# Visual Enterprise Management: Strengthening C-Level Understanding via Spatial and Narrative Data Experiences

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**Abstract.** Modern enterprises generate large volumes of operational data, yet senior decision-makers often rely on static reports, slide decks, and specialist dashboards that can fragment organizational understanding. This paper proposes Visual Enterprise Management (VEM), an early-stage conceptual framework for representing enterprise information through spatial, interactive, and narrative data experiences.
Drawing on sensemaking theory, cognitive load theory, multimedia learning, and human-computer interaction, the paper argues that visual structure, progressive disclosure, and user-controlled exploration can support executive comprehension of complex organizational dependencies. VEM is positioned between analytical dashboard overload and visually rich but low-information simulation interfaces. The paper defines the conceptual problem, outlines theoretical foundations, identifies AI-supported functions, and proposes research questions for later design-science prototyping and evaluation.

**Keywords:** spatial visualization, interactive sensemaking, situation awareness, decision support

## 1 Introduction

A senior executive is responsible for the behavior of an organization whose internal dependencies are only partially visible. Supply timing, project risk, and customer churn evolve across different departments. Each department usually reports its own view through its own tools. By the time these views reach the top of the organization, they have often been flattened into PowerPoint slides, summarized in email, or displayed on dashboards. Although these dashboards are deemed useful within the department, they are configured for the specialists who maintain them, not for strategic decision makers. The result is fragmentation; two executives may discuss the same quarter, while relying on different partial representations of what is happening.

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Data availability alone is no longer sufficient. Enterprises collect more data than many leadership teams can interpret effectively. The difficulty is closer to a sensemaking problem. Weick, Sutcliffe, and Obstfeld describe sensemaking as the process through which ambiguous circumstances are turned into situations that can be named and acted upon [1]. For executives, this goes beyond the retrieval of indicators. They need a shared interpretation of how the moving parts of the organization relate to each other. Moving parts in this case can be market signals, resource constraints, or emerging risks.

Current enterprise tools unevenly support executive sensemaking. Dashboards work well when the question is already known, but are weaker when leaders need to notice unexpected dependencies, such as emerging risks or tensions across functions. Static reports can document a situation, but they do not easily support exploration, comparison, or progressive movement between the whole system and its parts.

In this paper, VEM is defined as an interactive representation of the state, dependencies, risks, and scenarios of the enterprise facing the executives. It combines spatial abstraction, progressive disclosure, narrative explanation, and AI-supported querying to help leadership teams examine how organizational elements relate to one another.

This paper is exploratory; no complete VEM system has been built or evaluated. Its contribution is conceptual. It defines the problem, identifies theoretical foundations, and sets out research questions for later design-oriented work.

## 2 Cognitive Foundations

Paivio's dual coding theory proposes that people encode information through partly independent verbal and nonverbal systems. Information represented through both channels can be recalled more reliably than information represented through one channel alone [2]. Sweller's cognitive load theory emphasizes the limits of working memory [3]. Comprehension becomes harder when a presentation forces the viewer to hold many disconnected elements in mind. This is a common problem in tables, dense reports, and dashboards that distribute related information between separate panels.

A well-formed visual representation can reduce this burden by embedding relationships in the display itself. Proximity, direction, size, and color can show relationships that would otherwise have to be reconstructed mentally. For executives working under time pressure, this can make connections, concentrations, and risk groups easier to perceive.

Mayer's research on multimedia learning adds an important condition: the combination of words and visuals helps when it manages cognitive load rather than increasing it [4]. It is important to note that visuals do not automatically improve understanding. A decorative image, a crowded diagram, or a poorly executed visual interface can make comprehension worse. For VEM, this implies that visual design must remain responsible for interpretation. Every visible ele-

ment should either represent a meaningful property of the enterprise or support the user's orientation within the system.

Retention is also relevant. Visual communication can heavily influence later recall [5]. A persistent visual representation may support both immediate comprehension and subsequent discussion, especially when it becomes a shared reference point for the leadership team.

## 3 Interactivity and Exploratory Sensemaking

Static visualizations can improve text when the underlying structure is spatial, relational, or comparative. They still have a central limitation: the viewer cannot control the flow of information. Reports and charts usually present information in a fixed form. They determine the sequence, the selected view, and the level of detail before the user begins reading. Dashboards may offer filters, but they often still assume that the user already knows which variables, periods, or comparisons matter.

*User-controlled exploration.* Interactivity changes the relationship between the user and the information. It allows the viewer to adjust the pace, direction, and level of detail. This is important when the user is building an interpretation rather than confirming a known hypothesis. In executive contexts, the question is often not only whether a metric changed but also why the change matters and how it connects to other parts of the organization.

