# Applied Semiotics: The 3 Semiotic Dimensions and AI's Transcendence of Human Semiotics in the Metaverse

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Portugal, June 22, 2025

## Abstract

Semiotics, the study of signs, underpins communication and abstraction, enabling the co-evolution of language and mathematics as parametric systems. Human semiotics, tied to physicality and emotion, are complex and chaotic, with countless variable and unpredictable factors. Traditionally an academic field, this essay argues for semiotics' increasing applicability due to AI and metaverse developments, which transcend human semiotics and their physical limits. The novel 3 Semiotic Dimensions Framework—first (formulation of the sign), second (interaction with the recipient), and third (full context design)—provides a practical model for consciously implementing semiotics in design processes, emphasizing the sender's strategic role in economic enterprises. These overlapping, dynamically adjusting dimensions address chaotic communication complexities, supported by systems, complexity, and chaos theory (Gleick, 1987; Waldrop, 1992), and depart from the sender-message-receiver model without dismissing it. The framework reflects AI's paradigm shift in human semiotics, where personalized, efficient sign systems surpass traditional frameworks like Peirce's triad (Peirce, 1931), marking an evolution in semiotics driven by human-IT communication. AI's optimization of marketing, gaming, learning, and metaverse workspaces is a semiotic process with interconnected outcomes, as shown by the PCC Framework (Kayser, 2025), which addresses ethical risks for responsible application, enabling this research to explore the implications of applied AI and its semiotic impact.

## Introduction

Semiotics, derived from the Greek *sēmeîon* (sign), studies how signs—words, symbols, gestures, or sensory cues—mediate meaning. Traditionally perceived as an intellectual discipline with limited practical impact, semiotics is crucial for understanding the co-evolution of language and mathematics through semiotic abstraction: linguistic patterns birthed mathematical concepts, which refined language, redefining mathematics in an intertwined evolution that enabled civilization (Lakoff & Núñez, 2000). A symbol like "A" or "1" is unique but, through semiotics, represents a universal value. This relates to Peirce's triad (representamen, interpretant, and object), famously illustrated by René Magritte's *The Treachery of Images* (1929), which depicts a pipe subtitled "this is not a pipe" to underscore representation's power (Foucault, 1983). These observations were groundbreaking, forming modern semiotics' foundation, but their applicability today is limited.

Human semiotics, reflecting existential dilemmas of mortality and uniqueness, are tied to emotion and aesthetics. Their inherent complexities—impacting message delivery, content, and reception through chaotic, contextual, and unpredictable factors like nervousness, blushing, or misspeaking—cause misunderstandings. These inadvertent disruptions, often barely conscious, penalize less eloquent communicators and empower manipulators like psychopaths or narcissists (Hare, 1999; Twenge &

Campbell, 2009). In contrast, AI employs semiotics to achieve specific aims through a result-driven, trial-and-error process that renders static triads less practical. By evaluating preferences, AI calculates probabilities and adjusts errors without regret or biases. The human notion of uniqueness stems from the physical experience of an organic body, prompting the need to predefine representational values for abstraction. However, such concepts do not apply to software operating outside time and space, given sufficient hardware and energy. For software, all is abstract, nothing truly individual, and data is inherently replicable. As code in action, AI represents semiotics at a purer, higher level, fundamentally transforming human semiotics.

Traditional models, such as sender-message-receiver frameworks (Shannon & Weaver, 1949; Jakobson, 1960), oversimplify communication's chaotic dynamics, where multiple sensory inputs meet individual preconceptions and associations. While foundational, these models are marginal in AI-guided, personalized marketing environments that leverage continuously updating data to refine methodologies. AI's data power and non-human operation reshape the human semiotic experience, marking a paradigm shift that does not negate Peirce's validity but highlights new practical possibilities. AI's semiotic approach involves continuous adjustment of what works, yielding empirical results that outperform static analyses of theoretical meaning elements. This essay proposes the 3 Semiotic Dimensions Framework as a foundational model for applying semiotics, particularly in online settings, focusing on the sender/creator's strategic design process across three dimensions—first (formulation of the sign), second (interaction with the recipient), and third (situational design). These overlapping, dynamically adjusting dimensions, supported by systems, complexity, and chaos theory (von Bertalanffy, 1968; Gleick, 1987; Waldrop, 1992), address communication's chaotic nature.

