaching
June 21-22, 2012, at UMass Lowell

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Performamatics: Acknowledgments

- Additional Senior Personnel
  Sarah Kuhn – UMass Lowell Dept. of Psychology
  Scott Lipscomb – Univ. of Minnesota Dept. of Music
  Fred Martin – UMass Lowell Dept. of Computer Science
- MIT Media Lab Lifelong Kindergarten Group
  John Maloney – Staff Researcher, Scratch Lead Developer
  Mitchel Resnick – LEGO Papert Prof. of Learning Research
  Eric Rosenbaum – Doctoral Student
- NSF Awards CNS-0722161
  and DUE-1118435

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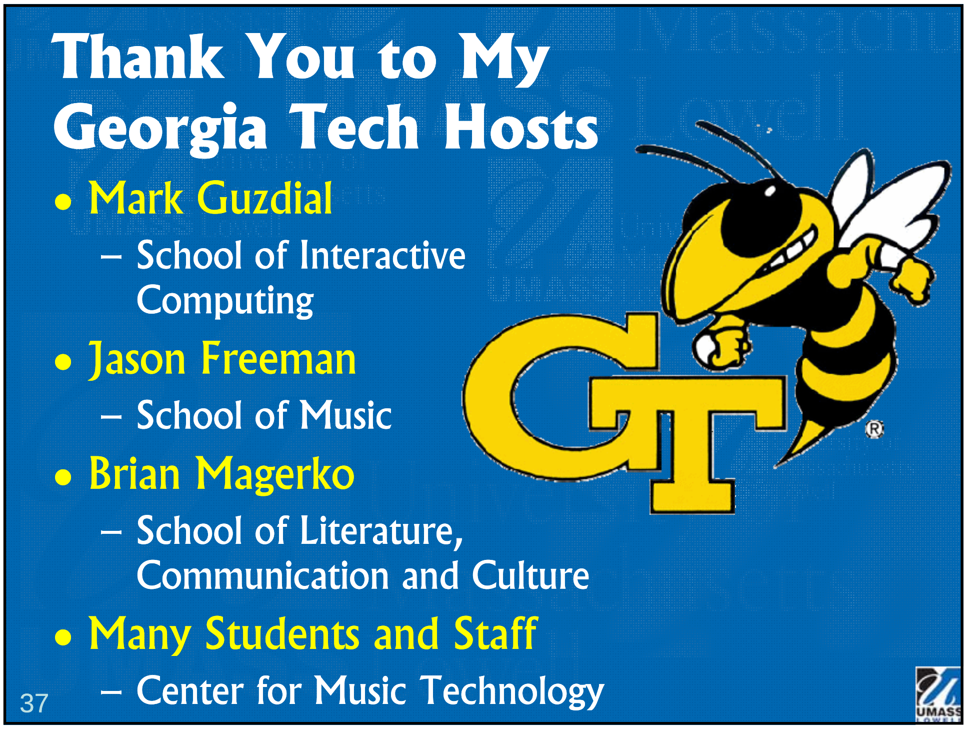

Thank You to My Georgia Tech Hosts

- Mark Guzdial
  - School of Interactive Computing
- Jason Freeman
  - School of Music
- Brian Magerko
  - School of Literature, Communication and Culture
- Many Students and Staff
  - Center for Music Technology

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Harper Farms, Lancaster, MA, 10/27/2011

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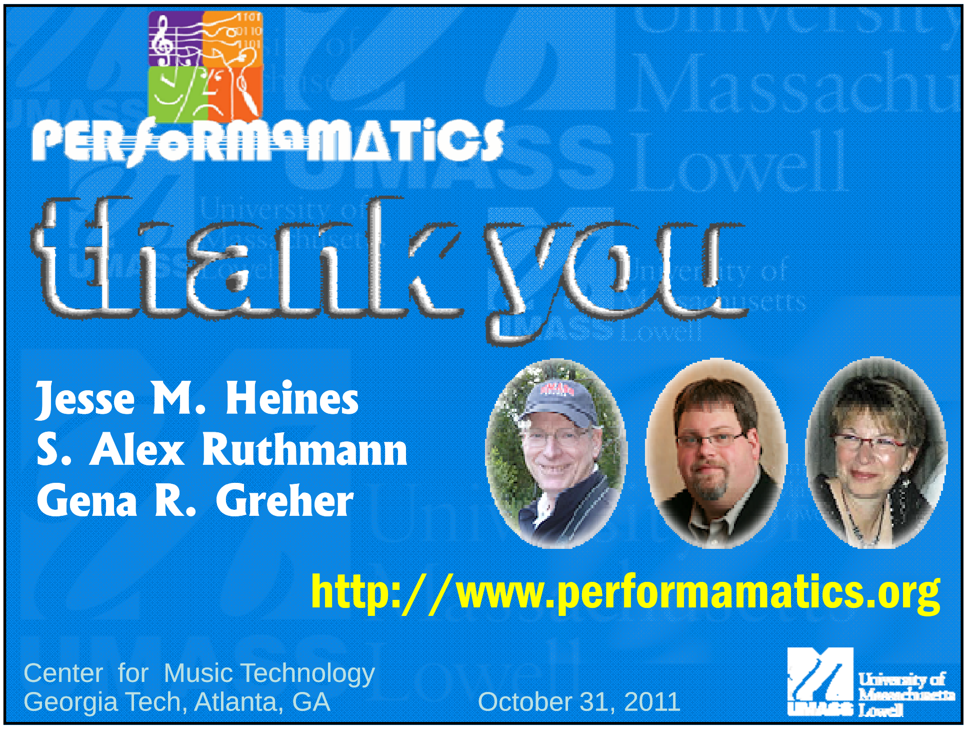

PERformaMATiCS

thank you

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