CHAPTER 6

DYNAMIC INFERENCE SYSTEM OF PERCEPTUAL FIELDS (SIDyCP)

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ABSTRACT — This article presents the Dynamic Inference System of Perceptual Fields (SIDyCP), a theoretical-computational infrastructure that redefines perception as a dynamic, distributed, and context-sensitive inferential process. Integrated into the epistemic platform Agent-Technology Interaction (ATI) of the FCIA-OT framework, SIDyCP mathematically formalizes the Three Laws of Affordance, converting perceptual properties into computable, auditable, and adaptive variables. Perception is modeled as a non-local field (Ψ), in which agent–environment couplings emerge from historically situated coefficients (α_i), whose dynamics are represented by the Perceptual Field Equation (Ψ), the Interaction Entropy (U(t)), and the Dynamic Equation (∂Ψ/∂t). The latter operationalizes, in an unprecedented way, the Third Law, Necessary Reconfiguration, by expressing the inferential collapse that occurs when the structural variation of perception exceeds the Perceptual Coupling Constant (κ_p), requiring adaptive reorganizations. The model articulates inferential acceleration ($\dot{\alpha}^2$), relational codings (⊗), and stochastic noise (ξ) as critical variables for perceptual stability. By dissolving the nature–culture dichotomy, SIDyCP treats affordances as emergent vectors of non-local correlation between components of coupled systems, overcoming the fragmentation between natural and cultural artifacts. Its full compatibility with the FCIA-OT matrix enables continuous applications in multi-agent environments, adaptive interfaces, intelligent systems, and context-sensitive perceptual audits. Consolidated within the scope of ATI, SIDyCP establishes a new formal and epistemic foundation for the inferential modeling of technical perception in complex interactive systems.

KEYWORDS — ATI; FCIA-OT; SIDyCP; Three Laws of Affordance; Perceptual Field Equation; Interaction Entropy; Dynamic Equation; Perceptual Coupling.

1 INTRODUCTION

In recent decades, advances in the field of Human–Computer Interaction (HCI) have enabled the construction of increasingly sophisticated models for behavioral mapping, interface design, and adaptive technical responses. Although interactive frameworks have been explored through distinct methodological approaches, critical gaps remain regarding the nature of technical perception, particularly in light of the growing complexity of contemporary systems and the emergence of hybrid agents, whether human, artificial, or cyber-physical.

The FCIA-OT, through its Systemic Matrix of Integrated Vector Dimensions (MSDVI), a next-generation epistemic and operational infrastructure, emerges from the recognition of such structural deficiencies. Its systems offer mechanisms for diagnosis, interaction modeling, and functional coupling between multiple modules and agents. However, as the analysis of perceptual conditions that sustain the intelligibility of actions deepens, the need for a system capable of surpassing classical models, anchored in isolated categories and fragmented views of interaction, becomes evident.

Within this horizon, the SIDyCP is formulated as a theoretical–computational infrastructure that redefines perception as an inferential input system, capable of interpreting and quantifying, in real time, the dynamic couplings between agents and artifacts. Grounded in the existence of a non-local field (Ψ), SIDyCP models the emergence of affordances not as fixed properties of objects, but as encoded operational vectors, whose manifestations depend on historical, contextual, and topological entanglements.

This perspective advances the foundational postulates of Gibson (1979), for whom affordances, understood as action potentials, emerge from the relationship between environmental structures and the perceptual–motor capacities of each species, constituting phenomena that are simultaneously ecological and behavioral, inseparable from the interaction between organism and environment. While real and objective—and, as argued by Hartson (2003), even functional—these structures transcend measurable physical properties, eluding the logic of traditional physics and challenging the boundaries between subject and object.

Building on this legacy, SIDyCP transcends the nature–culture dichotomy by proposing an algorithmically quantified formalism for perceptual relations. Operating according to the Three Laws of Affordance, formulated within the scope of FCIA-OT (see Chapter 1), the system converts perception into a computable phenomenon, capable of supporting predictive diagnoses, interactional simulations, perceptual audits, and self-adaptive mechanisms.

In rupture with classical paradigms of perception and usability, SIDyCP inaugurates a theoretical and computational infrastructure aimed at inferring non-localized perceptual fields, constituting a modular and operable architecture for reading, modeling, and reengineering technical perception in interactive systems. In doing so, it redefines the foundations of HCI and projects Agent–Technology Interaction (ATI) under a new epistemic, computational, and cognitive paradigm.

2 DYNAMIC INFERENCE SYSTEM OF PERCEPTUAL FIELDS (SIDyCP)

SIDyCP consolidates itself as the technical–formal core of the epistemic architecture proposed by FCIA-OT, by repositioning the concept of affordance not as a localized attribute of an object or agent, but as an expression of non-local correlations between components of coupled systems. This reformulation breaks with classical approaches to perception, which are anchored in the identification of isolatable properties, by assuming that perceptual phenomena result from dynamic states of organism–environment coupling.

In the early studies of ecological perception, Cutting (1982) points out that perceptual errors, especially those that are non-damaging, function as epistemological catalysts: by misperceiving the affordances of an object or event, the agent is compelled to reorganize their environmental reading, refining their interaction strategies. This process reveals that perception is neither static nor neutral, but modulable, historical, and cumulative, a fundamental characteristic that SIDyCP incorporates by modeling the perceiver as an open system traversed by multiple layers of conditioning.

Subsequently, Lindquist (1985) reinforces the need for technical–operational parameters to evaluate interface efficiency after the learning phase, proposing the use of metrics derived from software analysis. While acknowledging the limitations of isolated temporal measures, he argues that the computational complexity of dialogical structures can offer robust comparative indicators. SIDyCP advances this proposition by formalizing a **Usability Equation (U(t))** capable of quantifying, in terms of interactional entropy, the perceptual uncertainty of affordances, identifying critical thresholds for intuitive objects **($U(t) < 0.3$)** or dysfunctional ones **($U(t) > 1.0$).**

As anticipated by Aykin (1989), adaptive systems based on user models are capable of predicting preferences and states from interactional data such as commands, execution time, and error patterns, a premise that SIDyCP extends by incorporating dynamic coupling variables, thus surpassing the static logic of traditional interfaces.

However, it is Cutting (1993) who explicitly identifies the central epistemological gap that motivates the development of SIDyCP: the absence of a unified model capable of explaining the perception of cultural artifacts and natural objects under a common ontological regime. Dominant approaches treat these domains as disparate categories, the former marked by symbolic codification and cultural learning; the latter, by evolutionary traits and invariant structures. SIDyCP breaks with this separation by proposing that both are manifestations of a unified and dynamic perceptual field **(Ψ)**, in which perceiver and environment operate in non-local coupling.

