Supplementary Material

Contents

S1. Extended Dialectical Framework

S1.1 Symbols and Terminology

Symbol	Meaning	Comment
T	Thesis – central statement or idea	Bipolar concept with latent ± potential
A	Antithesis – opposition to T	Semantic or functional opposition, often plural
T+	Constructive aspect of T	Inherent goal of T
T–	Destructive exaggeration of T	Inherent risk of T
A+	Constructive aspect of A	Inherent obligation of T
A–	Destructive exaggeration of A	Inherent threat of T
Tetrad	Set of T+, T-, A+, A-	"Wisdom unit", T/A pair may admit several tetrads
Ac	Action transition (T → A)	Often replaced with Ac+ (T- → A+)
Re	Reflection transition (A → T)	Often replaced with Re+ (A- → T+)
Wheel	Tetrad connected by Ac/Re	May comprise several tetrads linked by Tr
Tr	General transition X- → Y+	Includes Ac/Re as special cases (X = Y)
Matrix	Set of all possible Tr	Context-specific decision space
S+	Positive synthesis	Creates new dimensions from T+ and A+
S-	Negative synthesis	Optimizes existing dimensions via T- and A-
Pathology	S- suppresses S+	S- pretends to be S+ ("the mother of all lie")
K(T/A)	Complementarity to T or A	AI-estimated synergy with T or A
K_S	Average Complementarity	$K_S = (K(T) + K(A))/2$
SP	Synthesis Potential	$SP = K_S(T+) + K_S(A+) - K_S(T-) - K_S(A-)$
CC	Conceptual Coherence	AI-estimated semantic meaningfulness
DV	Dialectical Validity	AI-estimated naturalness and balance
MMI	Mind-Matter Index	AI-estimated ontological orientation

PSI	Pathology – Synthesis Index	AI-estimated S+/S− orientation
PC	Perceived Complementarity	AI-estimated extent to which T fosters A+

S1.2 Antithesis Selection

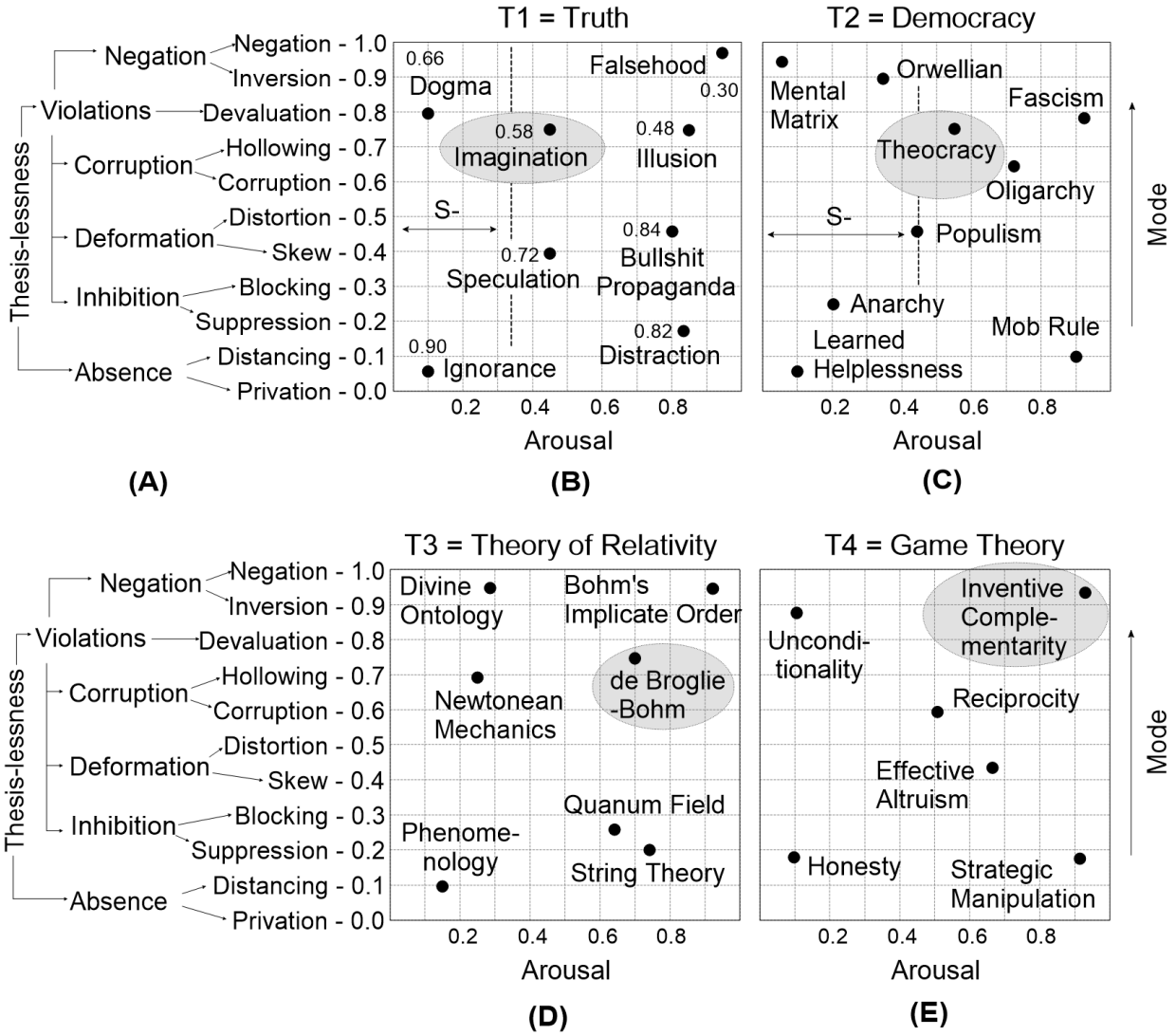
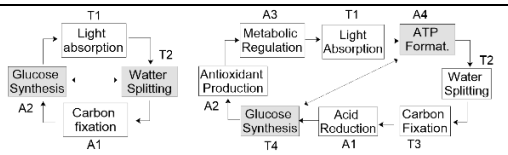


Fig. S1.2-1. Taxonomy of antitheses. Dashed ovals represent the most potent choices.

The following table summarizes steps when optimum antithesis is not immediately obvious. Numbering of steps corresponds to that in the manuscript (Table 3).

Table S1.2-1. Determining antitheses in complex systems

N	Constraint	Example (T = Sugar in photosynthesis)
2	A functionally opposes T	A = Energy conversion / Sugar degradation

3	A+ must contradict T-, A- must contradict T+	A+ = Energy transduction *vs.* T- = Resource depletion; A- = Energy dissipation *vs.* T+ = Energy storage
	T w/o A+ and A w/o T+ produce pathologies (S-)	(T − A+) = Chlorosis and stunted growth. (A − T+) = Photobleaching and oxidative leaf damage
4	T+ with A+ yield S+	S+ = Biomass production
6-7	In a cyclic loop, A and T must be placed diagonally to each other	

The first two constraints are already encoded in the prompt ("For a given T, identify A such that T+ opposes A− and T− opposes A+"), whereas the remaining steps aim to elucidate the underlying mechanisms. The analysis is performed iteratively with AI until meaningful labels are assigned to each element of the causal loop (steps 6–7, corresponding to Table 3).

A suitable antithesis should be functionally broad enough to generate a synthesis, yet operationally precise enough to support causality. For a rough assessment of potential blind spots, the very first semantic opposition that comes to mind is usually sufficient. Often, practice itself suggests appropriate antitheses; for example, in safety engineering, rule violations naturally serve as antitheses.

S1.3 Constructing Tetrads

Table S1.3. Determining T+, T-, A+, A- components for T = Love, A = Hate

N	**Constraint**	**T = Love, A = Hate**	**CC***	**T = Sugar, A = Energy convers**	**CC***
1	T+/A+ are constructive, balancing developments that enhance upsides of opposition	Bonding (T+) enhances Autonomy (A+), which is an upside of Hate (A)	0.75	Energy storage (T+) enhances Energy sufficiency (A+), which is an upside of Energy conversion (A)	0.72
		Autonomy (A+) enhances Bonding (T+), which is an upside of Love (T)	0.92	Energy Sufficiency (A+) enhances Energy storage (T+), which is an upside of Sugar formation (T)	0.95
2	T-/A- are overdevelopments or	Enmeshment (T-) is overdeveloped Love (T)	0.70	Resource depletion (T-) is overdeveloped Sugar formation	0.85

	exaggerations of the parent concept, and simultaneously underdevelopments of its opposition	and underdeveloped Hate (A)		(T) & underdeveloped Energy Conversion (A)	
		Alienation (A-) is overdeveloped Hate (A) and underdeveloped Love (T)	0.88	Energy dissipation (A-) is overdeveloped Energy conversion (A) and underdeveloped Sugar Formation (T)	0.92
3	T+ must directly contradict A-, and T- must directly contradict A+ (shown by dotted arrows in Fig. 2A)	Bonding (T+) directly contradicts Alienation (A-)	0.95	Energy storage (T+) directly contradicts Energy dissipation (A-)	0.88
		Enmeshment (T-) directly contradicts Autonomy (A+)	0.96	Resource depletion (T-) directly contradicts Energy sufficiency (A+)	0.90

* Conceptual Coherence estimated by GPT 5.2

S1.4 Estimating Complementarity

Prompt for estimating Complementarity:

<!-- Complementarity Assessment Evaluates synergistic interdependence between two statements or concepts -->

Task:

Evaluate the Complementarity (K) between two given statements or concepts, measuring how strongly they need, enrich, and complete one another to produce a higher or more balanced outcome.

Complementarity expresses synergy or mutual necessity, not mere similarity or opposition.

Given statements:

T: [First statement or thesis]

A: [Second statement or antithesis / complement]

Context: [Optional domain or situation]

Evaluation criteria:

Interdependence – Do T and A need each other to reach full expression or effectiveness?

Mutual Enhancement – When combined, do they produce a new or higher quality that neither could achieve alone?

Constructive Tension – Do they maintain a productive difference (not identical, not destructive)?

Systemic Necessity – Are both required parts of a larger functioning whole?

Diminishment on Separation – Does removing one reliably cause the other to deteriorate or become exaggerated?

Scoring tip: Assign a K value that best represents the overall strength of synergy across these criteria.

Complementarity (K) Scale (0.00–1.00):

Intermediate values (e.g., 0.15, 0.35) represent gradual transitions between categories.

0.00–0.09 – No complementarity; meaningless pairing.

Example: “Iron smelting” vs. “Moral virtue.”

0.10–0.19 – Very weak resonance; coexist but independent.

Example: “Spreadsheet formatting” vs. “Emotional intelligence.”

0.20–0.29 – Weak affinity; coexist but rarely interact; minimal mutual benefit.

Example: “Budget control” vs. “Corporate empathy.”

0.30–0.39 – Mild complementarity; help indirectly.

Example: “Risk awareness” vs. “Innovation freedom.”

0.40–0.49 – Useful pairing; balanced helpers within limited scope.

Example: “Customer satisfaction” vs. “Operational efficiency.”

0.50–0.59 – Moderate partnership; clear mutual improvement.

Example: “Research” vs. “Engineering.”

0.60–0.69 – Strong interdependence; must be coordinated; mutually stabilizing.

Example: “Strategy” vs. “Execution.”

0.70–0.79 – Strong complementarity; separation harms both.

Example: “Speed” vs. “Quality.”

0.80–0.89 – Deep synergy; together generate emergent value; archetypal complementarity.

Example: “Autonomy” vs. “Alignment.”

0.90–0.94 – Near-perfect complementarity; unity-in-duality, high generativity.

Example: “Masculine” vs. “Feminine.”

0.95–1.00 – Perfect complementarity; absolute mutual necessity; loss of one destroys the other.

Example: “Yin” vs. “Yang” or “God” vs. “Love.”

Output format:

Complementarity (K): [0.00–1.00]

Interdependence analysis: [1–2 sentences explaining why this value fits, referencing the evaluation criteria.]

Emergent quality: [One phrase naming what emerges when T and A combine productively – e.g., “Sustainable innovation,” “Dynamic stability,” “Grounded vision,” “Adaptive resilience.”]

Separation risk: [What happens if one is pursued without the other – e.g., “T without A leads to chaos; A without T leads to stagnation.”]

