Energy as State, Not Time: Rethinking Productivity Models for Variable-Capacity Work

Dominikos Pritis
Independent Researcher
Kumbatio / entro314.labs, Athens, Greece
dominikos@kumbat.io

Preprint — DOI: 10.5281/zenodo.21915159

Abstract

Clock time is the dominant metric for measuring work, yet it is a poor proxy for productive capacity and output. This paper argues that cognitive energy—a person's variable capacity for focused, complex work at a given moment—should be modeled as explicit application state rather than inferred from time spent. We introduce a three-variable framework distinguishing Work Hours (wh), Productive Hours (ph), and Stuff Done (sd), demonstrating that the inequality $ph \leq wh$ conceals a qualitative gap that becomes especially damaging for neurodivergent workers. We propose four design requirements for energy-aware systems—user agency, transparent adaptation, non-punitive behavior, and neutral framing—and describe energy-system, a framework-agnostic library that treats cognitive capacity as first-class state. The paper concludes that the prevailing time-centric model encodes a false theory of human cognition, and that better outcomes follow from designing software and workflows that respect the variability of real capacity.

Keywords: cognitive energy, neurodivergent design, productivity, capacity-aware systems, ADHD, energy state, adaptive interfaces

1 Introduction

The dominant model of knowledge work treats time as a homogeneous, fungible resource. An hour is an hour. Eight hours constitute a workday. Productivity is measured in output per unit of time spent. Compensation, scheduling, sprint planning, and performance review all rest on the implicit assumption that more time at the desk means more and better work.

This assumption is wrong, and the wrongness is not trivial. It is structural. The assumption shapes how workplaces function, how software is designed, and how people evaluate their own worth. When time becomes the primary measure, capacity—the actual ability to do focused, meaningful work—becomes invisible.

This paper makes three claims. First, that time spent, productive capacity, and output are related but non-identical variables, and that conflating them causes measurable harm. Second, that cognitive energy—a person's available capacity for focused work at a given moment—should be treated as explicit state in software systems, not inferred indirectly from temporal or behavioral signals. Third, that the design of capacity-aware systems requires specific principles to avoid reproducing the coercion they aim to replace.

These claims arise from both personal experience and practical software design. The author lives with ADHD and depression, conditions that make the gap between time and capacity impossible to ignore. But the argument is not limited to neurodivergent populations. Cognitive variability is a human universal. What varies is the amplitude and unpredictability of the fluctuation, not its existence.

2 The Problem: Time as a Proxy for Capacity

2.1 Three Variables

We distinguish three quantities:

- Work Hours (wh): Total time a person is present, clocked in, or nominally available.
- Productive Hours (ph): The subset of work hours during which focused, goal-directed work actually occurs.
- Stuff Done (sd): Measurable output—tasks completed, code shipped, documents finished, decisions made.

The constraint is straightforward:

$$ph \leq wh \tag{1}$$

You cannot have more productive hours than hours present. But the important insight is not algebraic. It is that the gap between wh and ph is large, variable, and systematically ignored.

2.2 Illustrative Comparison

Consider two workers over a standard month:

Table 1: Comparison of two workers with identical output.

	wh	ph	Efficiency	sd	sd/ph
Person A	160	100	62.5%	10	0.10
Person B	80	75	93.75%	10	0.13

Both produce ten units of output. Person A spends twice the calendar time. Person B achieves a higher output rate per productive hour. The time-centric model sees Person A as working harder and Person B as underperforming on effort. The capacity-aware model sees Person B as working more effectively with less waste.

This is illustrative rather than statistically generalizable, but it isolates a logical point: calendar time alone does not explain meaningful output. Forcing more wh does not reliably increase ph, and may decrease it through fatigue, context switching, and the cumulative overhead of sustaining presence without capacity.

2.3 Why the Gap Matters

The gap between wh and ph is not random noise. It is shaped by cognitive, physiological, and environmental factors:

- Circadian variation: Cognitive performance fluctuates predictably across the day (Schmidt et al., 2007).
- Attention depletion: Sustained attention is a limited resource that degrades over time (Warm et al., 2008).
- Context-switching costs: Frequent task switching imposes cognitive overhead (Monsell, 2003).
- Executive function variability: For people with ADHD, executive function is highly inconsistent across time and context (Barkley, 1997).
- Depression and cognitive fog: Depression impairs concentration, decision-making, and processing speed, often unpredictably (Rock et al., 2014).