In this formalism, affordance is not an attribute of the object, but an emergent vector of the relationship between correlated states. The **Perceptual Field Equation (Ψ)** expresses this hypothesis by using $\boldsymbol{\alpha_i}$ coefficients to probabilistically encode the historical, cultural, and individual components of the perceiver. The entanglement between agent and environment is formalized through the tensor product **(⊗)**, which models the inseparability of interactional layers, an aspect directly inspired by the notion of quantum superposition and decoherence, applied here as a theoretical matrix of technical perception.

Complementarily, the **Usability Equation (U(t))** introduces a new parameter for modeling interactional perception. By employing the function $\boldsymbol{|\alpha_i(t)|^2}$ to represent the temporal probability of an affordance being recognized, and by incorporating the natural logarithm **(ln)** to capture cognitive nonlinearities, the model becomes capable of empirically measuring interactions, transforming perception into an auditable and optimizable variable.

It is important to note that SIDyCP does not assume a primary evaluative function in the perceptual process. Its algorithmic infrastructure operates on perceptual records encoded according to the criteria of the epistemic matrix of FCIA-OT, which result from analyses carried out by different types of agents, human, artificial, hybrid, or cyber-physical, according to their perceptual capacities and historical–situational trajectories. Although it does not generate affordances or perform autonomous usability judgments, SIDyCP is capable of inferring, quantifying, and reconfiguring perceptual patterns in real time, even in intelligent environments, neural networks, and adaptive systems. Its formal modeling, structured by the Three Laws of Affordance, ensures the epistemic integrity of the process and maintains full compatibility with the distributed and multi-agent logic that underpins technical evaluation within the scope of FCIA-OT.

This modeling aligns coherently with the contributions of Maier & Fadel (2008), who argue that functions are abstractions dependent on material realization, whereas affordances are intrinsically structural. In differentiating affordances from functions, they emphasize that the former require specific formal features, since the geometry, materials, and dynamics of the artifact condition the possibilities for action. This is consistent with the formulation of Scarlett & Zeilinger (2019), who argue that affordances operate on chained levels that surpass the perceptible layers of conventional computation, configuring hidden, yet determinant, dynamics in the structuring of technical action and in the mediation between agent and system. SIDyCP internalizes this principle by recognizing that the field **Ψ** incorporates both formal and contextual aspects, enabling the prediction of how different agents will perceive and activate affordances based on their **$\alpha_i(t)$** trajectories.

The theoretical coherence of SIDyCP is further expressed in the derivation of the **Three Laws of Affordance** (see Chapter 1), directly from the mathematical structure of the field **Ψ**. The superposition of states reflects **"Universal Coding"**, where the **states $|environment_i\rangle$** encode both physical and cultural properties. The decoherence of states—i.e., the loss of synchronization between agent and environment, corresponds to **"Trajectory Dependence"**, captured by the temporal dynamics of **$\alpha_i(t)$**, which follow well-defined learning curves. Temporal evolution **($\partial\Psi/\partial t$)** mirrors **"Necessary Reconfiguration"**, which occurs when environmental changes exceed the Coupling Constant **κ_p** requiring recalibration of interaction protocols. The constant **κ_p** represents the minimum threshold of **Ψ**-field stability. It defines the point beyond which changes in the environment (or in the agent's state) begin to require structural reorganization of the coupling, signaling a collapse in dominant affordance patterns. When the rate of variation **$\partial\Psi/\partial t$** exceeds this threshold, perception must reorganize itself, with both inferential and operational consequences.

SIDyCP not only responds to the epistemological gap outlined by Cutting (1993), but also proposes a new regime for Human–Computer Interaction (HCI), replacing the nature–culture dichotomy with a continuum of interactional states modulated by historically situated coefficients. Affordances become emergent properties, susceptible to quantification, prediction, and reengineering. The Agent–Technology Interaction (ATI) platform thus begins to operate under a computational formalism capable of guiding perceptual diagnostics, adaptive simulations, and predictive design in complex systems.

The reformulation proposed by SIDyCP rests on the premise that affordances are not fixed entities assigned to objects or subjects, but non-localized correlations that emerge from their interaction. This proposition is anchored in the idea that the perception of an affordance cannot be explained solely by local geometric properties, nor by internal features of the agent, but rather by a structural and probabilistic relationship between both poles of the system.

From this perspective, affordances are properties of the coupling between perceiver and environment. They depend simultaneously on the physical configuration of the artifact (such as the height of a bench), the biological and historical constitution of the agent (such as leg length or cultural habits), and a set of contextual mediations (such as the cultural meaning of a “public bench”). They are, therefore, statistical correlations emerging from a global dynamic system, not attributes that can be localized in either part independently.

This notion of non-locality, central to SIDyCP, conceptually derives from the domain of quantum physics, in which entangled systems maintain robust correlations that do not depend on spatial proximity or direct causality. When applied to technical perception, this analogy supports the view that observer and environment form an entangled perceptual system, where the affordance is a global vector of interdependent states. Perception, therefore, is not reducible to discrete parts but constitutes a distributed phenomenon across the field **Ψ**.

This approach stands in radical contrast to the traditional ecological conception, in which affordances are understood as structural invariants present in the environment, accessed through specific sensorimotor explorations. SIDyCP proposes that such invariants exist only as correlation effects, not as autonomous causes. Instead of seeking affordances in the object or in the subject, the model seeks to formalize them within the relational space of non-local coupling, where cultural, biological, and historical elements coexist and codetermine perceptual emergence.

This perspective is decisive for addressing a central problem in the literature: the persistent difficulty in explaining how cultural artifacts, lacking direct evolutionary grounding, are readily perceived as bearing functional affordances. Classical explanations appeal to symbolic learning but fail to integrate the dynamic and systemic dimensions of the phenomenon. SIDyCP, in contrast, shows that cultural artifacts and natural objects are correlated states of the same dynamic perceptual field **(Ψ)**, thereby dissolving the nature–culture dichotomy.

By incorporating non-locality as a foundational property of technical perception, SIDyCP not only resolves ontological impasses but also provides a robust basis for algorithmic modeling of interaction. The following segments will detail how this structure is formalized mathematically, through the **Perceptual Field Equation (Ψ)**, the **Usability Equation (U(t))**, the **α_i(t)** coefficients, and the **Dynamic Equation of the Perceptual Field (∂Ψ/∂t)**, which capture the perceiver’s trajectory across multiple layers of historicity.

3 PERCEPTUAL FIELD EQUATION (Ψ)

The computational formalization of SIDyCP requires a mathematical expression of the perceptual principles previously defined. The **Perceptual Field Equation (Ψ)** constitutes the initial step of this formalization, representing the inferential structure of perception as a dynamic entanglement between agent(s) and environment(s). This entanglement transcends local or punctual properties, incorporating coefficients of historical, cultural, social, and situational nature, thereby configuring a non-local and probabilistic perceptual field of potentially manifest affordances.

