No Such Media

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Aesthetic

- Maker
- Cross functional (software, hardware, music, visual)
- Experimenting with new things
- Fail early and often
- Deploy and document
  - Performances
  - Installations
  - Web site
- Refine, Rework, Remix

Motivation

- Fun
- Freedom
- Personal taste
- Learning
- Socialization
- Deadlines

Interests

- Algorithmic composition
- Selective Randomization
- Languages
- User Interfaces (both soft and hard)
- Networking

Initial Training

- Musician
- Software Engineer

… and then there was MIDI

KeyKit

- Textual programming language – procedural, interpreted, multi-tasking, graphics, object-oriented
- Specialized for MIDI algorithmic and realtime manipulation, first-class “phrase” data type, realtime scheduling
- Multi-window graphical user interface, pull-off menus and buttons, tools include multi-track editor, drum pattern editor
- Entire user interface and all tools written in the language and provided as source code in library, easily customized and extended

Development History

- 1.0 - BASIC-like
- 2.0 - realtime
- 3.0 - grammer, rewrite, fast enough to avoid built-ins
- 4.0 - graphics
- 5.0 - first multi-window attempts, multi-tasking, fifos, tools using tasks/fifos
- 6.0 - object-oriented, multi-window interface completely rewritten, pull-off menus/buttons
- 7.0 – support for multiple MIDI ports

MIDI Phrase is a first-class data type

- Time-ordered list of MIDI “notes” - can be system-exclusives, isolated note-on, isolated note-off, or full note with duration
- Constant value syntax

```
ph = 'c e g'          # ph is a c major triad
ph = 'dc2,e,f'        # ph is an arpeggio, channel 2
```

- Structure-like manipulation of attributes :

```
ph.dur = 1b           # all note durations = 1 beat
ph.pitch += 12        # transposed up an octave
```

Phrase Operations

- Serial concatenation

```
ph = ph1 + ph2
```

- Parallel merging

```
ph = ph1 | ph2
```

- Removing notes

```
ph = ph1 - ph2
```

- Matching notes

```
ph = ph1 & ph2
```

- Nth note

```
ph = ph1 % n
```

Phrase Operations - the “select”

```
ph = ph1 { ??.pitch > 60 }
ph = ph1 { ??.dur > 1b }
ph = ph1 { isonbeat(??,4b) }
ph = ph1 { ??.number < 4 }
ph = ph1 { rand(3)==0 }
ph = ph1 { isinscale(??,scale) }
ph = ph - ph { ??.type == MIDIBYTES }
```

Other Language Features

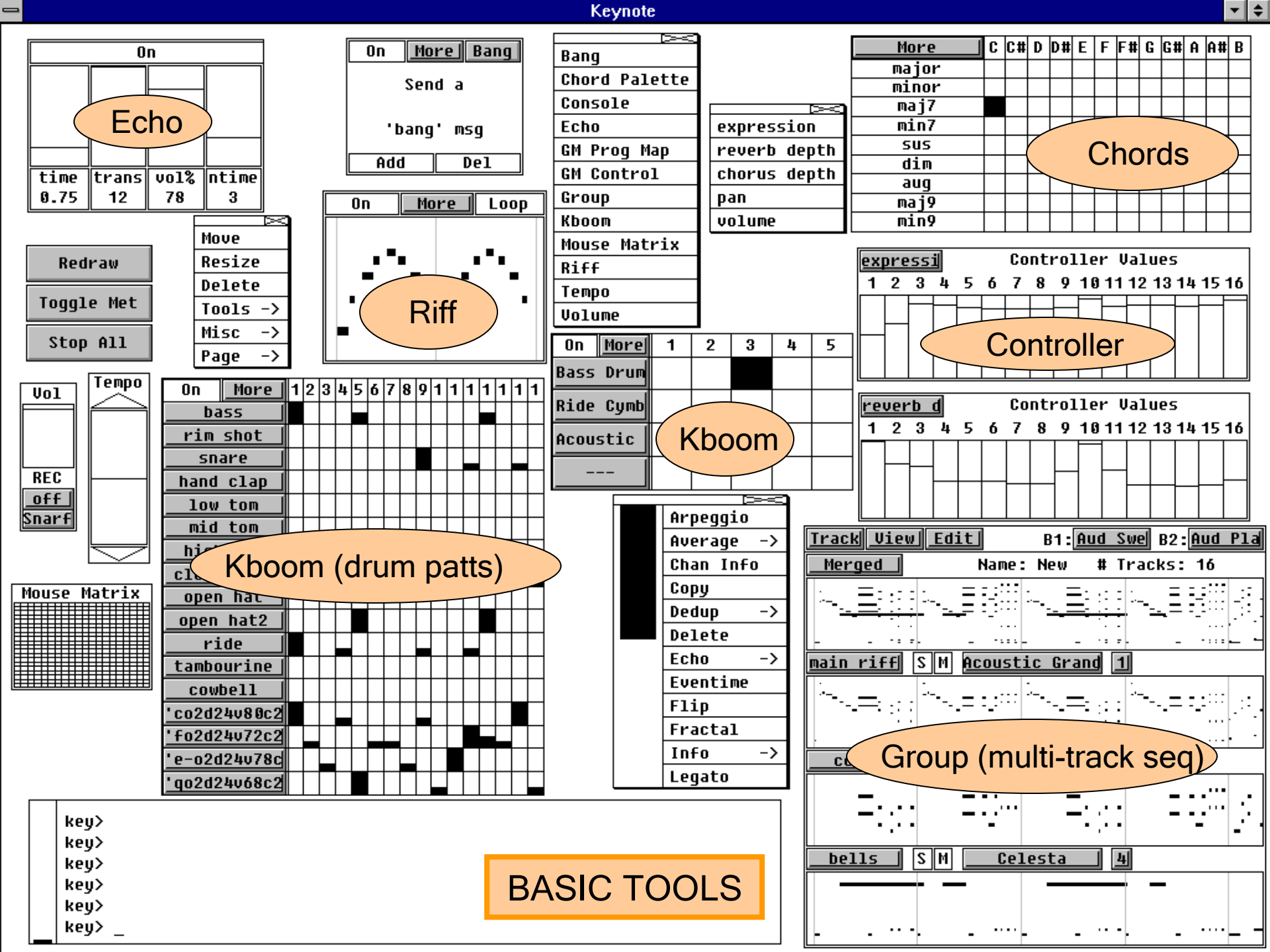
- Variable arguments - … , nargs(), argv(), varg()
- Fifos and locking
- Objects
- Graphics - primitive elements are:
  lines, rectangles, text, windows,
  phrase windows, menus
- Machine-dependent hook – mdep() – used to add/expose non-portable features
- TCP/IP hooks available for Windows and Linux, network interaction

Tasks and I/O

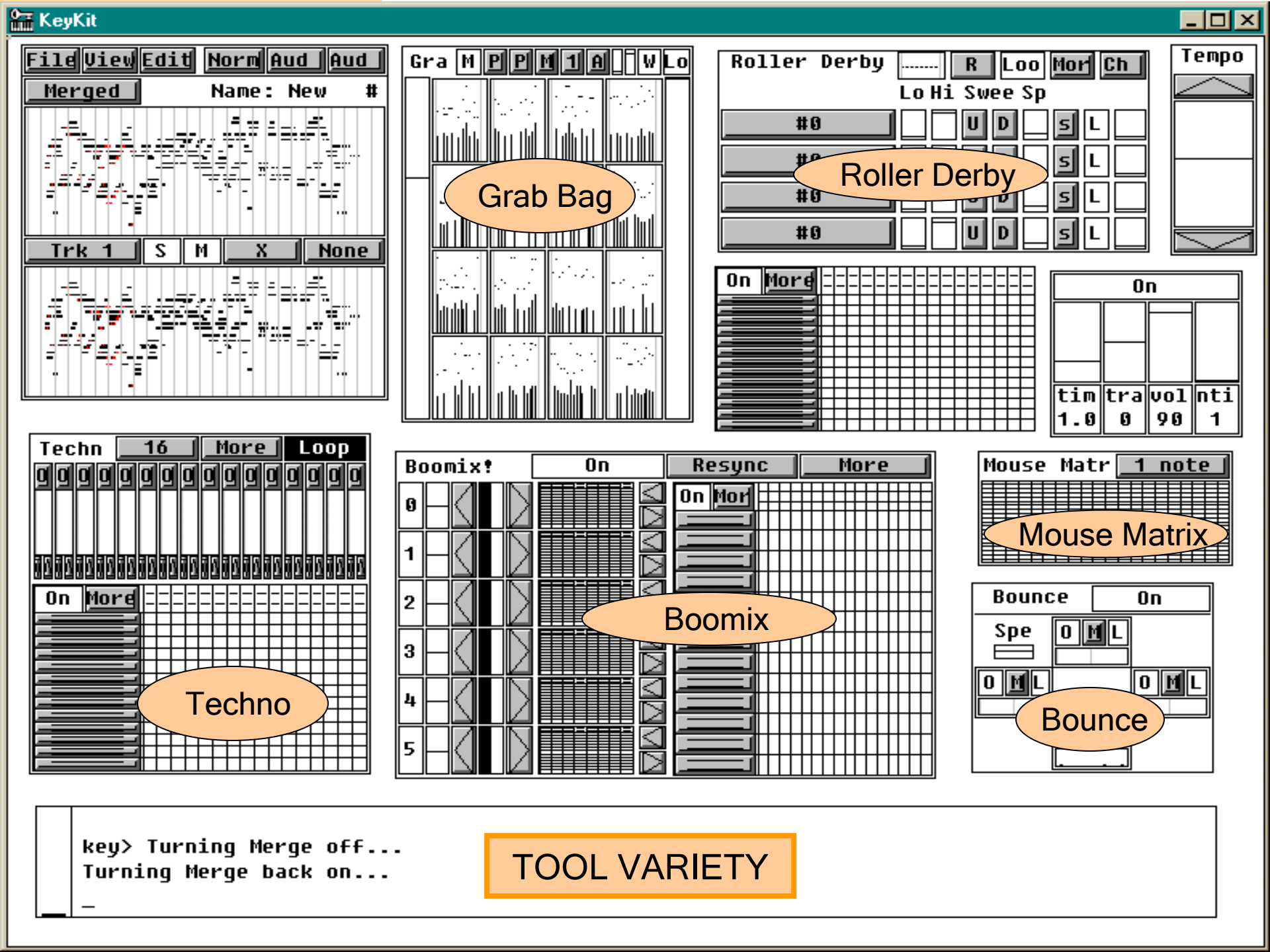
- All tasks are time-shared evenly, interleaved at the interpreted instruction level
- Scheduled MIDI output events are tasks as well, but performance can’t be degraded by other tasks
- MIDI input is always being recorded, available in a global variable for easy and immediate processing
- MIDI, mouse, and console input events can be read from special fifos
- Reading a fifo (with no data waiting) blocks a task
- lock() and unlock() used for exclusion and synchronization

KeyKit - the GUI

- Completely implemented with Keykit code, even pull-off menus, dragging of windows, window-manager-like operations, etc.
- Each tool is independent, with consistent methods for resizing and inter-tool communication
- Consistent saving/restoring mechanism of individual tools is highly leveraged, used for:
  - Copying between like tools
  - Copy/paste of entire tools
  - Moving tools between “pages”
  - Manipulating of tools within tools
  - Broadcasting of a tool and its contents across a network