AI's transcendence of human physicality and emotion alters human behavior, fostering *post-human semiotics* in the metaverse, observable in AI-optimized marketing, gaming, learning, and workspaces (Stephenson, 1992; Gibson, 1984; Bailenson, 2018). Here, *post-human semiotics* refers to AI-driven sign systems not exclusively human-made, and *para-reality* denotes abstract environments based on human concepts (e.g., algebraic mathematics, legislation, computer technology, AI, the internet). These postulations integrate semiotics with behavioral science (Skinner, 1953; Sapolsky, 2017) and the PCC Framework (Kayser, 2025), which models chaotic buying decisions influenced by psychological, cultural, and contextual factors, ensuring practical applicability while addressing ethical concerns through market-driven regulation rather than bureaucratic oversight. Customer dissatisfaction, as a free-market mechanism, efficiently regulates AI's semiotic applications by incentivizing ethical design to maintain trust and engagement (Beasley & Danesi, 2002). This essay excludes speculative implications of AI-bionic integration (e.g., Neuralink) due to their current unpredictability, though such technologies will likely accelerate post-human semiotics.

# The Foundational Role of Semiotics

## Language, Mathematics, and Applied Semiotics

Semiotics enables representation, with language and mathematics co-evolving as parametric systems. Linguistic abstraction drove mathematical patterns (e.g., counting), which enhanced language's precision, forming a feedback loop (Lakoff & Núñez, 2000). Early pictographs lacked clarity, prompting writing systems like Chinese logographs (DeFrancis, 1989), while clay tokens evolved into numerals (Schmandt-Besserat, 1992). Both rely on semiotic codes: "A" or "1" represents a universal value, as Magritte's painting illustrates (Foucault, 1983). Wittgenstein (1953, §43) views mathematics as a language game, and Eco (1976) sees both as semiotic frameworks driving progress (Goody, 1986). Applied semiotics underpins civilization's advancement as the foundation of abstract thinking, creating

a *para-reality* through linguistic and mathematical concepts that distorts human perception. Computer technology, particularly AI, increasingly fuses human reality and para-reality, redefining human semiotics—a process under-explored in semiotic research but pondered in works by Gibson and Stephenson (Luckin et al., 2023; Henriksen et al., 2021; Johnson & Smith, 2024).

Semiotics' uniqueness lies in its gap between theory and practice. Every fable, opera, or figurative painting is a practical semiotic application, often unconscious. Artists like P.P. Rubens or Sir Arthur Conan Doyle created semiotic masterpieces without knowing Peirce's triad. Doyle's Sherlock Holmes embodies semiotic theory, inspiring forensic police investigation through deductive reasoning drawn from medical diagnosis, despite no evidence of Doyle's familiarity with semiotics or Peirce (Eco, 1980). Eco's *The Name of the Rose* mirrors this as a medieval Sherlock Holmes narrative. Similarly, AI generates, refines, and surpasses human semiotic design through data-driven, iterative processes—such as machine learning and real-time user feedback—that dynamically adjust signs, rendering static frameworks like Peirce's triad less practical (see AI's Paradigm Shift). For example, in the metaverse, AI personalizes virtual signs (e.g., AR advertisements) by analyzing user behavior, bypassing predefined semiotic relationships. As Nadin (2017) argues, AI's semiotic processes prioritize computational efficiency over traditional models, redefining semiotics in digital contexts (Nadin, 2017).

Semiotics' scientific limitations stem from its unquantifiable specificity, with broad patterns and individual nuances. Human sign perception is part conscious, part subconscious, and instinctive, varying by person and context. For example, the word "apple" may evoke associations from smartphones to biblical imagery, pesticide concerns, South Tyrol's scenery, or even sexual impulses—outcomes unpredictable at an individual level. Perceptual errors, like those in Dalí or Arcimboldo paintings, and phenomena like pareidolia (seeing faces in patterns) further complicate prediction. AI marks a turning point, processing vast data to reduce errors rapidly, deducing what influences individuals with precision. This enhances applications like AI-assisted learning but risks abuse, opening doors to manipulation (Zuboff, 2019). AI makes semiotics scientifically relevant, fusing behavioral psychology, neurology, and IT, shifting focus from static sign theories to dynamic applications, visualized in Figures 1 and 3.