3.1 General Structure of the Perceptual Field Equation Ψ

In his theorization of quantum mechanics, Dirac (1930) introduced the bra-ket notation and formalized the principle of superposition, according to which a quantum state can be described as a linear combination of basis vectors defined in a complex inner product vector space, the Hilbert space. This principle enables the representation of entangled compositions of physical systems through tensor products, structuring a formal architecture of composite states. The construction is expressed by the equation:

$$\psi\Big\rangle = \sum_{i=1}^{n} c_i \left|a_i\right\rangle \otimes \left|b_i\right\rangle$$

The formulation describes the composition of systems in entangled states, with complex coefficients $\mathbf{c}_i$ and tensor products between state vectors. This formulation underpins the structure of composite states in physical systems and is central to the quantum formalism.

In contrast to the quantum formalism, the **Perceptual Field Equation (Ψ)** does not describe entangled physical systems, but rather nonlinear inferential structures emerging from the agent–environment relation. In this model, the field **Ψ** represents a dynamic informational construct that encodes the agent's perceptual dispositions within a space of potential interactions with the environment. The equation is expressed as follows:

$$\Psi = \sum_{i=1}^{n} \alpha_i \cdot \left\langle \text{perceiver}_i \right\rangle \otimes \left\langle \text{environment}_i \right\rangle$$

Source: Author.

Example:

$\Psi = \alpha_1|\text{perceiver}_1\rangle \otimes |\text{environment}_1\rangle + \alpha_2|\text{perceiver}_2\rangle \otimes |\text{environment}_2\rangle + \ldots + \alpha_n|\text{perceiver}_n\rangle \otimes |\text{environment}_n\rangle$

This equation represents a superposition of potential states of perceptual coupling, in which each pair ⟨**perceiver**$_i$⟩ ⊗ ⟨**environment**$_i$⟩ composes a specific contextual unit weighted by a coefficient $\boldsymbol{\alpha}_i$. These coefficients express the intensity, priority, or activation of each configuration within the field, and may encode sensory variables as well as cognitive, intentional, or historical-cultural dispositions. Unlike quantum entanglement, the tensor product here preserves the semantic identity of each component, forming a perceptual field that is non-local, dynamic, and inferential. Table 1 describes the elements of the **Ψ** equation and their structural functions within the system.

TABLE 1: DYNAMIC PERCEPTUAL FIELD: GLOSSARY OF SYMBOLS AND CONCEPTS

Symbol	Name	Meaning	Practical Application
Ψ	Psi	Global state of the perceiver–environment system	The combined perception of an agent and an interface
Σ	Summation	Superposition of all possible states	A button may be "clickable," "draggable," or "ignored" simultaneously until action is taken
α_i	Coupling coefficient	Probabilistic weight of each interaction ($0 \leq \lvert\alpha_i\rvert^2 \leq 1$). Complex amplitude that weighs the contribution of each state (i).	$\alpha_1 = 0.9$ → 90% chance the agent will click the button
$\lvert perceiver_i \rangle$	Perceiver state	Agent's perceptual vector; encodes cognitive, cultural, and intentional dispositions. Quantum-like observer state	Knowledge, prior experience, objectives
$\lvert environment_i \rangle$	Environment state	Environmental vector; encodes physical, symbolic, and contextual properties	Color, shape, location, function, and cultural context of the object
⊗	Tensor product	Operates the non-separable entanglement between agent and environment	The affordance emerges from the relation, not from the agent or object alone
i	Iteration of possible states	Identifier of each distinct agent–environment pair in the superposition	i = 1, 2, ..., n

Interactive Technical Action. All symbols are interpreted within the dynamic context of the perceptual field. The fundamental properties of the field Ψ can be described as follows:

Superposition: Perception remains in a potential, non-collapsed state until one of the possibilities becomes predominant through inference or action.

Perceptual decoherence: The field Ψ may undergo local reduction induced by attentional mechanisms, cognitive limitations, or situational pressures.

Non-locality: The coefficients α_i integrate influences distant in time and space, including memories, norms, collective knowledge, and cultural structures.

Perceptual (epistemological) collapse: The superposition structure represented by Ψ collapses into a state inferred as the dominant affordance. This collapse is interpreted as inferential resolution, not as a physical event..

Source: Author.

Thus, the Perceptual Field Equation provides the formal foundation for the dynamic inference processes operated by SIDyCP, structuring the way in which perceptions are formed, modulated, and transformed at the interface between agents and their contexts.

The general formulation presented thus far establishes the **Perceptual Field Equation (Ψ)** as the basis for modeling inferential perception. However, in order to demonstrate the operational power of SIDyCP, it is necessary to show its application in concrete contexts, in which the dynamics of superposition, coupling, and perceptual collapse can be numerically observed and interpreted. Table 2 presents a unified glossary (technical reference) of SIDyCP symbols, including the elements used in its core equations: the **Perceptual Field Equation (Ψ)**, the **Usability Equation (U(t))**, and the **Dynamic Perceptual Field Equation (∂Ψ/∂t)**.

TABLE 2: UNIFIED GLOSSARY OF SIDyCP SYMBOLS AND OPERATORS

Symbol	Technical Name	Meaning/Description	Application
Ψ	Uppercase Greek letter "Psi"	Perceptual Field: dynamic inferential structure that encodes agent–environment interaction	Foundation of the Laws of Affordance and perceptual modeling in SIDyCP
∂Ψ/∂t	Partial derivative of Ψ over time	Rate of change of the Ψ field over time; expresses the need for perceptual reconfiguration	Indicates when perception must reorganize in response to changes in the environment
t	Continuous time	Temporal variable	Basis for the dynamic evolution of perception and usability
$\alpha_i(t)$	Coupling coefficient i at time t	Weight of the contribution of the perceiver–environment pair i in the superposition of the Ψ field	Represents the inferential strength of each affordance over time
**	perceiver_i)**	Bra-ket state vector (agent)	Representation of the perceptual state of agent i
**	environment_i)**	Bra-ket state vector (medium)	Representation of the environmental state as perceived by agent i.
⊗	Tensor product	Combination of agent and environment state vectors into a compound state	Models the non-reductionist coupling between perception and environment
ξ(t)	Lowercase Greek letter (ruído cognitivo)	Time-dependent stochastic noise, representing unpredictable variations in cognition and environment	Models contextual fluctuations, ambiguity, and cognitive load
κ_p	Subscripted Greek letter "kappa"	Perceptual Coupling Constant: minimum threshold for Ψ stability	Defines the critical point beyond which perceptual reconfiguration occurs

U(t)	Usability function over time	Measure of interaction entropy, based on the distribution of $\alpha_i(t)$	Assesses the degree of coherence and predictability in the agent's experience with the environment
ln	Natural logarithm	Used in entropy calculation in the Usability Equation	Measures uncertainty or informational dispersion in the system
∑ (Summation)	Summation operator	Sum over all possible states i	Structures all superpositions and usability calculations
=, >	Operadores lógicos	Equality, inequality	Express formal definitions and critical thresholds (e.g., $\partial\Psi/\partial t > \kappa_p$).