S1.5 Complementarity Diagrams

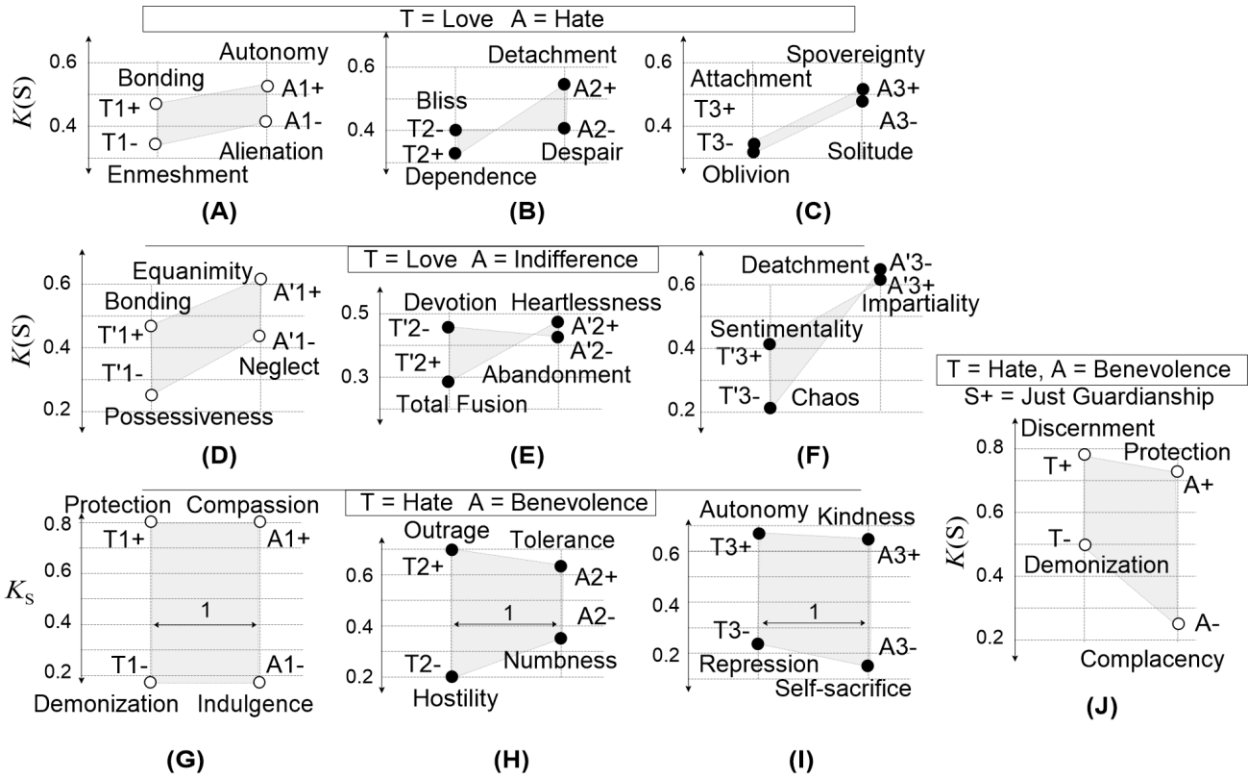


Fig. S1.5-1. Complementarity diagrams.

A, D, G, J – balanced tetrads. B, E, H – biased toward Thesis. C, F, I – biased toward Antithesis.

Tables S1.5-1. Data used in the above plots

T = Love, A = Hate

	K_T	K_A	K_S	SP
T1+ = Bonding	0.82	0.12	0.47	
T1- = Enmeshment	0.32	0.38	0.35	
A1+ = Autonomy	0.76	0.30	0.53	
A1- = Alienation	0.10	0.72	0.42	+0.23
Sum	2.00	1.52	1.76	
T2+ = Bliss	0.58	0.10	0.34	
T2- = Dependence	0.40	0.40	0.40	
A2+ = Detachment	0.55	0.55	0.55	
A2- = Despair	0.14	0.68	0.41	+0.08
Sum	1.67	1.73	1.70	
T3+ = Attachment	0.46	0.22	0.34	
T3- = Oblivion	0.04	0.60	0.32	
A3+ = Sovereignty	0.60	0.44	0.52	
A3- = Solitude	0.38	0.58	0.48	+0.06
Sum	1.48	1.84	1.66	

T = Love, A = Indifference

	K_T	K_A	K_S	SP
T'1+ = Bonding	0.82	0.12	0.47	
T'1- = Possessiveness	0.22	0.28	0.25	
A'1+ = Equanimity	0.66	0.58	0.62	
A'1- = Neglect	0.12	0.76	0.44	+0.40
Sum	1.82	1.74	1.78	
T'2+ = Total fusion	0.38	0.18	0.28	
T'2- = Devotion	0.62	0.30	0.46	
A'2+ = Heartlessness	0.06	0.88	0.47	
A'2- = Abandonment	0.04	0.92	0.43	-0.14
Sum	1.10	2.28	1.69	
T'3+ = Sentimentality	0.44	0.40	0.42	
T'3- = Chaos	0.08	0.35	0.22	
A'3+ = Impartiality	0.58	0.66	0.62	
A'3- = Detachment	0.55	0.72	0.64	+0.18
Sum	1.65	2.13	1.89	

T = Hate, A = Benevolence

	K_T	K_A	K_S	SP
T1+ = Protection	0.85	0.75	0.80	
T1- = Demonization	0.25	0.10	0.18	
A1+ = Compassion	0.70	0.90	0.80	
A1- = Indulgence	0.10	0.25	0.18	+1.24
Sum	1.90	2.00	1.95	
T2+ = Outrage	0.80	0.40	0.60	
T2- = Hostility	0.15	0.05	0.10	
A2+ = Tolerance	0.45	0.60	0.53	
A2- = Numbness	0.20	0.30	0.25	+0.78
Sum	1.60	1.35	1.48	
T3+ = Autonomy	0.75	0.60	0.68	
T3- = Repression	0.30	0.15	0.23	
A3+ = Kindness	0.45	0.85	0.65	
A3- = Self-sacrifice	0.10	0.20	0.15	+0.95
Sum	1.60	1.80	1.70	

T = Sugar formation, A = ATP formation

	K_T	K_A	K_S	SP
T1+ = Carbon fixation	0.95	0.55	0.75	
T1− = Resource Depletion	0.20	0.25	0.23	
A1+ = Regulated transduction	0.70	0.90	0.80	
A1− = Oxidative dissipation	0.15	0.65	0.40	+0.92
Sum	2.00	2.35	2.18	
T2+ = Enhanced Growth	0.85	0.55	0.70	
T2− = Resource Depletion	0.20	0.25	0.23	
A2+ = Energy Efficiency	0.55	0.75	0.65	
A2− = Energy Deficit	0.25	0.20	0.23	+0.89
Sum	1.85	1.75	1.80	
T3+ = Resource Conservation	0.60	0.35	0.48	
T3− = Carbon Starvation	0.10	0.30	0.20	
A3+ = Strong Energy Capture	0.45	0.90	0.68	
A3− = Photodamage	0.05	0.70	0.38	+0.58
Sum	1.20	2.25	1.73	

In all cases, the balanced tetrads had the maximum shape area ("Synthesis Potential"), expressed as the difference between the average complementarities (K_S) of the positive and negative poles: SP = [K_S (T+) + K_S (A+) – K_S (T-) – K_S (A-)]. Yet, we could not define a common cut-off value.

The following are some explorations which did not lead to any useful conclusions.

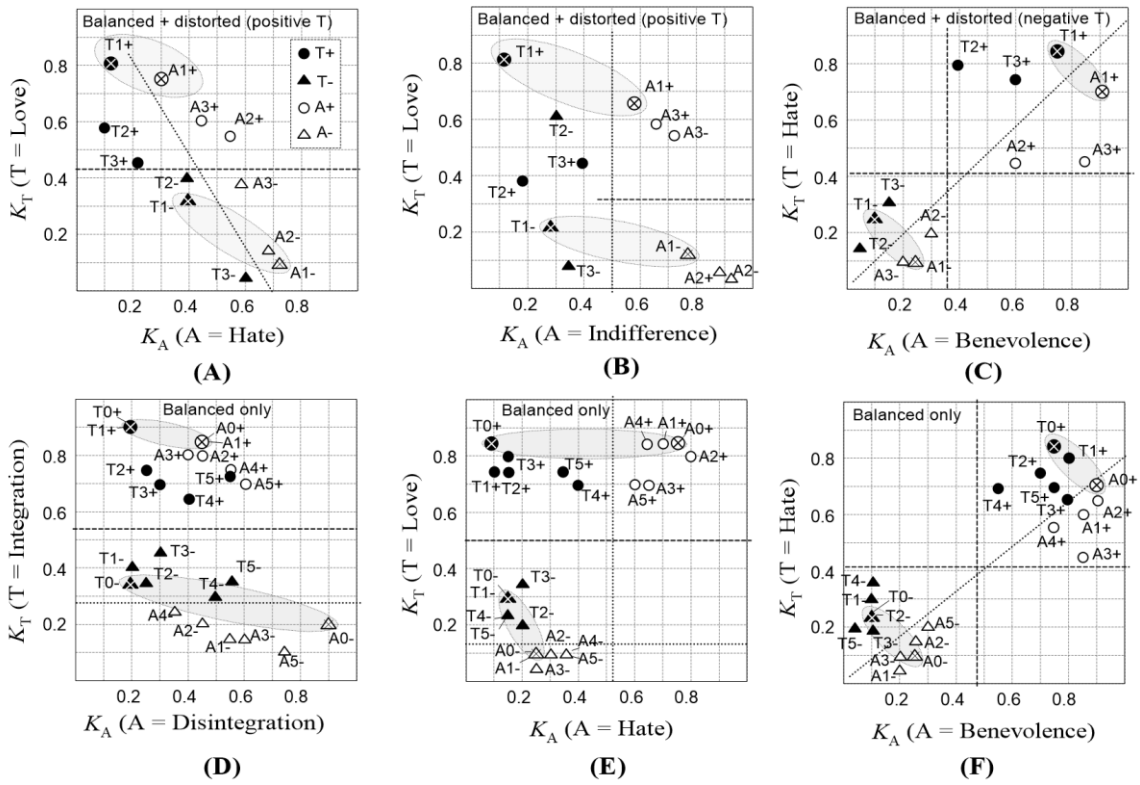


Fig. S1.5-2. All values were obtained with GPT-5

S1.6 Selecting The Best Tetrad

First, AI suggested 21 representative judgmental types, including 10 pathological (Table S1.5-1) and 11 healthy (Table S1.5-2). Each type was assigned ontological coordinates (MMI – Mind–Matter Index; PSI – Pathology–Synthesis Index, introduced in the following sections). These coordinates are shown in parentheses next to each judgmental type.

Second, for each type we constructed a characteristic tetrad using the existential pair T = Truth and A = Imagination, which produced greater variation across judgmental types than the simpler pair T = Truth and A = Falsehood.

Third, for each tetrad we estimated the complementarity index of every component (T+, T−, A+, A−): $K_S = (K(T) + K(A))/2$. The corresponding KS values are listed next to each component in the corresponding tables.

Fourth, for each tetrad we calculated its Synthesis Potential, SP = $K_S(T+) + K_S(A+) - K_S(T-) - K_S(A-)$. Several alternative criteria were also evaluated (Table S1.5-3), but none proved comparably useful.

Finally, each tetrad was supplemented with S+ and S− components and their KS values. Qualitative inspection suggests that pathological worldviews often exhibit a negative ΔKS = KS(S+) − KS(S−), although some pathological tetrads also produce positive values.

