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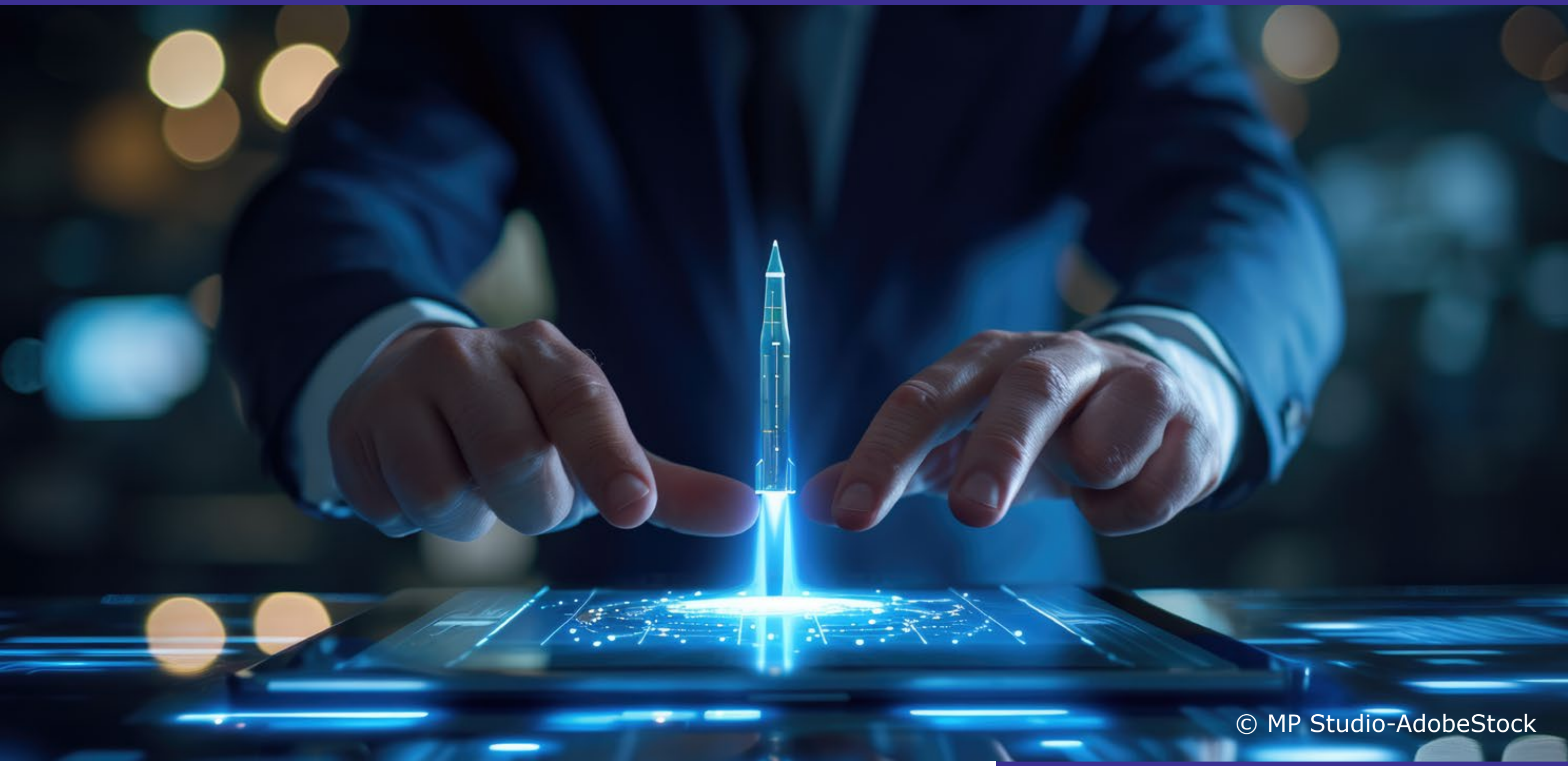

LIGHTS - Innovation/Entrepreneurship

Navigating the vision-reality gap in technological transitions: A socio-cognitive analysis of the autonomous vehicle industry

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Navigating the vision-reality gap in technological transitions: A socio-cognitive analysis of the autonomous vehicle industry

