Integrating System Dynamics Principles into Large Language Model-Assisted CEO Decision Support: A Framework for Strategic Transition Management

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Abstract

Despite substantial investments in strategic planning, empirical research consistently documents failure rates of 40% to 70% for strategic initiatives [1][2]. This paper argues that executive decision-making remains constrained by **LESR thinking**—Linear, Episodic, Static, and Reductionist cognitive frameworks [3][4]—which systematically overlook feedback loops, delays, and systemic interdependencies that shape organizational outcomes. We propose that **System Dynamics (SD)**, augmented by **Large Language Models (LLMs)**, provides CEOs with a practical framework for managing dynamic strategic transitions. Drawing on Forrester's foundational work on counterintuitive social system behavior [5], Sterman's analysis of learning in complex systems [6], and Teece's dynamic capabilities framework [7][8], we develop a **Digital Twin-based strategic architecture** supported by SD-informed staff teams and LLM-enhanced scenario generation. The paper introduces institutional mechanisms including the **weekly "Friday Reflection"** practice and a **Thriving & Flourishing Strategic Dashboard** with leading indicators for dynamic ROI gaps, organizational unlearning velocity, and capability erosion metrics. We conclude that integrating SD and AI as complementary tools can significantly enhance executive decision-making by revealing hidden structures, managing transition dynamics, and safeguarding long-term organizational capability [9][10].

Keywords: System Dynamics, Large Language Models, Strategic Decision-Making, Executive Leadership, Digital Twin, Organizational Capability, Dynamic Capabilities

1. Introduction and Motivation

1.1 The Strategy Implementation Gap

The persistent gap between strategic intent and realized outcomes represents one of the most significant challenges in contemporary management. Cândido and Santos's comprehensive review documents that between 40% and 70% of strategic initiatives fail to achieve intended objectives, with implementation obstacles including resistance to change, inadequate resource allocation, and misalignment between strategy and organizational capabilities [1][2]. This failure rate is particularly pronounced in complex transformation contexts such as AI-driven initiatives and corporate mergers, where boards frequently approve business cases that subsequently dissolve under operational complexity and human resistance [11][12].

1.2 The LESR Thinking Trap

A central explanatory factor for implementation failures is the dominance of **LESR thinking** in executive decision-making—cognitive patterns that are Linear, Episodic, Static, and Reductionist [3][4]. Sterman's seminal analysis demonstrates that human decision-makers systematically misperceive feedback in dynamic systems, leading to "policy resistance" where interventions produce unintended consequences [6]. LESR manifests through:

- **Linearity**: Assuming proportional cause-effect relationships while overlooking reinforcing and balancing feedback loops [6][13]
- **Episodicity**: Treating problems as isolated events rather than manifestations of underlying structure [5][14]
- **Static framing**: Relying on snapshot analyses rather than monitoring stocks, flows, and trajectories over time [15][16]
- **Reductionism**: Decomposing systems into components such that emergent properties and interconnections are lost [17][18]

Such framing "stifles critical thinking" by obscuring the "slips between the cup and the lip" where strategies derail: adoption delays, quality erosion, talent attrition, and trust breakdowns [6][19].

1.3 The Opportunity: SD-Augmented by LLMs

System Dynamics offers a structured methodology for moving from static planning to dynamic transition management [20][21]. Meanwhile, LLMs provide new capabilities for scenario exploration, knowledge synthesis, and narrative interpretation [22][23]. This paper argues for upskilling CEOs and C-suite teams to utilize SD—supported by AI/LLMs—as a core strategic toolkit rather than a technical add-on or outsourced "black box" [9][24].

2. From LESR Thinking to Systemic Strategy

2.1 System Dynamics as a CEO Capability

System Dynamics reframes strategy as the design and management of **underlying subtle structure**: the feedback loops, accumulations, and delays that generate observed performance [5][20]. For CEOs, SD functions as a **visual and narrative language** that connects disparate initiatives into coherent dynamic maps, makes time delays and worse-before-better dynamics explicit, and surfaces where intuitive solutions trigger counterintuitive long-term damage [6][25].

Mintzberg's distinction between intended and realized strategy underscores this need: the "real" strategy emerges through learning, politics, and adaptation over time—elements that SD explicitly incorporates [26][27]. The methodology enables executives to navigate what Forrester termed the "counterintuitive behavior of social systems," where well-intentioned interventions generate unexpected outcomes through feedback dynamics [5][28].

