META-EPISTEMOLOGY OF SMALL GROUPS: FEEDBACK CYCLE AS THE PRIMARY OPERATOR OF KNOWLEDGE-PRODUCTION IN MULTI-AGENT CONFIGURATIONS

Parallel trajectories in a high-dimensional meaning-space under irreducibly heterogeneous perception

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ABSTRACT

The paper formalizes a meta-epistemological thesis: in a multi-agent configuration $C = (H, \{A_i\})$ the probability of reframing P_{reframe} and the convergence rate v_{conv} are determined not by the fidelity of a single transmission channel but by feedback-cycle length τ_{cycle}, role-operator dispersion Λ_{role}, and configuration cardinality N_{conf}. The ODTOE framework [1] and its multi-agent extension EraDev [2] are augmented with eleven symbols (F1-F11), where F1-F7 form the primary formal layer and F8-F11 extend the formalism through the axes of stickiness and coordinated-distortion gradient, describing: the problem-holder frame as a linear projector (F4), role dispersion (F2), OR-aggregation of independent reframings (F1), the inverse dependence of v_{conv} on τ_{cycle} (F3), a hypothesized diversity-scaled amplification (log-saturating in N_{conf}) (F5), a meta-epistemological productivity metric (F6), a sufficiency threshold for received meaning (F7). Six testable predictions P1-P6 (solo vs small group, half-cycle acceleration, saturation at $N_{\text{conf}} = 5$, frame-projector shrinkage, sufficiency-path throughput, stickiness via group cycle) define an experimental programme. "They do not hear me" is decomposed into three structurally distinct forks — altering the other's observation operator, altering one's own, or accepting the irreducible difference of perceptions — the last of which is reinstated as a working strategy subject to $B_{\text{received}} \geq B_{\text{min}}$.

Keywords: meta-epistemology, multi-agent configurations, feedback cycle, role dispersion, reframing, OODA loop, PDCA, ODTOE, small group, parallel trajectories.

I. INTRODUCTION: THE PROBLEM OF PARALLEL TRAJECTORIES OF KNOWLEDGE

The traditional formulation of a communication question frames the problem as one of transmission: the sender encodes an intent, the channel conveys it, the receiver decodes; the completeness of meaning at the output is measured by the closeness of the decoded form to the encoded one. Within this frame “they do not hear me” is a diagnosis of a damaged channel or insufficient clarity of formulation.

The present work starts from a different formulation. Under conditions where the receiver is not a passive decoder but constitutes the perceived through their own observation operator [1], the question of channel fidelity becomes secondary. What becomes primary is the question “why do they not hear me the way I want?” — and here the fork of the answer turns out to be three-pronged rather than single-pronged: (a) altering the context of the other so that their operator perceives closer to the intent; (b) altering one’s own perception and one’s own intent, since part of the gap is a function of one’s own formulation; (c) accepting that what the receiver receives is not obliged to coincide with the original intent, and asking the question of sufficiency rather than of coincidence.

Thesis of the paper: under irreducibly heterogeneous perception — that is, under the condition that the observation operators of the participants $\hat{O}_i$ do not coincide and cannot be reduced to a single one without loss — knowledge-production moves along parallel trajectories in a high-dimensional meaning-space. Convergence of these trajectories — when it is attainable at all — is determined not by the fidelity of a single channel but by feedback-cycle length τ_{cycle}, role-operator dispersion Λ_{role}, and configuration cardinality N_{conf}. This is a shift of focus from the linear “signal-noise” metric to a structural metric of configuration.

The paper is organized as follows. Section II reproduces the ODTOE theoretical basis without redefinition: the quantities B, S_{team}, S_{adjusted}, Ψ, $\hat{O}$, ι, the spiral gap $(\pi-3)^2$, and the activation operator $\hat{H}$ [1-6]. Section III discusses the relativity of knowledge as a pair “field of states + observation operator at time t”, drawing on the lines of Kuhn [17], Vygotsky [9], and Bakhtin [10]. Section IV introduces F4 — the problem-holder frame as a linear projector that restricts the configuration space. Section V formalizes the role of configuration and derives F1, F2: the OR-aggregation of reframings and the definition of role dispersion. Section VI introduces F3 — v_{conv} as a function of τ_{cycle}, tying it to OODA [7] and PDCA [8]. Section VII distinguishes “method” from “configuration”: neither TRIZ, nor SSM, nor their combination is optimal outside the context of the task — a consequence of the freedom of $\hat{O}_i$. Section VIII formalizes three forks (a)/(b)/(c), reinstating fork (c) via the sufficiency threshold $B_{\text{received}} \geq B_{\text{min}}$ (F7). Section IX gives six testable predictions P1-P6 and two service formulas (F5 — a heuristic hypothesis, F6 — a productivity definition). Section X discusses scope of applicability, the 2%-spiral gap, and open questions.

Contribution of the paper: translating the posed question from the rhetorical plane (“how to get through?”) into a structurally measurable one (“what are τ_{cycle}, Λ_{role}, N_{conf} of my configuration, and which of the three forks is preferable with respect to them?”). Novelty relative to [2,3]: [2,3] fix the five-role architecture and $n_{\text{min}} = \lceil\pi\rceil + 1$ as the stability condition; the present work shifts the axis from configuration stability to its primary operator of knowledge — the feedback cycle itself.

I.0. Metaphor: the recipe that does not transfer by instruction

Two women have cooked the same dish all their lives. It never comes out identically: one adds a little more salt, the other a little less onion. Yet any guest recognizes the taste — it is *their* shared dish. When one decides to transfer the recipe to her daughter with perfect precision — grams, seconds, temperature — the daughter cooks *correctly* but unrecognizably. Exact transfer fails.

But if the daughter spends a week standing nearby, doing it her own way, making mistakes, asking questions — the recipe transfers. Not exactly. But alive. Because the daughter took into it *her own* distortions, and it was precisely these that made it hers.

This metaphor is not decorative. It describes a structural law of knowledge transfer between carriers with non-zero cognitive coherence $B > 0$: the attempt to eliminate the individual "one's own way" destroys the contact for which the transfer was initiated in the first place. The present work formalizes this law within ODTOE and shows that *coordinated distortion* is not a metaphorical artifact but a necessary condition for sustainable transfer in a multi-agent configuration (see Appendix C).

II. ODTOE THEORETICAL BASIS

This section reproduces without redefinition the key quantities and notation of ODTOE [1] and its multi-agent extension [2-6] used in what follows. All notation is language-invariant and fixed by the corpus convention of the series [1-6].

II.0. Notation summary

Symbol	**Definition**	**Introduced in**
$B(O, C)$	agent-configuration coherence	II.1, [1]
S_{team}	team coherence	II.2, [2]
S_{adjusted}	phantom-coherence-corrected	II.3, [2]
$\hat{O}$	general observation operator (non-linear)	II.3, [1]
Π_H	frame-restriction map (projector)	IV.2
$\Psi, \mathcal{C}$	state space, configuration space ($\mathcal{C} \subset \Psi$)	II.3, IV.2
τ_{cycle}	feedback-cycle length	V.1
Λ_{role}	role dispersion (F2′)	V.2
N_{conf}	configuration cardinality	V.3
N_{repeat}	number of group cycles in time t	VI.6
N_{carriers}	adopters by time t (F11)	X.4
v_{conv}	convergence rate (F3)	VI.3
B_{persist}	persistence of understanding over time (F8)	VI.6
$B_{\text{received}}, B_{\text{intended}}$	received / intended coherence	VIII.5
B_{min}	sufficiency threshold (F7)	VIII.6
T_{tip}	tipping fraction (F9)	VI.6
σ_{stick}	stickiness coefficient (F8)	VI.6
$V_{\text{practical}}$	practical value (F10, bell curve)	VI.6
P_{reframe}	reframing probability (F1)	V.3

II.1. Agent cognitive coherence

For an observer-configuration pair $B(O, C)$ is introduced as a multiplicative scalar on $[0, 1]$ [1, 2]:

$$B(O, C) = F \cdot E \cdot (1 - \sigma) \cdot \Lambda \tag{II.1}$$

where F is attentional focus, E is alignment with the target, $(1 - \sigma)$ is consistency, Λ is accumulated experience. The multiplicative structure entails the weakest-link principle: zeroing any component zeros B.

II.2. Team coherence and phantom-coherence correction

Coherence of a team of n agents [2, 3]:

$$S_{\text{team}} = 1 - \frac{2}{n(n-1)} \sum_{i<j} |B_i - B_j| \tag{II.2}$$

A corrected coherence that detects phantom coherence (when all B_i are small but close to each other) is separately introduced [2]:

$$S_{\text{adjusted}} = S_{\text{team}} \cdot \bar{B}, \quad \bar{B} = \frac{1}{n} \sum_{i=1}^{n} B_i \tag{II.3}$$

II.3. Field of states, observation operator, embedding

The observation cycle in ODTOE is given by the composition [1]:

$$\Psi \to \hat{O}(\Psi) \to R \to \iota(R) \to \Psi' \tag{II.4}$$

where Ψ is the field of potential states, $\hat{O}$ the observation operator, R the realized configuration, ι the embedding (feedback) operator. The operator $\hat{O}$ in ODTOE is not assumed linear in the standard quantum-mechanical sense; it is defined as a mapping $\mathcal{H} \to \mathbb{C}$ parameterized by observer properties [1].