Keynote
On
Echo
time 0.75
trans 12
vol% 78
ntime 3
On More Bang
Send a
'bang' msg
Add Del
Bang
Chord Palette
Console
Echo
GM Prog Map
GM Control
Group
Kboom
Mouse Matrix
Riff
Tempo
Volume
expression
reverb depth
chorus depth
pan
volume
More C C# D D# E F F# G G# A A# B
major
minor
maj7
min7
sus
dim
aug
maj9
min9
Chords
Redraw
Toggle Met
Stop All
Move
Resize
Delete
Tools ->
Misc ->
Page ->
On More Loop
Riff
expressi
Controller Values
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Controller
On More 1 2 3 4 5
Bass Drum
Ride Cymb
Acoustic

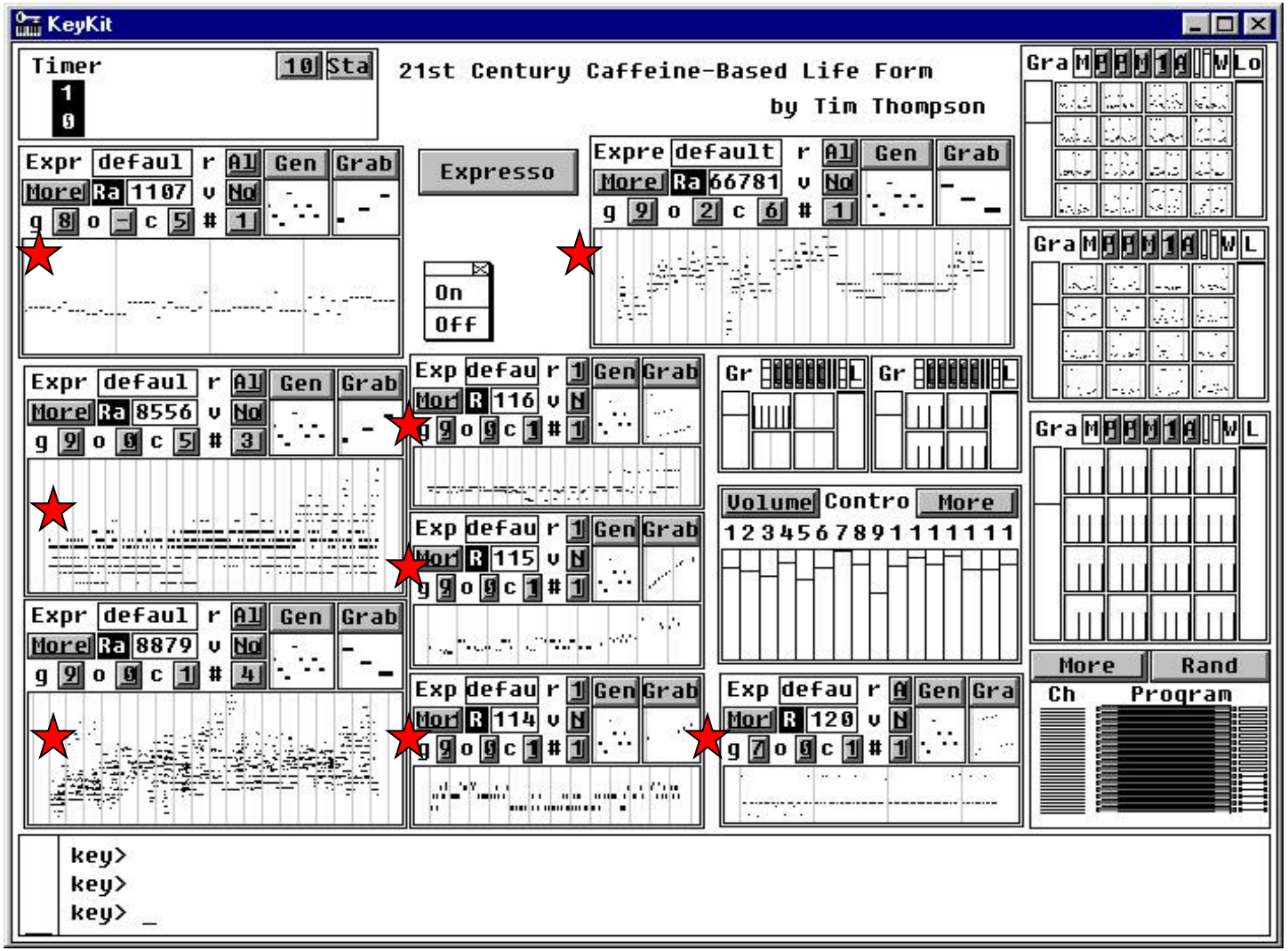
Kboom
reverb d
Controller Values
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Vol
REC
off
Snarf
Tempo
On More 1 2 3 4 5 6 7 8 9 1 1 1 1 1 1 1
bass
rim shot
snare
hand clap
low tom
mid tom
open hat
open hat2
ride
tambourine
cowbell
'co2d24v80c2
'fo2d24v72c2
'e-o2d24v78c
'qo2d24v68c2
Kboom (drum patts)
Arpeggio
Average ->
Chan Info
Copy
Dedup ->
Delete
Echo ->
Eventime
Flip
Fractal
Info ->
Legato
Track View Edit B1: Aud Swe B2: Aud Pla
Merged
Name: New # Tracks: 16
main riff S M Acoustic Grand 1
bells S M Celesta 4
Group (multi-track seq)
Mouse Matrix
key>
key>
key>
key>
key>
key> _
BASIC TOOLS


KeyKit
File View Edit Norm Aud Aud
Merged
Name: New #
Trk 1 S M X None
Gra M P P M 1 A W Lo
Grab Bag
Roller Derby R Loo Mor Ch
Lo Hi Swee Sp
#0
#0
#0
#0
U D S L
Roller Derby
Tempo
On More
On
tim tra vol nti
1.0 0 90 1
Techn 16 More Loop
On More
Techno
Boomix! On Resync More
0 1 2 3 4 5
On Mor
Boomix
Mouse Matr 1 note
Mouse Matrix
Bounce On
Spe
O M L
Bounce
key> Turning Merge off...
Turning Merge back on...
TOOL VARIETY

Then I moved to Silicon Valley…

- Woodstockhausen
- Skronkathon
- Y2Kx LoopFest
- Dorkbot
- Illuminated Corridor
- Maker Faire
- BArCMuT (Bay Area Computer Music Technology) Meetup
- Visual Music Meetup
- LoveTechSF
- SHARE San Jose
- Zero1.org, ZER01, 01SJ Biennial, SubZero Street Faire

An Algorithmic music “instrument” used for “21st Century Caffeine-based Life Form” at Woodstockhausen 2000



Oops, I made a typo

- Woodstockhausen 2001
- All-QWERTY Performance

Performances with dance pads

- Woodstockhausen performance – Happy Feet
  - Done entirely on 4 dance pads
  - No hands, No light, and EL-wire-outlined pants
- With Wireless QWERTY keyboard

The Mother of All Opportunities

Dance Pads at Burning Man 2002

Movie

Burning Man 2003

Dancing under the Stars of Lyra

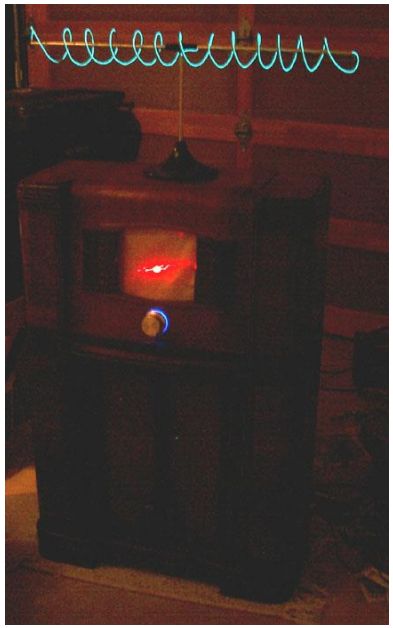
Movie1

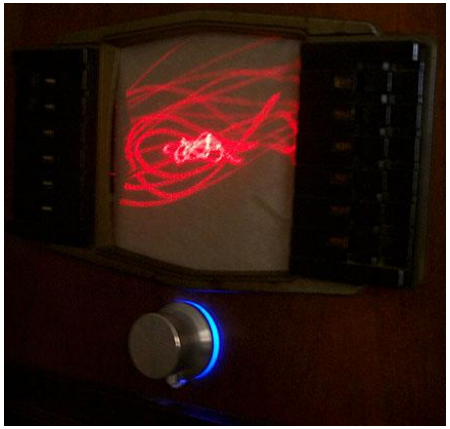
Movie2

Dance Pads at Burning Man 2003

- Electronics and dance pads were very reliable
- Generator was not

Burning Man 2004 - Radio Free Quasar





Audio

Radio Free Quasar at Burning Man

Radio Free Quasar at Burning Man

Radio Free Quasar – the pieces

- 10 robust VST plugins chained serially
- Collection of WAV files
- Python program:
  - selects wave files
  - enables/disables/randomizes VST plugins
  - allows interactive control from keyboard
- Big knob on radio sends keypresses
- Automatic randomization if no user input

VST Manipulation in Python

- nosuch.vstutil module
  - AudioSnippet
  - AudioLoop
  - PaAudioDevice
  - VstPlugin
    - methods: can_receive_midi, is_synth, is_vst2, name, num_inputs, num_outputs, num_params, num_programs, param_label, param_display, param_name, program_name, send_midi, get_enable, set_enable, set_param, set_program, set_input

Basic use of nosuch.vstutil.VstPlugin

- Instantiate it:

```
v = VstPlugin(dll="ringmod.dll")
```

- Connect its input to the output of other plugins

```
v.setinput(v2)
```

- Randomize its parameters

```
n = v.num_params()
for i in range(n):
  v.set_param(i,random())
```

Connecting a VST synth and effect

```
effect = VstPlugin(dll="BJ Ringmodulator.dll")
synth = VstPlugin(dll="StrataVar.dll")

# Connect output of synth to effec
effect.setinput(synth)

# Open audio and connect effect's output to it
a.open()
a.start()
a.attach(effect)

# Send random MIDI notes to synth
# while randomizing parameters of both VSTs
for i in range(100):
   time.sleep(2.0)
   pitch = int(random() * 128) % 128
   vstrandparam(synth)
   vstrandparam(effect)   # see next slide
   synth.send_midi(1,pitch,8000,80)
```

Other Algorithmic music (using KeyKit)

- Algorithms create lots of possibilities, but I choose which ones to keep
- Example using L-Systems (fractal expressions)
  - 23 Shots of Expresso
- Example using the digits of PI (3.14…)
  - Irrational
  - Irrational Too

Graphics gets interesting

- Affordable equipment
  - Webcams
  - Video mixers
  - Security cameras
  - Video processors
- GPUs and CPUs fast enough for realtime

Visual Music experiments

- Python used for OpenGL support and convenience
- KeyKit is interface to input devices (MIDI, iGesture)
- Messages sent over TCP/IP to Python process
- MIDI sliders and buttons control graphics parameters
- MIDI from drummer triggers graphics
- Text typed interactively is used as graphics
- Words typed interactively can immediately search clip-art database whose images are then used as graphics
- Used in dud (improvised art ensemble) - **`www.dudland.com`**