Educational research supports the value of controlled exploration. Merkt et al. found that interactive video can improve learning outcomes when users can pause, rewind, and control progression [6]. Rop et al. reported related effects in learning from diagrams, where pacing and layout influenced the effectiveness with which learners processed information [7]. These findings cannot be transferred directly to executive decision-making without empirical testing, but they support a general design principle: users benefit when they can regulate the delivery of information in relation to their current understanding.

*Macro views and group sensemaking.* For enterprise visualization, the above suggests a macro view with a deeper inspection where attention is directed. Details remain available but are not visible all the time. The user first perceives the whole, then explores relevant parts, and opens the underlying data when needed.

Interactivity can also support group decision making. Executive teams discuss, challenge, and negotiate interpretations. A shared representation gives participants a common reference for testing scenarios and tracing how local changes may propagate.

## 4 Design positioning

*Two failure modes.* VEM is partly defined by two design failure modes it seeks to avoid. These modes appear in different parts of current practice and create opposite problems for executive users.

The first is the analytical dashboard. Modern business-intelligence tools are precise and useful for domain experts. Among many features, they support filtering, comparison, and quantitative monitoring. Their limitations appear when they are used as the primary interface for senior leadership. A human-resources dashboard may show hiring counts and demographic segments on several linked charts. This may be useful for an HR analyst, but for a CEO, the same view can be too detailed and too dependent on domain knowledge. The dashboard answers local numerical questions, while the executive may need to understand cross-domain effects and decide where attention is needed.

The second failure mode is the cinema inspired interface. Digital twins and visually rich simulations can represent physical or operational environments in great detail. In some engineering contexts, this detail is valuable. At the executive level, excessive fidelity can reduce readability. Film-inspired interfaces fail in another way: they may look sophisticated while conveying little or no verifiable information. Their design goal is often spectacle rather than interpretation.

*VEM's middle position.* VEM is positioned between these two modes. It needs enough visual richness to sustain attention but enough abstraction to remain readable at enterprise scale. It also needs informational honesty: each visual element should correspond to a real data relation, state, or uncertainty. This balance can be difficult to achieve. Analytical tools tend to accumulate detail because detail feels rigorous. Cinematic interfaces tend to add spectacle because great visuals are persuasive in a demonstration. VEM treats readability, abstraction, and informational honesty as design constraints rather than aesthetic preferences.

## 5 Real-Time Spatial Systems as a Technical Reference

The cognitive and interaction requirements discussed above imply the need for systems that can represent complexity spatially, support progressive disclosure, and respond to user exploration in real time. Several technical components relevant to such systems already exist in adjacent domains. Many have matured in the video game industry, which has spent decades building real-time interactive environments for non-technical users. Games routinely present complex systems through spatial layout, progressive disclosure, feedback, and interaction. These capabilities are relevant to enterprise visualization, although their purpose must be redirected.

Real-time rendering and spatial data processing are the clearest technical references. Game engines already display large navigable environments at interactive frame rates while also managing scale and user orientation. These techniques

are relevant to representations of facilities, supply networks, and market regions. Massively multiplayer games also show that many changing states can be managed in a shared environment, although enterprise modeling requires different assumptions and validation.

Game AI provides further transferable ideas. Pathfinding, behavior modeling, anomaly detection, and pattern recognition have all been used in interactive systems. In enterprise contexts, similar methods can help detect unusual flows, changing dependencies, or behavior that diverges from expected patterns. For example, methods used to detect cheating activity in online environments can be conceptually related to detecting unusual operational or financial patterns in business systems.

VEM does not require enterprise visualization to invent real-time graphics, interaction design, or AI-assisted pattern recognition from the start. It asks how established techniques can be configured for a different audience and purpose: executive sensemaking rather than entertainment.

## 6 AI Support for Enterprise Sensemaking

Artificial intelligence plays a supporting role in VEM. It does not replace executive judgment or function as an unquestioned source of truth. Its value lies in helping users access, organize, and interpret complex system representations.

The first use is natural-language querying. A senior leader should be able to reshape the view by asking a question rather than translating an intention into a query language. A request such as "show where margin is declining" or "highlight regions exposed to this supplier" should become an interaction with the visual environment. Natural language can also support the narrative layer by producing short explanations of why a pattern is visible and which dependencies contribute to it. This keeps the non-technical user close to the question, while reducing dependence on a specialist intermediary.

The second use is attention guidance. Models of normal business behavior can be used to highlight areas that diverge from expected patterns. This connects to Endsley's model of situation awareness, which separates three activities: noticing relevant elements, understanding what they mean, and projecting how they may develop [8]. AI assistance can support the first level by helping the user notice changes that would otherwise remain buried. The user can then focus on comprehension and projection.