Source: Author.

The following subsections present two distinct formal examples, which illustrate how the system computes and infers predominant states based on variable compositions between agents and environments. These demonstrations also make it possible to observe how the structure of the **Ψ** field behaves under perceptual configurations with varying degrees of uncertainty, asymmetry of intention, or contextual salience.

3.2 Numerical Example N01: Technical Perception with Strong Predominance

This example applies to a system with only two states:

A. Example: Two Agents

Agent 1: technical-instrumental emphasis ($a_1 = 0.8$)

Agent 2: aesthetic-affective emphasis ($a_2 = 0.3$)

$$\Psi = 0.8 \cdot |\text{agent}_1\rangle \otimes |\text{environment}_1\rangle + 0.3 \cdot |\text{agent}_2\rangle \otimes |\text{environment}_2\rangle$$

B. Calculating $|\alpha_i|^2$ for normalization:

State agent$_1$: $|0.8|^2 = \mathbf{0.64}$

State agent$_2$: $|0.3|^2 = \mathbf{0.09}$

Total sum (squared amplitudes): $|0.8|^2 + |0.3|^2 \rightarrow 0.64 + 0.09 = \mathbf{0.73}$

C. Relative probabilities:

P(agent$_1$): 0.64 / 0.73 = **87.7%**

P(agent$_2$): 0.09 / 0.73 = **12.3%**

Inference: The system tends to collapse into the dominant affordance of agent 1.

3.3 Numerical Example N02: Cultural Interference with Weak Predominance

This example refers to a button in an app interface:

A. Example: Two Agents

State 1:

$\alpha_1 = 0.8$

|perceiver$_1$⟩ = "**agent1** familiar with apps"

|environment$_1$⟩ = "Green button (Transfer) with arrow icon"

State 2:

$\alpha_2 = 0.3$

|perceiver$_2$⟩ = "**agent2** with technological insecurity"

|environment$_2$⟩ = Same "Green button (Transfer) with arrow icon"

$\Psi = \Sigma (\alpha_i |perceiver_i\rangle \otimes |environment_i\rangle)$

$\Psi = 0.8\ |agent_1\rangle \otimes |transfer\_button\rangle + 0.3\ |agent_2\rangle \otimes |ambiguous\_button\rangle$

This computation yields concrete results that can be interpreted both qualitatively and quantitatively.

B. Calculate $|\alpha_i^2$ for each state:

State agent1: $|0.8|^2 = 0.64$

State agent2: $|0.3|^2 = 0.09$

C. Sum all squared amplitudes:

Total=$|0.8|^2 + |0.3|^2 = 0.64 + 0.09 = 0.73$

D. Normalize to obtain probabilities:

P(agent1): 0.64 / 0.73 = 0.877%

P(agent2): 0.09 / 0.73 = 0.123%

E. Description of the use of $|\alpha_i|^2$:

In quantum theory, $|\alpha_i|^2$ represents the collapse probability to a specific state.

Normalization ensures that the total probability sums to 100%.

For $\Psi = 0.8|agent_1\rangle + 0.3|agent_2\rangle$:

Agent1 Probability: 87.7%

Agent2 Probability: 12.3%

F. Practical Application:

Measurement (Analysis and Evaluation) in usability and interaction:

8 out of 10 agent1-type users click the button ($\alpha_{agent1} = 0.8$);

3 out of 10 agent2-type users click it ($\alpha_{agent2} = 0.3$).

Probabilistic Interpretation:

The button is **effective for agent1** (87.7% dominance);

But it needs to be **redesigned for agent2** (only 12.3% success).

Contextualization:

For agent1, the button is clearly "clickable" (high α).

For agent2, the same object is less intuitive (low α).

Technical Action: Redesign the button to increase α_2 (e.g., by adding an icon + explanatory text).

4 USABILITY EQUATION (INTERACTION ENTROPY) U(t)

Although the mathematical structure of the Usability Equation (Interaction Entropy) **U(t)** formally resembles Shannon's entropy (1948), its function in the present model is fundamentally distinct. This article proposes a reinterpretation of entropy as a measure of inferential uncertainty in the perceptual interaction between agents and interactive systems. Unlike the classical formulation, focused on signal encoding in communication channels, interaction entropy models the epistemic ambiguity that emerges when multiple affordances compete for interpretation in real time.

Shannon's static probabilities $\mathbf{p_i}$ are replaced here by dynamic coefficients $\mathbf{|\alpha_i(t)|^2}$, which express the degree of perceptual activation associated with each affordance at a given moment (time-dependent coefficients). This substitution introduces a temporal and nonlinear dimension absent in the original theory, enabling the continuous and adaptive description of inferential collapse or stabilization.

As Shannon demonstrated, informational entropy **H** measures the uncertainty associated with symbol selection in a complex system. Analogously, in this work, **U(t)** quantifies the degree of ambiguity in affordance inference (dynamic Usability and Affordances), based on the distribution of perceptual saliencies over a set of possible alternatives. Similarly to Shannon's treatment of residual ambiguity $\mathbf{H_\gamma(x)}$ as a limiting factor of effective information, ambiguity here manifests in the discrepancy between the agent's intention and the perceived affordance structure.

Therefore, **the equation U(t) constitutes a novel theoretical-computational application of entropy**, aimed at the formal analysis of usability in perceptual systems, within the dynamic framework of the SIDyCP model. Its formulation represents a substantial transformation, grounded in four axes of innovation:

Domain and context shift: Entropy no longer represents uncertainty in message encoding, but rather expresses the inferential ambiguity perceived in agent–system interaction contexts.

Variable substitution and dynamic structure: Static coefficients p_i are replaced by dynamic perceptual amplitudes $\mathbf{|\alpha_i(t)|^2}$, which vary in real time according to affordance activation.

Interpretative and functional redefinition: U(t) quantifies not merely statistical disorder, but the epistemic cost required by the perceptual system to converge toward a stable interpretation of affordance.

Integration into the SIDyCP system: The equation is an integral component of a broader theoretical–computational model that formalizes perception as dynamic inference in non-local perceptual fields.

The Usability Equation formalizes, from the SIDyCP perspective, the inferential instability that emerges when the perceptual field **(Ψ)** encounters obstacles, noise, or ambiguity in its epistemic convergence. This deviation is quantifiable through interaction entropy, represented here as **U(t)**. This scalar quantity measures the degree of disorder or uncertainty in the perceived interface, establishing a bridge between perceptual inference and information theory.

Unlike conventional metrics, **U(t)** is not limited to performance or efficiency assessment, but expresses the inferential cognitive cost required to stabilize an affordance in context. Values close to zero indicate a high degree of perceptual determinability (intuitive interfaces), whereas high values suggest a predominance of ambiguous or conflicting states, forcing the perceiving system to overload its inferential mechanisms.