3D Input Device #1 - iGesture pad

- **`www.fingerworks.com`**
- Inexpensive multi-touch pad
- Excellent responsiveness
- Event data: x, y, proximity, eccentricity, orientation, contacts, device, finger, hand, xvelocity, yvelocity
- Multiple pads can be used simultaneously
- Apple bought the company in 2005 and took the product off the market ☹
- Technology and expertise used in iPhone

A Custom Controller for Performing Graphics

- Fingerworks iGesture pads
  - Multitouch with area-detection
  - Extremely responsive

Dud - examples

- Chico : multitouch drawing, Python OpenGL graphics, webcam
  - movie
- Illuminated Corridor : Photoshop realtime drawing, one camera, dancer
  - movie
- Novato : two cameras
  - movie
- Musicians' Union : camera, Python OpenGL graphics
  - movie1
  - movie2

Dud - examples

- John Patrick's : drum-triggered graphics, camera
  - movie
- Musician's Union : dancer, FreeFrame, tracking
  - movie
- 21 Grand : dancers, indoor/outdoor cameras, four projectors, FreeFrame video looping
  - movie

Different Skies 2007

- 20 Electronic musicians and one visual performer gathered for a week-long workshop at Arcosanti in Arizona
- Music was composed for a concert at the end of the week
- Interactive graphics (no clips) was composed to match each piece of music
- The graphics performance rig:
  - Interview

- The two-hour concert:
  - movie
- A time-compressed video of the two-hour concert:
  - Two hours in two minutes

Different Skies 2007

Other uses of Fingerworks iGesture pads

- Finger Fresco at Maker Faire 2007

Movie

Finger Painting with Planets

- Maker Faire 2008

Movie

Finger Painting with Planets

- Installation for people to play with
- Generates music and graphics simultaneously
- Controller with buttons, knobs, LCD, multitouch pad
- Fingers on pad trigger music or graphics
- Graphics motion is simulated gravitational attraction
- Collisions of planets trigger music
- Musical keyboard controls (only) selection of notes

Big Pieces

- KeyKit – input and realtime processing
- Plogue Bidule – VST host for sounds
- Salvation – Freeframe host for visuals
- Planets – Freeframe plugin
- Cairo – drawing on bitmap (from Python)
- Chipmunk – Physics simulation (from Python)
- OpenCV – raster manipulation (from C)
- OSC – communication between KeyKit and Planets

Multiple Languages

- Once avoided, now embraced
- Library availability
- Device I/O availability
- Robustness
- Ease of Development
- Familiarity

In Hindsight, the Good Things

- Python integration in low-level code works well
- Bitmap manipulation with multiple toolkits can work
- OSC is a simple and lightweight transport format
- Local sockets for inter-app API invocation good for:
  - Flexibility in choice of languages and applications
  - Portability
  - Firewalling
  - Robustness
  - Separating device I/O from graphics/audio output