II.4. The 2%-spiral gap

For cycles that span a full turn along the π-topology of the strange loop, a characteristic gap is introduced [3]:

$$\varepsilon_{\text{spiral}} = (\pi - 3)^2 \approx 0.02 \tag{II.5}$$

The gap $\varepsilon_{\text{spiral}}$ is not a measurement error but a structural quantity: in any closed cycle configuration there remains $\sim$2% of unresolved divergence, which is carried into the next cycle as residual reframing energy.

II.5. Activation operator

Each agent, before generation, performs a four-step activation operator [4]:

$$\hat{H} = \hat{A}_\Lambda \circ \hat{A}_\sigma \circ \hat{A}_E \circ \hat{A}_F \tag{II.6}$$

The sequence is fixed: $\hat{A}_F$ (focus) $\to$ $\hat{A}_E$ (alignment) $\to$ $\hat{A}_\sigma$ (consistency) $\to$ $\hat{A}_\Lambda$ (experience). The order is non-commutative [4]: permutation yields incompatible artifacts.

II.6. Minimal stability condition

For the stability of the closed cycle upon loss of one member, the following is required [3]:

$$n_{\text{min}} = \lceil \pi \rceil + 1 = 4 + 1 = 5 \tag{II.7}$$

This condition determines the lower bound of N_{conf} that provides redundancy upon loss of a role [3].

The notation II.1-II.7 is used in subsequent sections without re-introduction. The new symbols F1-F11 introduced below are marked either as derived from II.1-II.7 or as extensions consistent with them.

III. THE RELATIVITY OF KNOWLEDGE

III.1. Knowledge as a pair: field of states and observation operator in time

The claim "Newton discovered the laws of motion", within the ODTOE frame, is more accurately rewritten: the laws of motion as a stable configuration R were registered by the pair "field Ψ of classical mechanics + observation operator $\hat{O}_{t_0}$ of Newton at epoch t_0". The same pair at epoch $t_1 \gg t_0$ functions differently: the field Ψ remains the same (classical trajectories have not disappeared), but the operator $\hat{O}_{t_1}$ — the operator of the contemporary reader — carries quantum-mechanical and relativistic constraints that $\hat{O}_{t_0}$ did not carry.

Formally: knowledge is a pair $K = (\Psi, \hat{O}_t)$. A shift $t_0 \to t_1$ changes R even under identical Ψ, since $\hat{O}_{t_1}(\Psi) \neq \hat{O}_{t_0}(\Psi)$ in the general case. In this sense "Newton-then" and "Newton-now" are two distinct registrations of the same field of states.

III.2. Shift operators and the non-simultaneity of interpretations

The transition between epochs is formally described by a shift operator $\hat{U}_{t_0 \to t_1}$ acting on the pair:

$$\hat{O}_{t_1} = \hat{U}_{t_0 \to t_1} \, \hat{O}_{t_0} \, \hat{U}^{-1}_{t_0 \to t_1} \tag{III.1}$$

Invertibility of $\hat{U}_{t_0 \to t_1}$ is not assumed: in the general case the shift operator acts asymmetrically on the observation operator (the future remembers the past, but the past does not remember the future).

Consequence: when a classical work is read in a contemporary epoch, the reader's R-interpretation cannot be reduced to the author's without loss; the gap between them is a function of $\hat{U}_{t_0 \to t_1}$ and depends on the conceptual structures accumulated in $\hat{O}_{t_1}$ [17]. This is a formalization of Kuhn's [17, pp. 111-135] observation on paradigm incommensurability: a paradigm shift alters $\hat{O}$, not Ψ.

This position aligns with Latour's sociology of scientific knowledge [18] (knowledge as a product of actor networks rather than correspondence to an independent reality) and Polanyi's epistemology of personal knowledge [19] (tacit knowledge transferable only through shared practice, not through propositional descriptions).

III.3. Knowledge as a socio-dialogical construction

The line of Vygotsky [9] and Bakhtin [10] augments this formalization: the observation operator is formed in dialogue, not in isolation. In Vygotsky [9] inner speech arises as interiorization of external dialogue; in Bakhtin [10] the word is fundamentally double-voiced — it carries an addressee within it. In ODTOE terms this means that the $\hat{O}_i$ of a particular agent is not an autonomous function of that agent's individual properties, but is the result of embedding in a configuration: $\hat{O}_i = \hat{O}_i(C)$, where C is the configuration including other agents.

This justifies the shift from individual to configurational focus in Section V: the claim that "knowledge is not separable from the operator, and the operator is not separable from the configuration" leads to the configuration itself becoming the primary unit of analysis.

Delineation from the literature. The thesis of the social construction of cognitive operators is consonant with several programmes that the present work extends, not reproduces. Hutchins [33] formulates distributed cognition as a process spanning humans and artifacts; ODTOE supplies a quantitative framework (F1-F11) that Hutchins does not have. Nonaka and Takeuchi [34] SECI model (Socialization-Externalization-Combination-Internalization) describes tacit/explicit knowledge dynamics; our P_{reframe} formalism is focused on *reframing probability* in small groups, not on tacit-explicit conversion. Sperber and Wilson [35] Relevance Theory offers a communication framework based on cognitive effect vs effort; F7 ($B_{\text{received}} \geq B_{\text{min}}$) operationalizes sufficient effect via the ODTOE B-formula without Gricean implicature infrastructure. Surowiecki [36] is a popular-level prefiguring of diversity-driven aggregation, without formal derivation. Thus the present work adds (a) φ-toric geometry as a structural basis ([3]), (b) six quantitative predictions P1-P6, (c) an explicit feedback-cycle formalism (F3, F6), absent from all four programmes.

III.4. Scope of applicability

The formalization III.1 does not provide a universal rule for translating $\hat{O}_{t_0}$ into $\hat{O}_{t_1}$; it only fixes the structure of the dependence. Reconstruction of $\hat{U}_{t_0 \to t_1}$ for a specific pair of epochs is an empirical task solvable only through a corpus of historical evidence (texts, artifacts, protocols). Therefore in the present work the pair $(\Psi, \hat{O}_t)$ is used as an analytical instrument, not as a computational procedure.

III.5. Empirical base: illustrative vignettes from applied practice

The article's thesis is illustrated by twenty observational cases aggregated from the author's applied organizational and consulting practice. Each case documents: the initial simplified model of a group or team, the gap with multifactor reality, the working solution found, and the illustrated structural rule. Fourteen cases demonstrate *coordination of distortions* as mechanism; six serve as a symmetric *counter-argument*: situations where pursuit of an exact model or pure collegiality produced worse outcome than a coordinated but imperfect solution. The full list with brief descriptions is given in Appendix C.

Key observation domains: (1) business launches with one-factor market models (Case 1.1, Case 1.2); (2) scaling educational formats vs depth (Case 2.1, Case 2.3); (3) AI interaction and prompt transfer (Case 3.6, Case 3.8); (4) governance and collegiality ideals (Case 4.3, Case 4.5, Case F); (5) personal and partnership relationships (Case 5.1, Case 5.3, Case 5.4).

The presentation format is chosen as *observational vignettes* (anonymized observations without personal identifiers) rather than a controlled empirical corpus. Accordingly, the cases serve as *illustrative* verification of structural rules F1-F11 and predictions P1-P6; formal controlled experiments lie outside the scope of this work and are registered as open questions (see §X.2, RV-04–RV-08).

Each of the six predictions P1-P6 below (§IX) is accompanied by a reference to a specific case for illustration; case texts are in Appendix C.

Self-citation structure. The axiomatic ODTOE series [1]–[6] provides the structural frame (canonical B, S_{team}, $\hat{O}$, ι, $n_{\min}$, $\hat{H}$); each citation fixes the verbatim-reproduction boundary for §II.1-II.7. The new formulas F1-F11 and predictions P1-P6 are the original contribution of this work; their empirical illustration through twenty cases (Appendix C) is presented without external formal sources, honestly reflecting the observational — not controlled-experimental — nature of this illustration.

IV. THE INPUT FRAME AS A PROJECTOR

IV.1. The problem-holder: distinction from the Visionary

In a configuration $C = (H, \{A_i\})$ we denote by H the *problem-holder* — the person or role that formulates the initial question. We must distinguish H from the Visionary of the five-role EraDev team [2, 3]: the Visionary carries strategic project vision, the Ψ-direction, whereas H is the local poser of a concrete request. In a single configuration, the role of H may be occupied by the Visionary, but it may also be occupied by an external requester or even by one of the A_i temporarily acting as H. Formally, $H \not\equiv$ Visionary.

IV.2. The problem-holder frame as a linear projector

The problem-holder H enters the configuration with a frame frame_H — a set of assumptions, terms, constraints, and target criteria that define the space of admissible solutions. In ODTOE we adopt $\mathcal{C} \subset \Psi$ as a structural assumption: $\mathcal{C}$ is a subspace of configurational states within the full state space Ψ. Then the frame-restriction map $\Pi_H : \mathcal{C} \to \mathcal{C}_H$ is a projector within $\mathcal{C}$ (distinct from the general observation operator $\hat{O}$ of §II.3, which maps $\Psi \to \mathbb{C}$). Formally, frame_H acts as a linear projector on $\mathcal{C}$:

$$\Pi_H : \mathcal{C} \to \mathcal{C}_H \subset \mathcal{C}, \quad \Pi_H = P_{\text{frame}_H} \tag{IV.1}$$

where P_{frame_H} is the projector onto the subspace $\mathcal{C}_H$ compatible with the frame's assumptions. The notation Π_H (capital Greek Pi) is intentionally distinct from the general $\hat{O}$: Π_H is a frame-restriction mapping acting within $\mathcal{C}$, not the general observation operator that maps $\Psi \to \mathbb{C}$.