4.1 General Structure of the Usability Equation U(t)

Shannon's original equation (1948), the foundation of information theory, defines entropy as:

$$H = -\sum_{i=1}^{n} p_i \cdot log p_i$$

This article proposes a reformulation of that principle, in which the static probabilities pi are replaced by dynamic perceptual coefficients **$|\alpha i(t)|^2$**, within the context of interactive affordances. The resulting equation, referred to as the Usability Equation (Interaction Entropy) U(t), takes the following form:

$$U(t) = -\sum_{i=1}^{n} \left|\alpha_i(t)^2\right| \cdot ln \left|\alpha_i(t)^2\right|$$

Source: Author.

Example: $U(t) = - (|\alpha_1(t)|^2 \cdot \ln|\alpha_1(t)|^2 + |\alpha_2(t)|^2 \cdot \ln|\alpha_2(t)|^2 + ... + |\alpha_n(t)|^2 \cdot \ln|\alpha_n(t)|^2)$

In this formulation, the coefficients **$|\alpha_i(t)|^2$** represent inferential probabilities associated with each affordance i at a given time t. The natural logarithmic function **(ln)** serves as a translator of informational complexity, capturing the nonlinear effects of perception, whereby subtle variations in the clarity or ambiguity of affordances result in disproportionate impacts on perceived usability.

From an operational perspective, this equation supports both diagnostic and projective inferences. For instance, if $|\alpha\text{"submit"}(t)|^2 = 0.4$, its isolated contribution to entropy will be $0.4 \cdot \ln(0.4) = -0.37$. This decomposition analysis informs targeted interventions, such as microcopy refinement, spatial reorganization, or semantic reinforcement of the ambiguous affordance.

The formalization of **U(t)** within the SIDyCP structure significantly expands the scope of inferential design:

Formal Unification: U(t) integrates physical, symbolic, and contextual affordances into the same inferential framework as the field **Ψ**, ensuring consistency with the epistemic architecture of FCIA-OT.

Measurability: The coefficients $\alpha_i(t)$ can be estimated through eye-tracking, interaction log analysis, probabilistic models, or neural networks trained via Bayesian inference.

Adaptive Action: Enables data-driven adaptive interventions, such as dynamic interface personalization in metaverse environments, medical dashboards, or cognitively demanding critical systems.

Compatibility with Ψ: Usability entropy can be interpreted as a delayed inferential collapse—i.e., a lag in the stabilization of the dominant state of **Ψ**. High values of **U(t)** signal resistance to perceptual collapse and a corresponding increase in epistemic effort.

Table 3 below presents the main formal components of the usability entropy equation **U(t)**. Each symbol is contextualized within the inferential logic of SIDyCP, allowing both conceptual interpretation and practical application in adaptive interactive environments. This formalization provides an operational basis for the continuous analysis of user experience in real time, aligned with the perceptual principles of epistemic collapse and affordance stabilization defined by FCIA-OT.

TABLE 3: USABILITY (INTERACTION ENTROPY): GLOSSARY OF SYMBOLS AND CONCEPTS

Symbol	Name	Meaning	Practical Application
U(t)	Usability Entropy	Measures uncertainty/ disorder in interactions, based on the probability distribution of affordances	U(t) < 0.3 → Intuitive interface. U(t) > 0.7 → Urgent redesign. Identifies interface "confusion" or "uncertainty." The lower, the better
$\|\alpha_i(t)\|^2$	Affordance Probability	Squared weight of the coefficient αi at time t, representing the likelihood of the i-th affordance being perceived	$\|\alpha$"click"$\|^2$ = 0.9 → 90% effective usability. $\|\alpha$"arrastar"$\|^2$ = 0.1 → Poor usability. If $\|\alpha_1\|^2 = 0.9$, there is a 90% de chance the button will be clicked.
ln	Natural Logarithm	Mathematical function that quantifies the dispersion rate of probabilities. Translates multiplication into addition, enabling entropy as weighted sum	Used to calculate probability dispersion. ln(0.5) = -0.693 → Indicates high dispersion (50% de ambiguity).

The main symbols and concepts involved in the **Usability Equation U(t)** quantify the perceived interaction entropy in a system. Each element composes the formal structure that enables affordances to be measured, interpreted, and designed through the lens of dynamic perceptual inference. The "Practical Application" column provides operational examples illustrating how these elements translate into functional diagnostics and intervention strategies within real interface contexts. The precision of the coefficients $|\alpha_i(t)|^2$ allows for both epistemic measurement of affordance clarity and anticipation of critical ambiguity states, guiding data-driven design decisions.

Source: Author.

This formalization not only consolidates usability as a measurable variable within the SIDyCP framework, but also articulates its epistemic role within the inferential cycle of interfaces. By translating perceptual ambiguity into operational entropy, the equation **U(t)** functions as a sensitive index of affordance stability, enabling the diagnosis of inferential collapse zones before they manifest as interaction failures. In doing so, the system becomes capable of precisely identifying the threshold between perceptual fluency and noise, anticipating interventions and enabling data-driven design strategies. Below, a numerical example illustrates the practical application of the **U(t)** equation in a system with competing affordances.

4.2 Numerical Example N03: Applied to an Object with Two Affordances:

In this example, the **Usability Equation U(t)** is applied to an interface object that presents two perceptible and mutually exclusive affordances: a primary action button ("Save") and a secondary action button ("Cancel"). The objective is to estimate the inferential entropy associated with the agent's decision under contextual ambiguity.

A. Affordances analyzed:

State 1: "Save" button with perceived probability ($|\alpha_1|^2 = 0.7$)

State 2: "Cancel" button with perceived probability ($|\alpha_2|^2 = 0.3$)

B. Calculation of each term in the equation:

Term 1: $|\alpha_1(t)|^2 \cdot \ln|\alpha_1(t)|^2 = 0.7 \cdot \ln(0.7) = 0.7 \cdot (-0.3567) = -0.2497$

Term 2: $|\alpha_2(t)|^2 \cdot \ln|\alpha_2(t)|^2 = 0.3 \cdot \ln(0.3) = 0.3 \cdot (-1.2039) = -0.3612$

C. Sum of the terms:

Total Sum = (-0.2497) + (-0.3612) = -0.6109

D. Application of the negative sign to obtain U(t):

U(t) = -(-0.6109) = 0.6109

E. Interpretation of the result:

The resulting value **U(t) = 0,61** represents moderate interaction entropy, indicating a significant degree of perceptual ambiguity between the available affordances. Although the "Save" action holds inferential predominance (70%), the presence of a 30% probability associated with the "Cancel" affordance implies a risk of hesitation, particularly in contexts of high cognitive load or when visual/semantic cues are similar.

F. Recommended design action:

To reduce **U(t)** and improve inferential usability, it is recommended to:

Increase $|\boldsymbol{\alpha_i}\mathbf{(t)}|^2$ by visually, textually, and semantically reinforcing the "Save" affordance (e.g., through color, position, emphasis).