Finger Painting with Planets

- Night Lights show at Climate Theater

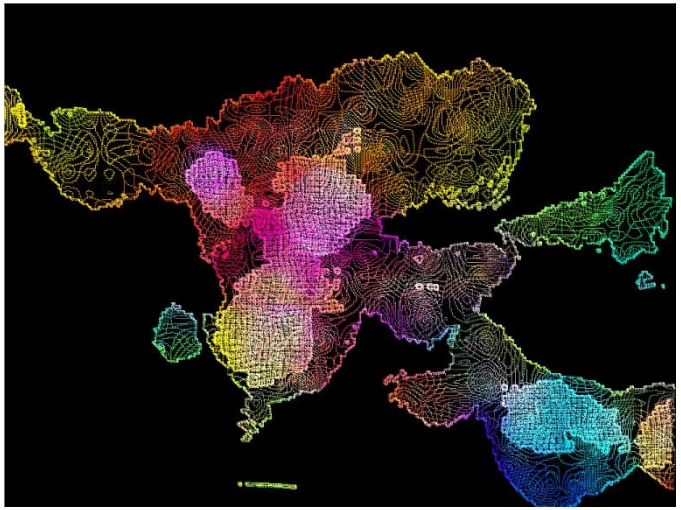
Movie

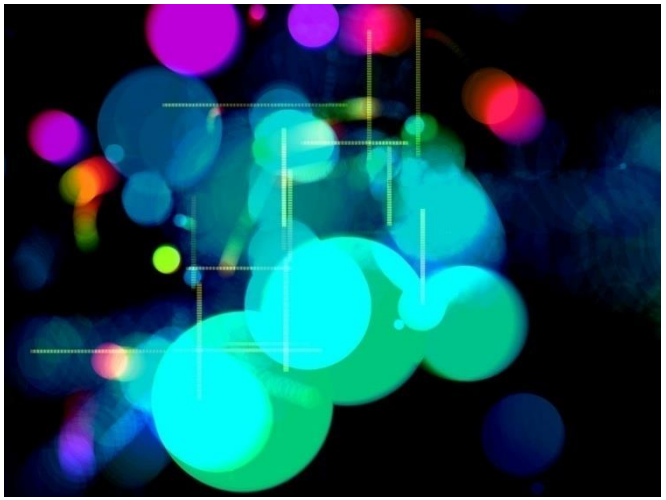
Finger Painting with Planets

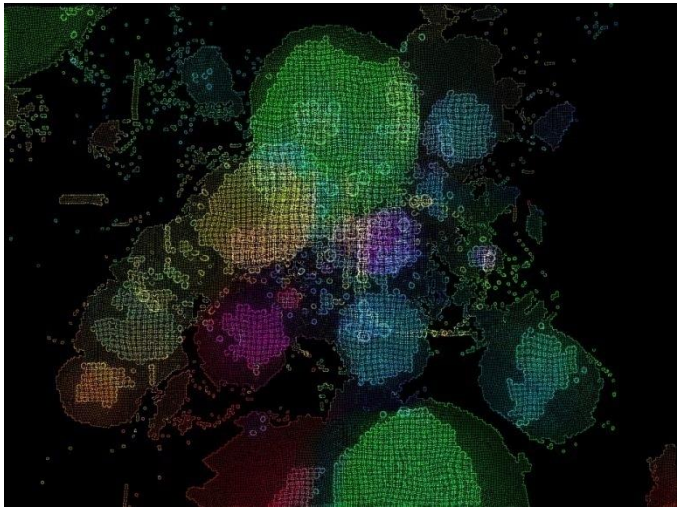
- Yuri’s Night

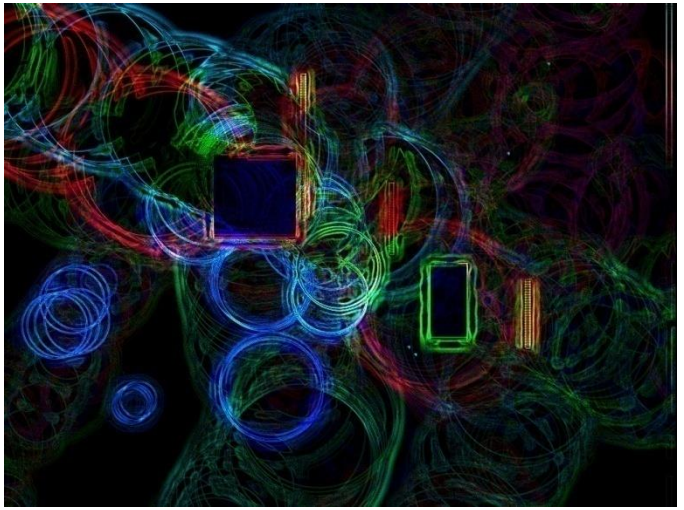
Movie

Examples of Visual Output

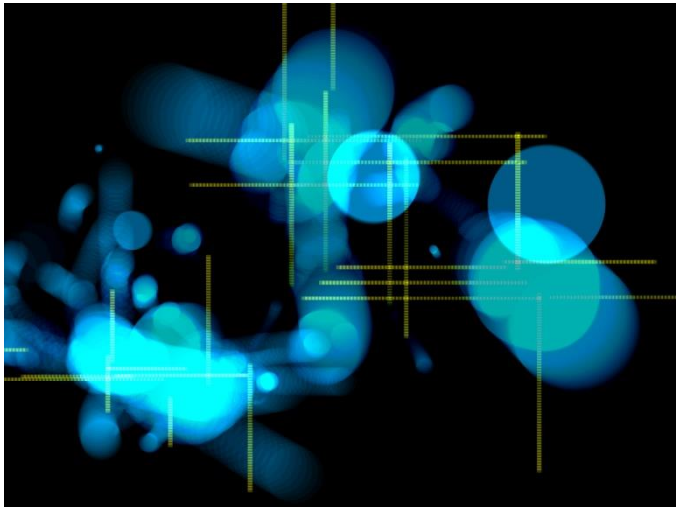


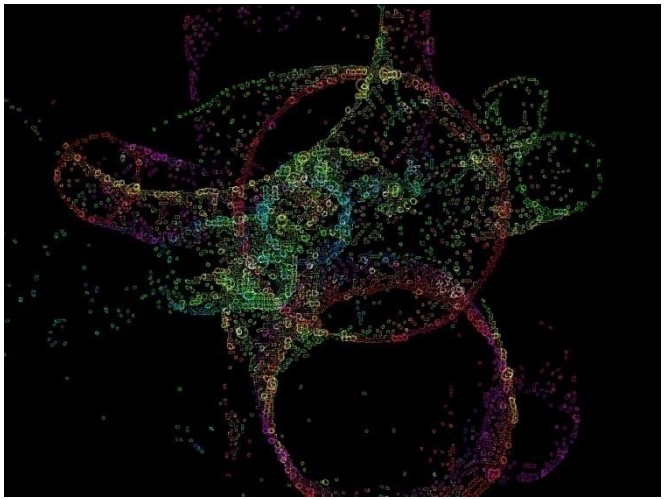


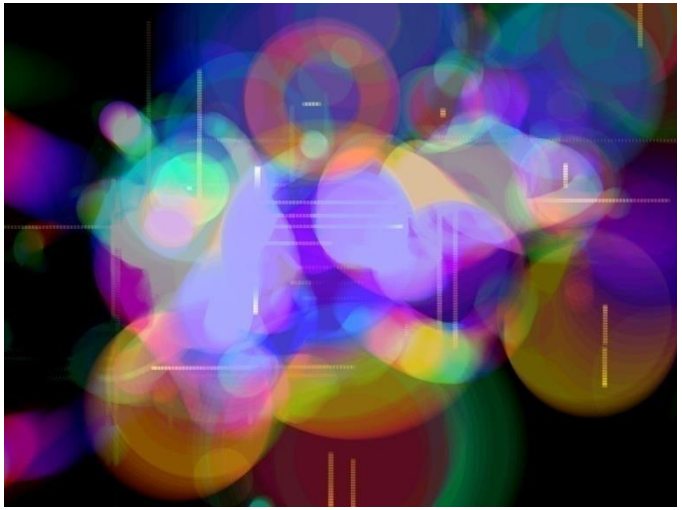


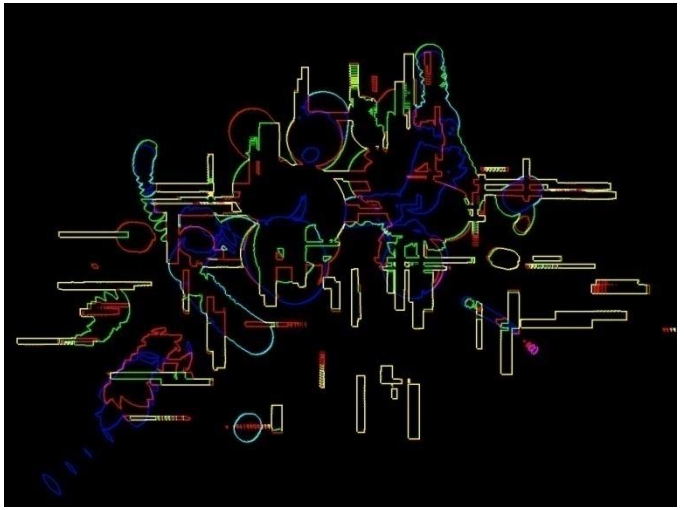


Examples of Visual Output

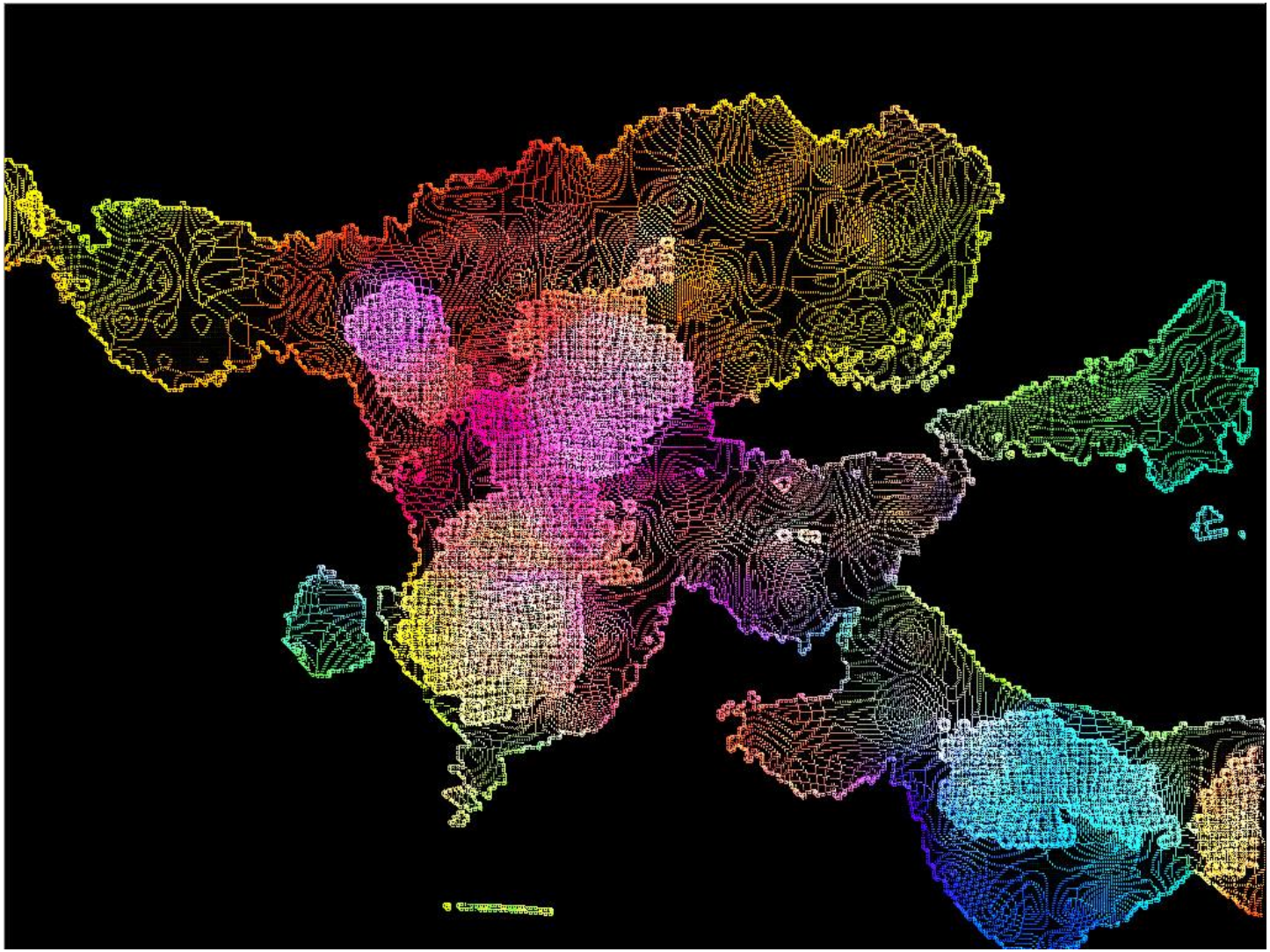








Examples of Visual Output



Examples of Visual Output

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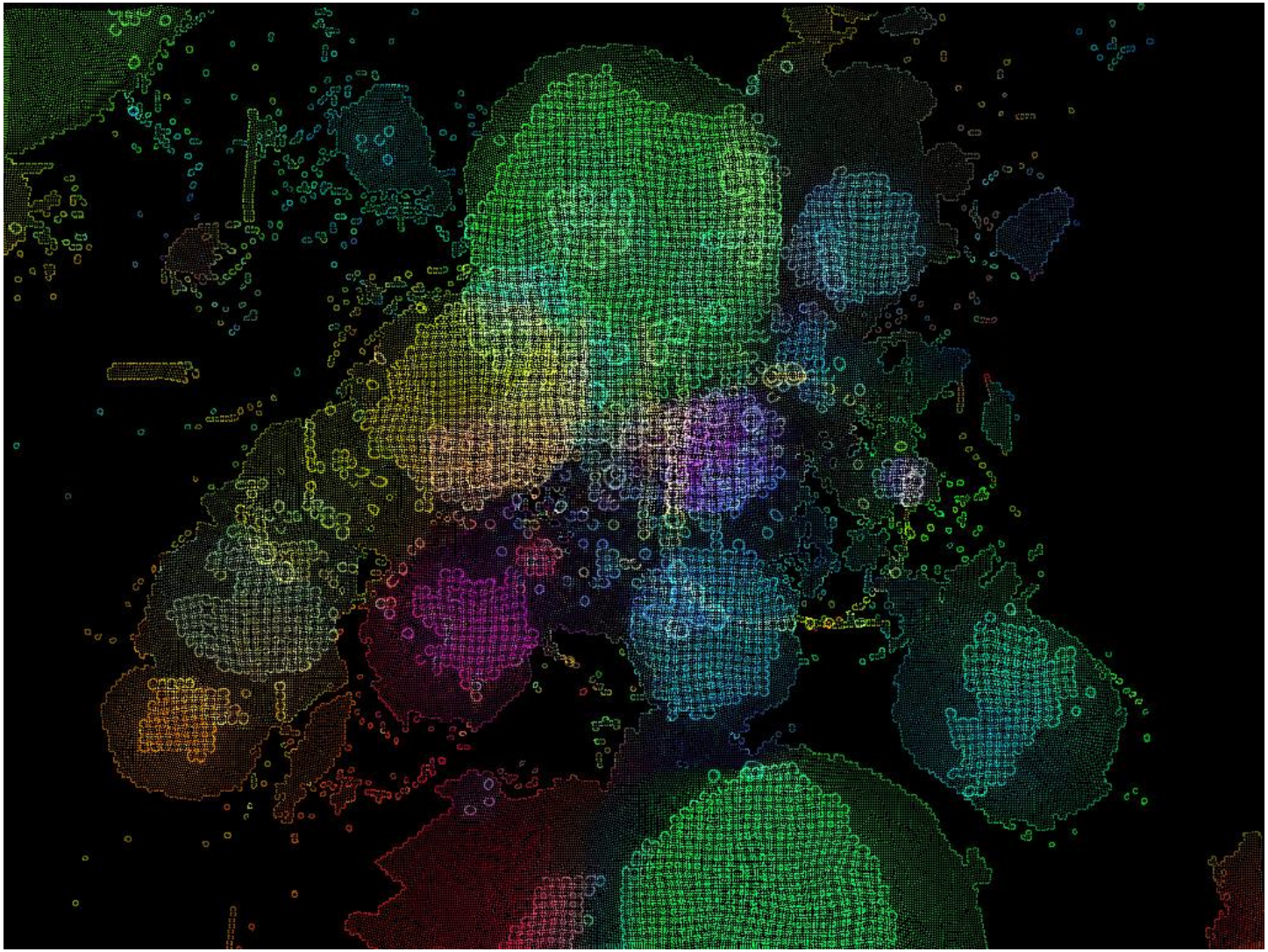

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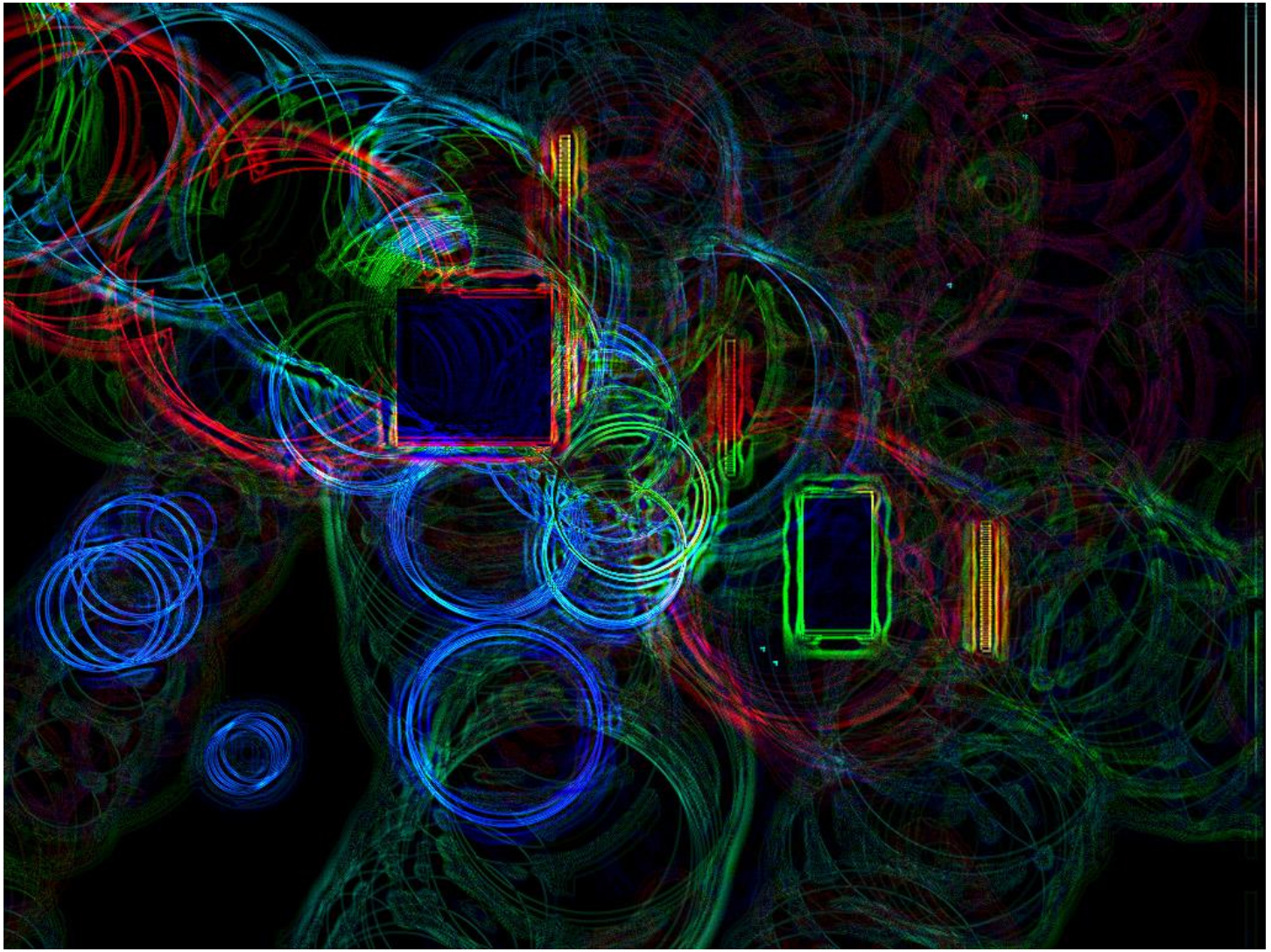

