# *Lanterns*

## An Enacted and Material Approach to Ensemble Group Activity with Responsive Media

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## ABSTRACT

This paper takes an empirical and processual approach to the study of coordinated group activity through enacted and experimental movement research with responsive media. We focus on the dynamic emergence of what we will refer to as ensemble. Informed by readings from process philosophy and new materialism, we take into account the vitality of matter in investigating a notion of subjectivity unhinged from compartmentalized conceptions of the human. Methodologically we suspend ontological assumptions which occlude, mask, or ignore emergent relations and unprestatable events. These concerns underline the design tactics of an immersive media environment and apparatus for research creation. The *Lanterns* digital-physical system employs a design ethos of *semantically shallow computation* towards an experientially *responsive* environment. We give an overview of the motivating questions for this line of enacted inquiry and describe our experimental process and outcomes with the *Lanterns*.

## CCS CONCEPTS

• **Applied computing** → **Media arts**; *Performing arts*; *Sound and music computing*; • **Human-centered computing** → HCI theory, concepts and models; Interaction design theory, concepts and paradigms;

## KEYWORDS

digital-physical hybrid systems, group activity and ensemble, material computing, responsive media, movement research, research-creation

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## 1 INTRODUCTION: PROBLEMATIZING GROUP ACTIVITY

The prefix of Latin origin *co*, meaning together, joint or jointly, mutual or mutually points us toward the relational dynamics found in group activities (e.g. a group preparing a meal, a crowd's distributed movements through urban spaces, or children playing tag). We define ensemble as corporeal gesture coordinated across messy assemblages of bodies, matter, intention, and atmosphere.

Our project does not set out to create a definitive account of *how* we do things together. We present ensemble instead as a problematic in the style of Gaston Bachelard.[5] In short, we are not interested in producing solutions or mechanistic explanations. Its local examples (e.g. holding a conversation while walking through a downtown, or experts performing a string quartet) always unfurl into the messy and hidden layers of different cultural, physical, and rhythmic strata. For this reason we begin our inquiry instead with some open questions:

- What do we mean by *togetherness* broadly?
- How can we condition enacted experience for coordination to emerge?
- How can we collectivize group dynamics instead of reducing to individual agents, without returning to dualistic vocabularies e.g. self, body, or without discretizing messy fields of coordination into skin-bound bodies with brains?
- How do non-human matter, objects, tools, and organisms participate in ensemble with humans? Without? How can we leverage skills learned in lived experience?

The paper's central thrust details the design and construction of a digital-physical responsive media system, *Lanterns*. Along the way, we comment on the hardware and software implementation's implications for our particular research-creation approach. We share some insights from experiments and conclude with a discussion about the relationality between non-humans and humans in fields of coordinated activity.