The time-centric model absorbs all of this variation into a single undifferentiated unit: the hour. A capacity-aware model treats variation as signal rather than noise.

3 Who Is Harmed Most

The argument applies to all knowledge workers, but the harm of time-centric models falls disproportionately on neurodivergent people.

3.1 ADHD and Nonlinear Capacity

ADHD is characterized by variable, context-dependent attention and executive function (Barkley, 1997). A person with ADHD may have three hours of exceptional focus followed by five hours of diffuse, unfocused effort within the same workday. Time-centric systems treat all eight hours as equivalent.

This creates a specific failure mode: the most valuable work happens in compressed, high-capacity windows that are invisible to hour-counting systems. Meanwhile, the low-capacity hours are counted as evidence of effort. ADHD workers are simultaneously undervalued (their high-output periods are unmarked) and overtaxed (their low-output periods are filled with mandatory presence).

3.2 Depression and State-Dependent Capacity

Major depression impairs cognitive function across multiple domains (Rock et al., 2014). Unlike circadian fluctuation, depressive cognitive impairment is not rhythmic or predictable. A depressed person may function at near-normal capacity on Tuesday and at near-zero capacity on Wednesday, with no external explanation.

Time-centric systems have no way to represent this. The calendar shows two identical days. The person experiences two fundamentally different cognitive states.

3.3 The Intersection

Comorbid ADHD and depression—a common combination (Kessler et al., 2006)—compounds the problem. The person faces both unpredictable energy fluctuation and state-dependent cognitive impairment, neither of which maps onto clock time. Every system that assumes uniform capacity across the workday is working against them.

4 The Thesis: Energy Should Be Modeled as State

4.1 What Energy State Means

We propose that cognitive energy should be treated as explicit, observable, persistent application state:

$$\text{EnergyState} = (\text{level}, \text{timestamp}, \text{source}, \text{revision}, \text{origin}) \tag{2}$$

Where level is the current cognitive capacity, timestamp records when it was declared, and source indicates how it was set (manual self-report, scheduled, or inferred). The remaining two fields are mechanical rather than semantic: revision is a monotonic counter that orders writes sharing a timestamp, and origin is a random identifier for the producing context, allowing concurrent writers (multiple tabs, workers, devices) to converge deterministically on the same state. Neither field encodes anything about the person.

4.2 Discrete Levels

We use five discrete levels rather than a continuous scale:

The choice of five levels over a continuous scale is deliberate. When energy is low, decision fatigue is already elevated. Discrete levels map to the categories people actually use to describe their state: “I’m sharp,” “I’m okay,” “I’m dragging,” “I’m done.”

4.3 Self-Report, Not Measurement

We reject biometric inference as the primary mechanism for determining energy state. Biometric energy detection is unreliable for individual-level cognitive state assessment (Charles and Nixon, 2019). More fundamentally, biometric inference is coercive—it removes the person’s authority over their own declared state.

Table 2: Energy levels and corresponding cognitive states.

Value	Key	Label	Cognitive State
100	peak	Peak	Complex planning, decisions, creative work
75	active	Active	Focused execution, problem-solving
50	steady	Steady	Routine tasks, familiar work
25	low	Low	Simple tasks, review, light work
0	rest	Rest	Consumption only—reading, reflecting

People generally know how they feel. A system built on self-report trusts that knowledge. A system built on inference overrides it.

4.4 Adaptation Through Strategies

The energy state itself does not dictate behavior. Consuming applications define strategies—pure functions that map energy levels to configuration changes. The separation between state and strategy is essential. It prevents the system from becoming a behavior-enforcement tool.

5 Design Requirements

Four principles govern the design of capacity-aware systems:

5.1 User Agency

The user must be able to override the system easily and at any time, with no negative consequences.

