# calligraphic video

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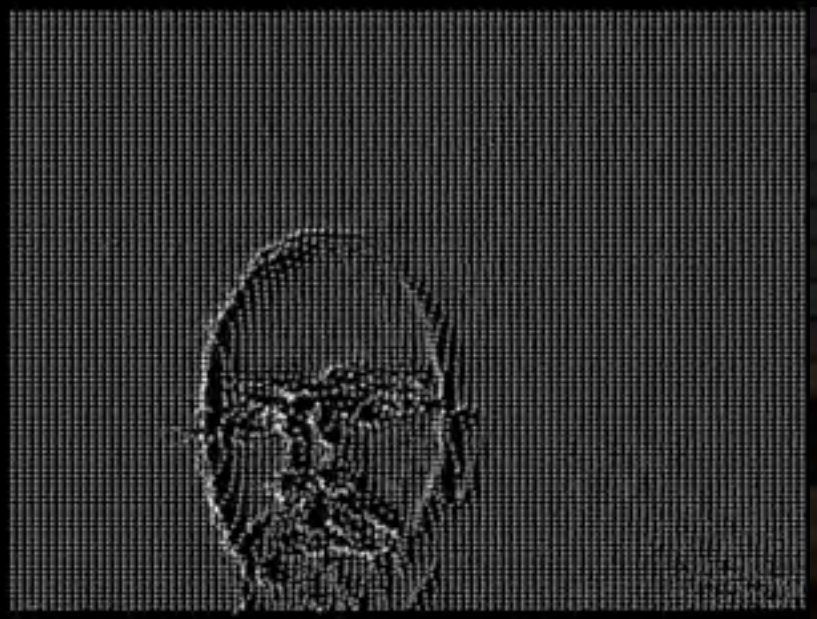
**Session: Interactive Art Program Track 3: Visual**
**Session Chair: David A. Shamma (Yahoo! Research, USA)**
*Thursday October 22, 2009 16:00-17:30*
*Hall: Meeting Room 8024 @ Beijing Hotel*

# examples

optical flow



x″

lifetime

# light as smoke

*D. Nain, Y. Serita, TML 2004-2005 early Navier-Stokes*

# light as ink

*Ojija 2007: composite gesture: body movement, live painting, realtime video*
*sha, montanaro, cho, concordia dancers + tml media choreography*

# phenomenological approach

continuous ontology
rich ~~complex~~
corporeal intuition

# challenges

# limit of complex displays

Information + Decisions =>

Cognitive load

3D displays, menus, OO-ontology =>

Combinatorial complexity

# observations

# Q. What makes something palpable?

tg2001 sha sponge foam

# kinesthetic intuition

Dense displays, combinatorially infeasible

Different strategy:

- Leverage body intuition from birth
- Shallow semantics
- Physical synchrony


# schema-free epiphany

TML CTIA Wireless Fashion Show Atlanta 2004

Designer J. Fantauzza. angle-based granular synthesis, but no specific a priori gesture

∴

schemas after the fact

latent predisposition

tg2001 sponge+foam

# Q. Embodied epiphany sans training

∴

everyday human experience

is

embodied

(not cognitive)

$\therefore$

# everyday human experience is continuous

continuously evolving in time

continuous in space

# felt meaning*

"Experiencing is nonnumerical & multischematic"

A more precise order not limited to one set of patterns and units

Categories may be logically but not experientially prior to instances

* ***Gendlin 1997.***
*qv. Sha 2002, 2008, Husserl 1919-1938 (1980, 1982, 1989); Maturana & Varela 1980*