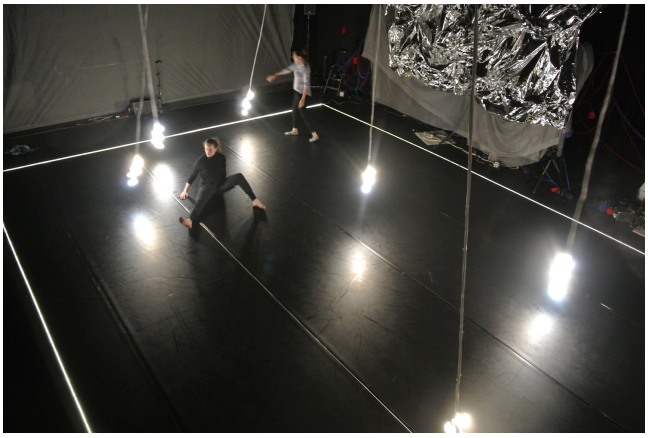

**Figure 1: Dancers in free play with the *Lanterns* system. Image copyright authors.**

## 2 BEYOND THE AGENT-BASED MICROWORLD: WHAT'S AT STAKE?

### 2.1 The Agential Limitations and the Emergence of Ensemble

Post-digitality in the arts and sciences mark a movement away from "God's eye", computationalist and simulation-based approaches to complex systems and movement towards heterogenous enacted and embodied approaches. Enacted approaches undermine traditional understandings of coordination and ensemble, namely, that subjectivities may be contained within discretized human bodies, whose movement in the world may be sufficiently represented by logical operators. In agent-based simulations used to model flow of people, flocking of birds, traffic, etc., graphical avatars stand in for so-called autonomous agents, who act according to pre-given rules which dictate speed, proximity to other avatars, avoidance etc.[8] While these techniques of simulation afford many practically useful advantages over enacted experiment (notably w.r.t. scale), the latter approach leverages the embodied knowledges of the material and biological world. We do not need to train avatars to walk in order to understand the dynamics of a crowd moving through an airport[3], we look to in-situ examples of people moving through an airport. There are also philosophical points which motivate an insistence on enacted experiment. When we are free to dispense with the notion of the agent (no more than an ontological bracketing of subjectivity and corporeality) we may sidestep reductive accounts of relationality as interacting sets of coded logical behaviors and sensitize our inquiry to emergent relations.

## 3 *LANTERNS*: AN APPARATUS FOR ENSEMBLE AND COORDINATION

### 3.1 Overview

The Lanterns system is a sandbox for exploring a variety of interest areas, including human interaction in physical-digital systems, experiential approaches to dynamical systems, and corporeal entrainment between matter and biology. This section describes the *Lanterns* system used in experimentation [7] as well as in installations and dance performances [6].

### 3.2 Physical Construction: Sensor + Media Hardware Architecture

The *Lanterns* are tangible pendant objects with responsive sound and lighting behaviors. The lamps are suspended from a hacked GameTrak joystick tracking the lamps' movements. (see Figure 2). Each lantern consists of six dimmable LED with plastic diffuser, sockets, and a bundle of six cloth-covered electrical wires.[1] Suspended from a theatrical grid, the cluster of bulbs and sockets hovers only a few feet above the ground.

An Arduino Uno reads the joysticks position data. Formatted as OSC messages, the data is sent to central computer running MaxMSP via an Arduino Ethernet Shield and a Cat 5 hub (see Figure 2).

The lighting strands plug into a 4-channel/8-outlet dimmer multipack clamped to theatrical grid. The dimmer pack is connected in series with other lanterns' dimmer packs. The dimmer packs afford real-time control via the DMX lighting protocol, which in this case corresponds to each individual bulb's intensity (though two of the channels will control two bulbs). DMX data streams to the dimmers via an ArtNet Ethernet node, which is linked into a shared ethernet switch. ArtNet allows for many devices on the network to send control data, which means the lights can also be controlled by a traditional theatrical lighting board or other computers on the network.[2]

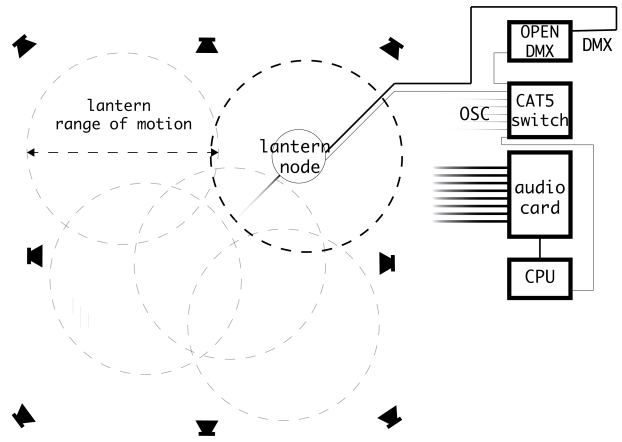


**Figure 2: Hardware diagram of the responsive media system**

### 3.3 Software: Sound and Light Feedback Design

On the central computer, the data is received and processed for sonification and lighting in a MaxMSP patch. The sound is spatialized over a multi-channel array.[3] We employ simple analyses of the

[1] The plastic diffuser and LED technology make the pendants extremely durable.
[2] While base-state sound and lighting behaviors were robust enough for experimental work, more performative ventures such as dance performances made certain dramaturgical demands which were helpfully finessed through theatrical cuing schemas.
[3] In the case of our experimental space, we use eight speakers in a double-diamond configuration with two subwoofer channels.

position data to create simple media feedbacks: we extract the speed of each lantern from the joystick data vector as well as a measure of each lantern's proximity to other lanterns. Their proximity is determined heuristically by calculating the total distance of each lighting pendant to the group's centroid.