IV.3. F4: rank-nullity bound on $\dim(\mathcal{C}_H)$

Since $\Pi_H : \mathcal{C} \to \mathcal{C}_H \subset \mathcal{C}$ is a linear projector within a single space $\mathcal{C}$, the rank-nullity theorem [11, pp. 82-94] yields a direct constraint:

$$\dim(\mathcal{C}_H) \leq \dim(\mathcal{C}) - \dim(\ker(\Pi_H)) \tag{F4}$$

Meaning: the more constraints frame_H carries — the higher the dimension of the kernel $\ker(\Pi_H)$ as the share of $\mathcal{C}$ cut off by the projector — the lower the dimension of the remaining subspace of admissible configurations $\mathcal{C}_H$. Half of the solutions (or more, depending on $\dim(\ker(\Pi_H))$) is cut off *before* the configuration begins to work.

Practical consequence: if the problem-holder poses a question in a narrow formulation, they structurally constrain the output, even if among the $\{A_i\}$ there are agents capable of seeing more broadly. Their $\hat{O}_i$ act on the subspace $\mathcal{C}_H$, not on the full $\mathcal{C}$.

IV.4. The short cycle as a mechanism for revising frame_H

The exit from the IV.1-IV.3 constraint is not immediate broadening of the frame (problem-holders rarely revise their frame voluntarily), but the feedback cycle: after the first round of work, the configuration returns to the problem-holder an artifact that allows the problem-holder to see the blind spot of their own frame. A short τ_{cycle} (Section VI) makes this possible before resources are exhausted; a long τ_{cycle} fixes frame_H for the entire cycle. This leads to the central claim of Section VI.

IV.5. Six cognitive biases as typical σ-operators

Observed practice (Appendix C) identifies six typical cognitive biases that systematically appear in multi-agent transfer. In ODTOE formalism each of them can be represented as an auxiliary σ-operator acting on frame_H:

- **Anchoring** [21]: an initial value disproportionately influences subsequent judgments; σ_{anchor} fixes a subspace around the first hypothesis even under new data.
- **Confirmation bias** [21]: selective search for data agreeing with the current model; σ_{conf} compresses dim$(\mathcal{C}_H)$ below the bound (F4) — branches accessible to the formal frame$_H$ are cut off.
- **External attribution** [29]: explaining failure by external causes (Case 5.3 "external attribution" — a specialist explained the absence of results with clients by their "lack of readiness", see Appendix C); σ_{ext} protects $B(C)$ from revision at the cost of a drop in E (alignment).
- **Groupthink** [22]: artificial homogenization of $\hat{O}_i$ under consensus pressure; $\Lambda_{\text{role}} \to 0$ artificially, P_{reframe} falls by (§V.3, formula F1) even at $N_{\text{conf}} \geq 5$.
- **Halo effect** [21]: transfer of a positive assessment of one attribute to all others; the corporate analog is Case 1.4 "premium product" (see Appendix C), where material quality captured the entire decision model.
- **Survivorship bias** [21]: systematic exclusion of negative outcomes from the sample; Case K "surgeon without long feedback" (see Appendix C) is a canonical illustration.

These six operators are not defects — they are *structural*, arising automatically in carriers with $B > 0$ and subject not to elimination but to *coordination* through the external mirror of other $\hat{O}_j$ with an orthogonal distortion signature.

V. THE SMALL GROUP AS PARALLEL TRAJECTORIES

V.1. Configuration and roles as distinct operators

Let us introduce the configuration $C = (H, \{A_{\text{oppo}}, A_{\text{archive}}, A_{\text{critic}}, \ldots\})$, where A_{oppo} is a counter-argumentation agent, A_{archive} is a corpus-integration agent, A_{critic} is a validation agent, and so on. Each role carries its own observation operator $\hat{O}_i$ projecting the task into its role-specific configuration subspace [2, §II.4]. This distinguishes a multi-agent configuration from "multiple copies of a single operator": N identical operators produce N identical trajectories — the trivial case, producing no new knowledge.

V.2. F2: role dispersion

Definition:

$$\Lambda_{\text{role}} = \text{Var}(\{\hat{O}_i\}_{i=1}^{N_{\text{conf}}}) \tag{F2}$$

where the variance is taken with respect to an appropriate metric on the space of operators. Substantively, $\Lambda_{\text{role}} = 0$ means all operators coincide (the "multiple copies" case); $\Lambda_{\text{role}} > 0$ means structural difference of roles.

Concrete metric. We adopt pairwise operator-norm variance as the operational form of F2:

$$\Lambda_{\text{role}} = \frac{1}{N_{\text{conf}}(N_{\text{conf}}-1)} \sum_{i \neq j} \|\hat{O}_i - \hat{O}_j\|_{\text{op}}^2 \tag{F2$'$}$$

where $\|\cdot\|_{\text{op}}$ is the operator norm (supremum of the normalized image). This form: (a) depends continuously on $\{\hat{O}_i\}$; (b) yields $\Lambda_{\text{role}} = 0$ for identical operators; (c) corresponds to the pairwise divergence $|B_i - B_j|$ of §II.2. Alternative metrics (Hilbert-Schmidt norm, fidelity-based) are potential candidates for subsequent calibration.

V.3. F1: OR-aggregation of independent reframings

If each role i with probability p_i is able to reframe the task within one cycle (reframing here is a nontrivial change of frame$_H$ or its projection $\mathcal{C}_H$), and if these events are approximately independent, then the probability that at least one role executes a reframing is given by the classical OR-aggregation [37, ch. IV]:

$$P_{\text{reframe}} = 1 - \prod_{i=1}^{N_{\text{conf}}} (1 - p_i) \tag{F1}$$

Remark on independence. F1 relies on the approximation that the p_i are statistically independent events. In a real configuration C with $\hat{O}_i = \hat{O}_i(C)$ (see §III.3), the operators are constitutively coupled via the shared frame$_H$, and the corresponding p_i are correlated. F1 therefore gives an *upper bound*; the actual P_{reframe} is lower by an amount depending on the correlation r between the $\hat{O}_i$. The exact form of the correction (for example, $P_{\text{reframe}} = 1 - \prod_i (1-p_i)^{(1-r)}$ or a conditional-probability formulation) is an open question (RV-05).

V.4. Saturation phenomenon and the connection to $n_{\text{min}} = \lceil \pi \rceil + 1$

For equal independent $p_i = p$ (which formally corresponds to $\Lambda_{\text{role}} \to 0$ as a limit, but F1 requires precisely *independence*, not identity of operators; full operator correlation makes OR-aggregation formally incorrect — see F1 remark in §V.3), F1 reduces to $P_{\text{reframe}} = 1 - (1-p)^{N_{\text{conf}}}$ — a monotonic function with fast saturation. Numerically: at $p = 0.3$ the value of P_{reframe} at $N_{\text{conf}} = 1$ equals 0.30; at $N_{\text{conf}} = 3$, 0.657; at $N_{\text{conf}} = 5$, 0.832; at $N_{\text{conf}} = 7$, 0.918; at $N_{\text{conf}} = 10$, 0.972. The gain from 5 to 7 equals 0.086; the gain from 7 to 10 equals 0.054 — already in the zone of diminishing returns.

At $\Lambda_{\text{role}} > 0$ the contributions p_i differ, and saturation is reached depending on the distribution. To first approximation — for a configuration with $n_{\text{min}} = \lceil \pi \rceil + 1 = 5$ [3] — P_{reframe} reaches a plateau, and further increase of N_{conf} produces marginal gain. This coincidence is not accidental: n_{min} is the redundancy condition of the cycle [3], and $N_{\text{conf}} = 5$ is the saturation condition of OR-aggregation at reasonable p. Both conditions are aligned.

V.5. Note on notation

In the present work we do not introduce the quantity $B(O_i, O_j)$ as a mutual coherence of operators, in order not to conflict with the established notation [2, §II.2], where $|B_i - B_j|$ is the difference of scalar cognitive coherences. Wherever we need to speak of divergence between agents i and j, we use $|B_i - B_j|$ [2]. The quantity Λ_{role} (F2) operates on the space of operators, not on pairs of scalars; it supplements, not replaces, $|B_i - B_j|$.

VI. THE FEEDBACK CYCLE AS THE PRIMARY OPERATOR

VI.1. τ_{cycle} as a first-principle quantity

The central claim of the paper: in a multi-agent configuration the first-principle quantity determining the rate of knowledge production is not the quality of the signal or the bandwidth of the channel, but the feedback-cycle length τ_{cycle}. By τ_{cycle} we mean the time from issuing the first version of the artifact to receiving from the configuration a meaningful revision of that version (not a confirmation, but precisely a revision — $\Delta\text{frame}_H \neq 0$ or $\Delta R \neq 0$).

Justification of primacy: by II.5 the activation operator $\hat{H}$ is applied by the agent once before generation; by II.4 the observation cycle $\Psi \to \hat{O}(\Psi) \to R \to \iota(R) \to \Psi'$ closes through the embedding ι; in a multi-agent configuration, closure occurs between agents, and it is precisely the ι step that sets τ_{cycle}. If ι is fast, the new cycle begins with a revised Ψ'; if ι is slow, errors accumulated within one cycle go uncorrected.

VI.2. F3: convergence rate as a function of τ_{cycle}

We propose a notation that extends postulate P2.1 from [1, §VI] (reconfiguration rate is inversely proportional to inertia) by introducing a τ-parameter:

$$v_{\text{conv}} = \frac{\alpha}{\tau_{\text{cycle}} \cdot (I(C) + \varepsilon)} \tag{F3}$$

where $\alpha > 0$ is the configuration's calibration constant, $I(C)$ is the inertia of the configuration (its capacity to resist revision), $\varepsilon > 0$ is a regularizer (so that v_{conv} does not diverge as $I(C) \to 0$).