# Human Complexity and Miscommunication

Human semiotics, tied to mortality and uniqueness, connect to emotion and aesthetics (Barthes, 1977). Unconscious cues—nervousness, sweating, misspeaking, blushing—cause misunderstandings, penalizing less eloquent communicators and favoring manipulators exploiting polished communication (Hare, 1999; Twenge & Campbell, 2009). These chaotic signs, driven by action-reaction inputs, require systems, complexity, and chaos theory to model unpredictability (Gleick, 1987; Waldrop, 1992). For example, a nervous speaker's blush undermines credibility, while a psychopath's charm masks deceit, skewing social outcomes (Mehrabian, 1971).

# AI's Paradigm Shift in Semiotics

Human semiotics are constrained by physicality, but AI operates across contexts, unbound by space, time, or emotion (Russell & Norvig, 2020). This shift, envisioned in Stephenson's *Snow Crash* (1992) and Gibson's *Neuromancer* (1984), enables a metaverse where humans interact virtually via AR/VR (Bailenson, 2018). AI's personalized, efficient sign systems transcend Peirce's triad—not because it is invalid but because applied semiotics prioritize sender-driven design over static theoretical structures (Nadin, 2017). As human creators like Doyle intuitively bypassed Peirce's triad, AI transcends it

through computational optimization, dynamically reformulating signs based on real-time data (see Foundational Role). While AI lacks human emotional depth, its data-driven approach predicts behavioral patterns with high accuracy, though this raises ethical concerns about manipulation (Zuboff, 2019). This *post-human semiotics* mitigates communication disparities, as seen in virtual workspaces or drone warfare interfaces (Singer, 2009; Hayles, 1999). For instance, AI's rapid adjustment of signs in the second dimension and situational control in the third enhance metaverse interactions (see 3 Semiotic Dimensions Framework).

# Historical Context: The Evolution of Semiotics

Semiotics evolved from Aristotle's rhetoric (Aristotle, 1984) to Augustine's divine signs (Augustine, 1991). Peirce's triadic model (Peirce, 1931) and Saussure's semiology (Saussure, 1916) formalized modern semiotics, with Eco (1976, 1980), Lévi-Strauss (1963), and Barthes (1977) applying it to culture, anthropology, and media. By the 2000s, semiotics' complexity limited practical use despite academic presence (Chandler, 2007; Kress & van Leeuwen, 2006). AI, systems, complexity, and chaos theory offer tools to redefine applied semiotics, shifting focus from theoretical models like Peirce's triad to practical, sender-driven frameworks (Cobley & Bankov, 2022).