Each lanterns position data are mapped to banks of filtered noise which are tuned to various pitch collections. Their speed and acceleration control playback speed and tuning of a bank of samples. These sounds track their lantern's position through the space across the multichannel sound array, whhich also flutter the lights.

The total distance from the pendants' centroid controls the pitch and amplitude modulation of sub-bass oscillators; as the lanterns gather together, the oscillators pitch into an audible range and pulse more frequently. The amplitude of this synth maps to the amplification of the light's control data.

### 3.4 Design Implications and Material Computation

The simplicity of the media feedbacks aims to highlight the prebaked, kinematic rhythmic character of each individual lantern as well as their relationships to other lanterns. The spatially diffused sounds, pulsing lights, and moving pendants constitute an experientially rich set of inter-penetrating fields of media and matter. Instead of algorithmically injecting variance into the interaction, we aim for a reproducible sonifications and lighting behaviors which leverage the rhythms, movements, and energies directly from moving human bodies and analog matter. In this way, *Lanterns*' responsive sound and lighting de-emphasize algorithmic virtuosity. Instead virtuosity is always already relational, social, and lived.

Tightly coupling sound and light to the movements of the physical system also works to de-center the human's hierarchical footing by destabilizing "interactive" design frameworks in which humans *control over* media through sensors are not slaved to the human body or extend as prostheses. As we will discuss later, the lanterns also evade our desire for control or precision through their own physical volatility.

A key aspect of our approach to experimental phenomenology is to rely not on models of "psychological" or "cognitive state" but instead to use semantically shallow models to drive the computation, described in [11]. This design principle results from an abductive approach to studying rich experience with the least possible commitment to theoretical models of experience. In particular, we have developed rich responsive media systems that leverage the embodied physicality and physics, but eliminate the need for modeling "user" "psychology" in code.[11] *Lanterns* draws on these methods, techniques and design principles.

Material computation or natural computing in foundations of computer science and engineering, and new materiality in cultural studies signal a turn to the design of responsive environments and computational media paying as much attention to material qualities like elasticity, density, wear, and tension as to social and cognitive experience. This demands thinking about and designing computation in a non-reductive way that spans formal divides between symbolic-semiotic, social, and physical processes.

One radical context for the lanterns work is the investigation of hybrid physical-digital models of computation, especially those that blend digital microprocessors instantiating Turing computation with the physics of analog matter. Following [10] and [9], we generalize computation as the reproducible transition from state to state of a structure (physical, biological, informatic) under some deterministic scheme. In [9], the authors observe that sound computing already exemplifies a rich history of hybrid physical-digital computation, where the processing of sound leverages both the physics of the analog and algorithmic (the code) parts of a computational-electronic-musical "instrument." Most importantly, we consider the human to be part of the system, following human-in-the-loop design common in AI research motivated by augmentation rather than automation (replacement) of human activity. *Lanterns* radically simplifies the complexity of the dynamics of the parts to clarify the relation among the physics, the digital computation, and the human performers.

We single out temporal (generalized rhythmic) aspects of activity such as cadence in swing, body and sound, as described below. The basic observation is that simple ballistic physics of the lanterns allow the performers to play most creatively to invent *ensemble* gestures that would be impractical to anticipate and model and embed into code in advance.[4]

## 4 EXPERIMENTAL OBSERVATIONS AND DISCUSSION

Our movement experiments with the *Lanterns* system points to insights about the relationality between coordinating human bodies and the material counterparts via fields of media. Table 1 summarizes the activities and inventions generated during experimental working sessions with a group of four dancers who have worked together for years.

The first column describes various recurrent pendant movements which we discovered through improvised and unstructured play (in other words, things the lanterns seemed to *like* to do). We made these patterns objectives for some playful exercises which were repeatable with different number of movers or lanterns (described in column two). An important methodological point was then not to instruct each other *how* to make this happen. Instead unexpected coordinations and tactics emerged collectively and processually, transforming the relation between dancers, between the moving pendants, and between humans and pendants (column three).