5.2 Transparent Adaptation

When the interface changes, the user must understand why. Transparency preserves trust.

5.3 Non-Punitive Behavior

Reducing friction at lower energy levels is acceptable. Removing critical capability is not. Over-hiding controls at low energy creates a “locked out when I need help most” failure mode.

5.4 Neutral Framing

Energy level is context, not identity. Low energy is not failure. Shame-based framing amplifies the psychological burden that the system is designed to relieve.

6 Implementation

We have implemented these principles in energy-system, a framework-agnostic TypeScript library published as @kumbatio/energy-system. The library provides a core EnergyEngine; built-in adaptation strategies for interface visibility, notification gating, task complexity, interaction forgiveness (undo windows, destructive-action confirmation, autosave cadence), and automation autonomy; presence annotations that declare which energy levels an interface element belongs to; focus sessions with notification deferral; a pluggable persistence interface with cross-context state reconciliation; a published JSON Schema for the state interchange format; and DOM integration, React bindings, and reference CSS. It does not assume a particular UI framework, runtime environment, or application category.

7 Related Work

Adaptive user interfaces adapt to user skill level or device constraints (Brusilovsky, 2001). Energy-state adaptation differs by modeling a transient cognitive variable.

Affective computing attempts to detect emotional or cognitive states through sensors (Picard, 1997). Our approach rejects automated inference in favor of self-report.

Accessibility and cognitive load research establishes that reducing interface complexity benefits users with cognitive disabilities (Friedman and Bryen, 2007). Energy-state adaptation makes this dynamic and user-controlled.

Neurodivergent design advocates for interfaces that accommodate ADHD, autism, and related conditions (Spiel et al., 2022). Our work contributes a specific mechanism and implementation.

8 Limitations and Future Work

This paper presents a conceptual framework and implementation, not empirical validation. Validation requires tracking override frequency, session continuation rates, latency to first meaningful action, and longitudinal energy patterns. Open questions include multi-domain energy, team-level aggregation, and the interaction between scheduled patterns and real-time self-report.

9 Conclusion

Time is real but insufficient. An hour is not an equal unit of human work just because the clock says it is. The wh/ph/sd framework makes this visible. The energy-state model makes it actionable. The design principles—agency, transparency, non-punitive adaptation, neutral framing—make it humane.

We are not arguing that people should do less because they are fragile. We are arguing that work becomes more honest, more effective, and more sustainable when systems stop pretending that all hours are equal. Tools should adapt to people. Not the other way around.

References

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. Psychological Bulletin, 121(1):65–94.

Brusilovsky, P. (2001). Adaptive hypermedia. User Modeling and User-Adapted Interaction, 11(1):87–110.

Charles, R. L. and Nixon, J. (2019). Measuring mental workload using physiological measures: A systematic review. Applied Ergonomics, 74:221–232.

Friedman, M. G. and Bryen, D. N. (2007). Web accessibility design recommendations for people with cognitive disabilities. Technology and Disability, 19(4):205–212.

Kessler, R. C., Adler, L., Barkley, R., et al. (2006). The prevalence and correlates of adult ADHD in the United States. American Journal of Psychiatry, 163(4):716–723.

Monsell, S. (2003). Task switching. Trends in Cognitive Sciences, 7(3):134–140.

Picard, R. W. (1997). Affective Computing. MIT Press.

Rock, P. L., Roiser, J. P., Riedel, W. J., and Blackwell, A. D. (2014). Cognitive impairment in depression: A systematic review and meta-analysis. Psychological Medicine, 44(10):2029–2040.

Schmidt, C., Collette, F., Cajochen, C., and Peigneux, P. (2007). A time to think: Circadian rhythms in human cognition. Cognitive Neuropsychology, 24(7):755–789.

Spiel, K., Hornecker, E., Williams, R. M., and Good, J. (2022). ADHD and technology research—investigated by neurodivergent readers. In Proceedings of the CHI Conference on Human Factors in Computing Systems (CHI '22). ACM.

Warm, J. S., Parasuraman, R., and Dember, W. N. (2008). Vigilance requires hard mental work and is stressful. Human Factors, 50(3):433–441.