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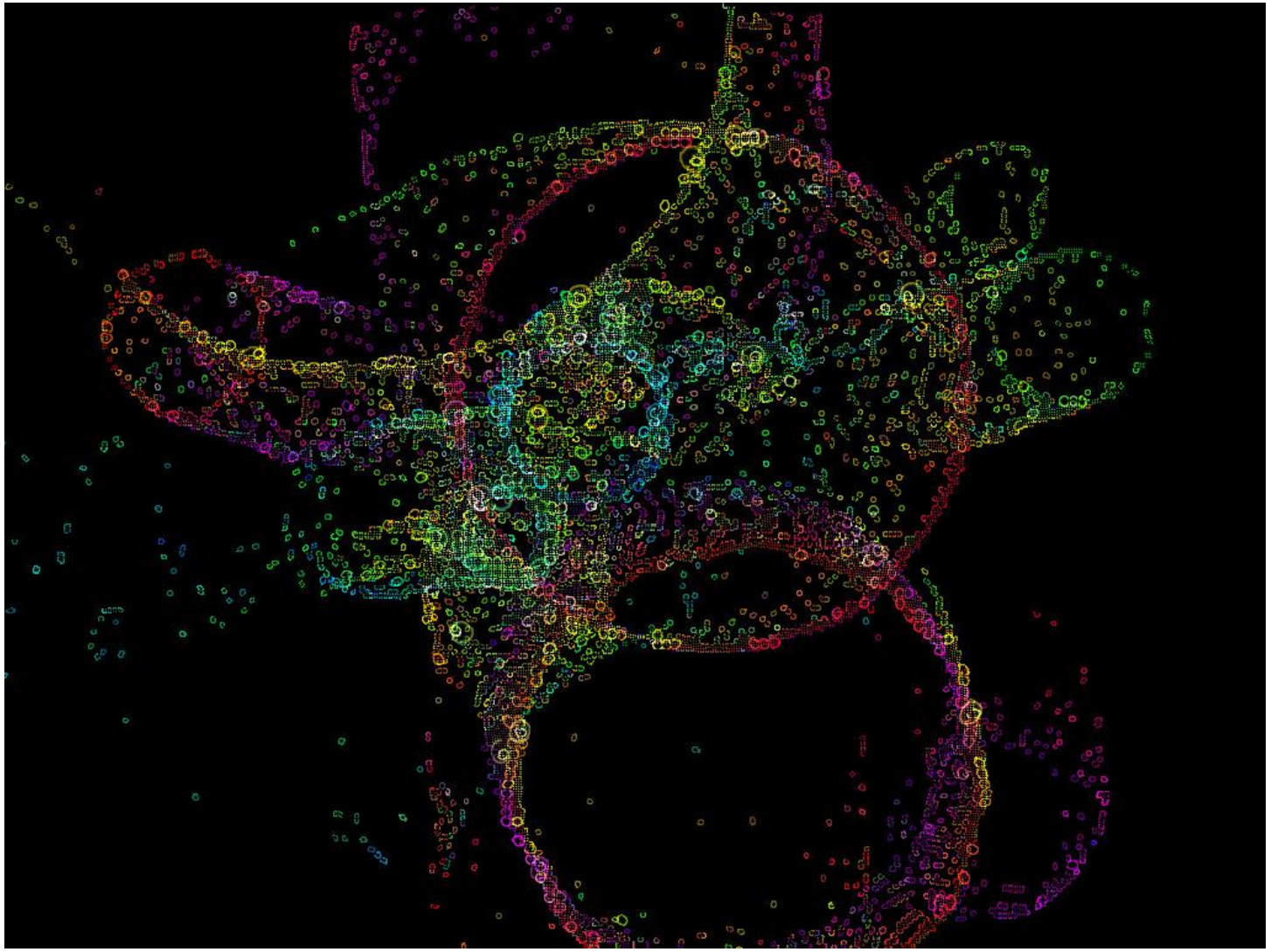
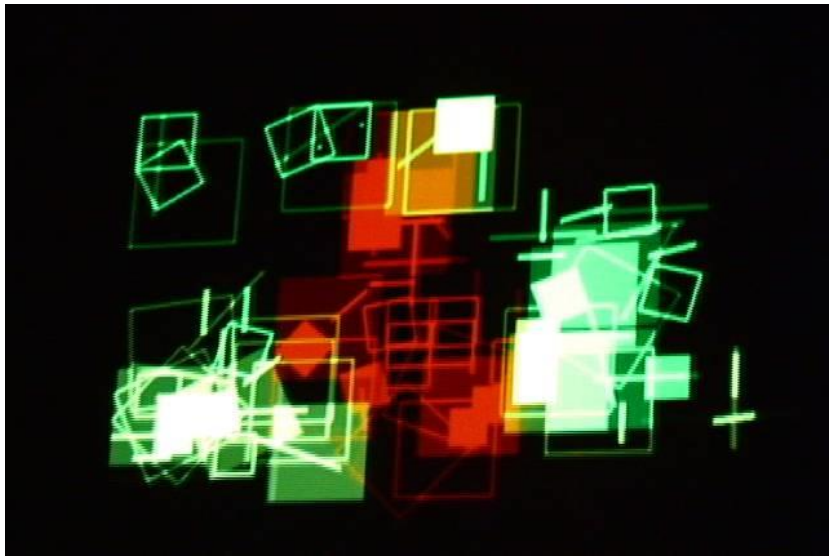


Double Vision

- Collective of dancers, musicians, and media artists
- Free innovation within a particular theme
- First show's theme was DNA
- Installation consisted of Conway's game of Life, audience could add DNA letters as patterns to it, and the generations of cells would trigger music and graphics



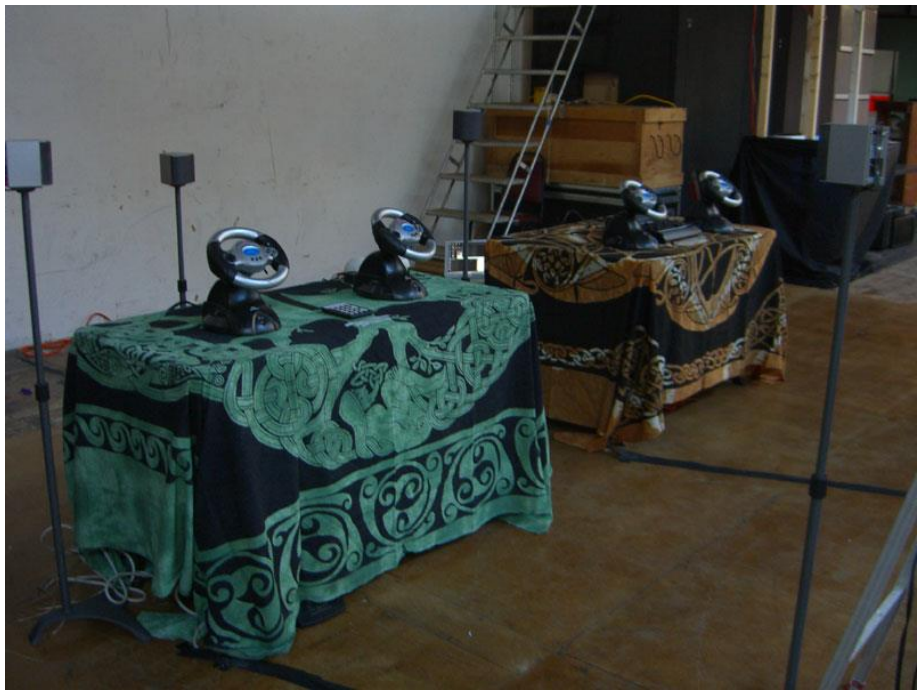
Double Vision – SpectraBall

- Dance pads used to control balls bouncing around in a maze
- Balls hitting the walls would trigger sounds in 4 speakers surrounding you - the sound location would match the direction in which the wall was hit

Double Vision – Cellspace show

- Steering wheel controllers used in two installations:
  - Art of Driving: drive around and “fire” graphics
  - Bouncing off the Walls: drive around a maze, firing balls, resulting in 4-channel music around you

Movie



DoubleVision – performing graphics

- Red Ink Studio – performing graphics with dancers and musicians

Finger Fresco 2.0

- First attempt at playing music and generating graphics simultaneously in an actual performance
- Used Fingerworks multitouch pads for playing music (same controller built for performing graphics, previously)
- Music keyboard controlled scales/chords
- Notes of the music triggered graphics
  - Movie

LoopyCam

- Camera-based visual performance instrument
- Performer controls camera position and visual processing with a single integrated device – a security camera screwed onto a $10 game controller
- First version used a USB webcam, but lighting was always an issue.
- Latest version uses a security camera which automatically turns on LEDs in low-light situations.

LoopyCam – how it works

- VVVV hosts FreeFrame plugins for visual effects
- One custom FreeFrame plugin records up to 8 video loops and controls their playback and positions
- KeyKit reads joystick buttons and sends OSC and MIDI messages over to VVVV to control the effects and looping
- Extensive “chording” of the buttons allows a large number of operations to be performed with the game controller’s buttons

LoopyCam Evolution

- First version restricted to 4 loops and quadrant positioning
- Was used at a DoubleVision event – showed great promise, especially for use with dancers
- Was installed in “automatic” mode in the window of the ATA Theater for the entire month of December, 2009, capturing and looping passers-by
- Lots of effort spent on making the installation foolproof and able to run reliably, because I was 50 miles away.