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Abstract

This paper explores the evolution of the autonomous vehicle (AV) industry through the lens of the vision-reality gap—the perceived divide between distant technological aspirations and present feasibility. Drawing on socio-cognitive theories and temporal construal frameworks, it traces five key phases in AV development: early military incubation, mobilization through DARPA competitions, hype following Google's initiatives, strategic recalibration after the 2018 Uber accident, and recent disillusionment. Using historical analysis and archival data, the study shows how fluctuating expectations shaped investments, business models, and field-level legitimacy. While early visions galvanized action, growing obstacles—technical, institutional, and political—led firms to shift focus to near-term, lower-level autonomy. The paper contributes a phase-based model of vision-reality dynamics, offering insights into how deep tech fields evolve through cycles of excitement and retrenchment. It highlights the need for strategic vision management that balances long-term ambition with practical, incremental goals.

Keywords: technology evolution, autonomous vehicles, vision, socio-cognitive view, hype

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Introduction

Technological transitions, particularly in "deep tech" domains like robotics and autonomous vehicles (AVs), often unfold through cycles of enthusiasm and disillusionment. These cycles are shaped not only by technical and economic realities but also by how actors imagine, articulate, and act upon the future. Drawing on socio-cognitive perspectives of technological evolution (Garud et al., 2014; Rindova & Martins, 2022), this paper investigates how the autonomous vehicle industry has navigated the fluctuating gap between a distant vision and near-term goals. By reconstructing the industry's historical trajectory through archival data and prior fieldwork on robotics, this study advances our understanding of how imagined futures shape, and are reshaped by, evolving technological, organizational, and institutional dynamics.

Theoretical background: socio-cognitive approaches to technological evolution

Recent scholarship emphasizes the role of imagined futures in shaping technological and organizational fields (Beckert, 2016; Augustine et al., 2019). Socio-cognitive perspectives suggest that technology development is not merely reactive to existing problems but also guided by visions of what is possible and desirable. Two cognitive processes are particularly relevant: forward-looking imagination and backward-looking interpretation. Forward-looking cognition enables actors to envision a plausible future and strategically work backward to build paths toward it (Beckert, 2016). Backward-looking cognition involves interpreting existing technologies and projecting future trajectories based on past and present developments (Kaplan & Tripsas, 2008).

Temporal construal theory (Trope & Liberman, 2003; Carton, 2018) offers a framework to distinguish between distant and near-term goals. Distant visions are abstract, inspiring, and open-ended, while near-term goals are specific, concrete, and time-constrained. These levels are temporally and hierarchically interconnected; however, the tension between them often leads to vision-reality gaps—disparities between imagined futures and what is currently technologically feasible or commercially viable.

Conceptual framework: the vision-reality gap and temporal dynamics

This study builds on the concept of "vision-reality gap" (Chang-Zunino, 2023; Rindova & Martins, 2022), defined as the perceived temporal distance between a technological vision and the present state of development. The paper proposes a phase-based model capturing the dynamics of this gap across four key phases: (1) mobilization around a vision, (2) narrowing of the vision-reality gap and emergence of hype, (3) widening of the gap and search for goals, and (4) disillusionment and potential revival of the vision. These phases reflect patterns of convergence and divergence between the distant and near-term visions, shaping field-level coordination, investment, and legitimacy.

Empirical context: the autonomous vehicle industry

The AV industry presents a compelling empirical setting to study the vision-reality gap due to its dramatic shifts in expectations, investment, and strategy. The industry's evolution has been reconstructed using over 1,000 media articles from Factiva, drawing on historical insights from the broader robotics field.

Phase 0: distant vision and incubation (1983-2004)

The AV vision originated in the early 1980s under the U.S. Department of Defense's Strategic Computing Initiative. A key project, the Autonomous Land Vehicle (ALV), aimed to revolutionize warfare through intelligent machines. However, these early autonomous vehicles were not at all practical: they moved at extremely an slow speed—around 5 km/h—and lacked the computing power to process environmental data in real-time. The broader AI community also faced growing skepticism, as the promise of intelligent machines ran up against technical and computational constraints of the time.

By the late 1980s, the overall hype around artificial intelligence began to fade. DARPA (Defense Advanced Research Projects Agency), reflecting the shifting tides in policy and performance expectations, scaled back its investment in robotics and AI. Although the ALV project survived in a reduced form, it was largely confined to a small network of defense contractors who recycled ideas and personnel across projects. The absence of new blood and cross-sector engagement limited innovation. This era, while ultimately falling short of delivering practical AV systems, planted the conceptual seeds of self-driving mobility by embedding the vision in public institutions and early technical blueprints.