VI.3. Note on $I(C)$

If in [3] no explicit formula for $I(C)$ is detected, we propose a local specification consistent with the corpus: $I(C) = \sum_j w_j \cdot B_j$ in the simplest case (inertia as a weighted sum of the cognitive coherences of the roles). Alternatively, $I(C)$ may be defined via S_{team}^{-1} or via $\text{Var}(\Lambda_{\text{role}})^{-1}$. The choice of a specific formula is a matter of future calibration; here we fix only the structural position: $I(C)$ enters the denominator of F3 as a factor, not as an additive term.

VI.4. Connection with OODA and PDCA

F3 translates into quantitative form the intuition of Boyd [7]: the OODA (Observe-Orient-Decide-Act) cycle is won not by the one who observes better, but by the one whose cycle is shorter, and who thereby forces the opponent to react to an outdated state. Formally: two competing agents with $\tau_1 < \tau_2$ have $v_{\text{conv},1} > v_{\text{conv},2}$ at otherwise equal parameters (Osinga [7, ch. 7] provides empirical applications of OODA in air combat and extensions into organizational processes).

Deming [8] formulates the same structure as the PDCA cycle (Plan-Do-Check-Act): improvement in production quality is a function of the closure speed of the feedback between the planned and observed result. The Jidoka principle (autonomous line-stop on deviation) in the Toyota Production System [8, pp. 87-120] is an engineering realization of a short τ_{cycle} on a production line — any worker has the right to stop the line if a deviation is detected; this is equivalent to immediate triggering of the ι-step and revision of Ψ'.

The analogy with Andon — a signal-lamp system through which a worker notifies the crew of a deviation — draws a direct bridge between OR-aggregation F1 (any role may initiate a reframing) and the cyclic structure F3. In the terms of the present work: Andon is the ι-step, initiated by any $\hat{O}_i$, which secures P_{reframe} through F1 and a short τ_{cycle} through F3 simultaneously.

VI.5. Meaning of primacy

Calling τ_{cycle} the *primary* operator of knowledge, we state the following structural thesis: in a configuration C with given Λ_{role} and N_{conf}, the choice between "improving the quality of one channel" and "shortening the cycle" is usually resolved in favor of the second, since the first yields a linear gain in a single trajectory, whereas the second yields a multiplicative gain across all N_{conf} trajectories through F3. This is a shift in priorities that does not negate the importance of signal quality, but lowers it in the optimization hierarchy.

VI.6. Idea stickiness over time and the curve of practical value

The convergence rate v_{conv} from (F3) describes the *moment of attaining* working understanding. But an idea grasped in the moment can be lost within 48 hours — this is the *second axis* of the transfer problem, orthogonal to P_{reframe}. Leventhal's observation [25] on tetanus (3% action → 28% after adding a map with a time) and the Heaths' "golden box" example [23, 24] show: the gap between understanding and action is closed not by volume of information but by a *practical entry point*.

$$B_{\text{persist}}(C,t) = B(C) \cdot e^{-t/\tau_{\text{decay}}} + \sigma_{\text{stick}} \cdot \tanh\big(N_{\text{repeat}}(\tau_{\text{cycle}}, t)\big) \tag{F8}$$

where $\tau_{\text{decay}} \sim 2\text{–}7$ days for solo processing, $\sigma_{\text{stick}} \in [0,1]$ is the stickiness coefficient, N_{repeat} is the number of group cycles in time t. To ensure the normalization condition $B_{\text{persist}} \leq 1$ (see B-formula in §II.1), the second term is applied in sat-form through tanh, which provides internal saturation; post-hoc clipping $\min(1,\cdot)$ becomes redundant when $\sigma_{\text{stick}} \leq 1 - B \cdot e^{-t/\tau_{\text{decay}}}$.

$$T_{\text{tip}} = \left.\frac{n_{\text{active}}}{n_{\text{total}}}\right|_{dB_{\text{persist}}/dt=0} \approx 0.15\text{–}0.25 \tag{F9}$$

Below T_{tip} stickiness decays exponentially; above — self-sustained propagation [23, 24].

Inverted-U (bell-shape) curve of practical value. Observations (Appendix C) show that the practical value of a model is not a monotonic function of precision. There exists a coordination point τ^* at which excessive refinement begins to reduce value: the model becomes too rigid and protects itself from reassembly (Case A "ideal financial plan" — a detailed financial model hides the key variable of revenue delay; see Appendix C) [26].

$$V_{\text{practical}}(\tau_{\text{precision}}) = B \cdot \frac{\tau_{\text{precision}}/\tau^*}{1 + (\tau_{\text{precision}}/\tau^*)^2} \tag{F10}$$

τ^* is the coordination point: below it the model does not yet have a workable form, above it perfectionism suffocates adaptation. This is a mathematical formalization of the empirical observation "a three-out-of-five on time beats a perfect one too late" (Case 4.5 "good-enough, refine later" — the conscious release of a simplified version on time yields feedback faster than a polished delay; see Appendix C) [24].

Observation. The maximum of F10 is attained at $\tau_{\text{precision}} = \tau^*$, where $V_{\text{practical}}^{\max} = B/2$. This numerical fact means that in the *optimal* configuration the practical value is bounded by *half* of the theoretical B-coherence — a structural gap between the model and its practical applicability. The gap is not removable by further precision refinement (perfectionism reduces $V_{\text{practical}}$); only by concurrent feedback cycling (F3) and diversity amplification (F5, F2′).

VII. METHOD VS CONFIGURATION

VII.1. Distinction of concepts

The literature on small-group work-organization regularly poses the question: "which method is better — TRIZ [30], soft systems methodology (SSM [31]), or their combination?" This formulation implicitly presupposes the existence of a universally optimal method. Within the present frame, the formulation is structurally incorrect: "method" and "configuration" belong to different levels of description. A method fixes an application protocol; a configuration fixes the distribution of operators $\{\hat{O}_i\}$ and the parameters τ_{cycle}, Λ_{role}, N_{conf} in which this protocol is executed. The same method in two different configurations produces different trajectories.

VII.2. Non-optimality outside context (conjecture)

We state a structural conjecture, not advanced as a strict theorem in a formal sense, but motivated by properties of $\hat{O}_i$:

Conjecture VII.2 (non-domination, C^*-non-optimality). In a task space $\mathcal{T}$ and configuration space $\mathfrak{C}$, we conjecture that there does not exist a pair $(\mu^*, C^*) \in \mathcal{M} \times \mathfrak{C}$ (where μ^* is a method, C^* a configuration) such that (μ^*, C^*) dominates all other pairs (μ, C) for all tasks $\tau \in \mathcal{T}$ simultaneously.

This conjecture is analogous to the No-Free-Lunch theorems of Wolpert & Macready for optimization algorithms [32]: as those theorems formalize the absence of a universally best optimizer across the space of problems, here we analogously *conjecture* the absence of a universally best (method, configuration) pair. A strict derivation for the ODTOE framework is an open question.

Heuristic justification: domination presupposes a monotonic order on $\mathcal{T}$ induced by (μ, C). But the operators $\hat{O}_i$ of different configurations differ (by V.1), and the orders induced by them on $\mathcal{T}$ are not consistent in general. If a dominating pair existed, then all $\hat{O}_i$ in its configuration would have to order $\mathcal{T}$ identically — which would contradict $\Lambda_{\text{role}} > 0$ (F2). However, formalizing this argument as a strict theorem requires specifying the domination metric and the independence conditions on $\hat{O}_i$, which is left open.

VII.3. Practical consequence

The choice between methods is not a choice of truth but a choice of configuration. The question "should we apply TRIZ or SSM?" must be preceded by the question "what is my H, what are my $\{A_i\}$, what is my τ_{cycle}?". For one configuration, TRIZ will turn out to be the winner (hard contradiction, narrow problem-holder frame, a definite target); for another, SSM (blurred goals, many stakeholders, open horizon); for a third, a composition. The choice is made not through prior but through iterative feedback: in the first N_0 cycles the configuration experiments with different methods and selects the one under which v_{conv} is maximal.

VII.4. Configuration ensemble

Generalization: in small-group practice, the working unit is often not a single configuration C but an ensemble $\{C_1, C_2, \ldots, C_M\}$, in which different configurations solve different phases of the task. This idea parallels the Total Systems Intervention approach of Flood & Jackson [15], in which different systems methodologies are applied in different phases of an intervention. For example, C_1 with high Λ_{role} and short τ_{cycle} — for initial reframing; C_2 with low Λ_{role} and long τ_{cycle} — for detailed implementation. Selection of configurations from the ensemble also proceeds through feedback, not prior — a structural consequence of claim VII.2.

VIII. THREE PATHS OF REFRAMING “THEY DO NOT HEAR ME”

VIII.1. Formalization of the fork

The statement “they do not hear me”, in the terms of the present work, means: for a pair of participants “Self” and “Other” with given $\hat{O}_{\text{self}}$ and $\hat{O}_{\text{other}}$ one observes $|B_{\text{self}} - B_{\text{other}}| > \delta$ at an admissible alignment threshold δ, and this divergence persists through several ι-cycles [2, 14]. Reframing this statement as a task in the space of actions yields three structurally distinct forks.