# responses

## phenomenological experiments

# ~~objects~~ textures

Richest visual fields

- texture- vs. object-oriented displays

Visually rich dense displays

- dense realtime, responsive graphics are now computationally feasible

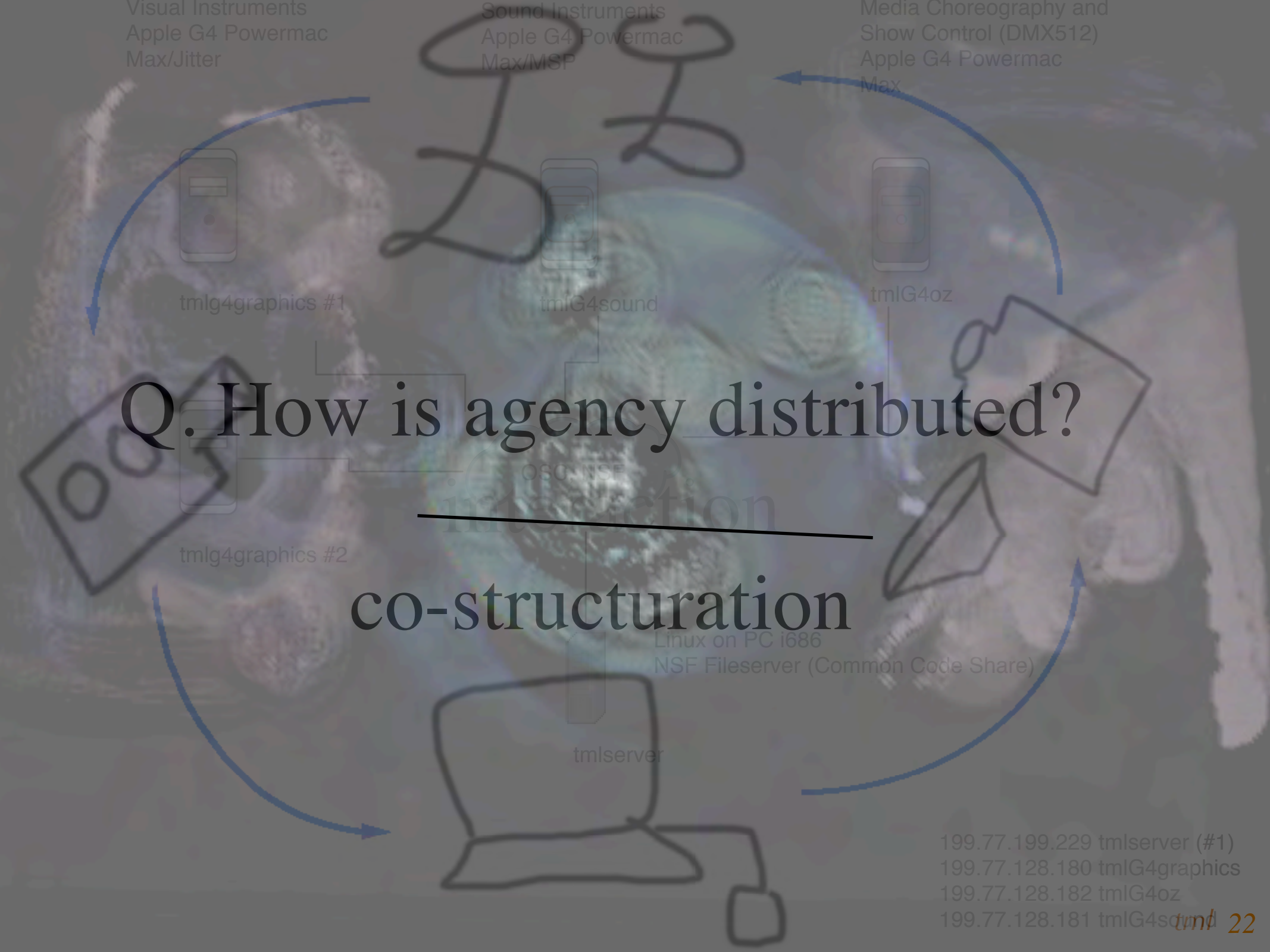
# apparatus for phenomenological experiments

Not to create objects, or even events as pre-specified sequences of states, but as *conditions on ranges of events*

# apparatus for phenomenological experiments

Assumption: No pre-existing typology (categories) of objects of experience prior to event.

# refined phenomenological research questions




# Q. How is agency distributed?

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# co-structuration

# Q. When is a movement a gesture? (intention)

Satinder Gill, Cambridge:

prosody, musicality and rhythm in collective gesture, 2005-2009.