2.2 The Role of Dynamic Capabilities

Teece, Pisano, and Shuen's dynamic capabilities framework provides theoretical grounding for SD application in strategic management [7][8]. Dynamic capabilities—**sensing** opportunities and threats, **seizing** through strategic action, and **transforming** through continuous renewal—require exactly the feedback-oriented, time-sensitive understanding that SD provides [29][30].

Organizations that develop these higher-order capabilities can adapt their resource base to maintain competitive advantage in volatile environments [25][31].

3. The AI-Merger Trap: A System Dynamics Case

3.1 Strategic Context

Consider a CEO leading a major merger with aggressive AI integration targets. Traditional business cases assume smooth adoption curves and deterministic cost savings; in reality, an **Unlearning Phase** occurs where productivity drops before new practices stabilize [32][33]. This phenomenon—well-documented in organizational learning research—represents a critical transition dynamic that linear planning fails to anticipate [34][35].

3.2 Critical Feedback Loops

The AI-merger context reveals two essential feedback structures [11][36]:

Loop A—The Productivity Mirage (Balancing): Rapid AI rollout yields visible early automation gains, encouraging accelerated deployment. However, when rollout speed exceeds staff capacity to unlearn legacy methods, bottlenecks and errors accumulate, triggering corrective slowdowns and rework costs [6][37].

Loop B—Capability Erosion (Reinforcing): High pressure and inadequate support increase staff anxiety, driving attrition among knowledge holders from the acquired firm. As **Organizational Capability** (a stock) erodes, the organization becomes more fragile, increasing reliance on AI outputs it can no longer critically evaluate, amplifying failure risks [38][39].

These dynamics illustrate Forrester's foundational insight: interventions optimizing short-term efficiency can generate long-run fragility and order-of-magnitude cost increases through feedback effects [5][40].

3.3 SD vs. LESR Framing

Traditional board presentations depict AI integration as linear milestone charts with deterministic benefits. An SD-based **Digital Twin** instead reveals [41][42]:

- The duration and depth of worse-before-better performance dips
- Thresholds beyond which capability loss becomes irrecoverable
- Sensitivity of outcomes to "soft" variables: trust, learning speed, psychological safety [6][43].

This reframes success from "Did we hit Year-1 savings?" to "Have we preserved and grown the system's capacity to thrive over 5–10 years?" [44][45]

Traditional analytical (LESR) thinking — are effective at describing *what* is happening within a system, but fundamentally inadequate for explaining *why* persistent patterns of behavior recur [90] By assuming proportionate causality, treating events as discrete occurrences, and decomposing wholes into isolated parts, LESR approaches systematically obscure the feedback structures — the stocks, flows, reinforcing and balancing loops, and time delays — that are the true generators of system behavior [89] and [65]. This distinction carries profound practical consequences: interventions designed on the basis of descriptive, event-level analysis frequently produce "fixes that fail," temporarily alleviating symptoms while reinforcing the underlying structural dynamics that caused them [64]. Meaningful and durable change, by contrast, requires structural understanding — an appreciation of why a system behaves as it does across time — and this is precisely the epistemological contribution of System Dynamics, which reframes analysis around causal feedback architecture rather than observable events,

thereby revealing the high-leverage intervention points that LESR thinking, by its nature, cannot access [90] and [65].

4. The Digital Twin and Staffer Support Architecture

4.1 Role Differentiation

The CEO's primary function is **Leader Integrator**, orchestrating cross-functional coherence rather than building models personally [9][46]. A **Staffer Support Team**—fluent in SD and AI—serves as the bridge between strategic questions and dynamic analysis by [24][47]:

- Translating board-level concerns into SD structures (stocks, flows, feedback)
- Utilizing LLMs to draft causal hypotheses, synthesize research, and generate scenario narratives [22][48]
- Maintaining and updating the Digital Twin as reality unfolds

This division prevents CEO entanglement in technical detail while ensuring modeling remains anchored to strategic intent [49][50].

4.2 Digital Twin Architecture

A practical Digital Twin for AI-merger contexts comprises four core elements [41][51]:

1. **Stock**: Organizational Capability (knowledge, culture, relationships) [38][52]
2. **Flow**: AI-Driven Transformation Rate (pace of process, data, role changes) [53][54]
3. **Converter**: Staff Anxiety/Resistance (shaping capability-to-value conversion) [6][55]
4. **Result**: Realized Synergy Value (actual, not projected, financial outcomes) [11][56]

LLMs function as **cognitive amplifiers**: generating alternative policies, surfacing overlooked interactions from text data, and creating narrative outputs for C-suite and board consumption—always grounded in the SD model rather than replacing it [22][57].