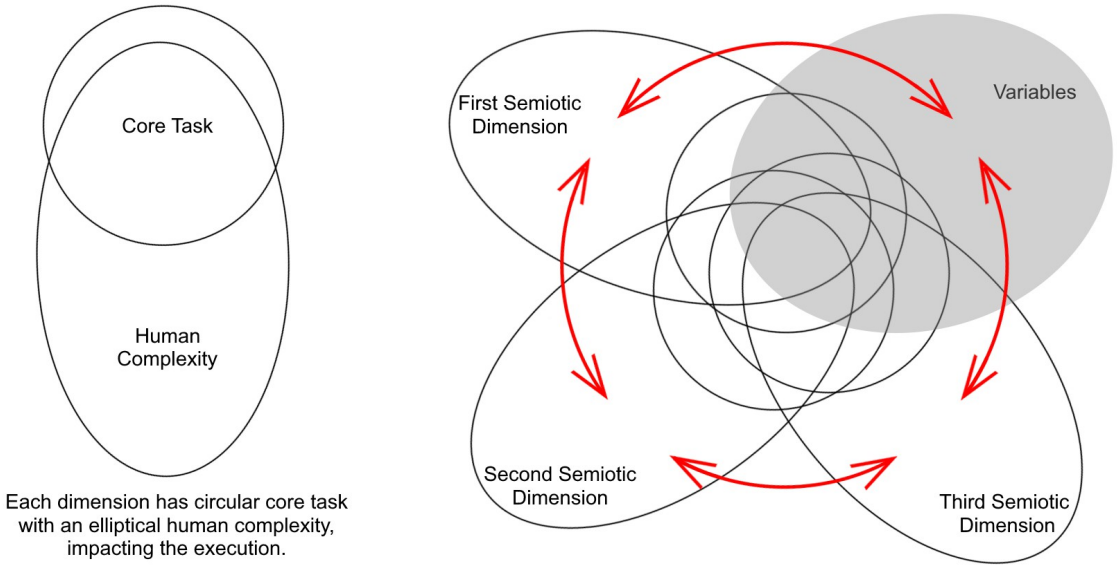
# The 3 Semiotic Dimensions Framework

This essay proposes the 3 Semiotic Dimensions Framework, focusing on the sender/creator's design process, distinct from the sender-message-receiver model (Shannon & Weaver, 1949; Jakobson, 1960) without negating its elements. Labeled first, second, and third for clarity, these dimensions imply a conceptual timeline but overlap and dynamically adjust, reflecting practical semiotic possibilities (see Figure 1). Each increases in complexity, amplifying failure risks, explaining why physical supermarkets pale against AI-guided, AR/VR-enhanced online shopping (Kayser, 2025).

1. **First Dimension: Formulation of the Sign**
   The sender encodes aims into a sign's design, initiating a multidimensional process, e.g., a retailer's price tag conveying demand (Eco, 1976). The sender encodes "what they want," anticipating recipient interaction (second dimension) and situational factors (third dimension), dynamically interacting.
2. **Second Dimension: Interaction with the Recipient**
   Fearing the recipient may overlook the offer, the sender adds a poster: "SALE: TODAY ONLY!" to engage them, aligning with intent via language, culture, and preferences (Kotler & Keller, 2016). This dimension navigates reactions (e.g., disinterest, cultural misinterpretation), requiring adjustments with other dimensions. If the sign fails, the retailer refines it, perhaps with local symbols (e.g., a 'Christmas special!' poster evoking festive joy during the holiday season), addressing chaotic cues like customer moods or staff nervousness (Mehrabian, 1971). Noteworthy, the feedback loops and interactivity of the second dimension with the first and third already hint at AI's advantages in online (metaverse) settings, where its speed in adjusting signs via real-time data analysis enhances personalization (Kayser, 2025; Huang & Rust, 2021).
3. **Third Dimension: Situational Design**
   The sender stages the experience to maximize impact, e.g., a store with music, lighting, scents, and friendly staff to encourage impulse purchases (Lindstrom, 2008; Kahneman, 2011). This complex dimension adjusts to chaotic inputs like crowd dynamics or staff misspeaking, which penalize less eloquent communicators and favor manipulators (Hare, 1999). A nervous cashier's stutter prompts ambiance or training adjustments. This risks consumer exploitation, but free-

market dynamics—driven by customer dissatisfaction—regulate AI applications more efficiently than bureaucratic oversight, which often fosters inefficiency and corruption (Beasley & Danesi, 2002). At this level of complexity, AI's situational control in personalized online shopping, optimizing all three dimensions, proves vastly more efficient (Kayser, 2025; see Figure 3).

## Figure 1: Semiotic Dimensions Diagram




**Description**:
*Each dimension is a circle representing the core task (1: Encoding aim/formulating the sign, 2: Establishing communication with the receiver, 3: Designing the context to amplify the message), overlapped by a dashed ellipse for human complexity (education, culture, IQ & EQ, ethics, mood, etc.). The dimensions, in constant flux, overlap each other, interacting via four double-sided arrows. A transparent gray ellipse, also dynamic, overlaps all dimensions, representing variables (e.g., sensory distractions, technological glitches, societal trends). This diagram (compared to Figure 3) highlights how AI reduces chaotic variables in human-driven semiotics.*

The dimensions are iterative: formulation anticipates interaction and situation; interaction refines based on feedback (e.g., a cashier's blushing); situational design adapts to chaotic inputs (e.g., crowd behavior) (Lorenz, 1993). For example, if a "SALE" sign fails culturally, the retailer reformulates it, adjusts messaging, and enhances ambiance, iterating until sales improve (Kayser, 2025). A magician's performance illustrates this: formulating a trick (e.g., pulling a rabbit from a hat), engaging the audience (e.g., suspenseful gestures), and staging the situation (e.g., dramatic lighting). A heckler shouting, "The hat's rigged!" (Eco, 1980, p. 130) undermines credibility (Sebeok, 2001). The magician reformulates pacing, adjusts gestures, and alters effects, showing dynamic interplay. In the metaverse, AI optimizes this: virtual price tags (first dimension) are personalized via AR/VR (second dimension) in immersive environments (third dimension), mitigating disruptions like nervousness (Bailenson, 2018; Nadin, 2017; Tussyadiah, 2014).