*Craig Dongoski, Atlanta 2004.*

# specific research medium calligraphic video

structured light responding to gesture as a *quasi-physical material*

# desiderata, conditions

Real-time = “zero” latency

Dense

Robust

Screen-based delivery

# video texture graphics

Graphics

- 2D (not 3D) spare cycles
- lattice methods vs object
- (i.e. ***continuous ontology***)
- constant in number of objects !
- to limit: each pixel is a manipulable!

C dontemporary hardware architectures

# Prototype: heat equation

Laplace equation:

A scalar-valued field

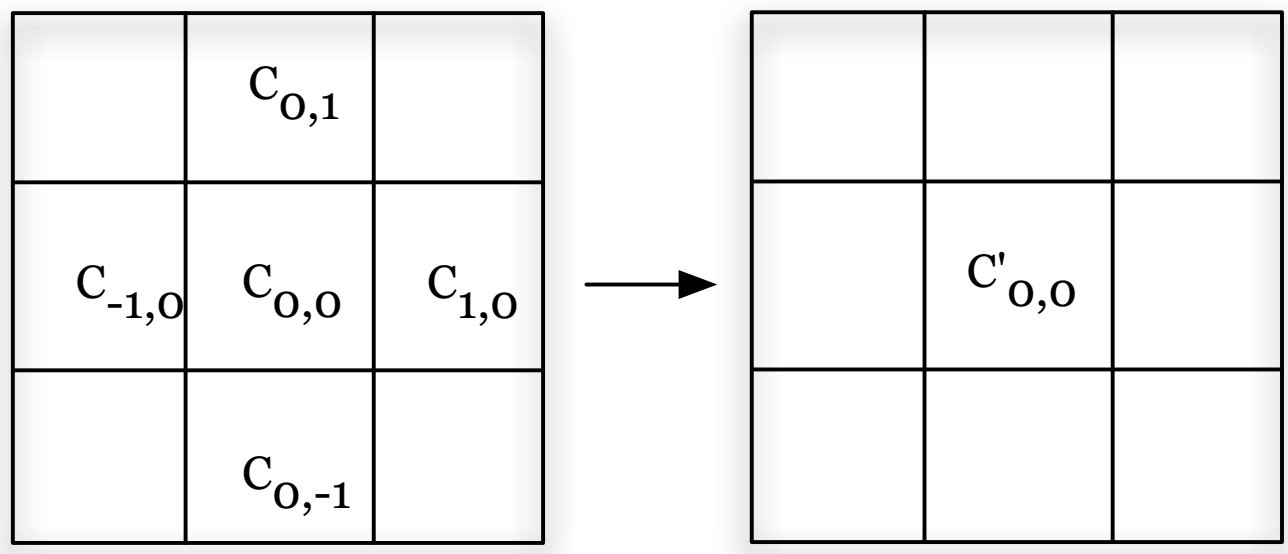
$$\phi(\mathbf{x}, t) : \mathbb{R}^n \times [0, \infty) \to \mathbb{R}$$

satisfying the PDE

$$\frac{\partial \phi}{\partial t} = \triangle \phi$$

# discretization of Laplace PDE

## and integration




$$C_{0,0} \rightarrow C'_{0,0} = 1/4 * (C_{-1,0} + C_{1,0} + C_{0,-1} + C_{0,1})$$

# calligraphic video

fire, smoke, Y. Serita, J. Fantauzza, TML

wave equation; Navier-Stokes equation

# Navier-Stokes

Michael Fortin 2007-2009 (Delphine Nain 2004-2006)

References: J. Stam 1999; Chorin & Marsden 1998; Fedkiw et al 2001; Irving et al. 2006; Kim 2008

# light as fluid

Michael Fortin. Optical flow mapped to density or “wind” in Navier-Stokes model.  Parallelized on multi-core CPU, and GPU

# Navier-Stokes equation 1

Assume: nearly time-independent pressure and temporature.