5. The Friday Reflection: Institutionalizing Systemic Learning

5.1 Creating "Sanctified Space" for Feedback Thinking

To transform SD from a consulting tool into a leadership practice, we propose the **weekly Friday Reflection**: a one-hour, no-PowerPoint session anchored by narrative memo and live Digital Twin review [9][58]. The format comprises:

- **15 minutes**: Silent reading of a memo framing one strategic issue through feedback and time delays [59][60]
- **45 minutes**: Facilitated loop thinking using the Digital Twin, exploring "What-If" scenarios and side effects [6][61]

The guiding question shifts from "What are we doing?" (tasks) to "Why is the system reacting this way?" (structure) [6][62].

5.2 Phased Digital Twin Engagement

The reflection process unfolds across three phases [9][63]:

Phase 1—Identifying Subtle Structure: TMT examines rollout plans, identifying where linear assumptions obscure feedback (e.g., ignoring trust-building time for AI adoption) [6][64].

Phase 2—Unscrambling the Productivity Paradox: Leaders distinguish healthy learning dips from structural change rejection, assessing "social cost" by identifying irreplaceable knowledge holders [6][65].

Phase 3—The 10x Financial Critique: Scenarios quantify technical debt (poorly integrated AI) and cultural debt (lost talent), comparing short-term savings with long-term market cap erosion [5][66].

This routine progressively upgrades TMT mental models, ensuring SD and LLM analysis feed directly into recurring decisions [6][67].

6. Metrics for Thriving and Flourishing

6.1 From Lagging to Leading Indicators

The proposed **Thriving & Flourishing Strategic Dashboard** replaces backward-looking KPIs with leading indicators aligned with SD structure [68][69]:

- **Dynamic ROI Gap** (Financial): Divergence between promised AI/merger savings and realized outcomes after rework, signaling over-automation traps [6][70]
- **Organizational Unlearning Velocity** (Human): Speed of staff transition to AI-augmented roles without sustained psychological safety degradation—drawing on Sterman's work on learning delays and the productivity paradox [6][71]
- **Algorithm Trust Score** (AI): Frequency and patterns of human AI overrides, indicating model-reality misalignment [72][73]
- **Technical & Cultural Debt Accumulation** (Risk): Projected 3–5-year costs of system rework and talent replacement—making the "10x cost trap" visible financially [5][74]

These indicators reposition "soft" cultural dynamics as quantifiable risk drivers in board discourse [9][75].

6.2 LLM-Enhanced Dashboard Intelligence

LLMs integrate to [22][76]:

- Generate concise, plain-language trend interpretations for directors
- Draft alternative policy narratives ("If we slow AI rollout 15% and increase training by X, capability erosion decreases by Y")
- Continuously mine internal text (surveys, incidents, exit interviews) to refine anxiety, trust, and unlearning assumptions [77][78]

This transforms the dashboard from static artifact to living interface between data, structure, and executive sense-making [41][79].

7. Rules of Engagement for C-Suite Adoption

To secure and sustain CEO attention, SD-plus-LLM offerings must adhere to clear principles [9][80]:

- **Avoid Jargon**: Employ strategy language, not technical SD or ML terminology; speak in terms of risks, optionality, and legacy [6][81]
- **Demonstrate Early Value**: Begin with one visible, high-stakes problem and deliver a small, credible Digital Twin win [49][82]
- **Visual and Monetary Anchoring**: Ground discussions in simple causal diagrams and 5-year financial horizons, including social and capability costs [5][83]
- **Political Protection**: Ensure senior "Champion" shields counterintuitive findings from dismissal when challenging prior commitments [1][84]

Supporting scholarship—including Mazzucato and Colamarino's critique of consulting "solutionism," critical management studies on corporate deception, and Forrester's and Sterman's foundational SD research—strengthens the case for internalizing these capabilities rather than outsourcing them [85][86].

8. Conclusion and Implications

The central proposition of this paper is that **strategy is not a snapshot but the management of transitions** [26][87]. CEOs must be upskilled to see, simulate, and steward these transitions using System Dynamics, augmented—not replaced—by LLMs. By institutionalizing practices like the Friday Reflection, empowering Staffer Support Teams, and building robust Digital Twins with Thriving & Flourishing dashboards, boards and C-suites can move from "fudge factors" and luck to disciplined, dynamic strategy practice [9][88].

The integration of SD and AI represents more than technological adoption; it constitutes a fundamental shift in how executives conceptualize their relationship with organizational complexity. As Teece's dynamic capabilities framework suggests, sustained competitive advantage accrues to organizations that can sense, seize, and transform—capabilities that SD

explicitly cultivates [7][29]. The future of strategic leadership belongs to those who can navigate feedback, embrace delay, and think in systems.

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