LoopyCam Evolution

- FreeFrame plugin enhanced to allow more flexible control and positioning of the loops
- Performances
  - Loop Salad solo performance at Luggage Store
  - This Here shows at Temescal Arts Center
  - SHARE San Jose jams at Villa Montalvo
  - With a Butoh dancer at Zeum in SF
  - I, Norton opera at the SF Electronic Music Festival

Galaxy – a Visual Music performance

- New Nothing Theater, part of Visual Music meetup
- Looping music played on a normal keyboard
- Graphics triggered by the notes of the music
- Graphics and music controlled by the “Finger Painting with Planets” controller
- Graphics makes use of Python within a FreeFrame plugin, allowing post-processing of the graphics with other FreeFrame plugins
- Movie 1
- Movie 2

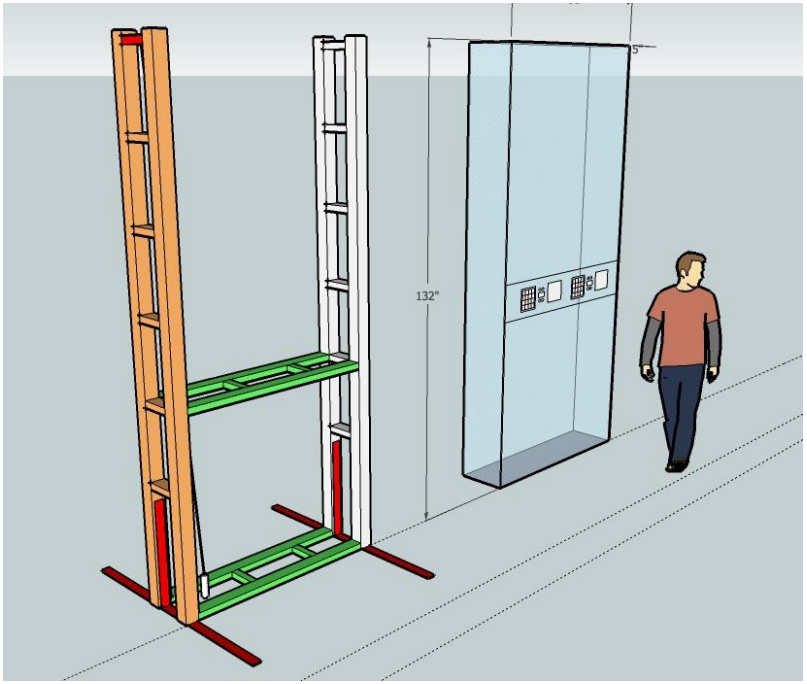
Loop Salad

- Combination of Galaxy and LoopyCam
- Visuals generated by Galaxy were projected, and also fed to LoopyCam (in “automatic” mode) to be processed and projected with a second projector
- Movie

Monolith 2.0

- Burning Man 2009 theme: Evolution
- 2001 Space Odyssey monolith
- One side is a highly evolved musical instrument
  - Two-person looper with over 100 controls
- The other side is a simple visual instrument
  - Chalkboard and chalk
- Built in my back yard over the summer
- Controller panels are usable independently

Monolith 2.0 – the construction



- Built to withstand 80 mph winds
- All battery-powered (swapped daily, recharged with solar panels at camp)
- Top had solar-powered fans for ventilation (though not really necessary)

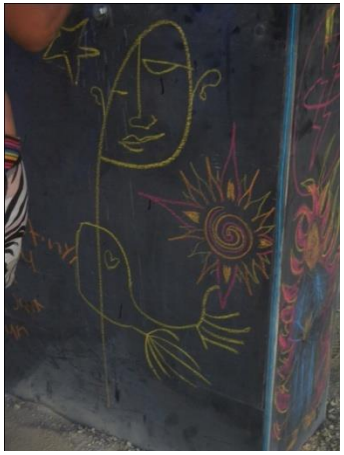
Monolith 2.0 – in my backyard

Monolith 2.0 on the playa

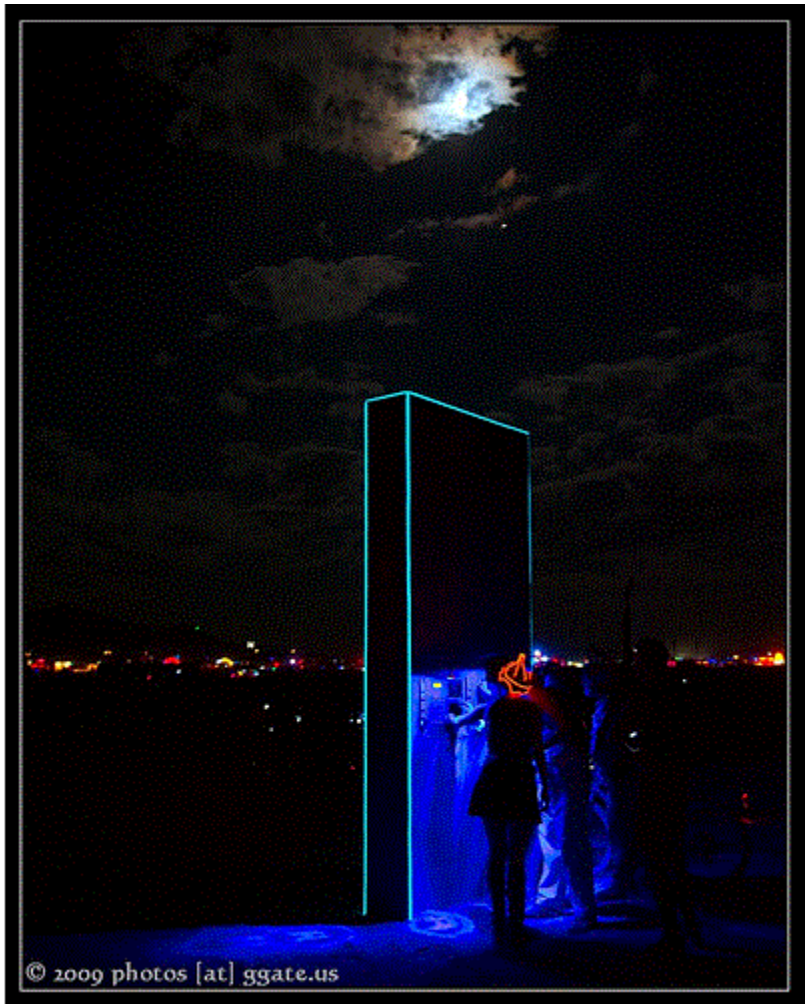
Monolith 2.0 – on the playa

Movie

Monolith 2.0 on the playa



Monolith 2.0 on Flickr

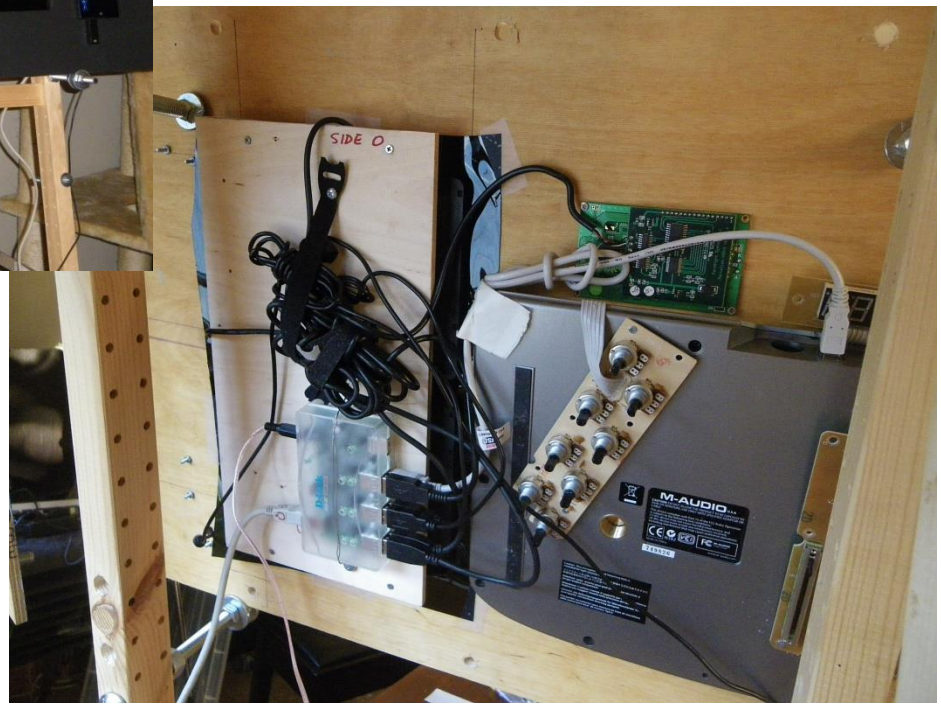


What's the controller part all about?

- Two independent controllers
- Each one is a 5-track looper - 1 track each for lead/bass/pads/drums/other
- The two loopers share tempo, scale, and transpositions, so they don't conflict musically
- Lots of labeled buttons to control:
  - Loop length, fading out
  - Chords, sounds, scales
  - Saving/loading loops
  - Audio effects (using one of the iGesture pads)

Monolith 2.0 – the controllers

- Korg Nanokeys used as buttons
- M-Audio Trigger Fingers used for drum pads



Buttons

- Originally was going to use arcade buttons
- Worldwide shortage of buttons due to release of Street Fighter IV
- Korg Nanokeys are cheap and come in black
- Convenient for labels
- Removed configuration buttons and covered in flexible acrylic for dust

Other Hardware

- Power consumption was a primary concern
- Asus Eeebox - Atom N270 running Windows XP, hosting a total of 15 USB devices
- Edirol UA-20 audio interface
- Sonic Impact (T-class) amplifier and two 6x9 speakers
- FM transmitter
- Lights - EL-wire outlining the monolith, and gooseneck LEDs
- 12 Volt deep-cycle batteries, swapped daily, charged with solar
- Battery 1: computer, amplifier, and both controllers (33 watts)
- Battery 2: EL-wire, lights, and FM transmitter

Software

- **Keykit**
  - Handles all input: 4 Nanokeys, 4 iGestures, 2 Trigger Fingers
  - MIDI looping
  - Controls the 2 LCD displays
- **Plogue Bidule**
  - VST hosting
  - Excellent routing features
- **Native Instruments**
  - Primarily FM8 (low CPU usage)
  - Battery 3 for drums

Feedback and Lessons Learned

- Both sides were well-used
- Burners always draw outside the box
- Message boards on the playa are useful
- People had lots of fun with the looper
  - At all hours of the day and night
  - Many came back repeatedly
  - Some people actually read labels
- Best feedback: non-musicians made music **and** realized that **they** were the ones making it

LoopyCam 2

LoopyCam 2

- LCD display displays menus and status
- Now usable by people other than myself
- Number pad (with chording) allows more operations
- Cinder-based application
- Uses both Freeframe 1.0 (raster-based) and FreeFrame 1.5 (OpenGL) plugins

A Renewed Focus on 3D Input

- 3D continuous input with hands
- Third dimension can be:
  - Slider or scroll wheel
  - Pressure (Wacom, Continuum, Eigenharp, Linnstrument, etc)
  - Area (Fingerworks, Magic Trackpad, iPad)
  - Vibration, Orientation, Acceleration (smartphones, joysticks)
  - Spatial (Kinect, Leap Motion, Senz3D)
- Recent breakthroughs and popularity in Spatial 3D
  - Fab or Fad?
  - Highly dependent on application

3D Input Device #2 – Microsoft Kinect

- Fastest-selling consumer electronics device ever
- Inexpensive and ubiquitous
- Good resolution and robustness
- Easy to access from custom software
- Can be used as a 3D scanner
- Tolerant of dust, intolerant of sunlight