A vector-valued field

$$\mathbf{v} : \mathbb{R}^n \to \mathbb{R}^n$$

Physical assumption 1: No sources or sinks, i.e. divergence free:

$$\nabla \cdot \mathbf{v} = 0$$

# Navier-Stokes equation 2

Physical assumption 2: Conservation of momentum

$$\rho = \text{density}$$

$$p = \text{scalar pressure}$$

$$\nu = \text{viscosity coefficient}$$

$$\mathbf{f} = \text{external force}$$

Newton's Second Law: force is the time rate of change of momentum:

$$F = \frac{d(m\mathbf{v})}{dt}$$

# Navier-Stokes equation 3

For some field $\mathbf{u}[\mathbf{v}(x,t)]$ which is a function of the velocity field $\mathbf{v}$, the total "material derivative" is

$$\mathbf{D}[\mathbf{u}] = \frac{\partial \mathbf{u}}{\partial t} + (\mathbf{v}\cdot\nabla)\mathbf{u}$$

So total force acting on a fluid element is:

$$\frac{\partial(\rho\mathbf{v})}{\partial t} + (\mathbf{v}\cdot\nabla)(\rho\mathbf{v}) = \nabla p + \nu\triangle(\rho\mathbf{v}) + \rho\mathbf{f}$$

# Navier-Stokes equation 4

Solving for time-derivative of velocity $\mathbf{v}$:

$$\frac{\partial \mathbf{v}}{\partial t} = -(\mathbf{v} \cdot \nabla)\mathbf{v} - \frac{1}{\rho}\nabla p + \nu \triangle \mathbf{v} + \mathbf{f}$$

For the densities, we just deal with the first term, known as the ***advection equation***. This moves the densities according to the velocity field.

# results

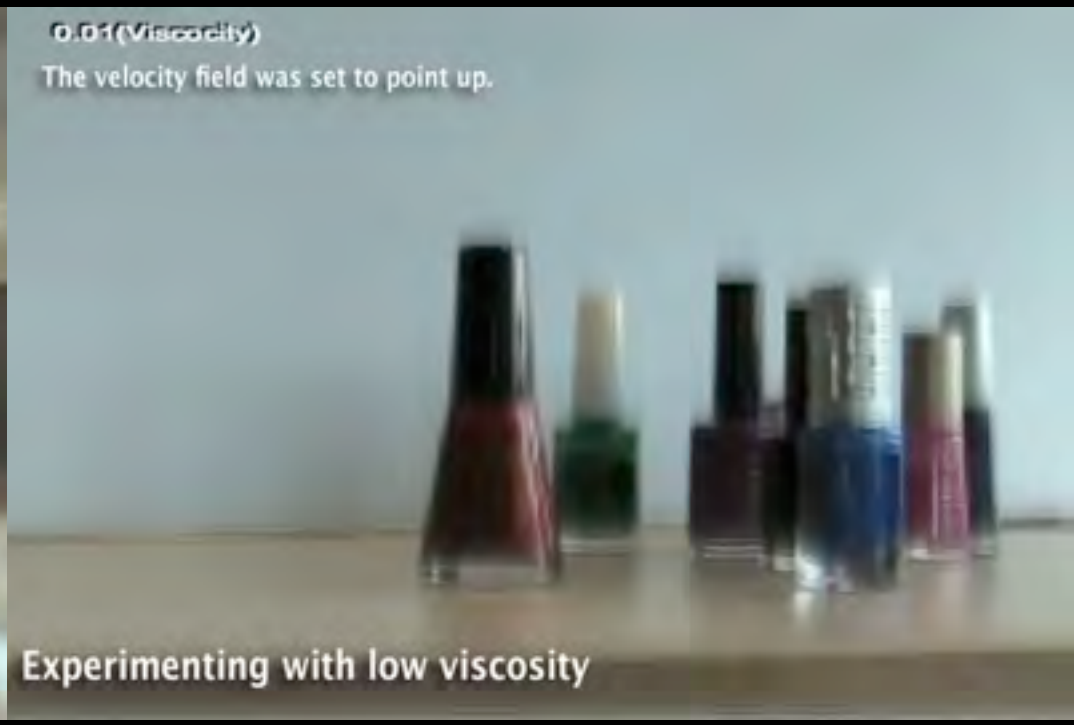

Each frame, a bit of color from a video-source is blended into the color of the density/matter.
Free surfaces aren't implemented, so density is colored, but there's no lack of it anywhere.