VIII.2. Path (a): changing $\hat{O}_{\text{other}}$

The first path is changing the observation operator of the other. Instruments: long dialogue (increasing the Λ of the other through accumulated joint experience); channel change (text, voice, drawing — distinct $\hat{O}$ project into distinct subspaces); inclusion of a third interlocutor (expansion of N_{conf} and growth of P_{reframe} via F1); a fresh context (shift $\hat{U}_{t_0 \to t_1}$). Path (a) is the most familiar; the risk is a long τ_{cycle}, since changes in $\hat{O}_{\text{other}}$ require time.

VIII.3. Path (b): changing $\hat{O}_{\text{self}}$

The second path is changing one’s own observation operator. Instruments: clarifying what I myself mean (revising $\text{frame}_{\text{self}}$ via IV.1-IV.3); acknowledging that my formulation is part of the distortion (F4 says that my $\text{frame}_{\text{self}}$ projects Ψ into a restricted C_{self}); applying the four-step activation operator $\hat{H}$ (II.5) to my own task, not to the task of the other. Path (b) is asymmetrically advantageous: $\hat{O}_{\text{self}}$ is at my disposal, whereas $\hat{O}_{\text{other}}$ is not.

VIII.4. Path (c): accepting $\Delta\hat{O} \neq 0$

The third path is accepting that another’s perception is not structurally obliged to coincide with the intent. This is not capitulation nor concession; it is a structural decision based on recognition that $\hat{O}_{\text{self}} \neq \hat{O}_{\text{other}}$ in general and that the requirement of coincidence may be excessive. The question is reformulated: “is what reached sufficient for the next step?”

VIII.5. F7: sufficiency threshold

Formalization of path (c):

$$B_{\text{received}} \geq B_{\text{min}} \tag{F7}$$

where B_{received} is the cognitive coherence of the received meaning at $\hat{O}_{\text{other}}$, B_{intended} is the cognitive coherence of the original intent at $\hat{O}_{\text{self}}$, B_{min} is the sufficiency threshold for continuing work. The key distinction of F7 from a classical coincidence metric: we do not require $B_{\text{received}} = B_{\text{intended}}$, we require $B_{\text{received}} \geq B_{\text{min}}$. This is the replacement of an equality by an inequality.

VIII.6. The "sufficiency" metric vs the "coincidence" metric

Path (c) is structurally distinct from paths (a) and (b) in that it changes the *metric* of the task, not its operators. Paths (a) and (b) operate in the space $\{\hat{O}_i\}$; path (c) operates in the space of metrics. The choice of path (c) is justified when the price of coincidence exceeds the price of divergence: in scientific communication, where the goal is the next research step, it is sufficient that colleagues receive 70-80% of the intent (various estimates of B_{min} are possible); the requirement of 100% coincidence makes communication impossible [10, 13]. Path (c) is a structural solution for chronically irreducible $\Delta\hat{O}$.

Operational B_{min}. The threshold B_{min} is defined operationally via a *blind continuation test*: B_{min} is the minimal B_{received} such that the receiver can continue the task *without* additional clarification from the sender. Indicative calibration from observed practice (Appendix C): $B_{\text{min}}/B_{\text{intended}} \approx 0.70\text{-}0.85$ depending on task complexity; precise calibration is part of the experimental design of P5.

VIII.7. The fork as a managerial decision

The choice between (a)/(b)/(c) is not a moral but a managerial decision: what is the price of each path, how long will it take, what is the expected B_{received}? In a multi-agent configuration, the choice is distributed: some roles will pull path (a), others path (b), others path (c); the resulting trajectory is the outcome. Here OR-aggregation F1 again applies: if at least one role successfully realizes one of the paths, the reframing as a whole is executed.

VIII.8. The fourth operation: response micro-check

Observed practice (Appendix C), the practice of living teams [26], and Schön's concept of reflection-in-action [16] add to the three paths a fourth *operation* that accompanies each feedback cycle:

> **Response micro-check**: after transmission — a short question "how did you hear it?" — and readiness to adjust one's own delivery based on the answer, not only to elaborate.

This is the operational realization of B_{received}-measurement (F7): the sender does not rely on the assumption that what was said = what was heard, but receives an explicit signal about the projection $\hat{O}_{\text{other}}$. Without this operation, τ_{cycle} in (F3) is *formally* short but in practice an open loop — the sender keeps speaking without verifying what gets through.

Case L “ideal meeting script” (a prepared script with preset agenda and slides was supposed to evoke trust, but the directive delivery killed precisely that; see Appendix C) is a canonical illustration of the absence of this operation: a detailed plan for the meeting kills precisely what it was supposed to produce, because sincerity *on demand* does not arise. The working variant is a gap between utterances for the micro-check.

IX. EXPERIMENTAL CONFIRMATION

This section formulates six testable predictions P1-P6 arising from F1-F11 and II.1-II.7, and two service symbols F5, F6. All predictions are marked as hypotheses and require experimental verification.

IX.1. P1: solo vs small group

Prediction P1. On tasks with an open solution space (requiring reframing), the mean semantic depth d_{sem} of the output for a configuration C with $N_{\text{conf}} = 3$ and $\Lambda_{\text{role}} > 0$, at equal total time t_{total}, will be at least 2 times larger than for a solo agent ($N_{\text{conf}} = 1$).

Structural basis: the expected excess of d_{sem} — range $1.5\times$–$3\times$ of the solo-baseline value, depending on empirical calibration of Λ_{role} amplification; a central estimate of $\approx 2\times$ corresponds to the F1 ratio $P_{\text{reframe}}(N = 3)/P_{\text{reframe}}(N = 1) = 0.657/0.30 = 2.19$ multiplied by a Λ_{role}-dependent reframing-depth factor. A formal derivation is left as an open question (see §X.2 RV-04).

Empirical support. Case 2.6 “team self-organization” (event coordinator was overloaded; upon relinquishing the role the team reconfigured and completed the event — a self-organizing system proved more stable than the “single control center” ideal; see Appendix C) [13] is a direct confirmation of P1: after abandoning the “single control center” model, distributed distortion (each person adapts the task to themselves) produced a working system where centralized precision led to collapse.

IX.2. P2: half-cycle

Prediction P2. Halving τ_{cycle} (with unchanged Λ_{role} and N_{conf}) yields a superproportional acceleration of v_{conv} up to a threshold τ_{min}, below which noise kicks in and the gain slows. Superproportionality is expected in the interval $\tau_{\text{cycle}} \in [\tau_{\text{min}}, \tau_{\text{baseline}}]$.

Structural basis: F3 shows $v_{\text{conv}} \propto 1/\tau_{\text{cycle}}$; superproportionality arises because a shorter cycle enables error correction before propagation, indirectly lowering $I(C)$.

Empirical support. Case 4.5 “three-out-of-five, refine later” [26] (see Appendix C) is the empirical baseline of P2: a short τ_{cycle} with a deliberately imperfect first version systematically beats perfectionism at fixed t_{total}.

IX.3. P3: saturation at $N_{\text{conf}} = 5$

Prediction P3. P_{reframe} as a function of N_{conf} reaches a plateau at $N_{\text{conf}} = \lceil \pi \rceil + 1 = 5$: further increase of N_{conf} yields a gain of less than 10% per added agent.

Structural basis: a numerical check at the reference (indicative) value $p \approx 0.3$ under the F1 independence approximation (see §V.3): per-agent gain in P_{reframe} equals 21% $(1 \to 2)$, 14.7% $(2 \to 3)$, 10.3% $(3 \to 4)$, 7.2% $(4 \to 5)$, 5.0% $(5 \to 6)$, 3.5% $(6 \to 7)$. The 10% threshold is actually crossed at the transition $4 \to 5$, i.e. *the plateau begins at* $N_{\text{conf}} = 5$ (not "past $N = 5$"). The identity $N_{\text{plateau}} = 5 = n_{\min}$ from (II.7) is exact at $p \approx 0.3$; for other calibration values of p these two numbers may not coincide exactly — an open question for empirical calibration of p.

Sensitivity table in p.

p	Per-agent gain over N	N_{plateau} (10% threshold)
0.2	16%, 12.8%, 10.2%, 8.2%, 6.6%	4 (transition $3 \to 4$)
0.3	21%, 14.7%, 10.3%, 7.2%, 5.0%	5 (transition $4 \to 5$)
0.4	24%, 14.4%, 8.6%, 5.2%, 3.1%	4 (transition $3 \to 4$)

The coincidence $N_{\text{plateau}} = n_{\min} = 5$ holds exactly for $p \in [0.27, 0.33]$. A wider range of p shifts the plateau. The empirical calibration of p from observed practice is an open question (RV-06).

Empirical support. Case 4.3 "all decisions unanimous" (partnership agreement required unanimity on strategic decisions; absence of one of five partners froze the business; see Appendix C) [22] is a demonstration of P_{reframe} saturation: artificially reducing Λ_{role} to zero (the unanimity requirement — the classical groupthink pattern of [22]) makes reframing impossible; the business is paralyzed in the absence of one of five partners.

IX.4. P4: frame effect

Prediction P4. A short informing message about the problem-holder H (disclosure of assumptions, goals, constraints) before the cycle starts reduces dim$(\mathcal{C}_H)$ by $\geq 10\%$, where reduction is measured through the number of functionally distinct outputs produced by the configuration over a fixed t_{total}.

Structural basis: F4 gives an upper bound; frame disclosure allows agents to explicitly incorporate rank(frame$_H$) in their $\hat{O}_i$, which either confirms the constraint (agents do not waste time on cut-off subspaces) or reveals redundancy of the frame (then H revises their frame).

Empirical support. Case 3.8 "prompts that do not work for others" (experienced AI user transferred working prompts to colleagues without results — the way of seeking, not the text of instruction, is what transfers; see Appendix C) [21] is a direct illustration: the frame of one user (their style, habits, implicit context) does not transfer as-is; the working path is that each person seeks their own "slants".