### 4.1 Indifferent Interlocutors: Towards an Asymmetrical Ensemble

These emergent tactics point towards a slippery connection between humans and the material system; clearly the humans are coordinating to work with the lanterns, but the pendants do not coordinate *back* in a way that is familiar to us. This impetus to collaborate is one-way; these lanterns do not wish or desire to participate in movement research. The indifference of the system's non-living matter seems obvious, most apparent to the dancers, who, despite their training to navigate complex spatial pathways and anticipate movements, were frequently caught a stray lantern to the face, or were scraped by the zip ties holding the lanterns

[4]We argue elsewhere that this is always the case with living systems because living systems have open rather than closed configuration spaces [4], but at the very least, this is a practical insight for building rich media systems for improvisatory activity.

**Table 1: Lantern Experiments and Etudes**

| MOVEMENT | EXERCISE and VARIATIONS | COORDINATIONS and TACTICS |
|---|---|---|
| Swinging | Lanterns swing like a pendulum; In phase/anti-phase, etc. | Run alongside swinging bulbs; Catch and release (using sight, using hearing); Grouping people w. lanterns, number of humans/lanterns |
| Circling | Lanterns swing like a circular pendulum; In phase/anti-phase; Moving in the same or opposite direction | Run alongside swinging bulbs; Catch and release (using sight, using hearing); Grouping people w. lanterns, number of humans/lanterns |
| Twisting | Lanterns wrap around each other; Number of lanterns to group; How many may be touched | Throw a pendant around another; thread them together |
| Gathering | Bring all the lanterns together | Gather and release (seated); Twisting or wrapping them to hold them together. |

*Source:* [12]

together. The impossibility of a symmetrical "collaboration" is evidenced by the marks left on bodies from collisions between moving humans and the lanterns: chipped paint, bruises, scratches.

Certainly the *Lanterns* matter to the collaboration in a way that cannot be understated. Physiological notions of intention or effort are absent, and yet the *Lanterns'* materiality is a constituent of the movement gesture. Recall the figure from Gilles Deleuze and Felix Guattari in *A Thousand Plateaus* in which they relate metallurgy to music. They write:

> If metallurgy has an essential relation with music, it is [...] of the tendency within both arts to bring into its own, beyond separate forms, a continuous development of form, and beyond variable matters, a continuous variation of matter [...] What metal and metallurgy bring to light is a life inherent to matter, a vital state of matter as such, a material vitalism that doubtless exits everywhere but is ordinarily hidden or covered, rendered unrecognizable.[2]

We see this continuous variation of matter and its hidden vitality in the asymmetry of the relations between the lanterns and human actors. Like blacksmith's metal, the lanterns are also active material in the formation of ensemble gesture "in which the materials themselves had a say."[2]

This asymmetry offers an understanding of difference within ensemble *without* falling back into categorical human/instrument dichotomies. Andrew Culp seeks to reclaim this understanding of difference from studies of complexity.[1] Culp suggests complexity bends too far the other way, towards a flat ontology which glosses difference and creates "a uniformization of diversity". In our experiments, asymmetry accounts for the continuous social, mental, and physical variation of matter which never collapses into individuals, agents, or actors. In other words, asymmetry shows difference and inhomogeneity without opposition, rendering insufficient dyadic language couplings like mind/matter, humans/objects, physical/mental, vitality/materiality. Continuous asymmetry subsumes these categories and transforms them onto non-binary, gradient spaces in which ensemble human corporeality has no privilege over matter.

The lanterns system seeks to condition our experience towards such an encounter with the material world. We sync with the swinging lanterns' rhythms, chasing after them, and gently pushing them along to keep them in motion. Unlike corporeality of the human (with its bipedal gait, anterior and posterior anatomies), the lanterns materiality affords radically different nodes of embedded rhythmic resonances. Our feet grounded, the pendant cables suspended between our moving bodies, we navigate an atmosphere filled with sonic and luminous amplifications of togetherness. Both our own fleshy scars and the wear on the lights, sockets, and cables remind us of our difference and the impossibility of some deeper humanistic connection, but they are also the very traces of these encounters, of the collisions of worlds, of the asymmetry of the human / non-human hybrid ensemble.

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