Human interacts with simulation
As before, incoming video is blended into the density field. The density field is essentially a floating-point bitmap that is advected each frame. Different effects can be achieved by increasing or decreasing the amount of source video that is blended in.

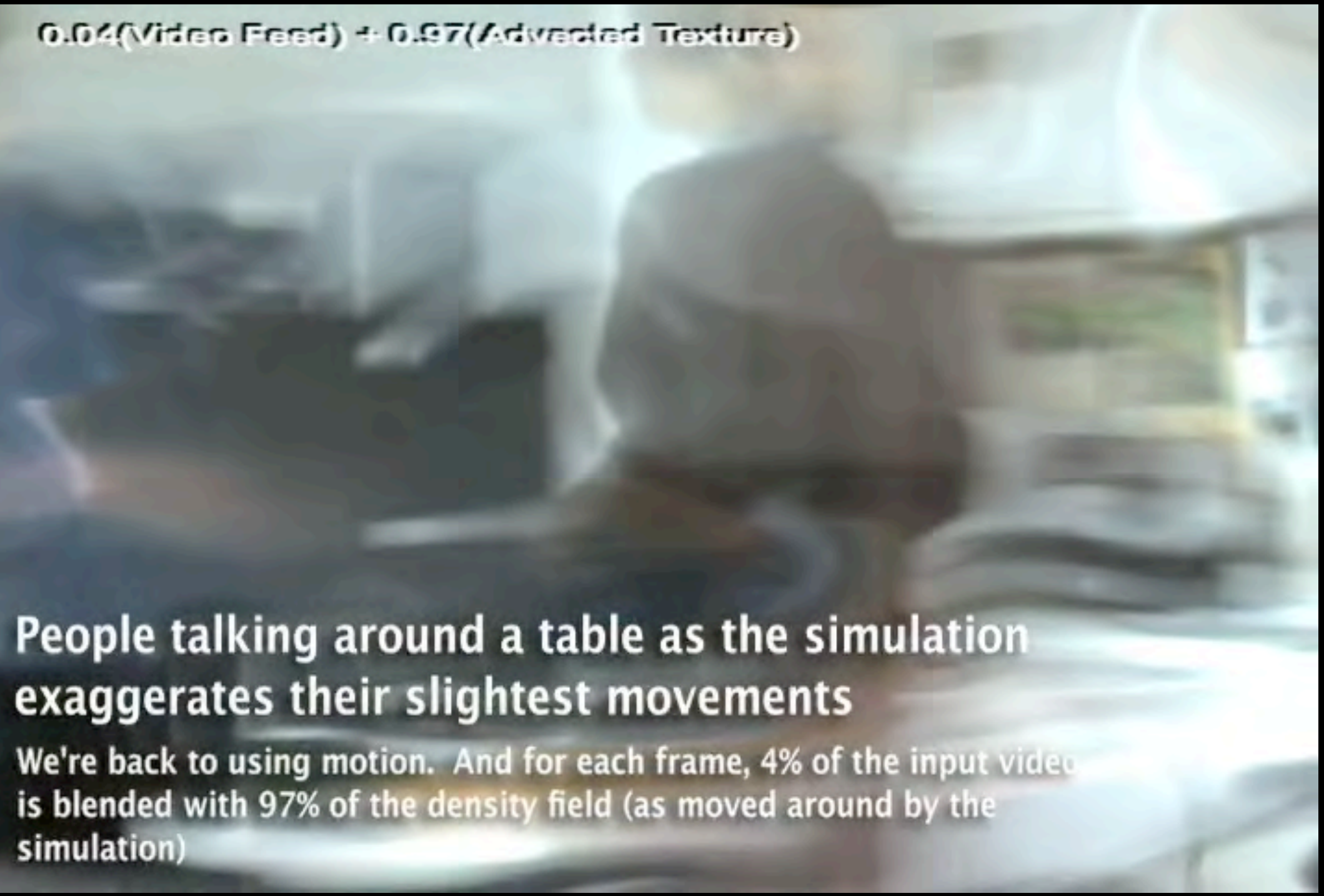
# Navier-Stokes 3


*color = heat, viscosity, heat tests*

# Navier-Stokes 3


*color = heat, viscosity, heat tests*


0.04(Video Feed) + 0.97(Advected Texture)
People talking around a table as the simulation exaggerates their slightest movements
We're back to using motion. And for each frame, 4% of the input video is blended with 97% of the density field (as moved around by the simulation)