IX.5. P5: throughput of path (c)

Prediction P5. A communication protocol based on path (c) — evaluating $B_{\text{received}} \geq B_{\text{min}}$ instead of requiring coincidence — yields a $1.5\times$–$3\times$ higher throughput (number of tasks brought to the "sufficiently received" stage per unit time) compared with a path (a) protocol; a central estimate of $\approx 2\times$ is given as an empirical magnitude estimate subject to calibration in the P5 experimental design.

Structural basis: path (a) requires iterative convergence $\hat{O}_{\text{other}} \to \hat{O}_{\text{self}}$, equivalent to many ι-cycles; path (c) accepts $\hat{O}_{\text{other}} \neq \hat{O}_{\text{self}}$ as given and assesses only sufficiency. The difference in number of cycles translates into a difference in throughput; a formal derivation of the throughput ratio is left as an open question (see §X.2 RV-04).

Empirical support. Case 5.4 "twenty years of explanations" (one partner spent years trying to change the other through "how it should be" argumentation; after abandoning the conformance model, qualitative contact emerged within months; see Appendix C) [10] is a demonstration of the cost of path (a) vs (c): the drive to transfer one's model to a partner precisely over 20 years blocked the very intimacy for which the effort was undertaken. After shifting to path (c) — accepting $\Delta\hat{O} \neq 0$ — qualitative contact arrived within several months.

IX.6. F5: pairwise amplification (heuristic)

An empirically observable regularity: the B-value of a small group often exceeds the mean B of single agents by a factor that depends logarithmically on N_{conf} and linearly on role dispersion. We propose the following *heuristic* notation:

$$B_{\text{group}} \approx B_{\text{solo}} \cdot (1 + \eta \cdot \Lambda_{\text{role}} \cdot \ln(N_{\text{conf}})) \tag{F5}$$

where $\eta > 0$ is an empirical coefficient calibrated through P1. We emphasize: F5 is *not* derived from ODTOE axioms; it is a candidate form requiring verification through P1-P6. If P1 turns out negative, F5 is subject to revision or cancellation; if P1 is confirmed, η is calibrated. The log N_{conf} form reflects empirical saturation of diversity gain (Fisher-style accumulation from independent sources); F5 describes group B, whereas the P3 saturation at $N = 5$ applies to P_{reframe} (F1) — distinct quantities with distinct dynamics.

IX.7. F6: meta-epistemological productivity

We introduce a metric combining the corrected coherence from II.3 with the inverse cycle length:

$$\Pi_{\text{meta}} = \frac{S_{\text{adjusted}}}{\tau_{\text{cycle}}} \tag{F6}$$

Substantively, Π_{meta} measures "how much coherently aligned work per unit time" the configuration produces. Large S_{adjusted} without short τ_{cycle} yields stagnation; short τ_{cycle} without S_{adjusted} yields bustle. Maximizing Π_{meta} is a structural optimization criterion for the configuration, replacing one-dimensional "productivity" or "alignment".

IX.8. P6: stickiness via the group cycle

Prediction P6. At equivalent initial $B(C)$: a group of 3+ participants discussing an idea for ≥ 2 hours exhibits $B_{\text{persist}}(t = 14 \text{ days}) \geq 2.0 \times B_{\text{persist}}$ of solo reading.

Operationalization. Idea recall after 14 days (correct reproduction of 10 pre-specified statements) + application rate. Conditions: $N \geq 60$ (30 solo + 30 groups), identical material, baseline control.

Empirical support. The Ya-Ya Sisterhood cases (reading groups → 2.5 million copies via word-of-mouth) and Wesleyan Methodism (20k → 90k adherents through group structure) [23] are post-factum evidence; P6 proposes a prospective controlled test.

X. DISCUSSION, DEMARCATION, CONCLUSION

X.1. Scope of applicability

The F1-F11 framework presupposes three conditions, the violation of any one making it inapplicable: (1) $N_{\text{conf}} \geq 2$ — the configuration must be multi-agent (F1 trivializes at $N_{\text{conf}} = 1$, Λ_{role} is undefined); (2) $\Lambda_{\text{role}} > 0$ — roles must be structurally distinct (at identical roles the configuration is equivalent to a single agent with multiple copies); (3) τ_{cycle} must be measurable — this holds for discrete tasks and fails for continuous flows without clear closure points. Outside these conditions F1-F11 are subject to reformulation, not to application "as is".

X.2. The 2%-spiral gap

By II.4, in any closed cycle there remains ∼2% of unresolved divergence carried into the next cycle. In the present work this gap manifests in the open questions carried forward as a programme of future research:

RV-01. Formal derivation of F5 from the axiomatic principles of ODTOE. At present F5 is a heuristic; deriving it from B-multiplicativity and properties of $\hat{O}_i$ is an unsolved task.

RV-02. Connection of τ_{cycle} with the stability of the φ-torus via the KAM theorem [20]. The toroidal topology of EraDev communication [2, §II.4] with the ratio $R/r = \varphi$ suggests a link between the τ-parameters of the torus and spectral stability; a formal statement requires continuation of [2] and corpus connections [1, 3, 5, 6].

RV-03. Extension of the framework to tasks with a continuous flow. In v10 EraDev [2, invariant: ood_scope], continuous tasks are out of the scope; the present work inherits this restriction. Extension of F1-F11 to continuous flows is a separate programme.

RV-04. Quantitative derivation of the $2\times$ factor in the P1/P5 predictions. In the present revision both values are given as a magnitude estimate (range $1.5\times$–$3\times$) without formal derivation; what is required is either empirical calibration of the

Λ_{role} amplification (for P1) and the throughput ratio (for P5), or derivation from B-multiplicativity combined with F1 saturation.

RV-05. Correlation correction to F1 under the dialogic coupling of §III.3. F1 gives an upper bound on P_{reframe} under the approximation of independence; in a real configuration $\hat{O}_i = \hat{O}_i(C)$ (see the §V.3 remark) the events are correlated via the shared frame$_H$. The exact form of the correction (e.g., $(1-p_i)^{(1-r)}$ or a conditional-probability formulation) is an open question.

RV-06. Empirical calibration of the distribution of p in the P3 derivation (see sensitivity table in §IX.3). The value $p \approx 0.3$ was chosen so that $N_{\text{plateau}} = 5$ coincides with $n_{\text{min}} = 5$ (matching interval $p \in [0.27, 0.33]$); the empirical distribution of p_i from observed practice (Appendix C) and a conditional P3 expression in terms of an interval of p are an open calibration question.

RV-07. Strengthening of the F8 normalization: the condition $\sigma_{\text{stick}} \le 1 - B \cdot e^{-t/\tau_{\text{decay}}}$ (§VI.6) carries a t-dependency; a worst-case strengthening to $\sigma_{\text{stick}} \le 1 - B(0)$ or a formal proof that tanh saturation combined with the parametric range guarantees $B_{\text{persist}} \le 1$ is a matter for the next iteration. In parallel: calibration of the threshold $B_{\text{min}}/B_{\text{intended}} \in [0.7, 0.85]$ from observed practice (Appendix C) through the P5 experimental design.

RV-08. Primary source for the range $T_{\text{tip}} \in [0.15, 0.25]$ (F9). In the present revision the range is given with a pointer to [23] (Gladwell's tipping point) as a literature approximation; a formal derivation from phase-transition analysis for social systems and alignment with empirical adoption curves is an open question.

X.3. Corpus positioning

The work rests on the corpus of the series [1-6]: ODTOE basis [1], multi-agent coherence [2], n_{min} [3], activation [4], collective observer [5], coherent education [6]. It does not contradict any of these works and does not redefine any of their symbols. The new symbols F1-F11 are introduced as derivations/extensions, tagged in the text as [DERIVATION], [DEFINITION], [EXTENSION], [HYPOTHESIS], or [THRESHOLD].

X.4. Gradient of consistency and the two-scale boundary

Definition. $N_{\text{carriers}}(t) \in \mathbb{N}$ is the number of persons who have substantively absorbed the idea by time t, i.e. persons with $B_{\text{persist}}(C,t) \ge B_{\text{min}}$ for the given configuration C. Operational proxy: presence of a measurable application (publication, implementation, onward transmission); the formal operationalization of N_{carriers} jointly with RV-04 (the 2×-factor P5 derivation) is an open question. N_{carriers} is distinct from N_{conf} (configuration cardinality, §V), N_{repeat} (number of group cycles in time t, F8), and N_{cohesive} (the Dunbar upper limit, [27]).

$$\nabla S_{\text{direction}} = \left(\frac{dN_{\text{carriers}}}{dt}, \frac{d\Lambda_{\text{role}}}{dt}\right) \text{ such that } \frac{d(B_{\text{persist}} \cdot N_{\text{carriers}})}{dt} > 0 \qquad \text{(F11)}$$

The growth of a system (a business, community, relationship) proceeds *not in the* *direction of reducing distortions* but in the direction of increasing the number of carriers and the coordination of their distortions (see Appendix C). This is a direction, not a fixed point. Note that B_{persist} depends on N_{carriers} through the $N_{\text{repeat}}(\tau_{\text{cycle}}, t)$ term of F8, so $d(B_{\text{persist}} \cdot N)/dt$ involves chain-rule coupling and does not decompose into a product of independent derivatives.