The third use is intelligent cross-sectioning. Enterprises are often divided according to reporting lines, but relevant patterns can cross those lines. AI methods may help identify groupings, correlations, or dependencies that do not match the formal organizational chart. This could reveal hidden value streams, shared bottlenecks, or cross-functional exposure.

The fourth use is predictive cascading. In a more mature system, AI could support scenario exploration by estimating how stress can propagate through dependencies. This should be presented as a model-based projection with un-

certainty, not as a definitive prediction. In strategic contexts, the purpose is to improve understanding of possible paths not to automate the decision.

Across these uses, AI should improve what leaders can notice and explore. It should remain subordinate to human judgment, especially because many executive decisions involve values, priorities, and trade-offs that cannot be reduced to optimization.

## 7 Design Tensions in VEM

VEM is shaped by several design tensions. These tensions synthesize the preceding sections. They define what later prototypes must balance during design, implementation, and evaluation.

The first tension concerns abstraction and detail. As discussed in the design-positioning section, VEM should operate mainly at the macro level. It should show enterprise-wide structures, dependencies, and states without recreating operational dashboards. Too much detail makes the view difficult to read, and too little detail reduces it to a decorative overview.

The second tension concerns exploration versus prescription. As discussed in relation to AI support, VEM should support judgment and discussion. It should not push leaders toward a single system-generated conclusion. This matters because executive sensemaking often depends on plausibility, shared interpretation, and action under uncertainty [1]. Many strategic problems also resemble wicked problems. They resist fixed definition and do not have true-or-false solutions [9].

The third tension concerns attention guidance and manipulation. A visual system must guide attention because presenting all information with equal emphasis creates overload. At the same time, users must be able to see why their attention is being directed to a specific element. If the system highlights a region, dependency, or risk, users should be able to inspect why it was highlighted. This is especially relevant when AI-assisted methods are involved. The ranking, warning, and recommendation mechanisms shape the interpretation before users examine the evidence.

The fourth tension concerns appeal and informational honesty. Visual appeal can influence adoption, credibility, and willingness to engage [10]. However, appeal must not come from decorative complexity. It should come from clarity, responsiveness, and a meaningful information density. For VEM, each visual element should remain traceable to a real data relation, state, or uncertainty. The interface should also remain usable enough for senior decision-makers to adopt.

The fifth tension concerns shared representation and role-specific interpretation. As discussed in relation to group sensemaking, a CEO, CFO, and COO may need to look at the same organizational structure while asking different questions. VEM should support a common visual reference without erasing functional differences.

These tensions suggest five design constraints for VEM. Abstraction must preserve meaning. Exploration must remain open rather than prescriptive. Users must be able to understand why attention cues appear. Visual appeal must

remain tied to informational honesty. Shared representations must allow for role-specific exploration. These constraints should be treated as provisional until they are evaluated through prototypes and executive sensemaking tasks.

## 8 Research Questions

Three research questions guide the next stage of the work.

- To what extent can a shared spatial representation improve alignment in executive interpretation compared to conventional reports or dashboards?
- How do abstraction, visual emphasis, spatial layout, and progressive disclosure affect what executives notice, prioritize, and discuss during sensemaking tasks?
- How can VEM balance attention guidance and user exploration without becoming overly prescriptive?
- Can exploratory scenario visualization improve executive comprehension of risk exposure, dependency, and system fragility?

*Research Methodology.* A design-oriented research approach is appropriate because the work aims to create and evaluate an artifact for a real organizational problem. Research should therefore proceed through iterative building, demonstration, and evaluation [11]. Early prototypes can test whether users understand the representation. Later prototypes can examine whether group discussion, alignment, and decision support improve compared to conventional reports or dashboards.

Evaluation could begin with comprehension tasks and executive interviews. The scenario workshops could then test how leadership teams use VEM during the discussion. Comparisons with existing reporting formats would show whether VEM changes what users understand and remember. The methodology remains open. If VEM is intended to support executive sensemaking, it should be tested for comprehension, alignment, and interpretation.

## 9 Conclusion

Executives often manage organizational systems they cannot fully see. Current enterprise tools provide valuable data, but tend to separate events from their wider context and fragment how leadership teams interpret the same situation. Visual Enterprise Management names a conceptual space between analytical dashboard overload and low-information cinematic visualization. It proposes a shared enterprise representation that is readable at scale, visually engaging, and grounded in real data relations.

The proposed framework is early and untested. Its value lies in defining the problem and setting up future empirical work. The next step is to build a VEM artifact and compare it with existing executive communication formats. The central question is whether a shared visual representation can improve how leadership teams see, discuss, and interpret complex organizational systems.

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