# implementation

Michael Fortin

Three hardware platforms:

- Apple Power G5 4-core CPU
- NVidia GPU
- Sony-IBM CELL (PS3)

# software environment

Max/MSP/Jitter

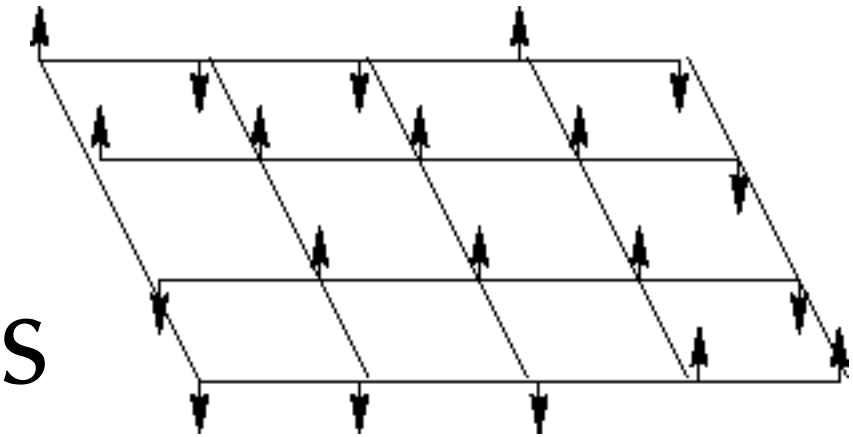
- lingua franca
- high expressive, don't waste time coding, get to run experiments

Extend in C, C++, Objective-C, etc.

# Ising model

Q. Is magnetic spin field palpable ?

# Ising Model magnetic domains



spin up or down of a magnetic domain

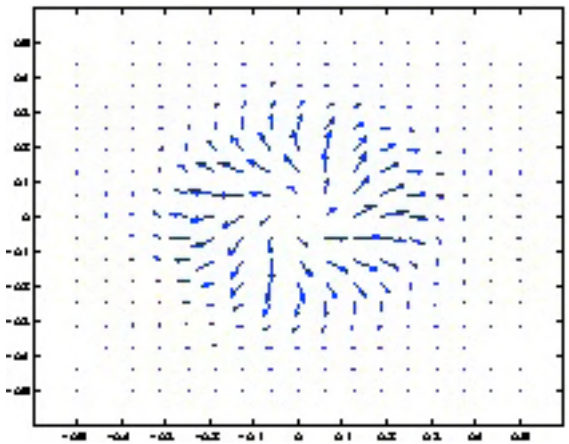
$$\sigma_i = \begin{cases} 1, & \text{“up”} \\ -1, & \text{“down”} \end{cases}$$

J > 0 encodes energy favoring aligned spins

H encodes external field on magnetic domain

$$E = -H \sum_i \sigma_i - \frac{J}{2} \sum_{(i,j)} \sigma_i \sigma_j$$

# Ginsburg-Landau spin glass



Generalization of Ising model from discrete range {0,1} to continuous range $S^1$

$$\iota u_t^\epsilon + \Delta u^\epsilon = \frac{1}{\epsilon^2}(|u^\epsilon|^2 - 1)u^\epsilon$$

in which vortices form as $\epsilon \to 0$.