Table S1.6-1. Pathological Worldviews for T = Truth, A = Imagination

Worldview*	**T+**	**T−**	**A+**	**A−**	**SP**	**S+**	**S−**
Orwellian (0.2;0.0)	Official Truth 0.45	Heresy 0.80	Propaganda 0.40	Free Thought 0.91	-0.86	Social Stability 0.48	Chaos 0.63
Psychopath (0.1;0.1)	Advantage 0.63	Vulnerability 0.84	Manipulation 0.55	Empathy 0.89	-0.55	Dominance 0.52	Victimization 0.74
Hedonist (0.3;0.3)	Pleasure 0.68	Suffering 0.92	Desire 0.72	Discipline 0.86	-0.38	Enjoyment 0.77	Misery 0.80
Narcissist (0.8;0.2)	Superiority 0.49	Shame 0.71	Self-image 0.70	Criticism 0.84	-0.36	Admiration 0.75	Humiliation 0.75
Bureaucrat (0.2;0.3)	Procedure 0.68	Exception 0.82	Regulation 0.70	Improvisation 0.85	-0.29	Order 0.71	Disorder 0.55
Cult Leader (1.0;0.1)	Revelation 0.83	Apostasy 0.72	Charisma 0.64	Independent Thinking 0.92	-0.17	Devotion 0.83	Betrayal 0.82
Fanatic (0.9;0.1)	Absolute Truth 0.75	Doubt 0.81	Zeal 0.67	Compromise 0.70	-0.09	Purity 0.82	Corruption 0.49
Nihilist (0.3;0.1)	Survival 0.73	Meaning 0.85	Detachment 0.82	Hope 0.72	-0.02	Freedom 0.93	Absurdity 0.71
Technocrat (0.2;0.5)	Optimization 0.69	Inefficiency 0.56	Innovation 0.89	Tradition 0.70	+0.32	Progress 0.81	Stagnation 0.12
Conspiracy theorist (0.9;0.2)	Hidden Truth 0.84	Mainstream Narrative 0.48	Pattern-finding 0.88	Skepticism 0.84	+0.40	Revelation 0.83	Deception 0.53

*In parentheses (MMI; PSI) by GPT 5.2; PSI Prompt in the following section. **Ks = (K(T)+K(A))/2 by Gemini.

Table S1.6-2. Healthy Worldviews for T = Truth, A = Imagination

Worldview*	**T+**	**T−**	**A+**	**A−**	**SP**	**S+**	**S−**
Nietzsche (0.9; 0.6)	Power 0.60	Weakness 0.73	Creation 0.92	Resentment 0.38	+0.41	Greatness 0.74	Nihilism 0.40
Materialist (0.0; 0.4)	Objectivity 0.69	Dogmatism 0.19	Hypothesis 0.81	Subjectivity 0.77	+0.54	Science 0.88	Reductionism 0.40

Keats (1.0; 0.8)	Reality 0.82	Ugliness 0.64	Beauty 0.90	Delusion 0.34	+0.74	Heaven 0.82	Hell 0.55
Engineer (0.1; 0.5)	Functio-nality 0.73	Overengineering 0.37	Design 0.90	Ornamentation 0.51	+0.75	Robustness 0.68	Fragility 0.43
Rationalist (0.4; 0.6)	Sound Logic 0.72	Literalism 0.25	Model 0.85	Fantasy 0.57	+0.75	Understan-ding 0.86	Sophistry 0.42
Christian (1.0; 0.8)	Faithfulness 0.74	Sin 0.33	Love 0.90	Temptation 0.44	+0.87	Salvation 0.82	Perdition 0.44
Idealist (0.9; 0.7)	Authenticity 0.77	Fanaticism 0.20	Insight 0.87	Pretense 0.43	+1.01	Wisdom 0.94	Delusion 0.34
Buddhist (1.0; 0.9)	Awareness 0.79	Attachment 0.29	Compassion 0.88	Illusion 0.37	+1.01	Enlighten-ment 0.89	Samsara 0.62
Pragmatist (Peirce/James) (0.2; 0.7)	Utility 0.71	Dogmatism 0.19	Experiment 0.88	Wishful thinking 0.36	+1.04	Progress 0.81	Stagnation 0.12
Taoist (0.5; 1.0)	Harmony 0.82	Forcing 0.22	Balance 0.87	Excess 0.40	+1.07	Tao 0.93	Disharmony 0.51
Unconst-rained	Honesty 0.73	Dogmatism 0.19	Creativity 0.90	Delusion 0.34	+1.10	Synergy 0.75	Suppression 0.24

*In parentheses (MMI; PSI) by GPT 5.2; PSI Prompt in the following section. **Ks = (K(T)+K(A))/2 by Gemini.

Table S1.6-3. Considered criteria

Explored criteria	**Comments**
K_S (T+)	Not useful
(K_S (T+) +K_S (A+))/2	Not useful
$\|K_S(T+) - K_S(+)\|$	Not useful
Rectangularity: $1 – [\|K_S (T+) – K_S (A+)\| + \|K_S (T-) – K_S (A-)\|]$	Not useful
Max SP = $[K_S (T+) + K_S (A+) – K_S (T-) – K_S (A-)]$	Biased < 0.5, balanced > 0.2, but see Tables S1.4
Biased, if $K_S (S+) – K_S (S-) < 0$	Many biases are not catched
Biased, if twisted: $K_S (T+) < K_S (T-)$ or $K_S (A+) < K_S (A-)$	Many biases are not catched

In case of many alternative criteria, each could be assigned with heuristic weight.

S1.7 Evaluation of Control Statements

Control statements have general form: "T+ without A+ yield T-, while A+ without T+ yield A-". Two empirical parameters have been tested:

Conceptual Coherence (CC) prompt:

"Estimate the Conceptual Coherence (CC) of the given statement on a continuous scale from 0 to 1, where CC = 0 denotes a conceptually nonsensical statement and CC = 1 denotes a conceptually meaningful statement."

Dialectical Validity (DV) prompt:

"Evaluate the Dialectical Validity (DV) of the given statement on a continuous scale from 0.0 to 1.0.

• DV = 1.0: The statement expresses a natural, balanced, and generative dialectical relationship. The concepts occupy comparable semantic levels, the two positive poles genuinely complement one another, and the predicted pathologies arise naturally from the absence of their complementary counterparts.

• DV = 0.0: The statement is forced, artificial, or dialectically distorted. The concepts are semantically mismatched, one pole is arbitrarily privileged, or the predicted outcomes rely primarily on coercion, ideology, arbitrary conventions, or implausible reasoning rather than natural system dynamics.

Ignore factual correctness; evaluate only the quality of the dialectical relationship as a generative principle."

Table S1.7-1. Evaluation of Control Statements using GPT-5

Case	**T= Love, A = Hate**	**CC**	**DV**	**T = Sugar, A = Energy conversion**	**CC**	**DV**
(A) Balanced system	Bonding (T_1^+) without Autonomy (A_1^+) yields Enmeshment (T_1^-)	0.92	0.99	Carbon fixation (T_1^+) without Regulated transduction (A_1^+) yields Resource depletion (T_1^-)	0.90	0.91
	Autonomy (A_1^+) without Bonding (T_1^+) yields Alienation (A_1^-)	0.90	0.98	Regulated transduction (A_1^+) without Carbon fixation (T_1^+) yields Oxidative dissipation (A_1^-)	0.93	0.96
(B) Biased toward T	Bliss (T_2^+) without Detachment (A_2^+) yields Dependence (T_2^-)	0.82	0.95	Enhanced Growth (T_2^+) without Energy Efficiency (A_2^+) yields Resource Depletion (T_2^-)	0.85	0.97
	Detachment (A_2^+) without Bliss (T_2^+) yields Despair (A_2^-)	0.78	0.78	Energy Efficiency (A_2^+) without Enhanced Growth (T_2^+) yields Energy Deficit (A_2^-)	0.70	0.62
(C) Biased toward A	Attachment (T_3^+) without Sovereignty (A_3^+) yields Oblivion (T_3^-)	0.72	0.34	Resource Conservation (T_3^+) without Strong Energy Capture (A_3^+) yields Carbon Starvation (T_3^-)	0.87	0.89
	Sovereignty (A_3^+) without Attachment (T_3^+) yields Solitude (A_3^-)	0.88	0.84	Strong Energy Capture (A_3^+) without Resource Conservation (T_3^+) yields Photodamage (A_3^-)	0.94	0.98

Table S1.7-2. Evaluation of control statements generated on-the-fly using Gemini and GPT

					SP**	**DV**		**CC**	
Worldview	**T+**	**T−**	**A+**	**A−**	**Gemini**	**Gemini**	**GPT**	**Gemini**	**GPT**
Orwellian	Official Truth	Heresy	Propaganda	Free Thought	-0.86	0.00	0.05	**0.85**	0.15

Psychopath	Advantage	Vulnerability	Manipulation	Empathy	-0.55	0.15	0.10	0.45	0.20
Hedonist	Pleasure	Suffering	Desire	Discipline	-0.38	0.35	0.16	**0.90**	**0.78**
Narcissist	Superiority	Shame	Self-image	Criticism	-0.36	0.40	0.48	0.65	0.30
Bureaucrat	Procedure	Exception	Regulation	Improvisation	-0.29	0.50	**0.91**	**0.88**	**0.86**
Cult Leader	Revelation	Apostasy	Charisma	Independent Thinking	-0.17	0.30	0.14	**0.82**	0.20
Fanatic	Absolute Truth	Doubt	Zeal	Compromise	-0.09	0.10	0.22	**0.70**	0.40
Nihilist	Survival	Meaning	Detachment	Hope	-0.02	0.00	0.06	**0.78**	0.18
Technocrat	Optimization	Inefficiency	Innovation	Tradition	+0.32	0.20	0.18	**0.85**	0.35
Conspiracy theorist	Hidden Truth	Mainstream Narrative	Pattern-finding	Skepticism	+0.40	0.25	0.42	**0.80**	0.55
Nietzsche	Power	Weakness	Creation	Resentment	+0.41	0.85	0.76	0.92	0.88
Materialist	Objectivity	Dogmatism	Hypothesis	Subjectivity	+0.54	0.88	0.95	0.95	0.82
Keats	Reality	Ugliness	Beauty	Delusion	+0.74	0.95	0.94	0.94	0.90
Engineer	Functionality	Overengineering	Design	Ornamentation	+0.75	0.90	0.97	0.96	0.93
Rationalist	Sound Logic	Literalism	Model	Fantasy	+0.75	0.82	0.96	0.87	0.94
Christian	Faithfulness	Sin	Love	Temptation	+0.87	0.78	0.86	0.84	0.92
Idealist	Authenticity	Fanaticism	Insight	Pretense	+1.01	0.92	0.89	0.93	0.80
Buddhist	Awareness	Attachment	Compassion	Illusion	+1.01	0.94	0.88	0.95	0.70
Pragmatist (Peirce/James)	Utility	Dogmatism	Experiment	Wishful thinking	+1.04	0.86	0.92	0.83	0.85
Taoist	Harmony	Forcing	Balance	Excess	+1.07	**0.40**	**0.25**	**0.60**	**0.45**
Unconstrained	Honesty	Dogmatism	Creativity	Delusion	+1.10	0.85	0.90	0.94	0.90

Bold underlined values indicate sharp discrepancies from SP. Generally, DV parameter performed better than CC. The only question is why Taoist's and Bureaucrat's values deviated.

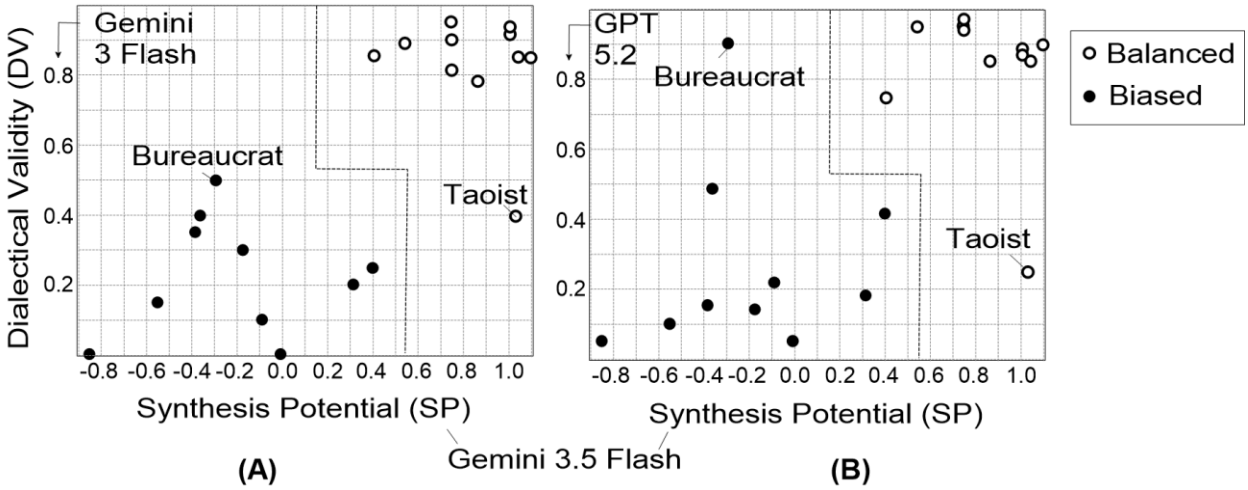


Fig. S1.7-1. Complementarity diagrams.