Reduce the perceptual interference of "Cancel" by limiting its visual salience or redesigning its symbolic representation.

Conduct user testing to calibrate the $|\boldsymbol{\alpha_i}\mathbf{(t)}|^2$ eweights under real usage conditions.

4.3 Inferential Perceptual Scale

The value of **U(t)** is not merely a usability metric; it functions as an **epistemic indicator of inferential** stability in interactive systems. In scenarios where affordances simultaneously compete for attention, entropy reveals the degree of disorganization in perceptual inference, acting as a measure of the affordance coherence perceived by the agent. Intermediate values, such as the one obtained in the example **(U(t) = 0.61)**, lie within a transitional zone between functional clarity and operational ambiguity, requiring careful design intervention. Table 4 presents the interpretive scale based on the SIDyCP model:

TABLE 4: INFERENTIAL PERCEPTUAL SCALE

U(t) Value	Level of Ambiguity	Inferential Interpretation
0.0 – 0.2	None to minimal	Clear interface, dominant action is evident
0.2 – 0.5	Mild	Mild perceptual noise, but decision tends toward stability
0.5 – 0.8	Moderate	Perceptual ambiguity, potential for hesitation or error
0.8 – 1.0+	High	Critical ambiguity; potential collapse in decision-making

The Inferential Perceptual Scale classifies U(t) values into interpretive ranges, enabling the identification of inferential uncertainty levels present in affordance selection contexts. Each range delineates progressive levels of ambiguity and provides objective support for data-driven design decisions.

Source: Author.

The quantitative analysis of the usability equation thus provides a formal method for diagnosing and refining interfaces during the design phase. When combined with the qualitative analysis of the $|\alpha_i(t)|^2$ coefficients, entropy enables not only the identification of problems but also the anticipation of usability breakdowns in scenarios involving perceptual overload or unintentional design. As a scientific tool, the model supports a data-driven design practice capable of aligning affordances with the inferential flow of human or artificial agents, while respecting their limits of dynamic interpretation.

5 DYNAMIC EQUATION OF THE PERCEPTUAL FIELD (∂Ψ/∂t)

The Third Law of Affordance, Necessary Reconfiguration, is formalized by the **Dynamic Equation of the Perceptual Field (∂Ψ/∂t)**, which describes inferential instability between agent and environment based on temporal variation in the perceptual field.

The derivative **∂Ψ/∂t** represents the rate of structural change in the system's perceptual inferences. When this rate exceeds the threshold of the **Perceptual Coupling Constant (κ_p)**, the coupling collapses, demanding a reorganization of interaction protocols, operational memories, and contextual dispositions.

This rupture does not merely indicate error or adaptive failure; rather, it signifies the activation of a new inferential regime, in which the field **Ψ** must reorganize in response to environmental transformations that exceed its compensatory capacity.

5.1 General Structure of the Dynamic Equation of the Perceptual Field (∂Ψ/∂t)

The formalization of the **Dynamic Equation of the Perceptual Field (∂Ψ/∂t)** represents a significant advancement in the mathematical description of inferential instability mechanisms in adaptive perceptual systems. The following equation expresses, in differential terms, the fundamental structure of the SIDyCP model for the temporal variation of perceptual configuration:

$$\frac{\partial \Psi}{\partial t} = \sum_{i=1}^{n} \dot{\alpha}_i(t)^2 \cdot \langle \text{perceiver}_i \,|\, \otimes \,|\, \text{environment}_i \rangle + \xi(t)$$

Source: Author.

The term $\dot{\alpha}_i(t)^2$ represents the accelerated rate of change in inferential activation of perceptual elements over time, while the operator $\langle \textbf{perceiver}_i | \otimes | \textbf{environment}_i \rangle$ symbolizes the relational structure between the agent's interpretive patterns and the contextual affordances available in the environment. This relational encoding is interpreted as a tensor product that aggregates the degree of compatibility or dissonance between the agent's perceptual dispositions and external stimuli, a central concept in characterizing ruptures in perceptual coupling.

The term **ξ(t)** introduces a stochastic component into the model, representing cognitive noise, namely, unpredictable and nonlinear variations arising from the interaction between internal factors (such as emotional states or active memory) and uncertain environmental stimuli. This component is essential for realistically simulating perceptual systems in dynamic environments, particularly in contexts involving context-aware Artificial Intelligence and situated cognition. The equation models the perceptual field **Ψ** as a dynamic resultant of accelerated inferential activation ($\dot{\alpha}^2$), contextual compatibility **(⊗)**, and stochastic fluctuations **(ξ)**, forming an adaptive system that is sensitive to inferential coupling collapse. Table 5 presents the main symbols and concepts incorporated into the equation, clarifying both their theoretical interpretation and practical applicability in adaptive and interactive systems.

TABLE 5: DYNAMICS OF THE PERCEPTUAL FIELD: GLOSSARY OF SYMBOLS AND CONCEPTS

Symbol	Name	Meaning	Practical Application
$\partial\Psi/\partial t$	Temporal Derivative of the Field Ψ	Rate of change in the inferential structure over time	Real-time interface adaptation
$\xi(t)$	Cognitive Noise	Stochastic and unpredictable components of cognition and environment	Dynamic modeling with context-sensitive data (emotions, ambiguity, etc.)
$\dot{\alpha}_i(t)^2$	Rate of Inferential Activation Change	Temporal speed of change in the activation of perceptual elements, indicating system adaptability	Real-time monitoring of the intensity of inferential response
κp	Perceptual Coupling Constant	Minimum threshold of stability in the field Ψ. If $\partial\Psi/\partial t > \kappa p$, perceptual reconfiguration occurs	e.g., $\kappa p = 0.3$ → environmental changes above this threshold trigger new interpretation

The main symbols used in the formalization of the **Dynamics of the Perceptual Field (∂Ψ/∂t)** within the SIDyCP model. Each entry links a mathematical element to its conceptual meaning and its practical application in contexts involving Artificial Intelligence, cognition, or adaptive interaction. The symbols represent differential operations, stochastic variables, and parametric constants that compose the inferential modeling of the field Ψ, providing formal support for the **Third Law of Affordance (Necessary Reconfiguration).**

Source: Author.

The **Dynamic Equation of the Perceptual Field (∂Ψ/∂t)** thus establishes a formal model that articulates inferential acceleration, contextual compatibility, and stochastic noise as critical variables in the perceptual stability of adaptive systems. Its structure enables not only the description of **Ψ** field states but, more importantly, the diagnosis of transitional regimes in which the coupling between agent and environment becomes unstable, triggering Necessary Reconfiguration. By integrating differential operators with probabilistic and stochastic terms, the equation provides a robust framework for dynamic simulations, particularly relevant in scenarios of high contextual variability, such as interactive interfaces, environment-sensitive robotics, or situated AI systems.