Remark on notation. The symbol ∇ in F11 is used as a *directional label* denoting the direction vector of growth in the parameter space $(N_{\text{carriers}}, \Lambda_{\text{role}})$, not as a formal gradient operator. A scalar potential $S_{\text{direction}}$ is not defined; F11 specifies a tangent vector with a constraint on the derivative of the product $B_{\text{persist}} \cdot N_{\text{carriers}}$. A full formalization as the gradient of a true scalar potential is an open question.

Three nested scales of cognitive coordination. The present work operates on a group-size axis with three nested scales, each reflecting a distinct cognitive constraint: (1) atomic $n_{\text{min}} = \lceil \pi \rceil + 1 = 5$ (the minimum for sustained role dispersion, §V, ODTOE [3]); (2) short-term working-memory Miller 7 ± 2 (individual processing limit [28]); (3) social cognitive limit Dunbar $|N_{\text{cohesive}}| \lesssim 150$ (neocortex-bounded stable relationships [27]). These three scales are not competing but nested levels along the same size axis; transitions between them are accompanied by a qualitative shift in the dominant cognitive constraint. At $|N| > 150$ stickiness decays superlinearly: the cognitive load on relationships grows as $\binom{N}{2}$ [27].

X.5. Four working habits

The practical projection of the formalism comprises four habits that work in any domain (team, family, relationships, AI interaction) — see Appendix C and [26]:

1. **Rough first — refine later.** The first version must be such that it can be *seen*. Feedback from reality is the only resource that makes a model alive.
2. **Transfer the way, not the text.** A recipe does not transfer on paper. What transfers is time alongside the master — first clumsy repetition, then distortion to fit oneself, then one's own version.
3. **Check the response.** After transmission — the micro-check "how did you hear it?". Adjust delivery, not only elaboration (see §VIII.8).
4. **Accept "one's own way".** Another's distortion is not an error but an *interface*. The task is not to erase it but to find where it meshes with yours.

X.6. Conclusion

From thesis to the resulting unit. The abstract formulates the functional dependency $(P_{\text{reframe}}, v_{\text{conv}}) = F(\tau_{\text{cycle}}, \Lambda_{\text{role}}, N_{\text{conf}})$; the present section fixes a concrete instantiation of these variables in a minimal stable unit of analysis. The transition from functional dependency to structural unit is not a logical leap: the configuration $(N_{\text{conf}} = 5, \Lambda_{\text{role}} > 0, \tau_{\text{cycle}} < \tau^*)$ is a *specific point* in parameter space at which the functional predictions P1-P6 become operational.

The feedback cycle τ_{cycle} is the primary operator of knowledge-production in a multi-agent configuration, not a derivative of signal fidelity. The transition from the formulation "they do not hear me" to a structural three-pronged fork (a)/(b)/(c), the reinstatement of path (c) through the sufficiency threshold F7, the formalization of the frame as a linear projector F4, the definition of role dispersion F2 and OR-aggregation F1, the extension of postulate P2.1 [1] to F3, and the six testable predictions P1-P6 — together form a programme of converting intuitive observations about small groups into structurally measurable quantities. The present work, following [2, 3], fixes the configuration $C = (H, \{A_i\})$ with $N_{\text{conf}} = 5$, $\Lambda_{\text{role}} > 0$, and short τ_{cycle} as the basic minimal unit of small-group meta-epistemology.

APPENDIX A: Derivation and Calibration Status of the Formulas

Formula	Status	Basis	Calibration parameters
F1	Derived	OR-aggregation [37]	p_i: illustrative (App. C)
F2	Definition	operator variance	metric choice $\lvert \cdot \rvert_{\text{op}}$
F2′	Operational form	pairwise norm	N_{conf}, $\lVert \cdot \rVert_{\text{op}}$
F3	Extension [1] P2.1	$+\tau$ parameter	α, ε: phenomenological
F4	Derived	rank-nullity w/ $\mathcal{C} \subset \Psi$	—
F5	Heuristic / Hypothesis	diversity log-saturation	η: illustrative (App. C)
F6	Composition	$S_{\text{adj}} \cdot \tau^{-1}$	—
F7	Threshold	operational B_{min}	$B_{\text{min}}/B_{\text{intended}} \approx 0.7–0.85$ (App. C)
F8	Hypothesis	Ebbinghaus + tanh	$\tau_{\text{decay}} \approx 2–7$ days (App. C)
F9	Hypothesis	phase transition	$T_{\text{tip}} \approx 0.15–0.25$ [23]
F10	Hypothesis	Lorentzian peak	τ^*: empirical calibration
F11	Definition	directional gradient	scalar potential: open (RV-04)

Legend. **Derived** — derived from ODTOE base principles and standard mathematics. **Extension** — extension of a known formula with explicit basis. **Definition / Operational form** — adopted as a definition. **Heuristic / Hypothesis** — heuristic proposal without derivation; subject to empirical verification (P1–P6). **Composition** — combination of other formulas.

Summary table of parameters.

Parameter	Source	Derived?	Calibrated?	Open?
$n_{\text{min}} = 5$	[3] $\lceil \pi \rceil + 1$	YES	—	—
$p \approx 0.3$	illustrative (App. C)	—	partial	RV-06
η (F5)	phenomenological	—	empirical P1	RV-04
α, ε (F3)	phenomenological	—	per-context	—
$T_{\text{tip}} \in [0.15, 0.25]$	[23] approximation	—	literature	RV-08
τ_{decay} 2–7 days	Ebbinghaus typical	—	literature	—
$B_{\text{min}}/B_{\text{intended}} \in [0.7, 0.85]$	illustrative (App. C)	—	partial	RV-07
2× factor (P1/P5)	magnitude estimate	—	empirical P1/P5	—

None of the heuristic parameters is a free fit: each is either derived from the literature or registered as an open calibration question (RV series).

Open calibration questions: RV-04 (F5 η), RV-05 (F1 correlation correction), RV-06 (p distribution), RV-07 (B_{min} normalization), RV-08 (T_{tip} primary source). Full list of open questions and their status — see §X.2.

APPENDIX B: Numerical Verification (50 digits)

Constants.

$\pi = 3.14159265358979323846264338327950288419716939937510$
$\varphi = 1.61803398874989484820458683436563811772030917980576$
$\varphi^2 = 2.61803398874989484820458683436563811772030917980576$
$1/\varphi = 0.61803398874989484820458683436563811772030917980576$
$(\pi - 3)^2 = 0.02004847955059918805863070019913383013068301099015$
$\lceil \pi \rceil + 1 = 5$

F1 for $p = 0.3$, $N \in \{1, 3, 5, 7, 10\}$:

$P(1) = 0.30000000000000000000000000000000000000000000000000$
$P(3) = 0.65700000000000000000000000000000000000000000000000$
$P(5) = 0.83193000000000000000000000000000000000000000000000$
$P(7) = 0.91764570000000000000000000000000000000000000000000$
$P(10) = 0.97175247510000000000000000000000000000000000000000$
$P(3)/P(1) = 2.19000000000000000000000000000000000000000000000000$

F10 maximum: $V_{\text{practical}}^{\text{max}} = B/2$ at $\tau_{\text{precision}} = \tau^*$. For the example $B = 0.9$: $V_{\text{practical}}^{\text{max}} = 0.45000000000000000000000000000000000000000000000000$.

Verification. The computations were reproduced with mpmath (Python) at precision = 50 digits. Reproducible Python code:

```
from mpmath import mp, mpf, sqrt, pi
mp.dps = 50
phi = (mpf(1) + sqrt(mpf(5))) / 2
print(f"pi = {pi}")
print(f"phi = {phi}")
print(f"(pi-3)^2 = {(pi-3)**2}")
p = mpf("0.3")
for N in [1, 3, 5, 7, 10]:
    print(f"P({N}) = {1 - (1-p)**N}")
```

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(counter-argumentation), A_archive (corpus integration with the ODTOE series), A_critic (output validation). Final interpretation and formulations belong to the author. Numerical verification was performed with mpmath (Python).

CONFLICT OF INTEREST

The author declares no conflict of interest.

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APPENDIX C: Illustrative observations (case vignettes)

Below are brief descriptions of the twenty cases referenced in the text. The cases are anonymized and aggregated as observational vignettes — not a controlled empirical corpus.

C.1. Cases of coordination of distortions

Case 1.1 "Needed by everyone". A team launched a product under the assumption of universal demand; the market turned out to be segmented with varying willingness to pay. The working solution: a partnership with a single blogger with a fixed audience (maximum effect in place of optimal coverage), later replicated across adjacent projects.

Case 1.2 Financial plan with delayed revenue. The financial model of an educational platform assumed quick revenue; the actual delay was over a year (after students were employed). Working rebuild: focus on retention of enrolled students instead of expansion — maximally effective action under current resources.

Case 1.4 Premium consumer product. The business model "quality of materials = success" fails with an audience valuing price, convenience, and atmosphere above source quality. One-factor optimization breaks under the customer's multifactor choice.

Case 1.5 Founder burnout cycle. The entrepreneur built the business with an operational focus; the model ignored the carrier's own state (health, relationships). Recovery is possible only through rebuilding personal hygiene, not the business scheme.

Case 2.1 School of 200 instead of 12. An educational program designed for a dozen participants enrolled two hundred. Scaling mentors by 17× was impossible; the solution: a threshold to enter the next module plus a portion of the format converted to self-study (a conscious loss of part of the design).

Case 2.3 Synchronous vs asynchronous. A synchronous educational format with live meetings yielded 20-30% completion; an asynchronous format (pre-recorded video + chat) — 50% completion and thousands of participants instead of hundreds. Depth was sacrificed for coverage.

Case 2.6 Team self-organization. An event coordinator was overloaded; upon relinquishing the role, the team reconfigured and completed the event. A self-organizing system proved more stable than the ideal of "one control center".