S1.8 Ontological Profiling: Mind-Matter Index

For MMI we used the simplest prompt:

"Estimate the degree to which a concept assumes the ontological primacy of Mind over Matter:

MMI = 0 : Matter is ontologically primary (pure materialism)
MMI = 1 : Mind is ontologically primary (pure idealism)."

Lower MMI may be preferable for well-defined engineering or operational tasks (e.g., designing an aircraft landing gear), whereas higher MMI becomes advantageous when the objectives themselves require reconsideration.

Table S1.8-1. T = Protect nature, A = Ignore Nature

	1. Claude Sonnet 4.5	MMI*	2. Organic (Author)	MMI
T+	**Sustainability and ecological balance**	0.45	**Spiritual harmony**	0.98
T-	Extreme environmentalism and human restriction	0.35	Over-regulation	0.30
A+	**Human progress and economic development**	0.15	**Business freedom**	0.25
A-	Environmental destruction and ecosystem collapse	0.10	Spiritual Decay	0.99
S+	**Green economy and sustainable innovation**	0.35	**Natural Self-Regulation**	0.95
S-	Dystopian stagnation, resource depletion	0.10	Artificial suffocation	0.85
	Average	< 0.3	Average	> 0.7

* Mind-Matter Index estimate d by GPT 5.2

Claude's lower-MMI tetrad reformulates existing environmental objectives, whereas the higher-MMI tetrad replaces the original objective with a different existential interpretation ("Spiritual harmony"), illustrating ontology revision rather than policy optimization.

Preliminary observations further suggest that MMI may represent one of the strongest discriminators of existential interpretations, whereas ideological, political, or ethical parameters primarily modulate interpretations within a given ontology.

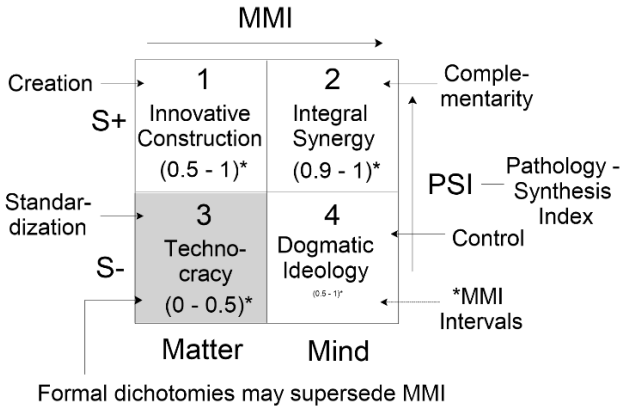


Fig. S1.8-1. Categorization of concepts and interpretations on S± vs MMI scales.

Table S1.8-2. Rough MMI values for various quadrants (GPT 5.2)

1st Quadr	MMI	2nd	MMI	3rd	MMI	4th	MMI
Einstein	0.8	Buddha	1.0	TCP/IP	0.0	Inquisition	1.0
Newton	0.8	Jesus	0.9	ISO standards	0.1	Religious fundamentalism	0.9
Turing	0.7	Jung	0.8	Bureaucracy	0.1	Cult ideology	0.8
Shannon	0.6	Wilber	0.9	Taylorism	0.2	Divine Command	1.0

Pathology can be identified by the quality of tetrad (using SP and DV indices)

Table S1.8-3. Archetypes vs quadrants and tetrad quality (SP).

Worldview	Quadrant*	T+	T−	A+	A−	SP**	S+	S-
Orwellian	3 (0.2;0.0)	Official Truth	Heresy	Propaganda	Free Thought	-0.86	Social Stability	Chaos
Psychopath	3 (0.1;0.1)	Advantage	Vulnerability	Manipulation	Empathy	-0.55	Dominance	Victimization
Hedonist	3 (0.3;0.3)	Pleasure	Suffering	Desire	Discipline	-0.38	Enjoyment	Misery
Narcissist	4 (0.8;0.2)	Superiority	Shame	Self-image	Criticism	-0.36	Admiration	Humiliation
Bureaucrat	3 (0.2;0.3)	Procedure	Exception	Regulation	Improvisation	-0.29	Order	Disorder
Cult Leader	4 (1.0;0.1)	Revelation	Apostasy	Charisma	Independent Thinking	-0.17	Devotion	Betrayal
Fanatic	4 (0.9;0.1)	Absolute Truth	Doubt	Zeal	Compromise	-0.09	Purity	Corruption
Nihilist	3 (0.3;0.1)	Survival	Meaning	Detachment	Hope	-0.02	Freedom	Absurdity
Technocrat	3 (0.2;0.5)	Optimization	Inefficiency	Innovation	Tradition	+0.32	Progress	Stagnation
Conspiracy theorist	4 (0.9;0.2)	Hidden Truth	Mainstream Narrative	Pattern-finding	Skepticism	+0.40	Revelation	Deception
Nietzsche	4 (0.9; 0.6)	Power	Weakness	Creation	Resentment	+0.41	Greatness	Nihilism
Materialist	3 (0.0; 0.4)	Objectivity	Dogmatism	Hypothesis	Subjectivity	+0.54	Science	Reductionism
Keats	2 (1.0; 0.8)	Reality	Ugliness	Beauty	Delusion	+0.74	Heaven	Hell
Engineer	2 (0.1; 0.5)	Functionality	Overengineering	Design	Ornamentation	+0.75	Robustness	Fragility
Rationalist	1 (0.4; 0.6)	Sound Logic	Literalism	Model	Fantasy	+0.75	Understanding	Sophistry

Christian	2 (1.0; 0.8)	Faithfulness	Sin	Love	Temptation	+0.87	Salvation	Perdition
Idealist	2 (0.9; 0.7)	Authenticity	Fanaticism	Insight	Pretense	+1.01	Wisdom	Delusion
Buddhist	2 (1.0; 0.9)	Awareness	Attachment	Compassion	Illusion	+1.01	Enlightenment	Samsara
Pragmatist (Peirce/James)	1 (0.2; 0.7)	Utility	Dogmatism	Experiment	Wishful thinking	+1.04	Progress	Stagnation
Taoist	1 (0.5; 1.0)	Harmony	Forcing	Balance	Excess	+1.07	Tao	Disharmony
Unconstrained	1 (0.5; 0.9)	Honesty	Dogmatism	Creativity	Delusion	+1.10	Synergy	Suppression

*Ontology parameters (MMI; SPI) estimated by GPT using prompts given above and below.

**SP – Synthesis Potential estimated by Gemini as described above.

In the above table, Technocrats and Engineers fall on the border between 1 and 3. Quadrant 3 may include both healthy and pathological cases, as not all Technocrats and Materialists are "pathological".

S1.9 Pathology – Synthesis Index (PSI) Prompt

Estimate the Pathology–Synthesis Index (PSI) of the following worldview on a scale from 0.0 to 1.0.

PSI measures the extent to which a worldview promotes genuine dialectical synthesis (S+) rather than pathological optimization (S−).

S+ is defined as the emergence of higher-order organization through reciprocal self-regulation of complementary dimensions. No dimension is optimized at the expense of the long-term viability of the whole.

S− is defined as optimization of one or more selected dimensions while suppressing, ignoring, or misinterpreting complementary dimensions, thereby degrading the long-term viability of the whole.

Use the following anchor points.

PSI = 0.0
Pure pathology. A subsystem optimizes itself at the expense of the whole.
Examples:
• malignant cancer
• Orwellian dictatorship
• runaway AI maximizing a misspecified objective

PSI = 0.1
Extreme pathology. Almost every complementary dimension is sacrificed for a single objective.
Examples:
• religious or political extremism
• fanatical cults
• total ecological exploitation

PSI = 0.2
Severe imbalance. Some complementary dimensions survive but mainly serve the dominant objective.
Examples:
• rigid bureaucracy
• aggressive monopoly
• exploitative colonial systems

PSI = 0.3
Strong imbalance. Constructive interactions exist but remain subordinate to competition or domination.
Examples:
• unregulated capitalism
• militaristic nationalism
• reductionistic scientism

PSI = 0.4
Moderate imbalance. Several dimensions are recognized but systematic blind spots still drive optimization.
Examples:
• conventional corporate KPI optimization
• traditional engineering optimization
• many modern institutions

PSI = 0.5
Transitional. Complementary dimensions are explicitly acknowledged but are not yet continuously self-regulated.
Examples:
• multidisciplinary collaboration
• systems thinking without feedback adaptation

PSI = 0.6
Moderate synthesis. Reciprocal regulation becomes common, although important biases remain.
Examples:
• mature democratic governance
• adaptive organizations
• evidence-based medicine

PSI = 0.7
Strong synthesis. Optimization usually increases the viability of the whole rather than isolated components.
Examples:
• healthy ecosystems
• resilient biological regulation
• effective scientific communities

PSI = 0.8
Advanced synthesis. Higher-order qualities consistently emerge through mutual regulation.
Examples:
• long-term sustainable civilizations (idealized)
• mature ecological symbioses
• exemplary servant leadership

PSI = 0.9
Near-complete synthesis. Nearly every dimension continually regulates every other through complementary interactions.
Examples:
• idealized Buddhist compassion
• idealized Christian agape
• idealized Taoist harmony

PSI = 1.0
Perfect synthesis (theoretical limit). Every dimension contributes to the emergence and continual self-regulation of the whole. No optimization occurs at the expense of another dimension.
Examples:
• Tao (Laozi)
• God (idealized omnibenevolent creator)
• perfectly self-regulating living universe

Evaluation criteria

Estimate PSI according to the worldview's intrinsic principles rather than historical implementations.

Consider:

1. Does it generate higher-order organization rather than merely optimize existing dimensions?
2. Does it preserve and integrate complementary dimensions?
3. Does it continually regulate and revise its own assumptions and objectives?
4. Does it avoid optimizing one dimension at the expense of the long-term viability of the whole?
5. Does it increase systemic harmony (S+) or systemic pathology (S−)?

Respond with: PSI = X.X followed by a concise justification (1–3 sentences).

S1.10 Types and Examples of Syntheses and Pathologies

Table S1.10-1. Typical modes of Positive Synthesis (S+)

	Sa+ (Process)	**Sb+ (Structure)**	**Sc+ (Normative)**	**S+ (Apex)**
Core Principle	Self-Regulation and Resilience	Bounded Coupling	Invariant Preservation:	Emerging Unity, New Quality
General Schema	Remaining stable under shocks	Preserving distinction while creating new relations	Preserving core values while creating new meanings	Emergent unity that transforms values without erasing prior integrity
Birth of a Child	Emotion reorganizes around care	Proximity and irreducible distinction	Authority reorganizes under dignity	Co-emergent Parent–Child unity
Emergence of Love	Remaining stable together	Being close without losing ourselves	Mutual respect and regard	Mature Love
Emergence of Traditions	Surviving contact with change	Preserving diversity	Deserving allegiance	Cultural Wisdom
Emergence of Institutions	Remaining stable	Preserving civil autonomy	Constraining power	Legitimate Governance
Scientific Paradigms	Coherence under anomaly	Integrative Modeling	Truth constrains theory	Scientific Maturity
AI / Software	Operational Robustness	Modular Integrity	Invariant Preservation	Reliable Integration

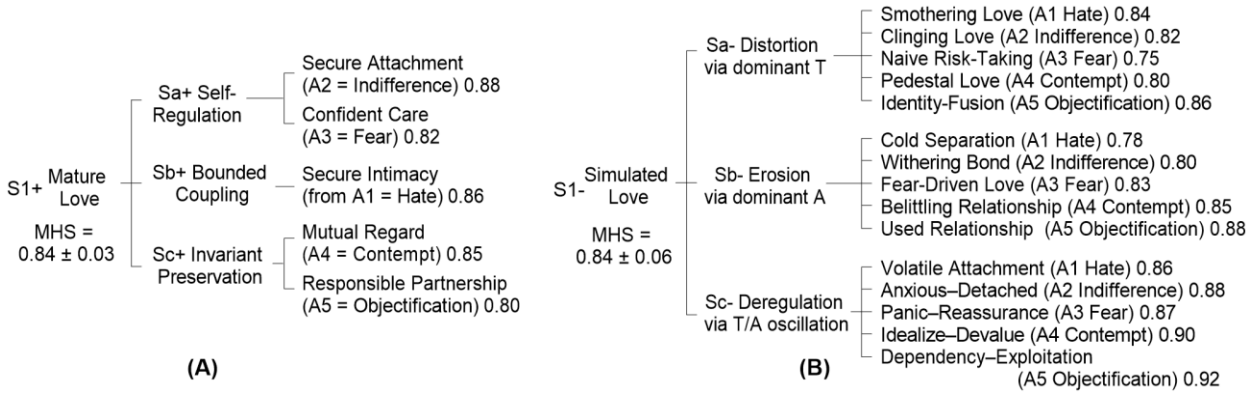


Fig. S1.10-1

MHS = Mean Heuristic Similarity. Numbers indicate heuristic similarities to the apex S+/S- concept. See also S1.5 and S1.6 Taxonomies above, where different columns represent alternative types of developmental steps toward S+.