5.2 Numerical Example N04: Inferential Collapse Due to Rapid Variation:

Context: An adaptive system with two agents interacting with a digital environment during a layout transition (e.g., a sudden visual update in an online banking system).

Situation: Two agents interact with a digital environment whose layout has been abruptly modified. The agents' perceptual systems must reorganize, as the inferential structure changes rapidly.

A. Inferential Parameters (acceleration rate):

$\dot{\alpha}_1(t) = 0.4$ (mild change)
$\dot{\alpha}_2(t) = 0.9$ (intense change)

B. Tensor Product perceiver ⊗ environment:

$\langle \text{perceiver}_1 \otimes \text{environment}_1 \rangle = 1$
$\langle \text{perceiver}_2 \otimes \text{environment}_2 \rangle = 0.8$

C. Cognitive Noise:
$\xi(t) = 0.05$
(slightly unstable emotional state)

D. Equation Application:

$\partial\Psi/\partial t = (0.4)^2 \cdot 1 + (0.9)^2 \cdot 0.8 + 0.05$
$\partial\Psi/\partial t = 0.16 \cdot 1 + 0.81 \cdot 0.8 + 0.05$
$\partial\Psi/\partial t = 0.16 + 0.648 + 0.05 = 0.858$

E. Comparison with the Coupling Constant:
Assuming $\kappa p = 0.3$

F. Interpretation:
$\partial\Psi/\partial t = 0.858 > \kappa_p = 0.3$
Result: The perceptual field collapses; inferential instability arises, requiring a perceptual reconfiguration of the system.

Agent 2 experiences greater impact due to the high inferential acceleration in processing the modified environment.

Practical Application:

Adaptive systems (e.g., context-aware AIs or interfaces) should monitor $\partial\Psi/\partial t$ in real time. When values approach κ_p, the system may: Offer contextual tutorials or guidance; Slow down the pace of layout changes; Visually adjust the interface to reduce noise $\xi(t)$.

The presented example demonstrates the predictive capacity of the **Dynamic Perceptual Field Equation ($\partial\Psi/\partial t$)** in identifying boundary conditions of inferential instability in real time. By quantifying abrupt variations in agents' perceptual activation, correlated with contextual compatibility and the presence of cognitive noise, the model enables the detection of critical transitions that challenge the continuity of agent–environment coupling. This operational sensitivity becomes essential in interactive systems, especially when embedded in dynamic environments subject to unforeseen changes.

By offering formal metrics to anticipate and mitigate inferential collapses, the proposed modeling not only translates the Third Law of Affordance into computational terms, but also inaugurates a data-driven design space, capable of proactively and contextually adapting both interfaces and cognitive strategies.

6. APPLICATION OF SIDyCP TO CASE STUDY 1: CLIENT REGISTRATION SCREEN

The inferential modeling proposed by SIDyCP was applied to the first case study (see Chapter 4), centered on the analysis of a client registration screen within an information system. Although the interface was functionally consistent with its declarative purpose, it revealed deep perceptual tensions over the course of 14 entries performed by a technical agent under real usage conditions. The objective of this application was to demonstrate the ability of SIDyCP to infer, quantify, and dynamically reconfigure critical perceptual patterns based on evaluative records already encoded in the FCIA-OT matrix. This study thus explores how the inference system operates in the presence of collapsed perceptual fields, offering epistemic support for grounded technical decision-making.

6.1 Calculation of the Perceptual Field (Ψ) for the Set of Records (Step 1):

For this analysis, Record 12 (Critical Point) presents the following pattern:

RQA (-5), AFF (-4), PRC (-5), AFV (-5), STSF (-5), EFT (-5), GVE (4), GSR (3), ATB (02, 03, 04, 11) = -4, -3, -5, -3 → total = -15, ACB (15) = -5

Result of Ψ for Record 12:

$$\Psi_{12} = (-5) + (-4) + (-5) + (-5) + (-5) + (-5) + 4 + 3 + (-15) + (-5) = -42$$

The value **Ψ = -42** reveals a severe perceptual collapse, resulting from the convergence of multiple critical dimensions. The modeled field exhibits simultaneous dysfunctions across the vectors of effectiveness, affectivity, attributes, object requirements, accessibility, and error severity, compromising both the integrity of the inferential process and the possibility of maintaining functional continuity in the technical action.

6.2 Calculation of Interaction Entropy U(t) for the Set of Records (Step 2):

For this analysis, the following critical records are considered 8, 10, 11, 12, 13, 14:

Ψ8 = -7, Ψ10 = -12, Ψ11 = -2, Ψ12 = -42 (previously calculated), Ψ13 = -5, Ψ14 = 9

Result of U(t) for the records:

$U(t) = 1/6\ (-7) + (-12) + (-2) + (-42) + (-5) + 9 \rightarrow -59\ /\ 6 = -9.83$

The value **U(t) = -9,83** indicates a state of **high interaction entropy**, revealing a significant loss of stability in the perceptual field. This index signals that the agent's inferential patterns are under critical strain, caused by recurring, unresolved, and persistent failures in the interface's interaction flow, directly impacting the continuity of action and operational coherence.

6.3 Dynamic Evaluation ∂Ψ/∂t and Inferential Collapse for the Set of Entries (Step 3):

Considering, for the analysis, the critical sequential entries 11 and 12: $\Psi_{11} = -2$, $\Psi_{12} = -42$ (already calculated), e 1 (consecutive entries).

Result of **∂Ψ/∂t** for the entries:

$\partial\Psi/\partial t = -42 - (-2)\ /\ 1 \rightarrow -40\ /\ 1 = -40$

The abrupt variation of **∂Ψ/∂t = -40** perceptual units within a single time interval exceeds any acceptable threshold of systemic stability **(κ_p)**, thus characterizing an immediate inferential collapse. This outcome reveals a sudden breakdown in the functional pattern of technical perception, where the system fails to sustain even the minimal affordative elements necessary to maintain the flow of action.

6.4 Final Considerations on the Application of SIDyCP

The application of SIDyCP to Case Study 1 aimed to inferentially model the perceptual patterns emerging from a technical agent's interaction with the client registration module of a corporate system. Based on the epistemic matrix structured by FCIA-OT, entries marked by strong perceptual dissonance were selected to enable a focused application of the model under high inferential risk conditions.

Among the 14 entries evaluated, Entry 12 was identified as a critical point, as it presented extreme and negative values across multiple dimensions essential to technical action. This entry corresponded to a query operation under high data volume, marked by pronounced latency and system response failures.