## Differentiation from Existing Models

Unlike Shannon and Weaver's (1949) linear model, which treats blushing as noise, or Jakobson's (1960) static functions, isolating emotional expression, the 3 Semiotic Dimensions Framework captures chaotic communication from the sender's perspective (see Table 1). A nervous cashier's stutter or a narcissist's charm skews perceptions, unaddressed by linear models (Hare, 1999; Mehrabian, 1971). Unlike Schramm's (1954) feedback or Barnlund's (1970) transactional models, emphasizing interaction, this framework formalizes multidimensional design, with situational design as a novel contribution. Systems, complexity, and chaos theory model non-linear dynamics (von Bertalanffy, 1968; Gleick, 1987; Waldrop, 1992). In the metaverse, AI-driven avatars reformulate signs, engage users, and design virtual contexts, mitigating complexities, as in Meta's Horizon Workrooms (Bailenson, 2018; Tussyadiah, 2014).

**Table 1: Comparison of Communication Models**

| Model | Focus | Strengths | Limitations |
|---|---|---|---|
| Shannon & Weaver (1949) | Linear transmission | Simplicity | Ignores chaotic variables |
| Jakobson (1960) | Linguistic functions | Contextual depth | Static analysis |
| Schramm (1954) | Feedback loops | Interaction focus | Limited situational design |
| Barnlund (1970) | Transactional dynamics | Mutual influence | Lacks multidimensionality |
| 3 Semiotic Dimensions | Sender-driven design | Captures chaos, AI applicability | Complexity |

# Applying the Framework: Marketing, Gaming, Learning, and Workspaces

## Marketing

Marketing showcases the framework's utility. A shampoo brand formulates an ad, engages demographics, and stages a sensory retail environment. Chaotic inputs—store odors, nervous staff, customer moods—disrupt effectiveness, favoring charismatic communicators (Chandler, 2007; Hare, 1999). The PCC Framework shows buying decisions are chaotic individually (Kayser, 2025). AI-guided online shopping, like Amazon's AR try-ons, optimizes all dimensions, transcending physical limits (Kaplan & Haenlein, 2019; Tussyadiah, 2014). For example, Nike's AR sneaker try-on app formulates virtual sneaker designs (first dimension), personalizes fit recommendations (second

dimension), and creates immersive store-like experiences (third dimension), demonstrating the framework's practical application (Huang & Rust, 2021).

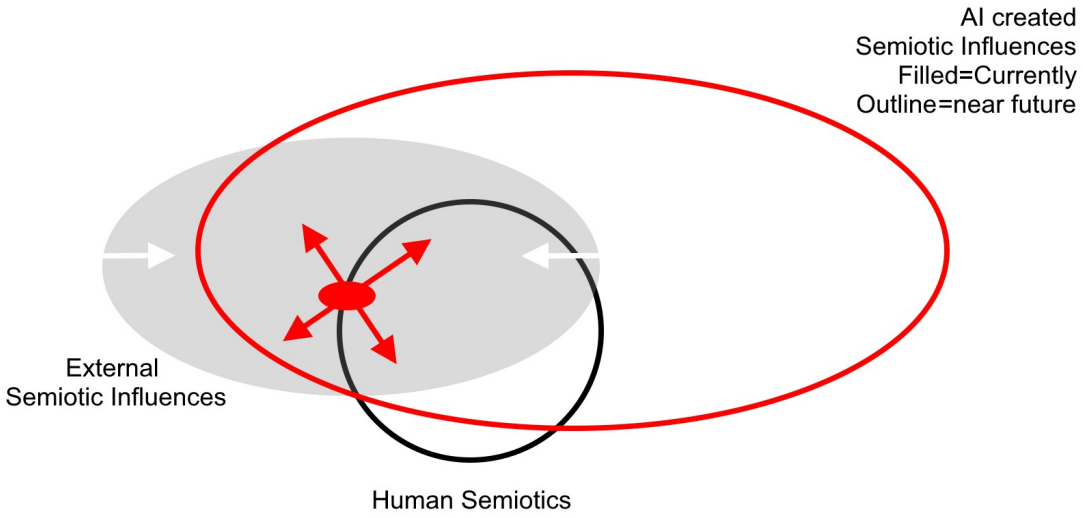
## Online Gaming and Learning

In gaming, AI formulates virtual environments, engages players, and stages immersive contexts, as in adaptive NPCs in *The Last of Us Part II* (Nadin, 2017; Yannakakis & Togelius, 2018). In learning, AI personalizes content on Coursera, tailoring to emotions via AR/VR (Dede, 2009). These transcend human semiotics' constraints, fostering practical semiotics in the metaverse.