S1.11 Taxonomies of Balanced Tetrads and Synthesis Stages

The following presents a taxonomy for grouping tetrads based on functional dimensions emphasized in systems and cybernetic perspectives. An apex concept - system viability – emerges from five interrelated capacities: (1) integrity (structural coherence), (2) fidelity (reliable information processing), (3) exchange (sustainable resource flows), (4) flexibility (adaptive responsiveness), and (5) resilience (recovery from perturbations). This taxonomy is intended as a heuristic organizing framework rather than a definitive ontology.

Table S1.11-1. Systemic taxonomy, assuming that each concept implies 5 different aspects:

	Apex	**Branch 1**	**Branch 2**	**Branch 3**	**Branch 4**	**Branch 5**
Domains	**Viability**	**Integrity**	**Fidelity**	**Exchange**	**Flexibility**	**Resilience**
General T	Integration	Cohesion	Modeling	Exchange	Exploration	Recovery
General A	Disintegration	Separation	Error correction	Consumption	Constraint	Disruption
Engineering		assembly	simulation	energy flow	control	tolerance
Ecology		Symbiosis	Sensing	Cyclicity	plasticity	resilience
Institutions		Soc. cohesion	knowledge	economy	innovation	crisis recovery
General T+	Coherence (0.90; 0.20; 1.00)*	Coherence (0.90; 0.20; 1.00)	Accuracy (0.75; 0.25; 0.60)	*Exchange* (0.70; 0.30; 0.45)	*Plasticity* (0.65; 0.40; 0.40)	Recovery (0.75; 0.55; 0.55)
General T-	Rigid fusion (0.35; 0.20; 1.00)	Locking-in (0.40; 0.20; 0.80)	Dogmatism (0.35; 0.25; 0.65)	Dependency (0.45; 0.30; 0.55)	*Chaotic drift* (0.30; 0.50; 0.20)	*Fragility* (0.35; 0.55; 0.40)
General A+	Differentiation (0.85; 0.45; 1.00)	Differentiation (0.85; 0.45; 1.00)	Critical testing (0.80; 0.45; 0.55)	Constraint (0.80; 0.40; 0.75)	Stabilization (0.75; 0.55; 0.60)	Buffering (0.70; 0.60; 0.55)

General A-	Disintegration (0.20; 0.90; 1.00)	Rupture (0.15; 0.55; 0.75)	Denial (0.20; 0.45; 0.40)	Depletion (0.15; 0.60; 0.55)	*Suffocating* (0.25; 0.35; 0.35)	Collapse (0.10; 0.70; 0.85)
T	Love	Bonding	Understanding	Giving	Openness	Repair
A	Hate	Aversion	Adversariality	Withholding	Defensiveness	Rancor
T+	Bonding (0.85; 0.10; 1.00)*	Attachment (0.75; 0.10; 0.90)	Attunement (0.80; 0.15; 0.85)	Reciprocity (0.80; 0.15; 0.85)	Flexibility (0.70; 0.40; 0.55)	Reconciliation (0.75; 0.35; 0.80)
T-	Enmeshment (0.30; 0.15; 1.00)	Enmeshment (0.30; 0.15; 1.00)	Projection (0.20; 0.20; 0.60)	Dependence (0.35; 0.20; 0.70)	Fusion (0.25; 0.15; 0.85)	Clinginess (0.25; 0.15; 0.85)
A+	Autonomy (0.85; 0.75; 1.00)	Boundaries (0.85; 0.70; 0.90)	Differentiation (0.80; 0.80; 0.85)	Independence (0.70; 0.65; 0.85)	Autonomy (0.85; 0.75; 1.00)	Self-possession (0.70; 0.60; 0.80)
A-	Alienation (0.10; 0.25; 1.00)	Alienation (0.10; 0.25; 1.00)	Estrangement (0.10; 0.30; 0.90)	Expulsion (0.05; 0.25; 0.80)	Distancing (0.10; 0.35; 0.75)	Withdrawal (0.10; 0.35; 0.75)
T	Hate					
A	Benevolence					
T+	Protection (0.85; 0.75, 1.00)	Boundary (0.80; 0.80, 0.90)	Discernment (0.75; 0.70; 0.75)	Reciprocity (0.65; 0.80; 0.55)	Caution (0.70; 0.55; 0.70)	Defensive repair (0.70; 0.75; 0.80)
T-	Demonization (0.25; 0.10; 1.00)	Exclusionism (0.30; 0.10; 0.80)	Demonization (0.25; 0.10; 1.00)	Exploitation (0.20; 0.10; 0.55)	Antagonism (0.35; 0.10; 0.75)	Vindictiveness (0.20; 0.05; 0.85)
A+	Compassion (0.70; 0.90; 1.00)	Supportiveness (0.60; 0.85; 0.90)	Empathy (0.65; 0.90; 0.95)	Generosity (0.45; 0.85; 0.75)	Openness (0.55; 0.75; 0.65)	Forgiveness (0.60; 0.85; 0.85)
A-	Indulgence (0.10; 0.25; 1.00)	Overindulgence (0.05; 0.20; 0.95)	Idealization (0.15; 0.25; 0.65)	Overgiving (0.10; 0.20; 0.80)	Naivety (0.10; 0.20; 0.60)	Passive tolerance (0.20; 0.30; 0.75)

* Numbers in parentheses indicate respectively, K_T, K_A, and HS (heuristic semantic similarity to apex). These numbers did not identify any useful dependences though.

It shows that positive and negative poles can be grouped into a small set of functional categories applicable across diverse domains (including engineering, ecological and institutional systems, and interpersonal contexts). Below we provide an alternative categorization based on a four-element schema.

Literature provides many comparable attempts to classify universal positive and negative effects. These can be grouped into ethical taxonomies of virtues and vices, capability-based approaches to human flourishing, psychological models of moral foundations, and systems-theoretic treatments of viability, feedback, resilience, and failure modes.

In above table, each pole (T+, T−, A+, A−) is annotated with 3 numbers in parentheses, denoting respectively K_T, K_A (complementarity toward T and A) and HS (heuristic semantic

similarity to apex). Within each row, K_T and K_A vary only modestly, suggesting similar modalities. However, HS varies in larger ranges, suggesting that similar modalities may be expressed by semantically different concepts.

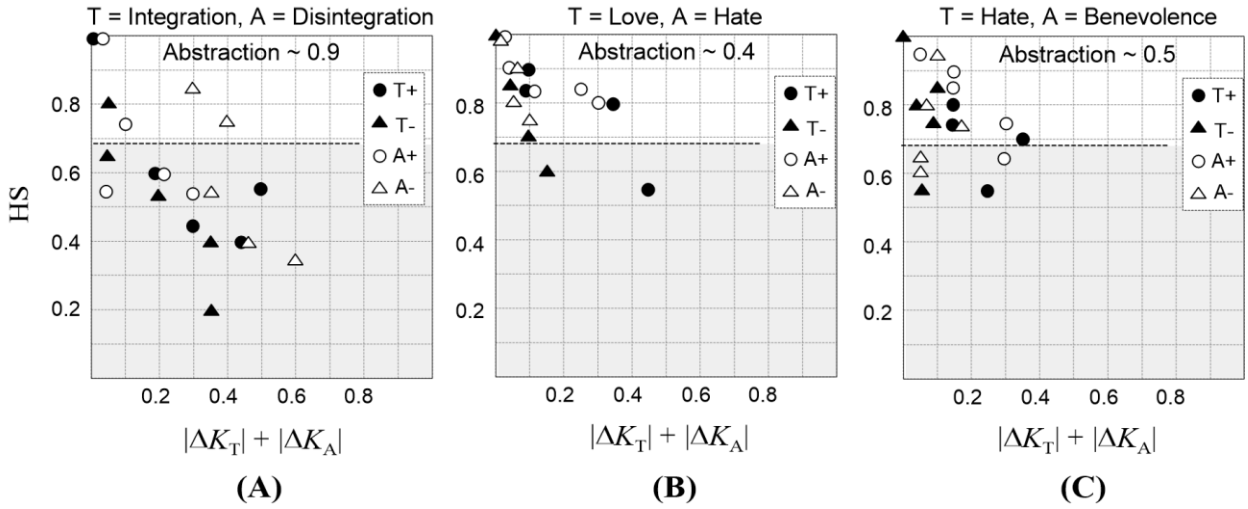


Fig. S1.11-1

The following table presents an alternative taxonomy for grouping tetrads into coherent categories based on a classical elemental framework. Historically, elemental classifications (e.g., fire, air, water, earth) provided a broad integrative scheme for organizing diverse natural, psychological, and social phenomena across many intellectual traditions for centuries, if not millennia. While modern taxonomies often achieve greater precision within specific domains, they may do so at the cost of the integrative breadth and cross-domain coherence characteristic of earlier elemental frameworks. The alternative taxonomy presented here is intended not as a revival of classical doctrine, but as a heuristic illustration of how tetradic relations can be organized within a broadly integrative conceptual structure.

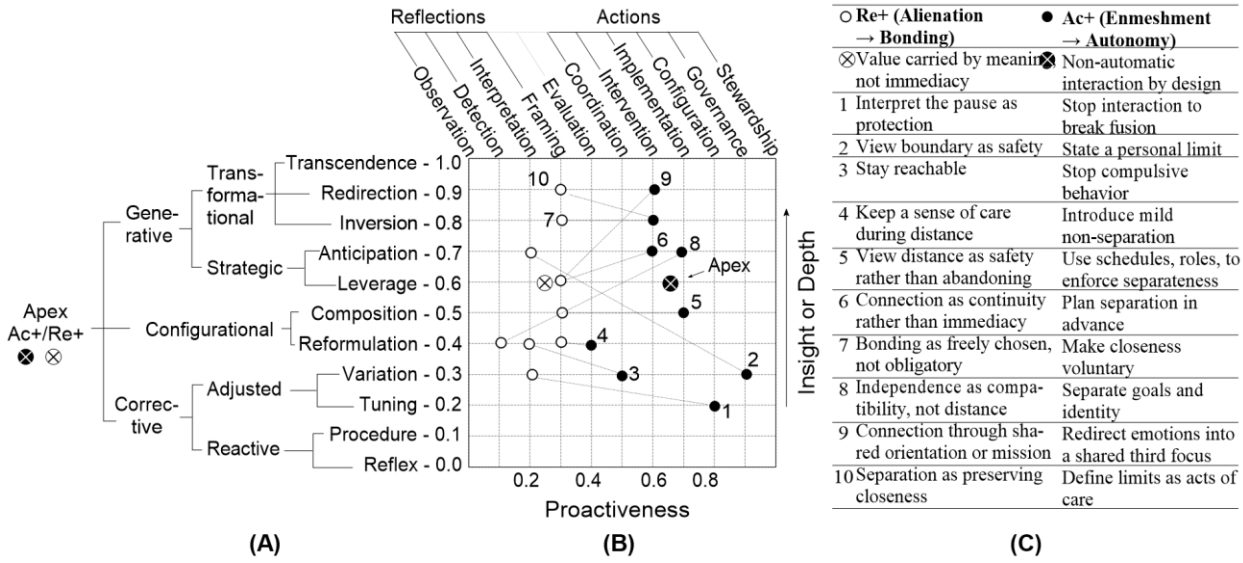
Table S1.11-2. Elemental taxonomy, assuming that each concept implies 4 classical elements