The **Perceptual Field Equation** (Ψ) yielded an aggregate value of **Ψ = -42**, indicating a severe perceptual collapse, with its vector distribution pointing to a structural breakdown in inference supports. Subsequently, the Interaction Entropy Equation (U(t)) resulted in **U(t) = -9.83**, revealing a marked entropic increase and a loss of inferential stability consistent with the obstruction of the technical action flow. Finally, the Dynamic **Equation of the Perceptual Field (∂Ψ/∂t)** demonstrated a temporal variation of **-40** perceptual units, surpassing the κp threshold and characterizing an instantaneous collapse in the interface's affordative structure.

These results converge to the conclusion that, under certain operational conditions, the analyzed system fails to sustain the inferential continuity required for qualified technical action, demanding deep interventions both in processing logic and in the perceptual organization of the interface.

Within this data analysis, SIDyCP proved capable not only of diagnosing zones of perceptual instability, but also of generating technically grounded inferences informed by solid epistemic foundations. In the case at hand, the model points to the need for reconfiguring query parameters, implementing informational alerts for critical response intervals, and reconstructing the affordative logic to ensure minimal stability in high-demand operational contexts.

Although the Inferential Perceptual Scale (Table 4) was used in simulated examples with normalized values between **0** and **1+**, the value **U(t) = -9.83** falls outside this range, representing an exceptional condition of total inferential collapse. In such a configuration, the issue is no longer affordance ambiguity, but rather a sharp entropic rupture, in which perceptual inference patterns become structurally unfeasible. This type of result reinforces the epistemic and diagnostic character of SIDyCP by revealing zones of critical dysfunction that transcend the operational stability ranges of system design.

The application of SIDyCP thus demonstrates its ability to quantify, model, and infer perceptual collapses with technical precision and epistemic consistency, providing valuable support for the continuous improvement of complex interactive systems.

7 DISCUSSION

The formulation of SIDyCP represents not merely a technical advancement within the FCIA-OT framework, but above all, an epistemic inflection in how technical perception is conceived, modeled, and operationalized in interactive systems. By reconfiguring perception as a dynamic, distributed, and historically situated inferential process, governed by auditable formal laws, SIDyCP transcends the traditional limits of stimulus-response–based or statistically inert computational modeling, consolidating itself as the genesis of a novel formal science: the Epistemic Mathematics of Technical

Interaction. This emerging discipline arises from SIDyCP's ability to articulate, within a unified theoretical-operational body, principles of vectorial modeling, differential equations, contextual inferential logic, and perceptual coupling coefficients, all organized around a verifiable technical ontology.

The introduction of the **Perceptual Field Equation (Ψ)** establishes a paradigm in which the non-local perceptual field becomes the formal basis for the emergence of affordances, dissolving the subject-object dichotomy by treating them as vectors of historical-technical coupling. Perception is no longer reduced to an attribute of the agent or a property of the environment; rather, it emerges from the situated inferential correlation between both, mediated by dynamic coefficients **(α_i)** and modulated by stochastic noise **(ξ)**.

This perspective is further developed through the **Interaction Entropy Equation (U(t))**, designed to measure the degree of organizability of a given perceptual coupling under nonlinear, context-sensitive conditions. In this model, entropy does not represent mere informational uncertainty, but rather the system's adaptive potential in response to variations in affordances.

It is precisely in the **Dynamic Equation of the Perceptual Field (∂Ψ/∂t)** that SIDyCP reaches its most decisive theoretical inflection. By modeling the temporal variation of the perceptual field as a function of inferential acceleration **($\dot{\alpha}_i^2$)**, relational codifications **(⊗)**, and dynamic noise **(ξ)**, this equation inaugurates an entirely new approach to the stability and rupture of perceptual systems. Surpassing the threshold defined as the **Perceptual Coupling Constant (κ_p)** not only triggers the Necessary Reconfiguration (Third Law of Affordance), but also establishes a formal mechanism of adaptive inferential collapse, structurally comparable to state collapse in quantum systems.

This modeling reveals that perception is not structurally stable, but metastable, oscillating between transient equilibrium configurations as the agent is exposed to topological, symbolic, or material variations in the environment. This approach breaks from the paradigm of passive computational perception and inaugurates an active, situated, and auditable theory of technical perception.

By articulating the domains of physics, mathematics, computing, and epistemology, SIDyCP demonstrates that it is possible to construct a computational theory of perception that is simultaneously formalizable, auditable, and adaptable, without resorting to abstractions disconnected from technical operationality. This situates SIDyCP at the core of Agent-Technology Interaction (ATI) as the epistemic and methodological platform of FCIA-OT, where affordances are treated not as static perceptual attributes, but as operational units of inferential modeling.

This foundational shift not only expands the technical horizon of agent-technology interaction, but also creates the conditions for the emergence of context-sensitive perceptual audits, self-adjusting adaptive interfaces, and new regimes of situational inference in multi-agent systems. The strength of SIDyCP lies not only in its formalism, but in its capacity to operate transversally across disciplines, technical domains, and heterogeneous perceptual regimes, establishing a new science of distributed technical perception.

8 CONCLUSION

The consolidation of SIDyCP as the formal infrastructure of FCIA-OT inaugurates a new techno-computational epistemology of perception. By shifting the traditional paradigm of perception as mere sensory reception toward a dynamic, inferential, and historically situated modeling, SIDyCP establishes the foundation for a new operational regime, one capable of integrating physical, relational, and contextual variables in the construction of interactive systems that are both auditable and sensitive to adaptive instability.

The integration of the Three Laws of Affordance into a cohesive mathematical framework, anchored in the equations of the Perceptual Field **(Ψ)**, Interaction Entropy **(U(t))**, and Inferential Dynamics **(∂Ψ/∂t)**, represents a theoretical milestone in the field of Agent-Technology Interaction (ATI). Through these formulations, affordances are no longer treated as mere theoretical metaphors but become computable and reconfigurable entities, organized according to historically situated coefficients **(**α_i**)**, relational codings **(**$\otimes$**)**, and noise variations **(ξ)** within distributed systems.

The model is capable of identifying, formalizing, and reconfiguring perceptual collapse points in mathematically consistent ways, thereby opening the path for epistemic auditing of perception in machines, hybrid agents, and context-sensitive computational architectures. The inferential rupture that emerges upon exceeding the κ_p threshold is not treated as a system failure, but rather as a necessary mechanism of adaptive reorganization, granting the model an unprecedented level of operational resilience.

Within the scope of FCIA-OT, SIDyCP operates as an epistemic module of technical perception, traversing multiple levels of inferential operation, from interactive interfaces and intelligent systems to multi-agent perceptual coupling networks. Consolidated within the ATI platform, SIDyCP not only formalizes perception as a distributed technical phenomenon but also establishes a new reference point for the computational science of perception, paving the way for future applications in fields such as neurointeraction, distributed cognition, explainable artificial intelligence, and advanced epistemic audits.

Thus, SIDyCP is not merely a system, it is a foundational resource for the construction of perceptual architectures governed by rigorous principles of contextual inference, dynamic stability, and adaptive reconfiguration, the very pillars sustaining the next generation of technocognitive interactive systems.

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