Phase 1: mobilization around a vision (2004–2015)

The AV field was revived through DARPA's Grand Challenge in 2004 and 2005. These were open-innovation competitions in which autonomous vehicles built by different teams raced through challenging terrain. The first event took place in the Mojave Desert, California, where all participating teams—including those from Stanford and Carnegie Mellon—failed to complete the course. The second event, held in 2005 along a 132-mile route near the California/Nevada state line, saw a dramatic turnaround: five teams successfully crossed the finish line, marking a milestone in AV development.

These competitions broke the "mind meld" of traditional defense contractors by attracting non-traditional actors such as university teams, students, and garage inventors. The dramatic improvement between the first and second races signaled not only technical progress but also proof of concept that energized the field. Google co-founder Sergey Brin attended the second challenge and was impressed by the results. Shortly thereafter, Google approached the Stanford team's leaders and persuaded them to join a new skunkworks initiative at the company, which would eventually become the Google X lab. This project laid the foundation for what would later be branded as Waymo.

Overall, the two DARPA Grand Challenge events reignited broad interest in the vision of autonomous vehicles. Media coverage surged, corporate attention intensified, and the concept of AVs shifted from a long-dormant military research idea to a plausible technological frontier for commercial innovation. The period marked a convergence around a distant but increasingly tangible vision that mobilized new resources and talent into the field.

Phase 2: narrowed vision-reality gap and hype (2015-2018)

This phase saw the perceived gap between vision and reality narrow dramatically. Google's launch of Firefly and the formal creation of Waymo were interpreted not only as technological breakthroughs but also as signals of commercial viability. Major automobile manufacturers viewed these developments as existential threats. For traditional incumbents, the idea that a tech company could leapfrog decades of automotive expertise provoked both urgency and alarm. Executives from companies like GM and Ford began investing heavily in the field, fearing they would be left behind in a new era of mobility.

The strategic implications were not lost on other players either. Lyft's CEO publicly stated that self-driving cars would radically transform how people move and live, even going so far as to suggest that urban infrastructure itself would need to be reimagined. This period marked the emergence of the AV field as a coherent technological and organizational domain, though its commercial applications were still evolving. While there was no collective vision of viable business models in the beginning, the concept of robotaxis soon gained prominence, becoming a focal point for framing the AV market's future potential.

Industry investments followed suit. GM acquired Cruise, Ford took ownership of Argo AI, and Uber invested in Otto, a startup focused on self-driving trucks. GM's CEO Mary Barra emerged as a vocal advocate of autonomous technologies, positioning her company as a forward-looking leader in the mobility revolution. These developments accelerated the convergence of technological vision and organizational action, reinforcing legitimacy and driving an influx of talent, capital, and media attention into the AV ecosystem.

Phase 3: widened vision-reality gap and strategic recalibration (2018-2021)

The fatal Uber self-driving accident in 2018 marked a turning point. The incident served as a negative proof of concept, shaking public confidence and triggering widespread skepticism about the readiness and safety of autonomous vehicle technologies. Many business analysts and media outlets began to question the once-optimistic projections surrounding AVs. In the aftermath, timelines for commercialization were pushed back, and the previously strong momentum began to slow.

Despite this setback, major firms that had made significant investments, such as Ford, GM, and Volkswagen, remained committed to the field, albeit with greater caution. Startups and legacy players alike began to pivot toward alternative and more pragmatic applications of the technology, such as logistics and last-mile delivery. The viability of the robotaxi model started to be questioned, as emerging challenges such as scalability, complex urban environments, and resistance from municipal authorities revealed deep institutional and operational barriers. Still, proponents such as the CEO of Cruise remained bullish, arguing that the technology was essentially ready and that time and public trust were the only remaining hurdles.

Meanwhile, many global automakers began to recalibrate their ambitions by experimenting with more attainable near-term goals, such as Level 2 and Level 3 driver-assistance systems (lower-level autonomous system). These moves reflected a broader strategic shift across the industry—from lofty, all-encompassing visions to incremental, staged progress. The unified vision that once galvanized the field gave way to a fragmented landscape marked by diversified strategies and tempered optimism.