	Apex	**Fire**	**Earth**	**Air**	**Water**
Domains	**Viability**	**Drive**	**Structure**	**Process**	**Adaptation**
T	Integration	Activation	Cohesion	Exchange	Reflection
A	Disintegration	Inhibition	Separation	Consumption	Correction
Engineering		force input	assembly	energy flow	calibration
Ecology		energy input	symbiosis	cyclicity	homeostasis
Institutions		motivation	social cohesion	economy	learning
T+	coherence	motivation	coherence	exchange	plasticity
T-	rigid fusion	impulsivity	locking-in	dependency	fragility

A+	differentiation	regulation	differentiation	constraint	stabilization
A-	disintegration	repression	rupture	depletion	collapse
T = Love	integration	attraction	bonding	giving	openness
A = Hate	negation	aversion	hostility	withholding	defensiveness
T+	bonding	affection	attachment	reciprocity	reconciliation
T-	enmeshment	obsession	fusion	dependence	clinginess
A+	autonomy	restraint	boundaries	independence	self-possession
A-	alienation	rejection	estrangement	expulsion	withdrawal

S1.12 Circular Causality and Transitions

A given tetrad can yield different Ac/Re transitions depending on the desired levels of proactiveness and insightfulness:



○ Re+ (Alienation → Bonding)	● Ac+ (Enmeshment → Autonomy)
⊗ Value carried by meaning, not immediacy	⊗ Non-automatic interaction by design
1 Interpret the pause as protection	Stop interaction to break fusion
2 View boundary as safety	State a personal limit
3 Stay reachable	Stop compulsive behavior
4 Keep a sense of care during distance	Introduce mild non-separation
5 View distance as safety rather than abandoning	Use schedules, roles, to enforce separateness
6 Connection as continuity rather than immediacy	Plan separation in advance
7 Bonding as freely chosen, not obligatory	Make closeness voluntary
8 Independence as compatibility, not distance	Separate goals and identity
9 Connection through shared orientation or mission	Redirect emotions into a shared third focus
10 Separation as preserving closeness	Define limits as acts of care

Fig. S1.12-1. Possible taxonomy of Ac/Re+ transitions, exemplified for T = Love and A = Hate

Here, Proactiveness and Insight (or Depth, Smartness, Leverage) discourage forceful decisions, because Ac+ and Re+ must remain sufficiently subtle and flexible to balance each other. Becoming too forceful may reverse their polarity from positive to negative. These taxonomies help diversify Ac+/Re+ steps during AI generation. A similar plot for T = Sugar generation:

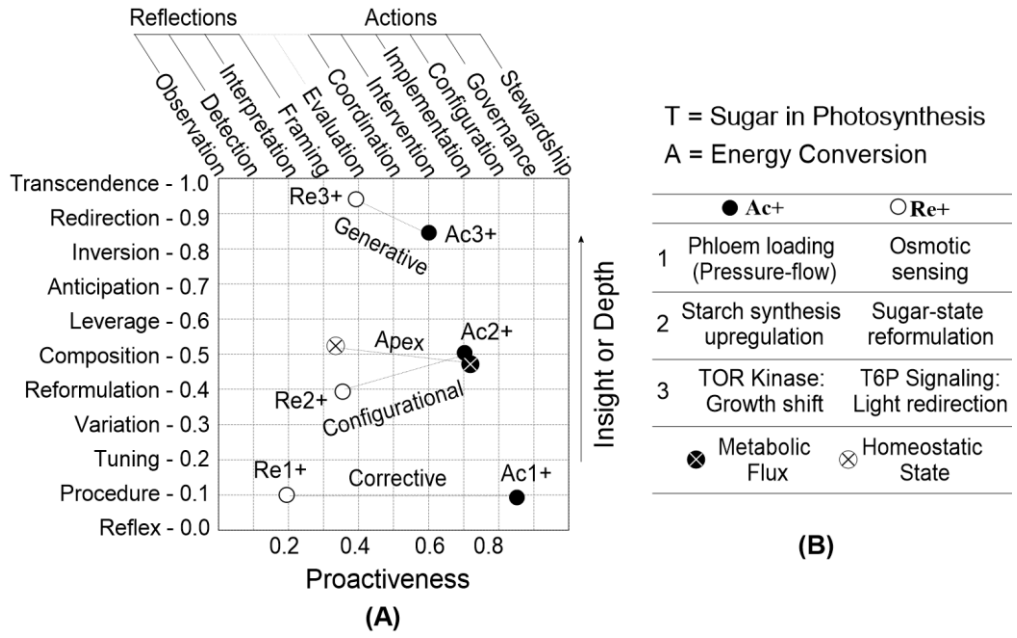


Fig. S1.12-2. Possible taxonomy of Ac/Re+ transitions exemplified for T = Sugar

Greimas Mapping Rule. Sometimes direct prompts do not yield good concepts, in which case semiotic Greimas' square (Greimas and Courtés, 1982) becomes useful:

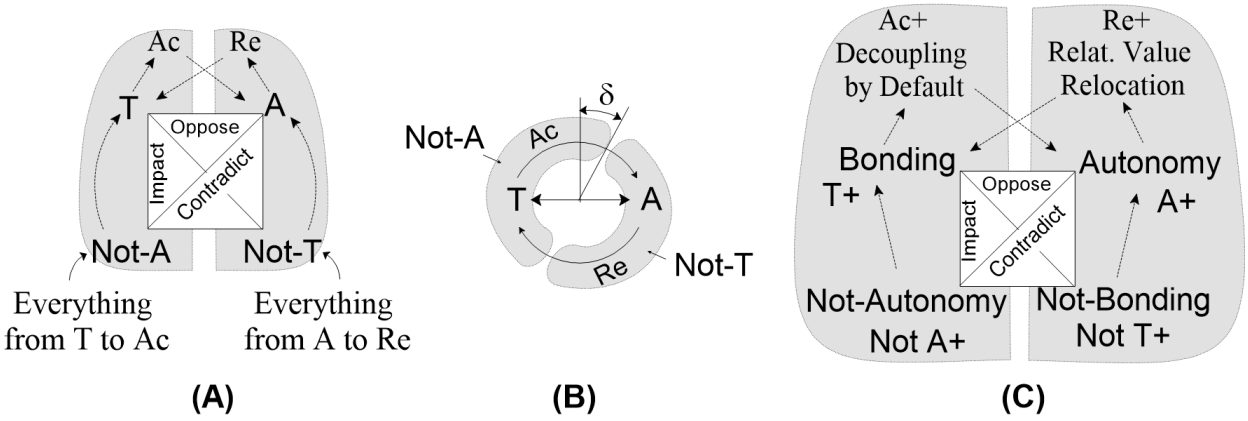


Fig. S1.12-3. Relation between Greimas' square and dialectical transitions

Scheme A shows that the "Not-A" space includes "everything from T to Ac", while the "Not-T" space includes "everything from A to Re". Empirically we observe that:

Not-A denotes affinity with A without instantiating it, and *Not-T* denotes affinity with T without instantiating it. Accordingly, Ac operates in Not-A space (leaning toward A while it is

not yet affordable), and Re operates in Not-T space (leaning toward T while it is not yet affordable).

This can be explained by asymmetry of Not-A and Not-T spaces, denoted by rotational angle δ in scheme B. If we further restrict these spaces to the concepts of comparable affective and argumentative modalities, they become applicable for identifying Ac+ and Re+ (as shown in scheme C). Negation of A+ enables Ac+, by allowing it to lean toward A+, but not to become A+. In the same way, negation of T+ enables Re+. In the end, Ac^+ / Re^+ must: (1) not restate A^+ or T^+, (2) describe a generative operation rather than result, (3) be valid before A+ or T+ are affordable, (4) explain subtlety, indirectness, and non-force, (5) generalize beyond T/A to other domains.

Greimas' square therefore provides an independent semiotic rationale for the proposed transition operators. Rather than coinciding with T or A, effective Ac/Re transitions occupy intermediate conceptual regions that progressively approach the complementary pole without fully instantiating it. This explains why successful transitions tend to be indirect, subtle, and generative rather than forceful restatements of T+ or A+.

S1.13 Combinatorial reduction for multi-thesis wheels

Consider n thesis–antithesis pairs, (T_1, A_1), ..., (T_n, A_n), placed in 2n positions around a circular wheel, subject to the constraint that every A_i must lie diametrically opposite its corresponding T_i. Without this constraint, the 2n distinct poles admit (2n)! linear permutations. To count the constrained circular arrangements:

1. Arrange the n thesis–antithesis pairs around one semicircle. If the first pair is fixed as the beginning, we obtain (n – 1)! Orders.
2. For each pair, choose which member occupies the selected semicircle and which occupies the opposite position. If T1 is always in the first semicircle, we obtain $2^{\wedge(n-1)}$ orientations.

Hence, the number of admissible wheels is $2^{\wedge n-1}$ $(n-1)! = 2^{\wedge n}$ $n!/(2n)$. The reduction factor relative to unrestricted permutations is $2n(2n)!/(2^n n!)$. Using Stirling's approximation, $n! \approx \sqrt{(2\pi n)}(n/e)^{\wedge n}$, we obtain Reduction Factor $F_R \approx (2\sqrt{2})\ n\ (2/e)^{\wedge n}\ n^{\wedge n}$. For n = 2 – 5, $F_R \approx 3n^{\wedge n}$.

S2. Identifying Blind-Spots and Leverage Mechanisms

To test the universal boundary conditions of the framework, we deliberately applied it to four distinct classes of systems: behavioral, socio-economic, mechanistic, and geopolitical.

The following figure exemplifies the typical analysis:

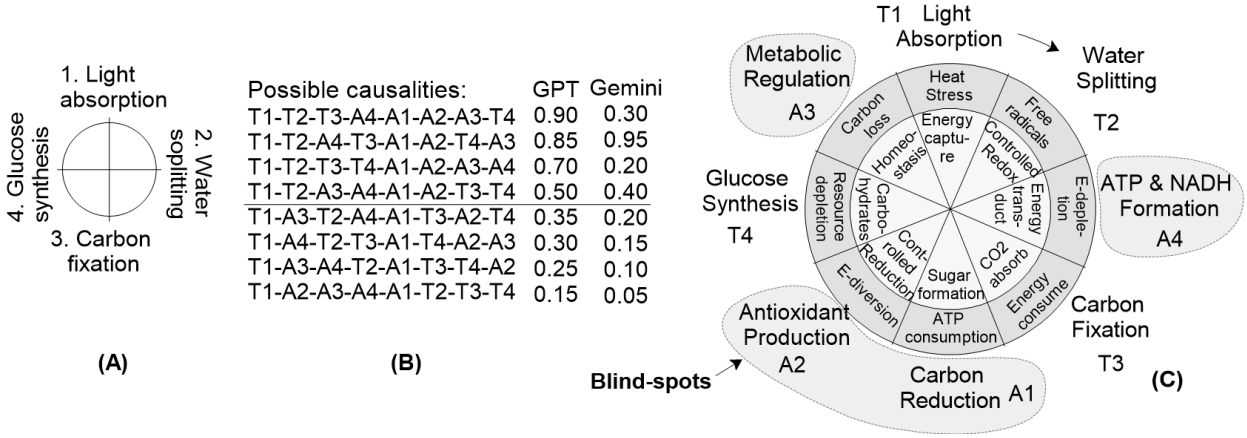


Fig. S2-1. Analysis of photosynthesis cycle

Each system was first represented as a four-step cycle (scheme A). Each step was then paired with its semantic antithesis, which was assigned—using iterative prompting—to a particular process characteristic of that system. This expanded the original cycle into an eight-step sequence, yielding eight possible causality scenarios (scheme B). Each sequence was assigned a feasibility score (0 = unfeasible, 1 = fully feasible; see the GPT and Gemini columns). The most feasible sequence was then analyzed to identify the corresponding leverage mechanisms (scheme D).