3D Input Device #3 - Leap Motion

- Extremely precise and fast
- Designed for finger and hand detection
- Close range – within a 2 foot cube
- No depth map, not usable as a 3D scanner
- Most developers are
  - Emulating 2D input devices or discrete inputs
  - Not taking advantage of continuous 3D

3D Input Device #4 – Creative Senz3D

- Time-Of-Flight technology (TOF) from SoftKinetic
- Development support by Intel, sold by Creative as Senz3D
- Depthmap format is virtually identical to original Kinect
- Additional confidence map – inherent to TOF?
- Much shorter range permits a different class of uses

3D Input Device #5 – Kinect 2

- Time-Of-Flight technology (TOF)
- Higher resolution than Kinect 1
- Shipping with Xbox One
- Windows version is available to developers

Spatial 3D Input

- Large movement is enjoyable, engaging, expressive
- Finger dexterity not necessary
- Unified and simultaneous control of all 3 dimensions
- Simultaneous control of multiple continuous values
- Hands-free (e.g. operating room, vehicles)
- Not just hands
  - Full body
  - Object scanning
  - Objects as fiducials

3D Input Challenges

- Discrete Control
  - Where is the trigger point?
  - Latency, feedback, confirmation
- Gestural Control
  - When to pay attention?
- Tactile feedback
- Controlling one dimension (or finger) independently
  - Latching values
- Reproducibility
- Historical bias and unfamiliarity

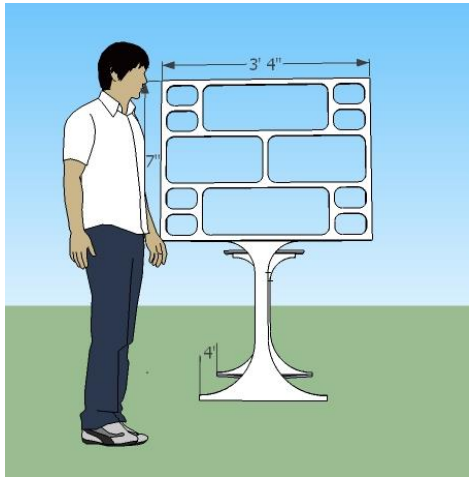
3D Input Devices – My Approach

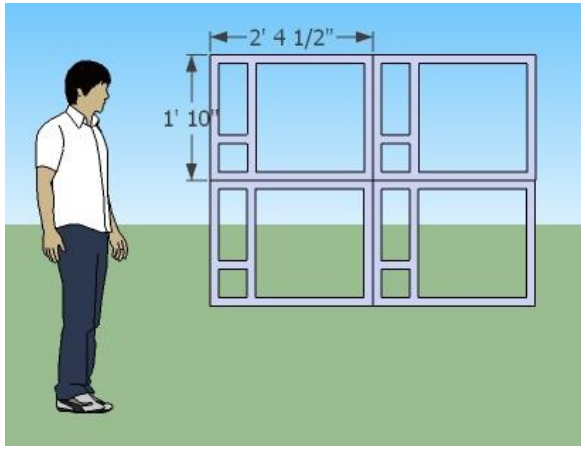
- Build casual instruments as interactive installations
  - Artwork where people create art rather than consume art
  - Obvious correlation between action and result
- Avoid things that are problematic
  - Add latency (quantize) rather than focus on reducing it
  - Use depth map only (skeleton tracking is easily disrupted)
- Introduce a physical reference
  - Improves amount of control (both perceived and actual)
  - More input areas, each one an independent instrument
  - Improves audience engagement and understanding

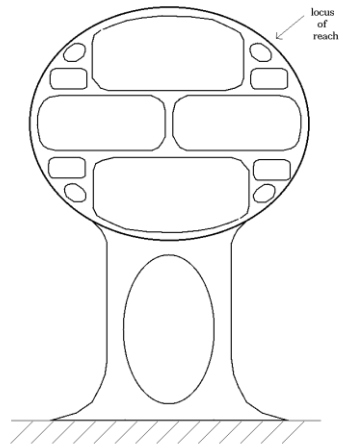
Space Palette - a 3D Instrument Interface

- Holes in a frame become 3D multitouch surfaces
- Any number of hands or objects, simultaneously
- Flexible layout allows many control possibilities
- Immediate access to different sounds/graphics
- Provides frame of reference for player and audience
- Larger visual footprint is more interesting to audience
- Immediately playable, no initial dexterity required
- Larger and less-restricted motion by player is relaxing and expressive

Space Palette - Evolution and Variations







Movies

Lightning in a Bottle 2011

Burning Man 2011

SF Decompression 2011

LoopFest 2011

Symbiosis 2012

Burning Man 2012

Burning Man 2013

Controlling the Music

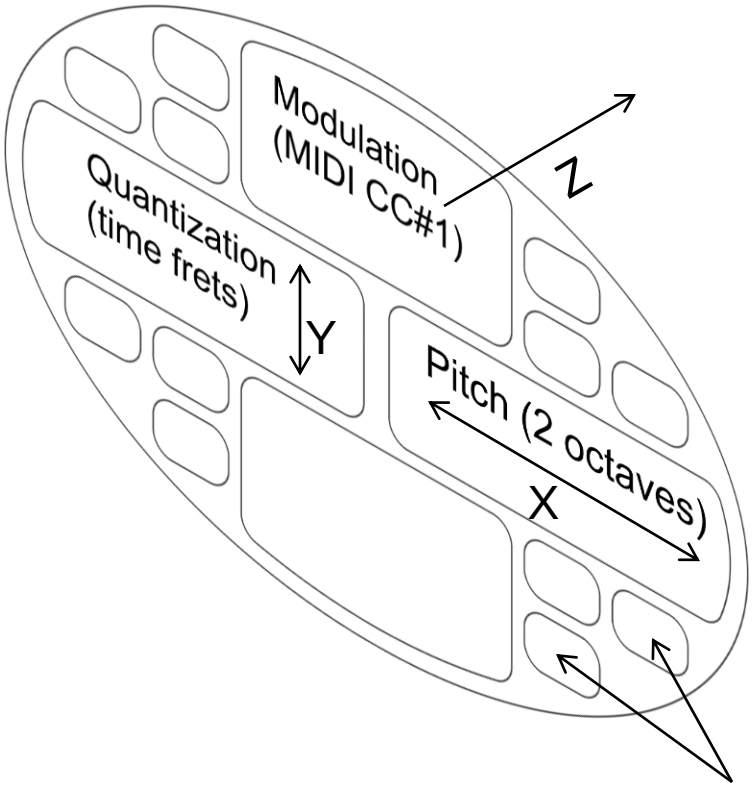
- Each large hole plays a different sound
- Horizontal position is pitch
  - All notes forced onto a particular scale and key
  - Typically two octaves across
- Vertical position controls timing quantization - “time frets”
  - Three bands: one beat, half-beat, quarter-beat
- Depth position:
  - Converted to MIDI aftertouch, used for vibrato, filtering, and mixing
- Small holes are buttons
  - Performance UI - change key, scale, sounds, looping
  - Casual UI – select presets

Controlling the Graphics

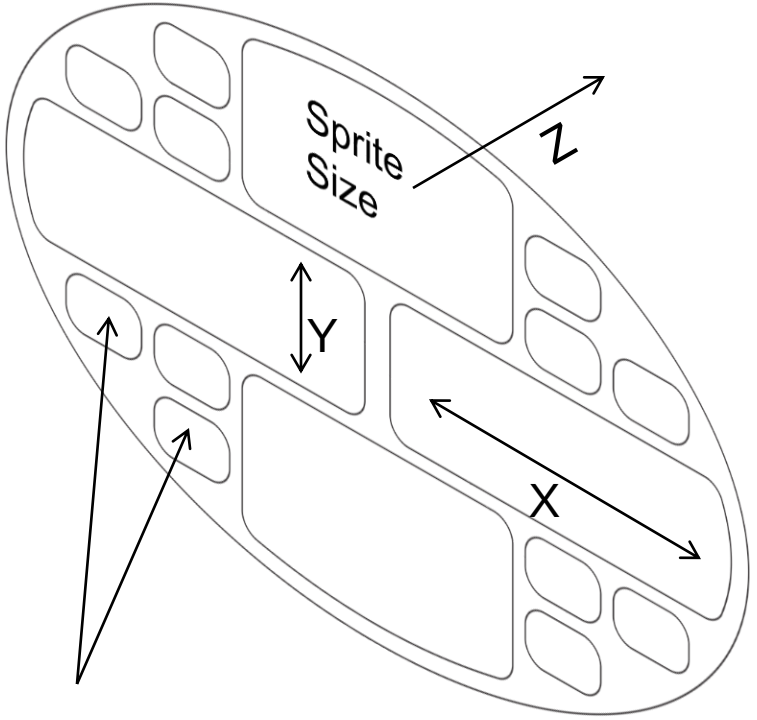
- Each large hole is an independent 3D drawing surface
- Each hole's drawing has independent shape/color/motion
- Depth controls the size of graphics
- Small holes are buttons
  - Performance UI - change color, shape, motion
  - Casual UI – select presets

Space Palette Interface

Musical Control



Graphical Control



Each button selects
a different set of sounds
and visual styles for the
four big holes

Comments about the Space Palette

- Most common:
  - I want one in my living room.
  - How much? Where can I get one?
  - I could stay here all night.

- Most interesting:
  - Why, it really opens up what an instrument is, right?
  - You gotta try it, you gotta try it, you gotta try it!
  - For those who can't cross that barrier [of playing music], they're literally crossing that barrier [hands reaching through].
  - Gorgeous… and powerful. (from a two-year old girl)
  - I never knew I was a creative person till I walked in there

Types of Instruments

- Casual Instruments
  - Prioritize fun and enjoyment
  - Few or no instructions
  - Immediate gratification, no learning curve
  - Path to proficiency is nice to have, but not required
- Performance Instruments
  - Prioritize proficiency and control
  - Instructions or training usually required
  - Proficiency requires practice, learning curve
  - Visualizations (real or virtual) for audience are beneficial

Where does the Space Palette fit?

- As a Casual Instrument
  - No learning curve: walk up, play, sound good
  - Natural interaction, effortless, engaging
  - Control over individual notes
  - Players recognize that they’re the ones controlling it
- As a Performance Instrument
  - Physical presence is more visible and entertaining
  - Performer’s larger movement engages the audience
  - More obvious correlation of physical actions to output
  - Frame of reference allows more and better control

Where does the Space Palette fit?

