

# Designing for Cognitive Rhythm: A Three-State Model for Managing Mental Energy in Tools for Thought

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**Main theme(s):** usage strategy / design strategy / assessing and measuring outcomes / adoption

**Target domain(s):** creativity, education, programming, data analysis, decision-making, knowledge work

**Cognitive 'target(s)':** reasoning, critical thinking, reflection, sensemaking, learning, metacognition

## Type of contribution & main idea

### Theoretical framework = Design principles

A three-state model for cognitive rhythm: Diffuse (exploratory), Aggregation (structuring), Drive (focused execution). ITT should support transitions between states rather than forcing constant productivity.

### The AI tool's key characteristics

**Role:** A rhythm-aware collaborator that adapts interface and behavior based on user's cognitive state. Acts as a **thought partner** that respects cognitive cycles rather than pushing constant productivity.

#### Key design patterns:

- State Declaration:** Let users explicitly signal their current mode (e.g., "Explore / Organize / Execute"). This externalizes internal rhythm as a collaborative object.
- Friction Shaping:** Adjust interaction friction to match cognitive state:
  - Diffuse: Low friction—quick capture, weak structure, tolerance for mess
  - Aggregation: Medium friction—guided clustering, alignment prompts
  - Drive: High guardrails—protected focus, reduced distractions
- Rhythm Transitions:** Explicitly support movement between states (Diffuse—Aggregation—Drive—Diffuse), including active cooldown to prevent burnout
- Recognition Cues:** Observable signals (experience cues, interaction patterns, risk indicators) enabling the tool to support rhythm without invasive monitoring. See Table 1 in paper for detailed cues per state.

**Motivation:** The AI interface adjusts its level of guidance based on cognitive state—more freedom in Diffuse, more structure in Aggregation, more protection in Drive.

## What you would like to discuss

**State detection:** User-declared vs. tool-inferred vs. hybrid?

**Personalization:** Minimum viable personalization for cognitive rhythm?

**Preventing Drive addiction:** How to avoid reinforcing "more output = better"?

**Measurement:** Lightweight (Likert) vs. rich (diaries)—right balance?

## Interaction & outcomes

How people use and interact with the AI tool for a specific activity (first column) and what outcomes this provides, enables, or leads to (second and third column).

### Interaction design/usage strategy

The tool adapts its interface based on cognitive state:

- Diffuse mode:** Low friction—quick capture, minimal structure, tolerance for messy notes, broad browsing encouraged
- Aggregation mode:** Medium friction—guided clustering, alignment prompts, disambiguation aids, pattern highlighting
- Drive mode:** High guardrails—reduced distraction entry points, protected focus, clear boundaries, interruption recovery

### Intermediary task outcomes

State-relative intermediary outcomes:

- Diffuse:** Many fragments captured; diverse ideas collected; broad exploration completed
- Aggregation:** Patterns identified; contradictions surfaced; coherent structure emerging; notes clustered meaningfully
- Drive:** Steady progress on output; momentum maintained; interruptions recoverable

These intermediary artifacts (fragments, clusters, drafts) scaffold the thinking process and shouldn't be

### Final task outcomes

- Material outcome:** Completed artifact (report, analysis, decision) of quality
- Cognitive outcome:** Better understanding of topic; new insights gained; learning retained beyond the session
- Balanced outcome:** Both productivity AND preserved cognition—not one at the expense of the other

The AI supported the full rhythm, leading to outputs that reflect genuine thinking, not just AI-generated

## Objective value

The 'objective' quality of the process and the outcomes—i.e. what makes them 'good' or desirable (e.g. critical thinking, understanding, new insights, learning).

This rhythm-aware interaction is valuable because:

- Preserves critical thinking by not rushing past exploration
- Reduces cognitive fatigue by matching friction to state
- Prevents skill atrophy by keeping human engaged appropriately

**Can be assessed by:** Interaction logs (time in each state, transition patterns), think-aloud protocols, comparing outputs with/without rhythm support.