## Metaverse Workspaces

The metaverse, a parallel reality, redefines semiotics (Stephenson, 1992; Gibson, 1984). AI-driven avatars formulate signs, engage users, and stage virtual contexts, mitigating nervousness and reducing manipulative advantages, as in Horizon Workrooms (Bailenson, 2018; Hare, 1999). In drone warfare, AI designs battlefield signals, optimizing chaotic contexts (Singer, 2009). This paradigm shift enhances communication (Chalmers, 2022).

**Figure 2: The Semiotic Development**



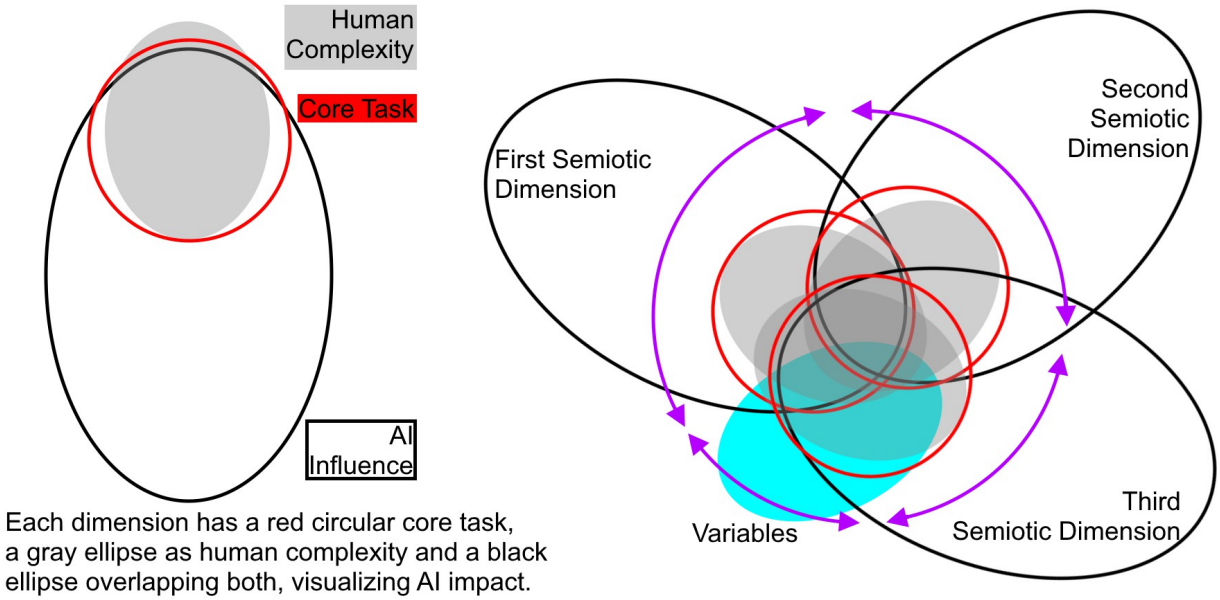

**Description**:
*Human Semiotics is a black-outlined circle, overlapped by a gray ellipse (external influences: nature, culture, science) and a red-outlined ellipse (AI-created influences), vastly overlapping both. A small red-filled ellipse within the gray ellipse shows AI's current influence, while a larger red-outlined ellipse estimates future impact, marked by four arrows indicating growth and two white arrows showing shrinking external influences.*

# AI's Semiotic Revolution

Human semiotics, constrained by emotion, cause disparities favoring manipulators (Twenge & Campbell, 2009). AI transcends these, creating post-human semiotics in the metaverse, altering identity

and interaction (Hayles, 1999). While AI cannot replicate human emotional nuance, its data-driven personalization outperforms traditional methods in scalability and efficiency, empowering marketing, gaming, learning, and workspaces, as supported by the PCC Framework (Kayser, 2025).