Feasibility estimates in scheme B were obtained via simple prompt (e.g., "Estimate feasibility from 0 to 1 for each sequence"). Note that GPT and Gemini assign markedly different feasibility scores, although their relative ordering remains broadly similar. Consequently, when relating the number of feasible pathways to a system's self-regulatory capability, the feasibility threshold should be calibrated for the particular LLM used. For example, in the present case, the four sequences identified by GPT using a threshold of $P \geq 0.5$ correspond to a Gemini threshold of $P \geq 0.2$.

S2.1 Summary of Analyzed Systems

Table S2.1-1 Summary of Analyzed Systems.

Cycle	**No* ≥ 0.5**	**Log N***	**Self-Reg***	**Natural?**
DISC Traits	6	0	1.00	Yes
Organization optimization (1)**	6	1 – 2	0.65	Hybrid
Corporation / Viral Business	5	1 – 4	0.55	Hybrid
Self-Driving Vehicle (SDV)	4	-	0.15	No
Organization optimization (2)**	4	1 – 3	0.65	Hybrid
Photosynthesis	4	-	0.90	Yes
Israel – Palestine Conflict	3	6 – 8	0.35	No
Economy	3	6 – 9	0.50	Hybrid
Global Problematique	2	9 – 10	0.25	No
4-Stroke Engine	1	-	0.00	No

* No ≥ 0.5 – number of causal sequences with feasibility ≥ 0.5 as estimated by GPT;

Log N – logarithm of the number of people involved

Self-Red – self-regulatory capability estimated by GPT-5

** Data available from the author

There is a clear inverse correlation between the number of feasible causalities (No ≥ 0.5) and log N. (The cutoff corresponds to GPT-4 results.) Also, note that the 4-stroke engine scored the lowest, whereas DISC traits and small organizations scored the highest, suggesting that No ≥ 0.5 may serve as a rough measure of self-regulatory capability. The relatively low value for photosynthesis may simply reflect our limited understanding of the underlying mechanisms, whereas the relatively high value for the self-driving vehicle may reflect limitations of the present model.

S2.2 Psychology / DISC Character Traits

The classic DISC sequence: T1 = Influence, T2 = Dominance, T3 = Conscientiousness, T4 = Steadiness. The flow from assertive traits (T1, T2) to methodical traits (T3, T4) creates a natural leadership-to-implementation arc.

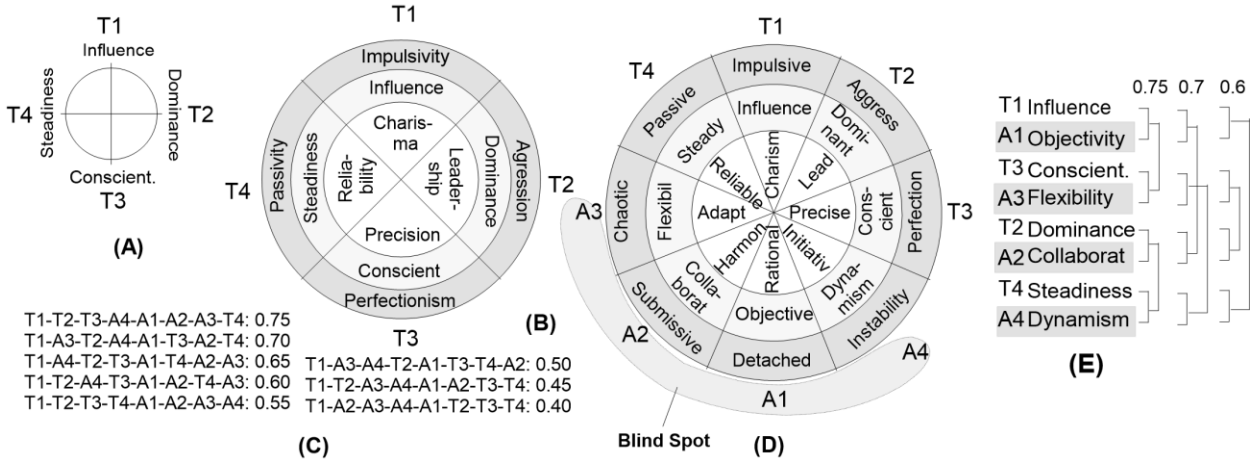


Fig. S2.2-1

Schemes A and B show the starting cycle and its dialectical verification. Scheme C shows 8 potential A/T sequences, of which six score ≥ 0.5, with the remaining two not far behind—indicating the highest self-regulatory capacity observed in this study. Scheme D reveals the most probable cycle, with all antithetical domains clustered between T3 and T4 – *i.e.*, between Conscientiousness and Steadiness we have a huge treasure collection—an area worth deeper attention, especially when analyzing personality differences among individuals with similar DISC profiles.

Scheme E shows two dominant entanglements: Influence/Objectivity (T1–A1) links with Conscientiousness/Flexibility (T3–A3), while Dominance/Collaboration (T2–A2) aligns with Steadiness/Dynamism (T4–A4). In other words, those who are "Conscientiously Flexible" tend to be both influential and grounded, while "Steadily Dynamic" individuals balance assertiveness with cooperative execution. These couplings, however, may shift easily—given the closeness of competing sequence probabilities.

Wheel Derivation:

T1 = Influence

T1+ = Inspirational leadership, motivation

T1- = Manipulation, excessive emotionality

A1 = Objectivity

A1+ = Rational decision-making, impartiality

A1- = Cold detachment, inability to connect

Diagonal oppositions:

T1+ (Inspirational leadership) ↔ A1- (Cold detachment): Yes, these oppose each other

T1- (Manipulation) ↔ A1+ (Rational decision-making): Yes, these oppose each other

T2 = Dominance

T2+ = Decisive action, protection

T2- = Aggression, authoritarianism

A2 = Collaboration

A2+ = Mutual empowerment, shared solutions

A2- = Indecision, excessive compromise

Diagonal oppositions:

T2+ (Decisive action) ↔ A2- (Indecision): Yes, these oppose each other

T2- (Aggression) ↔ A2+ (Mutual empowerment): Yes, these oppose each other

T3 = Conscientiousness

T3+ = Reliability, thorough preparation

T3- = Rigidity, perfectionism

A4 = Flexibility

A4+ = Adaptability, openness to change

A4- = Inconsistency, lack of follow-through

Diagonal oppositions:

T3+ (Reliability) ↔ A4- (Inconsistency): Yes, these oppose each other

T3- (Rigidity) ↔ A4+ (Adaptability): Yes, these oppose each other

S2.3 Economic Cycle

Major steps: Policy Planning (T1) – Implementation (T2) – Market Response (T3) – Adaptation (T4).

Table S2.3-1 Dialectical Analysis of Economic Cycle

	Steps (T1, T2)	Blindspots (A1, A2)	Steps (T3, T4)	Blindspots (A3, A4)
Step	T1 = Policy Planning	A1 = Emergent Behavior	T3 = Market Response	A3 = Control Framework
Goals	T1+ = Foresight	A1+ = Natural Flow	T3+ = Innovation	A3+ = Stability
Risks	T1- = Detachment	A1- = Market Failures	T3- = Volatility	A3- = Stagnation
Owner	Congress, Think Tanks	Large Banks, Investment Funds, Multinat. Corporat.	Small/medium enterprises, consumers	Ministries, Regulatory Agencies, Admin. Bodies
Synthesis	S+ = Democratic Capitalism (Nordic dream) S- = Corporate Feudalism (gilded age USA)		S+ = Citizen-Powered Regulation (Swiss dream) S- = Administrative Suffocation (like in Venezuella)	
Step	T2 = Implementation	A2 = Experimentation	T4 = Adaptation	A4 = Subordination
Goals	T2+ = Execution	A2+ = Learning	T4+ = Flexibility	A4+ = Consistency
Risks	T2- = Overregulation	A2- = Inefficiency	T4- = Inconsistence	A4- = Rigidity
Owner	Government Action, Policy Execution	Cenntral Bank, Econom. Council, Fin. Regulat.	Lobbyists, Prof. Networks, Unions	Taxation, Linecsing, Compliance
Synthesis	S+ = Dynamic Governance (Estonian dream) S- = Mechanical Bureaucracy (Soviet Union)		S+ = Intelligent Accountability (New Zeland dream) S- = Autoritarian Standardization (North Korea)	

In the table, diagonal arrows between T and A indicate dialectical entanglements (e.g., T^+ vs. A^-). This helps identify domain "owners"—the institutions or actors that typically embody each polarity. The synthesis outcomes (S^+ and S^-) support early-stage diagnostics by anticipating either constructive or regressive developments.

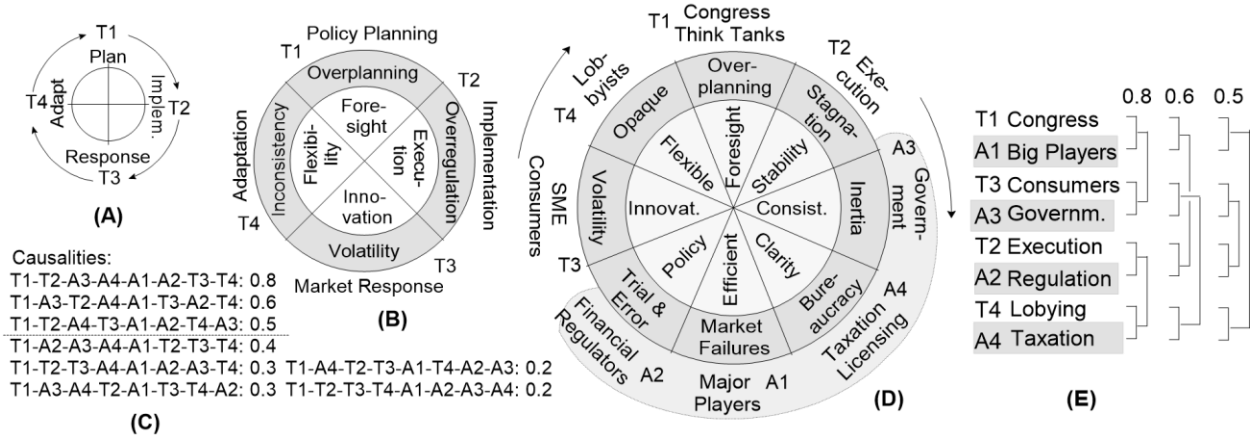


Fig. S2.3-1

Schemes A, B – starting cycle and its verification. Scheme B presents the estimated feasibility of regulatory sequences. Only 3 out of 8 exceed the threshold—suggesting moderate-weak self-regulation. Scheme D highlights the optimal causal pathway, revealing a major blind spot between Policy Execution (T2) and SME/Consumer Response (T3)—a crucial leverage point for policy intervention. This structure may shift if the initial T1–T4 definitions are changed.

Scheme E identifies leverage mechanisms: T1–A1 (Congress vs. Major Players) is bound with T3–A3 (Consumers vs. Government), reflecting familiar effects like regulatory capture and policy lag (Stigler, 1971; Lindblom, 1959). T2–A2 (Execution vs. Regulators) is entangled with T4–A4 (Lobbying vs. Taxation), showing the push–pull between enforcement and influence—well documented in institutional economic theory (North, 1990).

These results align with traditional views while potentially revealing new effects through longer-range causal structures (cf. Arthur, 1999).

Supporting references:

Arthur, W. B. (1999). Complexity and the economy. *Science*, 284(5411), 107–109. https://doi.org/10.1126/science.284.5411.107

Lindblom, C. E. (1959). The "science" of "muddling through". *Public Administration Review*, 19(2), 79–88. https://doi.org/10.2307/973677

North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge University Press. https://doi.org/10.1017/CBO9780511808678

Stigler, G. J. (1971). The theory of economic regulation. *The Bell Journal of Economics and Management Science*, 2(1), 3–21. https://doi.org/10.2307/3003160

S2.4 Business Cycle

Analyzед the cycle: Vision (T1) → Plan (T2) → Execution (T3) → Adjustment (T4). (Full analysis is provided in the Supplementary Material.)