Phase 4: disillusionment and diverging futures (2021-2024)

A series of setbacks, including Ford's exit from level 4 autonomy and GM Cruise's safety scandals and layoffs, deepened disillusionment. The robotaxi model was revealed to be more complex, costly, and politically entangled than anticipated. Many firms retreated to less ambitious, more feasible technologies. Yet, the distant vision remains latent, occasionally invoked as a long-term aspiration. This phase reflects a deepened vision-reality gap, a fragmented field, and a growing skepticism about near-term viability.

Discussion: the vision-reality gap as a structuring force

The case of the AV industry illustrates how the vision-reality gap functions as a structuring device for field-level dynamics. The expansion and contraction of this gap influence which actors gain legitimacy, how resources are allocated, and what kinds of organizational forms and narratives dominate. Importantly, the gap is not static but fluctuates in response to technological events, policy changes, market signals, and cultural narratives.

The tension between distant visions and feasible near-term goals reflects a broader pattern in deep tech industries such as biotech and robotics. Firms and policymakers must manage dual cognitive tasks: maintaining the inspirational power of long-term visions while investing in concrete, actionable short-term goals. The coexistence of multiple hypes (e.g., autonomy and electrification) further complicates attention allocation, requiring strategic prioritization and narrative control.

Implications for theory and practice

Theoretically, this study extends the socio-cognitive perspective on technology evolution by integrating temporal construal theory with field-level dynamics (Grodal, Krabbe, & Chang-Zunino, 2023). The phase-based model offers a heuristic for understanding how vision-reality gaps emerge, evolve, and potentially collapse. It also highlights how visions are not merely rhetorical devices but actionable constructs that mobilize, coordinate, and structure action.

For practitioners, the findings underscore the importance of strategic vision management. Overcommitment to distant visions without feasible short-term pathways can lead to disillusionment and wasted resources. Conversely, near-term goals devoid of inspiring narratives may fail to attract talent, investment, and legitimacy. Navigating this balance is particularly critical in high-uncertainty, capital-intensive domains.

Conclusion

Technological transitions in deep tech industries unfold not only through engineering progress but also through socio-cognitive processes of envisioning, narrating, and aligning futures. The autonomous vehicle industry's trajectory reveals the dynamic interplay between distant visions and near-term realities, structured through a fluctuating vision-reality gap. Understanding this gap—its origins, phases, and effects—provides valuable insight into how industries evolve, falter, and potentially revive. Future research could further investigate how multiple overlapping visions interact and how actors learn from cycles of hype and disillusionment to recalibrate strategic direction.

Strategic vision management, in practice, involves maintaining the motivational power of long-term aspirations while anchoring them in achievable short-term steps. In the AV sector, this requires aligning product roadmaps with incremental technical milestones—such as commercializing advanced driver-assistance systems (e.g., Level 2+ highway cruising), piloting conditional autonomy in constrained environments, and carefully scaling Level 4 deployments within geo-fenced areas. It also involves diversifying early applications of autonomous technologies to domains with simpler operating conditions, such as logistics, mining, or port operations, where performance and safety are more controllable. By grounding ambitious narratives in credible progress markers—like system disengagement rates or regulatory approvals—firms can avoid the disillusionment that stems from overpromising. Companies such as Waymo, which has focused on gradual geographic expansion, or Volvo, which is rolling out Level 3 features under specific regulatory conditions, illustrate how a more measured approach can sustain investor confidence and organizational learning while preserving a connection to the original vision.

The vision-reality gap framework is applicable beyond the autonomous vehicle industry, particularly in other deep-tech sectors characterized by high uncertainty, long development cycles, and bold narratives. In quantum computing, for example, firms manage the gap between the distant promise of revolutionizing cryptography and the current limitations of noisy-intermediate-scale quantum machines by emphasizing near-term use cases such as optimization and simulation. In the field of gene editing, visionary goals like eradicating hereditary disease are translated into more immediate targets, such as treating rare blood disorders with ex vivo therapies. Similarly, in commercial space ventures, aspirational goals like human settlement on Mars are balanced with revenue-generating activities like satellite internet services. In each case, the framework helps identify where an industry sits within the hype-disillusionment cycle and offers a heuristic for designing strategies that sustain legitimacy, guide investment, and support adaptive decision-making over time.

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