**Figure 3: The Semiotic Dimensions in the AI Era**




**Description**:
*Each dimension is a red circle (core task), overlapped by a gray ellipse (human complexity) and a black-outlined ellipse (AI influence). Variables (e.g., sensory distractions, algorithmic biases) form a smaller light-blue ellipse. All are in flux, intertwined, with purple double-sided arrows indicating mutual impact. Figures 1 and 3 show a shift from human-driven (e.g., emotional decision-making) to AI-driven (e.g., data-driven optimization) parameters, leading to different outcomes in sign creation.*

# Challenges and Future Directions

The framework faces challenges: semiotic complexity resists simplification (Eco, 1976); AI risks manipulation or bias in marketing and warfare (Floridi & Cowls, 2019; Mittelstadt et al., 2016); and modeling chaotic dynamics requires tools (Gleick, 1987; Strogatz, 2003). For example, AI-driven semiotics may reinforce stereotypes or target vulnerable demographics, necessitating ethical considerations. Free-market regulation, driven by customer dissatisfaction, mitigates these risks efficiently, as dissatisfied users demand transparency and fairness, incentivizing ethical AI design without bureaucratic inefficiencies (Beasley & Danesi, 2002; Thaler & Sunstein, 2008). Expanding to healthcare (e.g., diagnostic signs) or policy (e.g., public messaging) would broaden applicability. Future research should develop semiotic metrics, test empirically (e.g., AR/VR case studies), and explore AI ethics (Jobin et al., 2019).

# Conclusion

Semiotics, through language and mathematics' co-evolution, enables civilization, but human complexities like nervousness cause disparities. The 3 Semiotic Dimensions Framework, focusing on

sender-driven design, captures chaotic communication, departing from traditional models and Peirce's triad amid AI's paradigm shift. AI's transcendence fosters post-human semiotics in the metaverse, optimizing marketing, gaming, learning, and workspaces, as supported by the PCC Framework (Kayser, 2025). Through free-market regulation, this framework ensures applied semiotics' relevance while addressing ethical risks.

# References


Aristotle. (1984). *Rhetoric* (W. R. Roberts, Trans.). Princeton University Press.

Augustine. (1991). *On Christian Doctrine* (D. W. Robertson, Trans.). Prentice Hall.

Bailenson, J. (2018). *Experience on Demand: What Virtual Reality Is, How It Works, and What It Can Do*. W. W. Norton.

Barnlund, D. C. (1970). A transactional model of communication. In J. Akin et al. (Eds.), *Language Behavior: A Book of Readings in Communication* (pp. 43–61). Mouton.

Barthes, R. (1977). *Image-Music-Text*. Hill and Wang.

Beasley, R., & Danesi, M. (2002). *Persuasive Signs: The Semiotics of Advertising*. Mouton de Gruyter.

Chalmers, D. J. (2022). *Reality+: Virtual Worlds and the Problems of Philosophy*. W. W. Norton.

Chandler, D. (2007). *Semiotics: The Basics* (2nd ed.). Routledge.

Cobley, P., & Bankov, K. (2022). *Semiotics and Digital Culture*. Routledge.

Dede, C. (2009). Immersive interfaces for engagement and learning. *Science*, 323(5910), 66–69.

DeFrancis, J. (1989). *Visible Speech: The Diverse Oneness of Writing Systems*. University of Hawaii Press.

Eco, U. (1976). *A Theory of Semiotics*. Indiana University Press.

Eco, U. (1980). *The Name of the Rose*. Harcourt.

Floridi, L., & Cowls, J. (2019). A unified framework of five principles for AI in society. *Harvard Data Science Review*, 1(1).

Foucault, M. (1983). *This Is Not a Pipe*. University of California Press.

Gibson, W. (1984). *Neuromancer*. Ace Books.

Gleick, J. (1987). *Chaos: Making a New Science*. Penguin.

Goody, J. (1986). *The Logic of Writing and the Organization of Society*. Cambridge University Press.

Hare, R. D. (1999). *Without Conscience: The Disturbing World of the Psychopaths Among Us*. Guilford Press.

Hayles, N. K. (1999). *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. University of Chicago Press.

Henriksen, D., et al. (2021). AI and education: Ethical considerations. *Educational Technology Research and Development*, 69(1), 1–25.

Huang, M.-H., & Rust, R. T. (2021). A framework for AI-driven service innovation. *Journal of Service Research*, 24(1), 3–22.