- Both casual and performance?
  - User interface is greatly affected by the choice
  - A single physical interface can serve both
- Casual use is the current sweet spot
  - Confirmed by several years at Burning Man and other events
  - UI continues to be simplified, visual feedback added
- Performance use has been explored
  - Several solo and collaborative performances
  - Several UI style experiments (e.g. shift-select style)
  - Open source MultiMultiTouchTouch allows others to explore

Things Observed and Learned

- Casual use vs. performance use influences the design a lot
- Small holes are magnetic
- Labels are rarely read
- Musicians know how to rest, listen, and be selective
  - Some “non-musicians” can instinctively do those things
- Looping can be confusing
- Multiple users is fun, but can be confusing

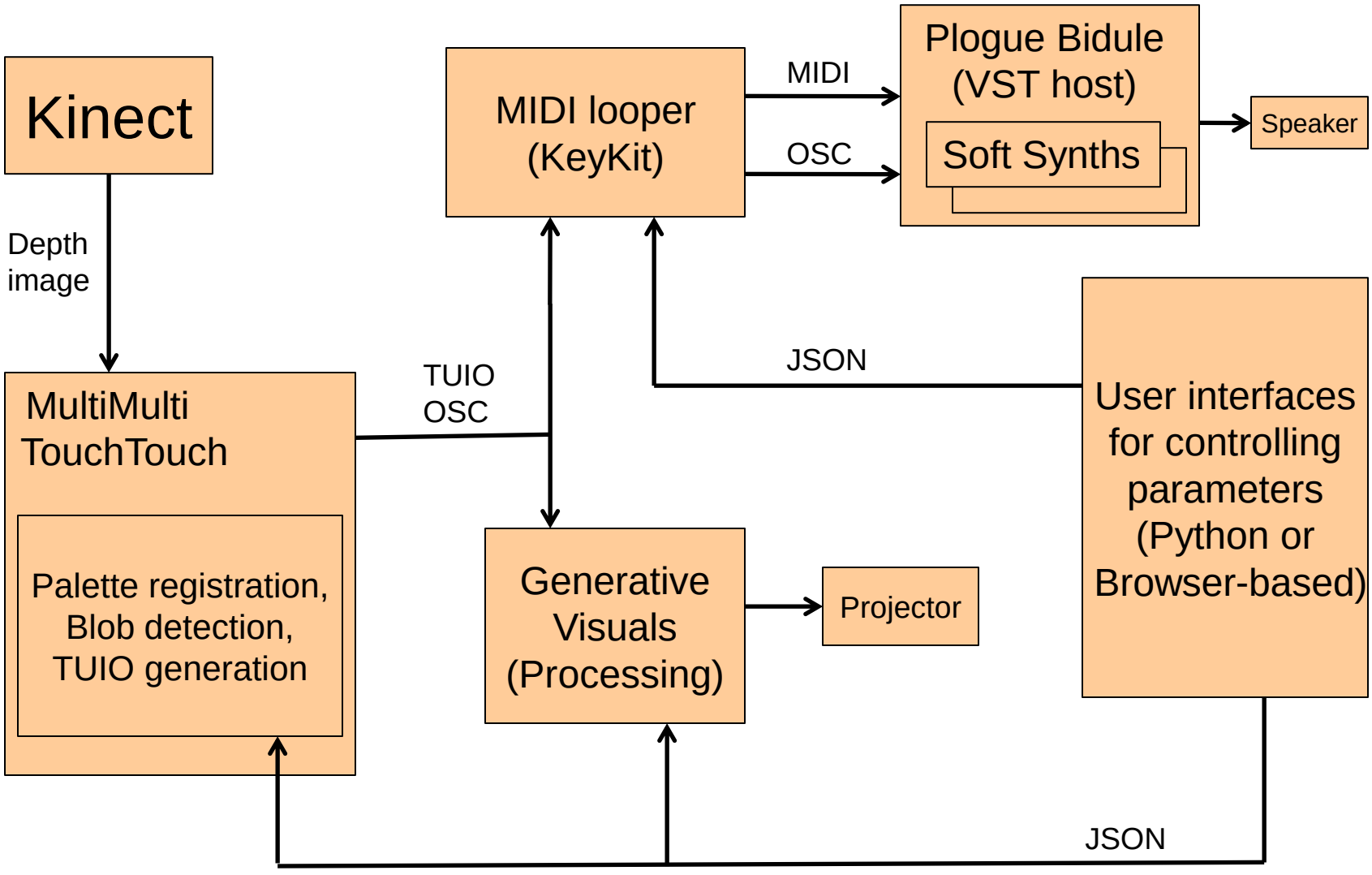
More Things Observed and Learned

- Correlation of graphics to hands is often not noticed due to extreme visual effects
- People love seeing their hands (debugging display)
- Effect of depth often needs to be explained, but is immediately appreciated
- Time-frets aren’t intuitive, but provide useful variety even if you aren’t aware of how it works
- Hand motion tendencies limit the pitch range used:
  - Depth-only with no up-down or left-right motion
  - Up-down with no left-right motion

Initial Evolution - 2011

- Initial prototype: 4 regions
- A little more control: 7 regions, 8 buttons
- Lightning in a Bottle
- West Coast Controller Battle
  - Tennis Ball !
- Simultaneous graphics using Processing (Java)
- Burning Man 2011
  - Multi Multi Touch Touch theme camp
- MusicTech Summit, Venice Art Crawl, Decompression, etc

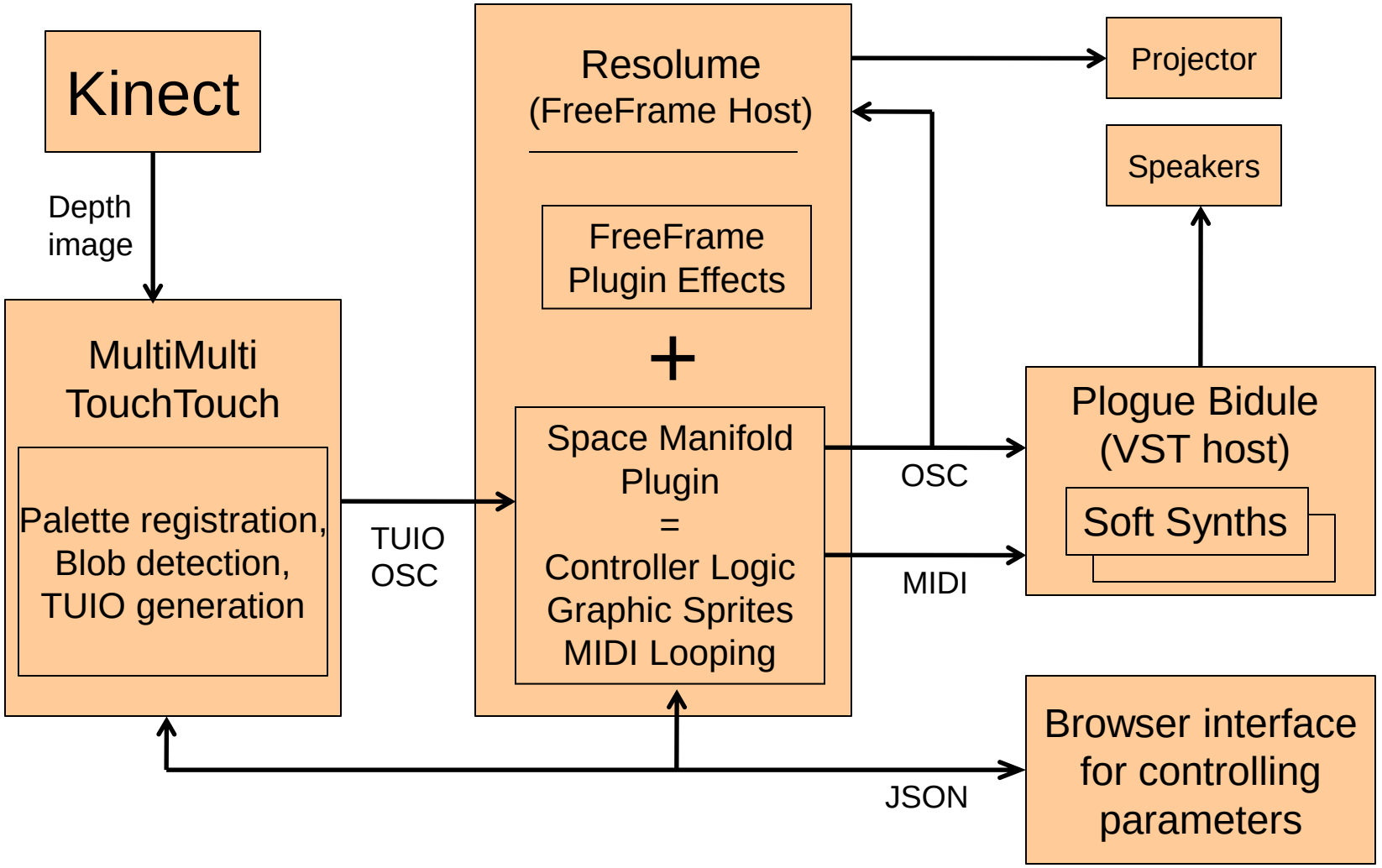
Design - 2011


Kinect
Depth image
MultiMulti TouchTouch
Palette registration, Blob detection, TUIO generation
TUIO OSC
MIDI looper (KeyKit)
MIDI
OSC
Plogue Bidule (VST host)
Soft Synths
Speaker
JSON
User interfaces for controlling parameters (Python or Browser-based)
Generative Visuals (Processing)
Projector
JSON

Recent Evolution - 2012

- Oval version – 4 regions, 12 buttons
- FreeFrame plugin inside Resolume
  - Eliminates KeyKit and Processing
  - More complex visual effects using other FreeFrame plugins
  - Resolume can be controlled with OSC
  - HTTP listener, JSON API = browser-based UI for parameter control
  - Single OSC listener and looping mechanism, better synchronization
  - Potential for interaction between graphics and music
- Python integration within FreeFrame plugin
  - Interactive development, more robust error handling
  - Live coding
  - Easier code sharing and distribution

Design - 2012


Kinect
Depth image
MultiMulti TouchTouch
Palette registration, Blob detection, TUIO generation
TUIO OSC
Resolume (FreeFrame Host)
FreeFrame Plugin Effects
+
Space Manifold Plugin = Controller Logic Graphic Sprites MIDI Looping
OSC
MIDI
Projector
Speakers
Plogue Bidule (VST host)
Soft Synths
JSON
Browser interface for controlling parameters

Progress in 2013

- Short-range 3D input using Creative Senz3D
  - Smaller Space Palette, single-person use
  - More practical for the living/family room
  - Multiple Palettes = Space Orchestra
- Time-Of-Flight cameras
  - Microsoft moving to TOF
  - Creative Senz3D is TOF
  - Higher resolution?

What’s new in 2014 and 2015?

- New Base, Golden Ratio, Monitor Frame

Software

- MMTT (MultiMultiTouchTouch)
- Resolume (FreeFrame host)
  - Projection mapping and visual effects
- Space Manifold (FreeFrame Plugin)
  - Receives TUIO/OSC, generates graphics AND music
  - Looping mechanism
- Plogue Bidule (VST host)
- VST Soft Synthesizers
  - Battery 3, Alchemy
- Browsers (local and remote)
  - User interface (and JSON API) to control MMTT, Space Manifold

MultiMultiTouchTouch (MMTT)

- C++ program uses libfreenect to talk to Kinect
- Uses depth image only
- Blob detection using OpenCV
- Trainable interactively on new frames, holes of any shape
- Trainable without a frame, using a specially-colored image
- Browser interface to control it, using JSON over HTTP
- Output is TUIO (a standard multitouch format) over OSC (a standard UDP protocol)
- Windows-only, source code is available

MidiFingers – a Leap Motion experiment

- Horizontal dimension controls pitch
- Vertical dimension controls timing quantization
- Depth (3rd) dimension controls volume/brightness
- Real-time control of musical scale
  - Press the notes of a chord/scale on a MIDI keyboard
  - Notes played with Leap are forced onto that chord/scale
- Python source code
  - **`http://github.com/nosuchtim/midifingers`**

No Such Media

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