# Ising video operator

Yannick Assogba, 2006

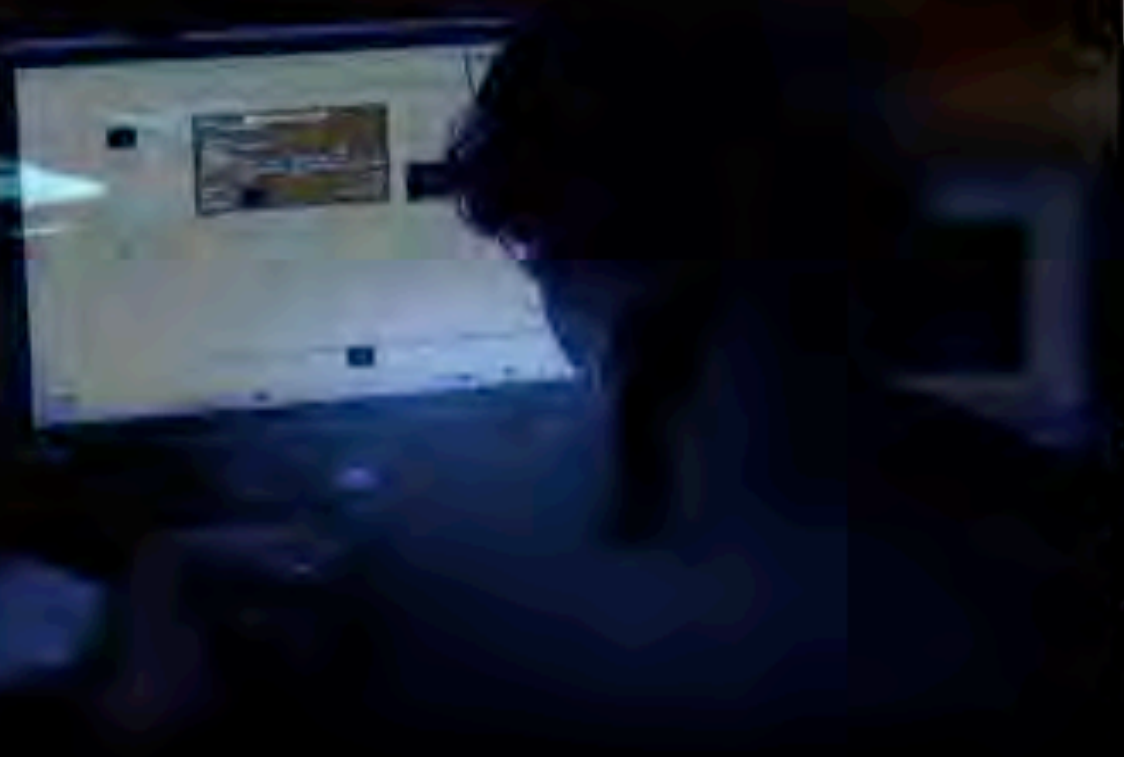
# applications: movement arts & architecture

re-embed in more richly meaningful contexts

# movement arts &

# responsive environments

# ARTAUDIAN lighting



camera-based tracking
mapping movement to
theatrical, structured
light

# Ouija: entrainment

*Ouija Experiment on Collective Gesture in Responsive Media Spaces, June-July 2007. Designed by Sha + Montanaro. SY Cho, dancers; T Sutton (sound), JS Rousseau (video), et al. TML*

# Ouija: Calligraphy

composite gesture: body movement + live painting + realtime video
June-July 2007 Hexagram Blackbox


- composite gesture: body movement, live painting, realtime video
- June-July 2007 Hexagram Blackbox