Jakobson, R. (1960). Closing statement: Linguistics and poetics. In T. A. Sebeok (Ed.), *Style in*

*Language* (pp. 350–377). MIT Press.

Jobin, A., Ienca, M., & Vayena, E. (2019). The global landscape of AI ethics guidelines. *Nature Machine Intelligence*, 1(9), 389–399.

Johnson, M., & Smith, R. (2024). AI learning environments and semiotic implications. *Journal of Educational Technology*, 45(3), 112–130.

Kahneman, D. (2011). *Thinking, Fast and Slow*. Farrar, Straus and Giroux.

Kaplan, A. M., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business Horizons*, 62(1), 15–25.

Kayser, K. H. (2025). PCC: The three main buying decisions. *Nodes*. https://nodes.desci.com/dpid/488/v6

Kotler, P., & Keller, K. L. (2016). *Marketing Management* (15th ed.). Pearson.

Kress, G., & van Leeuwen, T. (2006). *Reading Images: The Grammar of Visual Design* (2nd ed.). Routledge.

Lakoff, G., & Núñez, R. E. (2000). *Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being*. Basic Books.

Lévi-Strauss, C. (1963). *Structural Anthropology*. Basic Books.

Lindstrom, M. (2008). *Buyology: Truth and Lies About Why We Buy*. Doubleday.

Lorenz, E. N. (1993). *The Essence of Chaos*. University of Washington Press.

Luckin, R., et al. (2023). AI in education: A semiotic perspective. *British Journal of Educational Technology*, 54(2), 345–362.

Mehrabian, A. (1971). *Silent Messages*. Wadsworth.

Mittelstadt, B. D., Allo, P., Taddeo, M., Wachter, S., & Floridi, L. (2016). The ethics of algorithms: Mapping the debate. *Big Data & Society*, 3(2).

Nadin, M. (2017). Semiotics in the age of artificial intelligence. *Semiotica*, 2017(219), 1–23.

Peirce, C. S. (1931). *Collected Papers of Charles Sanders Peirce* (Vols. 1–6, C. Hartshorne & P. Weiss, Eds.). Harvard University Press.

Russell, S., & Norvig, P. (2020). *Artificial Intelligence: A Modern Approach* (4th ed.). Pearson.

Sapolsky, R. M. (2017). *Behave: The Biology of Humans at Our Best and Worst*. Penguin.

Saussure, F. de. (1916). *Course in General Linguistics* (W. Baskin, Trans.). McGraw-Hill.

Schmandt-Besserat, D. (1992). *Before Writing: From Counting to Cuneiform*. University of Texas Press.

Schramm, W. (1954). How communication works. In W. Schramm (Ed.), *The Process and Effects of Mass Communication* (pp. 3–26). University of Illinois Press.

Sebeok, T. A. (2001). *Signs: An Introduction to Semiotics* (2nd ed.). University of Toronto Press.

Shannon, C. E., & Weaver, W. (1949). *The Mathematical Theory of Communication*. University of Illinois Press.

Singer, P. W. (2009). *Wired for War: The Robotics Revolution and Conflict in the 21st Century*.

Penguin.

Stephenson, N. (1992). *Snow Crash*. Bantam Books.

Strogatz, S. H. (2003). *Sync: The Emerging Science of Spontaneous Order*. Hyperion.

Taleb, N. N. (2007). *The Black Swan: The Impact of the Highly Improbable*. Random House.

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving Decisions About Health, Wealth, and Happiness*. Yale University Press.

Tussyadiah, I. P. (2014). Toward a theoretical foundation for experience design in tourism. *Journal of Travel Research*, 53(5), 543–564.

Twenge, J. M., & Campbell, W. K. (2009). *The Narcissism Epidemic: Living in the Age of Entitlement*. Free Press.

von Bertalanffy, L. (1968). *General System Theory: Foundations, Development, Applications*. Braziller.

Waldrop, M. M. (1992). *Complexity: The Emerging Science at the Edge of Order and Chaos*. Simon & Schuster.

Wittgenstein, L. (1953). *Philosophical Investigations* (G. E. M. Anscombe, Trans.). Blackwell.

Yannakakis, G. N., & Togelius, J. (2018). *Artificial Intelligence and Games*. Springer.

Zuboff, S. (2019). *The Age of Surveillance Capitalism*. PublicAffairs.