Intermediary outcomes are valuable because:

- Fragments in Diffuse capture ideas that might otherwise be lost
- Structure in Aggregation makes final execution more coherent
- These artifacts can be revisited and reused

**Quality indicators:** Diversity of fragments (Diffuse), coherence of structure (Aggregation), completeness of draft sections (Drive)

**Measured by:** Artifact analysis, structure quality

Final outcomes are valuable because:

- Output quality reflects genuine understanding
- Learning persists beyond the session (Learning Residue)
- User developed skills, not just received AI output

**Measured by:** Output quality ratings (blind evaluation) Delighted recall tasks (1 week post-session) Transfer tests (applying knowledge to new problems)

## Perceived value & UX

How the process of using the AI tool and its outcomes is experienced by users (e.g. how they experience the cognitive work they are doing).

Users experience the interaction as:

- "Tool" gets their current mode
- Friction feels appropriate, not annoying
- Sense of collaboration, not obstruction

**Assessed by:** Post-session Likert prompts on Rhythm Alignment ("Did the tool match your state?") and Friction Appropriateness ("Was friction just right?")

Users appreciate intermediary outcomes when:

- They see value in captured fragments
- Structure helps clarify their thinking
- Progress feels meaningful, not just busy-work

**Harder when:** Under time pressure; when short-term goals (speed) conflict with process value

**Assessed by:** In-session experience sampling, post-task reflection prompts

Users experience final outcomes as:

- "I understood this better, not just completed it"
- Sense of ownership over the output
- Reduced Cognitive Debt (less fatigue/regret)
- Recognition that AI supported but didn't replace their thinking

**Assessed by:** Post-session questionnaires on clarity, ownership, fatigue; comparing perceived value with vs. without rhythm-aware tool

## How do people's goals interact with the AI tool's goals? Is there a tension?

**(1) What are people's task-level/short-term goals?**  
Users typically want to complete tasks efficiently—write a report, finish an analysis, meet a deadline. They might ask the AI to "help me draft this quickly" or "organize these notes."

**(2) What are people's higher-level/long-term goals?**  
Beyond immediate output, users often care about learning, developing expertise, maintaining critical thinking skills, and avoiding cognitive dependency on AI. They want to grow, not just produce.

**(3) How do the goals interact? Where are the tensions?**  
The tension is that optimizing for short-term productivity (constant "Drive mode") can undermine long-term cognitive goals. A user rushing to meet a deadline may skip the exploratory Diffuse phase where deeper understanding forms. The rhythm-aware ITT introduces "beneficial friction"—slowing users down at the right moments—which may feel counterproductive initially but serves their higher-level goals. The key is making this trade-off visible and giving users agency over when to prioritize speed vs. depth.

## How do you expect people to continue using this AI tool?

Users may initially resist friction that "slows them down." To support continued use:

- Stage 1:** Users choose their mode manually—full control builds trust
- Stage 2:** Tool suggests transitions but never forces; users see value when suggestions match their experience
- Stage 3:** Teams share states as coordination signals, adding social value

**Key:** Adoption depends on preserving user agency. If the tool feels like it's "deciding for them," they'll leave.

## How to proceed with this work/idea?

**Plan:** Prototype + pilot study comparing rhythm-aware vs. standard interface

**Measure:** Likert prompts, interaction logs, diaries, delayed recall

**From workshop:** Feedback on framing + collaborators for validation

## Key references (e.g. of main theories, empirical evidence, measurement methods etc.)

- [1] Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience*. Harper & Row. — Theoretical basis for "Drive" state as focused, execution-oriented cognition.
- [2] Pinoli, P., & Card, S. (2005). The Sensemaking Process and Leverage Points for Analyst Technology. Proc. Int'l Conf. Intelligence Analysis. — "Aggregation" as sense-making process.
- [3] Sweller, J. (1988). Cognitive Load During Problem Solving: Effects on Learning. *Cognitive Science*, 12(2), 257-285. — Theoretical grounding for friction and cognitive resource management.
- [4] Horvitz, E. (1998). Principles of Mixed Initiative User Interfaces. Proc. CHI, ACM. — Balancing automation and user agency in AI tools.
- [5] Tankelevitch, L., et al. (2023). Tools for Thought: Research and Design for Understanding, Protecting, and Augmenting Human Cognition with Generative AI. CHI EA. — Direct framing of the ITT research agenda this work contributes to.