# Frankenstein's Ghosts

# Frankenstein's Ghosts

*Reprocessed instruments. Blackbox Dec 2008.*

** Paul Bendzsa, Milan Gervais, * Pam Reimer, * Liselyn Adam; (* Blue Riders), + dancer Leal Stellick*

# architecture &

# responsive environments

lattice-field works gracefully with lots of people

Navier-Stokes & Wave  Blackbox Inaugural May 2006

# Cosmicomics

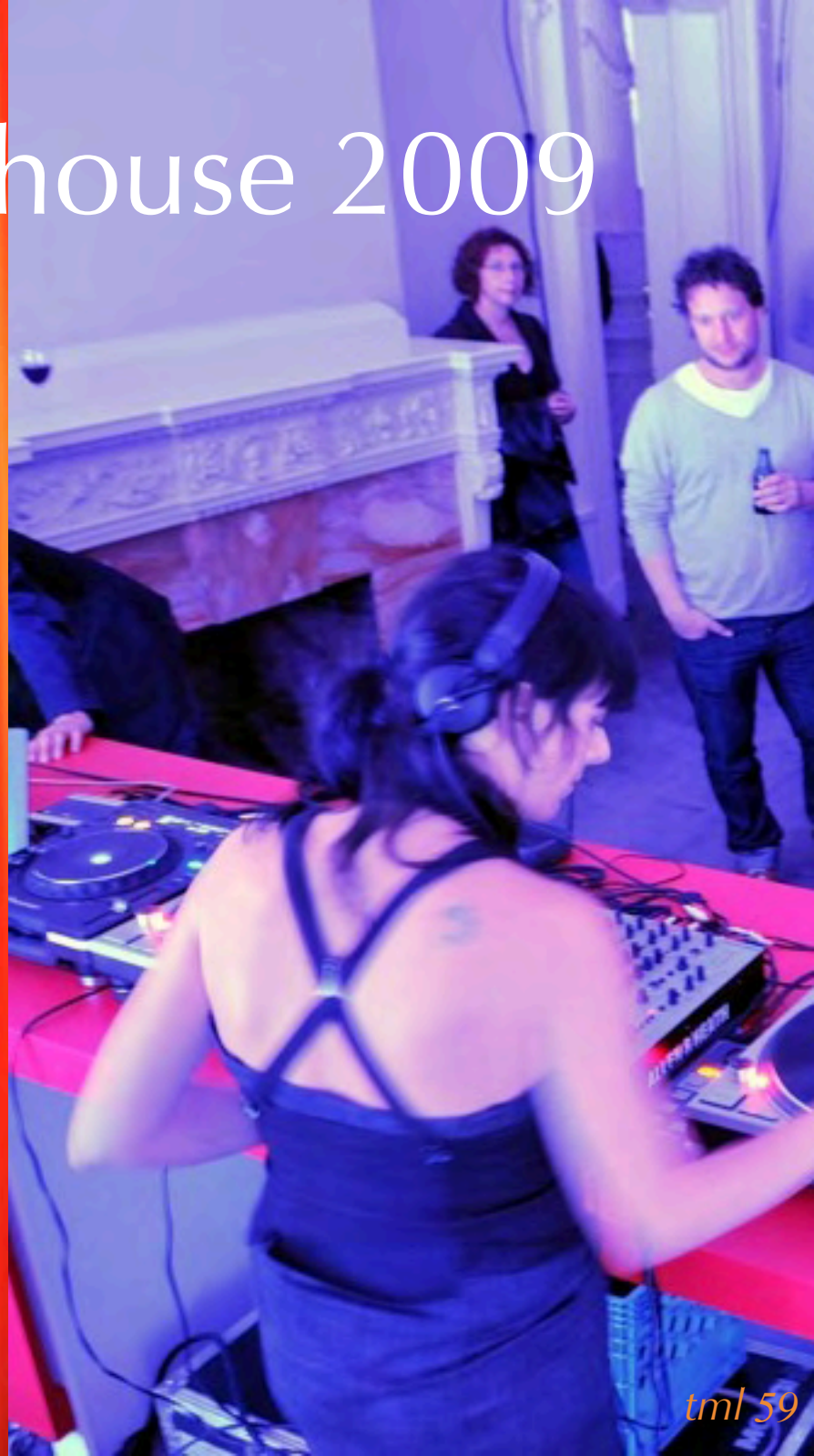
*Elektra July 2007*

*tml 57*

# canadian centre for architecture

*dmx animated led light panels*
*nuit blanche 20th anniversary 2009*
*morgan sutherland, navid navab, timi sutton*

# cca shaughnessy house 2009



# credits

**Students, Scholars, Artists**
**Who have passed through or**
**worked with the Topological Media Lab**

**Georgia Tech 2001-2005**
**Concordia University 2005 - 2007**

*topologicalmedialab.net*

Παντα το πυρ επελθον κρινεει και καταλεπσεται.

*Fire is the ravisher of all things. Heraclitus*