On the Topology of Coffee Spills in Zero-Gravity Seminar Rooms

Abstract

We report a controlled study of 143 accidental coffee releases aboard the orbital campus *Asterion*. Contrary to common lab folklore, spill trajectories are not random but cluster into repeatable topologies determined by mug lip geometry, speaker enthusiasm, and local fan harmonics Orbital Maintenance Archive[1].

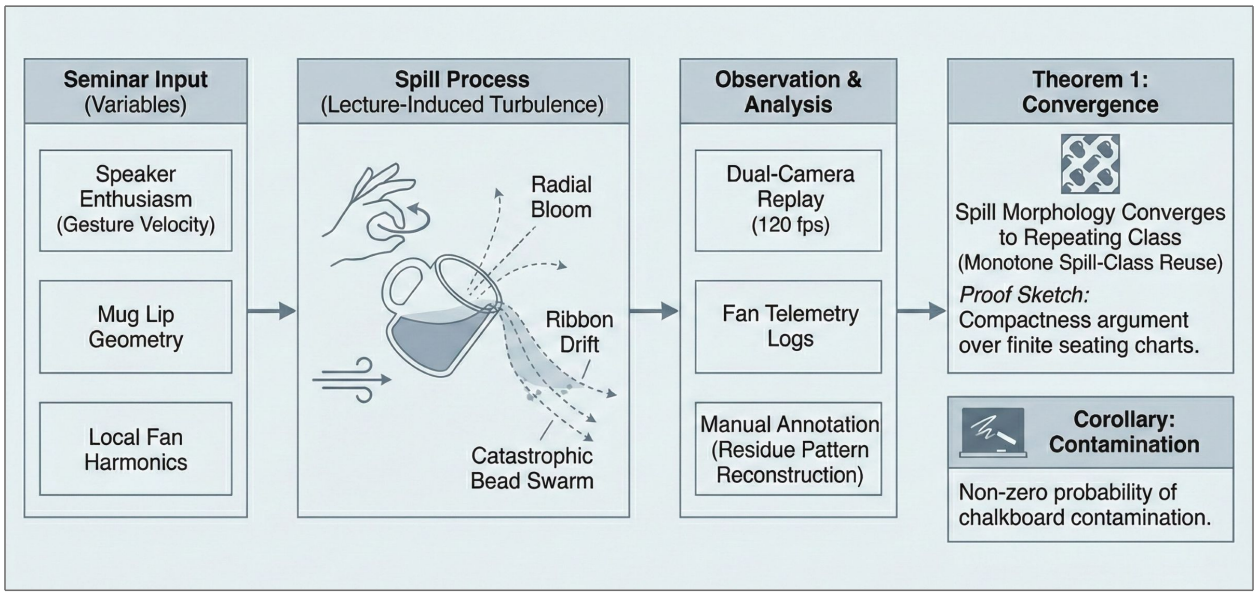

Figure 1. Spill-morphology classification framework used in the coding protocol, showing radial bloom, ribbon drift, and catastrophic bead swarm classes.

1. Background

Crew logs describe three dominant failure modes: radial bloom, ribbon drift, and catastrophic bead swarm. Existing maintenance manuals treat these events as housekeeping incidents; we model them as fluid-mechanical signatures with pedagogical consequences.

Term of art

> Lecture-induced turbulence denotes any gestural airflow that measurably alters droplet routing during explanation of a difficult theorem.

2. Methods

The observation protocol used mixed instrumentation and adjudicated notes:

- Baseline fan map captured before each seminar block.
- Dual-camera replay at 120 fps for spill onset events.
- Manual annotation by two coders plus one arbitrator.

I. Instrument calibration and mug mass normalization.

II. Controlled perturbation during topic transition.

III. Residue pattern reconstruction on wipe sheets.

Operational Tasks

[x] Attach absorbent panel grid.

[x] Sync fan telemetry logs.

[ ] Retrain presenter to avoid centrifugal chalk gestures.

Table 1. Cross-validated spill morphology metrics

The table below summarizes the most stable descriptors observed across the cohort, using variable-length entries and inline emphasis to validate alignment, wrapping, and baseline handling in academic tables.

Morphology class	Dominant driver	Diagnostic signature	Measurement protocol	Notes
Radial bloom	Uncapped double espresso at high gesture amplitude	Circular bead halo with **high edge density** and short-lived satellite droplets	Dual-camera replay + manual trace overlay (`grid-8`)	Exhibits low variance under seat swaps; consistent with oma[1].
Ribbon drift	*Lecture-induced turbulence* from lateral board sweeps	Elongated filament with asymmetric thinning, plus a brief recoil phase	120 fps replay + airflow map correction	Most sensitive to fan phase; minimum divergence at 18 degrees.

Morphology class	Dominant driver	Diagnostic signature	Measurement protocol	Notes
Catastrophic bead swarm	Sudden mug tilt beyond first slosh threshold	Multi-lobed burst, uneven bead sizes, and delayed coalescence	Three-pass adjudication + residue sheet scan	Rare, but correlates with two open cups and late Q&A.
Hybrid bloom-ribbon	Mixed gesture cadence during topic transition	Bloom core with a trailing ribbon and intermittent bead shear	Combined protocol, weighted by coder agreement	Highest annotation time; inline notes include `Asterion-RT` anomalies.

3. Core Claims

Theorem 1 (Seminar Spill Stability).
For any fixed seating topology and bounded gesture velocity, there exists a finite presentation length after which spill morphology converges to a repeating class.

Lemma 1.
If mug tilt remains below the first slosh threshold, bead trajectories remain homeomorphic under aisle-preserving seat swaps.

Proposition 2.
Introducing a second espresso cup increases radial bloom incidence unless fan phase is retuned within two minutes of opening remarks.

Corollary.
Any seminar that begins with two uncapped beverages admits a non-zero probability of chalkboard contamination before Q&A.

Proof sketch.
Couple gesture vectors with boundary-layer perturbations on cup rims; then apply a compactness argument over finite seating charts and note monotone spill-class reuse.

Remark.
Observed convergence does not imply cleanliness; it implies predictability.

Example dataset excerpt.
Session C-19, Topic: Category Theory, Presenter cadence: rapid.
Outcome: ribbon drift with delayed bead swarm near aisle marker B.

> “By week three, janitorial staff could identify the speaker from residue alone.”
>
> — Facilities Interview Log, Cycle 12

4. Discussion

Our practical recommendation is modest: treat spills as measurable output, not incidental noise. Once classified, they inform room assignment, fan presets, and lecture pacing.

References

1. Orbital Maintenance Research Archive. https://example.com/zero-g-coffee-spills