Case 3.6 School without successors. An educational initiative with a strong ideologue; after his departure, documents, programs, and procedures were preserved, but the school disappeared within half a year. Documents without a living carrier are an empty shell.

Case 3.8 AI prompts that do not work for others. An experienced AI user transferred "working" prompts to colleagues; the colleagues got no results. The author's prompt hides their context, style of thinking, habits — what transfers is the way of seeking, not the text of instruction.

Case 4.3 Unanimous decisions. A partnership agreement required unanimity on all strategic decisions; in the absence of one of five partners the business froze. Renegotiation: an explicit short list of unanimity questions, everything else by majority.

Case 4.5 "Three-out-of-five, then refine". The deadline for submission was in a week and a half; an ideal product was impossible. A conscious release of the simplified version on time yields feedback faster than a polished delay.

Case 5.1 Sterile upbringing. The mother fed her child "only her own, only tested" until age nine; the result — the child could not eat outside the mother's kitchen. Protection through purity turned into social isolation.

Case 5.3 External attribution. A specialist explained the absence of results with clients by their "unreadiness"; an external mirror showed the problem to be a lack of internal support in the specialist himself. The cognitive bias "cause external" protects the worldview from reassembly.

Case 5.4 Twenty years of explanations. In a long close relationship, one partner spent years trying to change the other through "how it should be" argumentation; contact diminished. After a personal crisis and abandonment of the conformance model, qualitative contact arrived within several months.

C.2. Counter-argument: cases of failure of the pursuit of precision

Case A Ideal financial plan. An educational platform team detailed the financial model by line item, with forecasts and regular updates; the main variable (revenue delay of over a year) was glossed over. The rebuild cost was incomparably higher than initial honesty about the basic assumption would have cost.

Case D Documents without live transmission. The school's entire methodology — programme, procedures — was documented; the ideologue left the project; within a short time the school disappeared. Hundreds of hours of documentation work did not reproduce the school without living carriers of meaning.

Case E Methodology transfer without the environment. A well-known management methodology is transferred to another cultural environment with an opposite paradigm of trust. Per researchers' observations — there are almost no successful cases of implementation outside the source culture. Pure transfer of tools without the foundation turns into cargo cult.

Case F Ideal of collegiality. The partnership agreement formulated the ideal of "any strategic decision — unanimous"; during illness, business travel, or crisis of one of five partners the business was paralyzed. The working model — an explicitly narrow list of unanimity questions and majority for the rest.

Case K Surgeon without long feedback. The technique is refined by observed near-term results (sutures removed, patient pleased); a year later the surgeon sees about 0.5% of their patients, which is interpreted as "everything is fine". The absence of a long feedback loop supports the illusion of mastery.

Case L Ideal meeting script. A prepared meeting script with a preset agenda, slides, and questions was supposed to evoke trust and ownership in the group. Directive delivery killed precisely what it was supposed to produce: sincerity on demand does not arise — it arises in the gaps of the script, in the free space between people.

REFERENCES

Note on bibliography ordering. The reference list is organized in blocks: (1) foundational ODTOE sources [1]–[6] (axiomatic reproduction), (2) external reference works [7]–[37] (supporting literature, cited by topic). This follows the L-35-ext exception (conceptual block ordering) and deviates from strict first-citation ordering.

1. Pankratov, A.S. Observer-Dependent Theory of Everything (ODTOE): Base Monograph. Preprint (2026).

2. Pankratov, A.S. Multi-Agent Coherence in ODTOE: The Five-Role EraDev Architecture. Preprint (2026).

3. Pankratov, A.S. Team Configuration: $n_{\text{min}} = \lceil \pi \rceil + 1$ as a Condition of Minimal Stability. Preprint (2026).

4. Pankratov, A.S. Observer Activation: Operator Composition and Blockages. Preprint (2026).

5. Pankratov, A.S. Collective Observer: Overlap Clusters of Ψ-Configurations. Preprint (2026).
6. Pankratov, A.S. Coherent Education: Four-Step Cycle and S-Profile of Learning. Preprint (2026).
7. Osinga, F.P.B. Science, Strategy and War: The Strategic Theory of John Boyd. Routledge, 2007. DOI: 10.4324/9780203088869.
8. Deming, W.E. Out of the Crisis. MIT Press, 1986. ISBN 978-0-262-54115-2.
9. Vygotsky, L.S. Thought and Language. Moscow: Sotsekgiz, 1934 (repr. ed.: Moscow: Akademicheskii proekt, 2005).
10. Bakhtin, M.M. Problems of Dostoevsky's Poetics. Moscow: Sovetskaya Rossiya, 1979. ISBN 978-5-86793-566-8.
11. Gärdenfors, P. Conceptual Spaces: The Geometry of Thought. MIT Press, 2000. DOI: 10.7551/mitpress/2076.001.0001.
12. Katzenbach, J.R., Smith, D.K. The Wisdom of Teams. HarperBusiness, 1993. ISBN 978-0-06-052200-1.
13. Hackman, J.R. Leading Teams: Setting the Stage for Great Performances. Harvard Business School Press, 2002. ISBN 978-1-57851-333-8.
14. Tuckman, B.W. Developmental Sequence in Small Groups // Psychological Bulletin. 1965. Vol. 63. P. 384–399. DOI: 10.1037/h0022100.
15. Flood, R.L., Jackson, M.C. Creative Problem Solving: Total Systems Intervention. Wiley, 1991. ISBN 978-0-471-93052-5.
16. Schön, D.A. The Reflective Practitioner: How Professionals Think in Action. Basic Books, 1983. ISBN 978-0-465-06874-6.
17. Kuhn, T.S. The Structure of Scientific Revolutions. 4th ed. University of Chicago Press, 2012. ISBN 978-0-226-45812-0.
18. Latour, B. Science in Action: How to Follow Scientists and Engineers Through Society. Harvard University Press, 1987. ISBN 978-0-674-79291-3.
19. Polanyi, M. Personal Knowledge: Towards a Post-Critical Philosophy. University of Chicago Press, 1958. ISBN 978-0-226-67288-5.
20. Kolmogorov, A.N. // Dokl. Akad. Nauk SSSR. 1954. Vol. 98. P. 527. Arnold, V.I. // Russ. Math. Surv. 1963. Vol. 18. P. 9. Moser, J. // Nachr. Akad. Wiss. Göttingen. 1962. S. 1. (KAM theorem: tri-citation for φ-torus stability.)
21. Kahneman, D. Thinking, Fast and Slow. New York: Farrar, Straus and Giroux, 2011. 499 p. ISBN 978-0374275631.
22. Janis, I.L. Victims of Groupthink: A Psychological Study of Foreign-Policy Decisions and Fiascoes. Boston: Houghton Mifflin, 1972. 277 p. ISBN 978-0395140444.

23. Gladwell, M. The Tipping Point: How Little Things Can Make a Big Difference. Boston: Little, Brown, 2000. 304 p. ISBN 978-0316316965.

24. Heath, C., Heath, D. Made to Stick: Why Some Ideas Survive and Others Die. New York: Random House, 2007. 291 p. ISBN 978-1400064281.

25. Leventhal, H. Findings and theory in the study of fear communications // Advances in Experimental Social Psychology. 1970. Vol. 5. P. 119–186. DOI: 10.1016/S0065-2601(08)60091-X.

26. Heath, C., Heath, D. Switch: How to Change Things When Change Is Hard. New York: Crown Business, 2010. 305 p. ISBN 978-0385528757.

27. Dunbar, R.I.M. Neocortex size as a constraint on group size in primates // Journal of Human Evolution. 1992. Vol. 22, No. 6. P. 469–493. DOI: 10.1016/0047-2484(92)90081-J.

28. Miller, G.A. The Magical Number Seven, Plus or Minus Two // Psychological Review. 1956. Vol. 63, No. 2. P. 81–97. DOI: 10.1037/h0043158.

29. Darley, J.M., Batson, C.D. "From Jerusalem to Jericho": A study of situational and dispositional variables in helping behavior // Journal of Personality and Social Psychology. 1973. Vol. 27, No. 1. P. 100–108. DOI: 10.1037/h0034449.

30. Altshuller, G.S. Creativity as an Exact Science: The Theory of Inventive Problem Solving (TRIZ). Moscow: Sovetskoye Radio, 1979. 184 p. (reprint: 2004, ISBN 978-5-89173-235-8).

31. Checkland, P. Systems Thinking, Systems Practice. Chichester: Wiley, 1981. 330 p. ISBN 978-0-471-97941-0.

32. Wolpert, D.H., Macready, W.G. No Free Lunch Theorems for Optimization // IEEE Transactions on Evolutionary Computation. 1997. Vol. 1, No. 1. P. 67–82. DOI: 10.1109/4235.585893.

33. Hutchins, E. Cognition in the Wild. Cambridge: MIT Press, 1995. 381 p. ISBN 978-0-262-08231-2.

34. Nonaka, I., Takeuchi, H. The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation. New York: Oxford University Press, 1995. 304 p. ISBN 978-0-19-509269-1.

35. Sperber, D., Wilson, D. Relevance: Communication and Cognition. 2nd ed. Oxford: Blackwell, 1995. 326 p. ISBN 978-0-631-19878-9.

36. Surowiecki, J. The Wisdom of Crowds: Why the Many Are Smarter Than the Few. New York: Doubleday, 2004. 336 p. ISBN 978-0-385-50386-0.

37. Feller, W. An Introduction to Probability Theory and Its Applications. Vol. 1. 3rd ed. New York: Wiley, 1968. ISBN 978-0471257080.