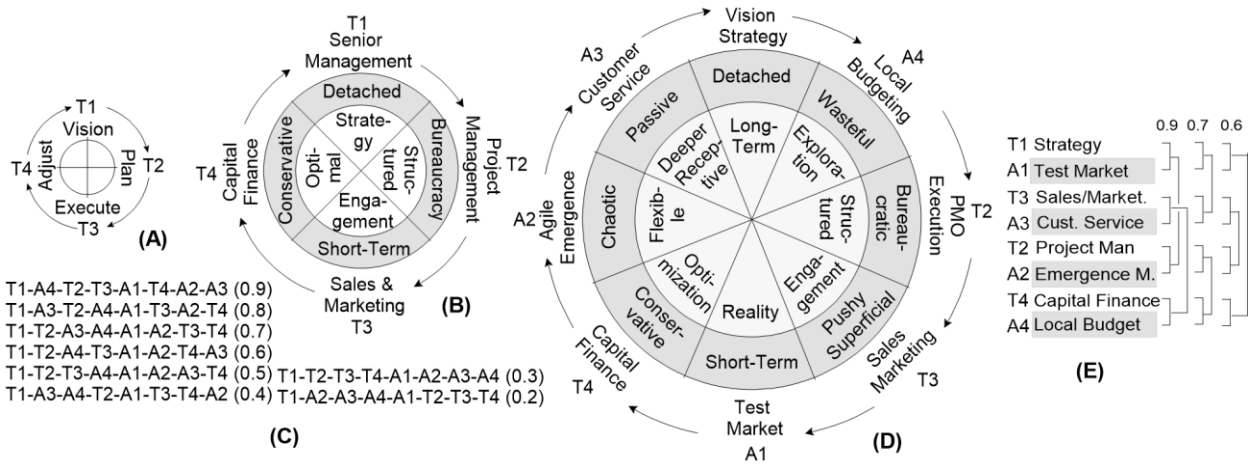


Fig. S2.4-1

Schemes A, B – starting cycle & verification. Scheme C shows that 5 out of 8 sequences exceed the 0.5 probability threshold—indicating a strong homeostatic capacity, provided the organization can align around one of these optimal sequences.

Scheme D shows the optimal sequence. The strategic vision (T1) is tested through a localized budget (A4), which funds execution (T2) and market entry (T3). Market response (A1) reveals feasibility ($A1^{+}$) or exposes short-termism ($A1^{-}$). If negative, the cycle loops back to revise the strategy (T1). If positive, capital (T4) should support not traditional project structures (T2), but agile problem-solving teams (A2), shifting focus toward customer service (A3) rather than extended marketing (T3). This enables value to grow through resonance and trust rather than persuasion.

This dynamic reflects patterns of disruptive innovation (e.g., early Facebook), where value emerges not through capital-pushed marketing but through ecosystem alignment and feedback. Over-reliance on mass marketing may yield shallow wins and unstable models.

Notably, the largest blind spot lies between Capital Finance (T4) and Vision (T1)—the innovation inflection point where reframing or leapfrogging occurs.

Scheme E highlights entanglements: Strategy and Market Testing (T1–A1) are entangled with Sales and Customer Service (T3–A3), while Execution and Adaptability (T2–A2) are entangled with Capital and Budgeting (T4–A4). These feedback loops align closely with principles from

agile management and dynamic capabilities theory (e.g., Teece, 2007), though their expression may vary by business context.

Table S2.4.-1

	Recognized Steps (T1, T2)	Blindspots (A1, A2)	Recognized Steps (T3, T4)	Blindspots (A3, A4)
Step Owner	T1 = VISION & STRATEGY Senior Management, Strategy Department	A1 = PRACTICAL REALITY Middle Management, Front-line Leaders (often overlooked)	T3 = MARKET SALES EXEC Commercial Teams, Product Marketing, Business Development	A3 = CUSTOMER EXPERIENC Customer Service, UX Researchers, Social Listening Teams (typically undervalued)
Goals Risks	T1+ = Strategic Foresight T1- = Unrealistic Vision	A1+ = Operational Feasibil A1- = Short-term Thinking	T3+ = Market Engagement T3- = Pushy Short-termism	A3+ = Deep User Understand A3- = Passive Observation
	S+: "Adaptive foresight" (like in Toyota) S-: "Ivory tower mandates" (like in Kodak decline)		S+: "Value co-creation" (like in Apple ecosystem) S-: "Manipulative selling" (like in Wells Fargo scandal)	
Step Owner	T2 = PROJECT MANAGEM. PMO, IT, Implementation teams	A2 = ADAPTIVE RESPONS Practice Integrators, agile problem-solvers (often misaligned)	T4 = CAPITAL ALLOCATION Executive Board, Corporate Finance	A4 = EXPERIM. INVESTMENT Innovation Labs, Skunkworks Teams, Corporate Venture (often disconnected)
Goals Risks	T2+ = Structured Implem. T2- = Bureaucratic Rigidity	A2+ = Flexible Adjustment A2- = Chaotic Reaction	T4+ = Resource Optimizat. T4- = Conservative Control	A4+ = Future-focused Explora A4- = Wasteful Spending
	S+: "Structured flexibility" (like in Spotify model) S-: "Process bureaucracy" (like in traditional IBM)		S+: "Strategic innovation portfolio" (like in Google's Alphabet) S-: "Short-term extraction" (like in pre-bankruptcy Sears)	

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28(13), 1319–1350.

S2.5 Four-Stroke Engine

The cycle: T1 = Fuel Intake, T2 = Compression, T3 = Combustion, T4 = Exhaust.

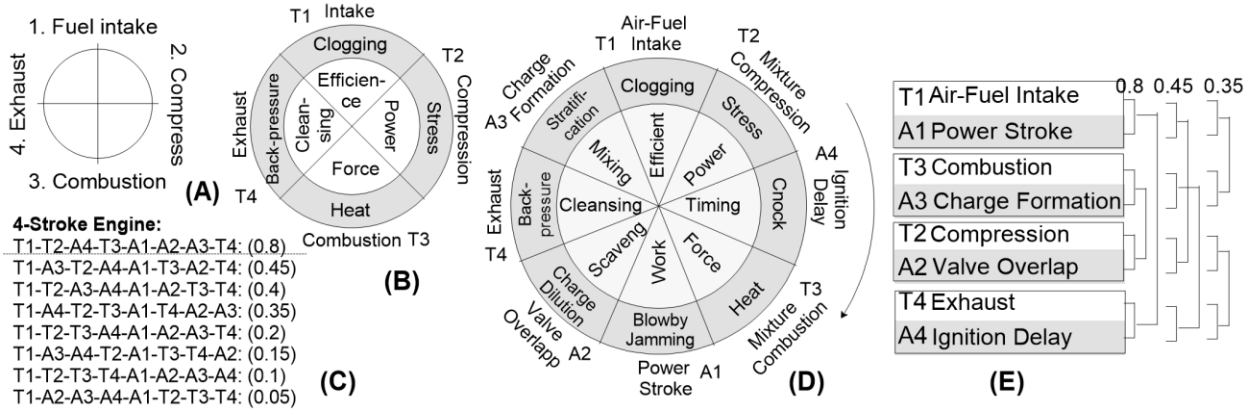


Fig. S2.5-1

Schemes A, B – starting cycle and verification. Scheme C shows only one valid path, suggesting extremely limited self-regulatory capacity. Scheme D highlights this sequence. The antithetical

domains are distributed fairly evenly, with a notable two-step blind spot between T3 (Combustion) and T4 (Exhaust)—a key zone for performance tuning.

Scheme E identifies key leverage points: T1–A1 (Fuel Intake / Power Stroke) is entangled with T4–A4 (Exhaust / Ignition Delay), while T2–A2 (Compression / Valve Overlap) is entangled with T3–A3 (Combustion / Charge Formation). These couplings reflect known interdependencies in combustion timing and airflow dynamics—areas long studied in mechanical engineering optimization (Heywood, 1988).

Heywood, J. B. (1988). *Internal combustion engine fundamentals*. McGraw-Hill.

Table S2.5-1

4-Stroke Engine

	Steps T1 - T2	Blindspots A1 - A2
Step 1	T1 = Air-Fuel Intake	A1 = Power Stroke
Goals Risks	T1+ = Efficient T1- = Clogging	A1+ = Work A1- = Blowby Jamming
Syn-thesis	S+ = Synergized Combustion (Hybrid Engine) S- = Energy Waste (Engine Cnocking)	
Step 2	T2 = Compression	A2 = Vale Overlapp
Goals Risks	T2+ = Power T2- = Stress	A2+ = Exhaust Scaveng A2- = Charge Dilution
Syn-thesis	S+ = Torque Harmony (Formula 1 Dynamic Tunning) S- = Thermal Stress (Unstable Vavle Tunning)	

	Steps T3 - T4	Blindspots A3 - A4
Step 3	T3 = Combustion	A3 = Charge Formation
Goals Risks	T3+ = Force T3- = Heat	A3+ = Mixing A3- = Stratification
Syn-thesis	S+ = Clean Burn Profile (Highly Efficient EV Hybrids) S- = Incomplete Burn (Dirty Exhaust in Cheap Engine)	
Step 4	T4 = Exhaust	A4 = Ignition Delay
Goals Risks	T4+ = Cleansing T4- = Back-Pressure	A4+ = Timing A4- = Cnock
Syn-thesis	S+ = Rhythmic Pulse Flow (Engine Break Systems) S- = Echo Pressure Loop (Backpressure Loss)	

S+ in each case involves a fine-tuned synergy, generating a new functional quality (e.g. smoother torque, cleaner combustion).
S- indicates dominance of one side, causing energetic or systemic inefficiency through forced uniformity.

S2.6 Self-Driving Vehicles (SVD)

Starting cycle: Data Gathering (T1) – Data Analysis (T2) – Decision-Making (T3) – Execution (T4).

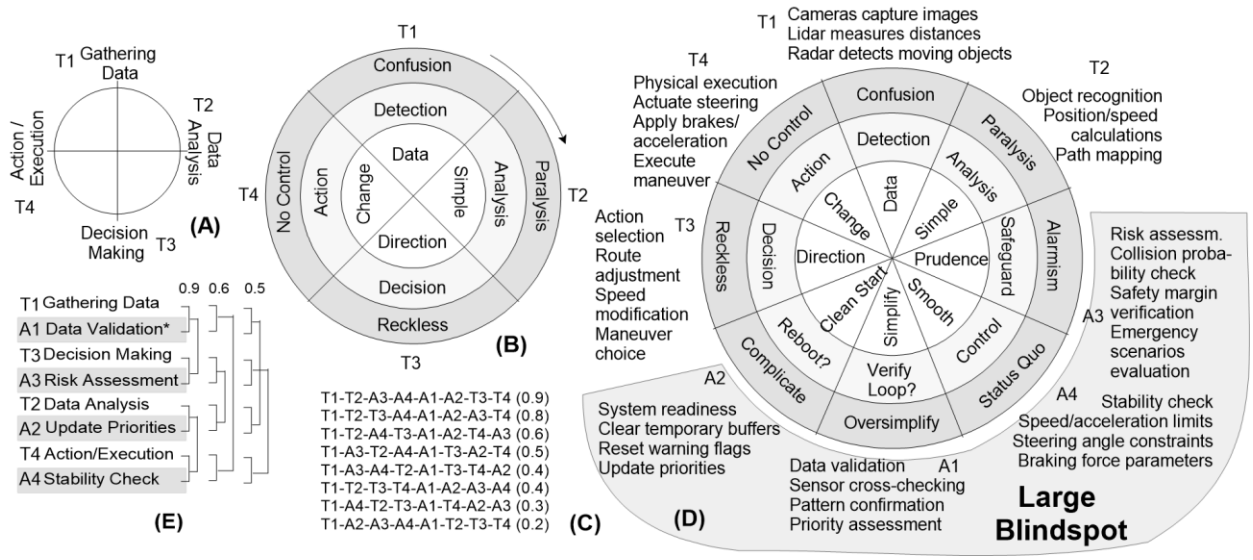


Fig. S2.6-1

Schemes A, B – starting cycle. Scheme B – 4 of 8 sequences have feasibility scores ≥ 0.5, indicating a fairly high self-regulation potential. Scheme C highlights that the Decision-Making stage (T3) is preceded by a large blind spot (A1–A4), which must be accounted for within the Data Analysis stage (T2). Notably, this blind spot includes processes reminiscent of the OODA loop (Observe–Orient–Decide–Act), suggesting that pre-decision quality control is essential. Specifically, once A1+ = Proper Simplification is achieved, priorities should be re-evaluated and system memory reset (A2 = RAM Clearance).

Scheme C illustrates two key entanglements: T1–A1 (Data Gathering/Validation) is entangled with T3–A3 (Decision/Filtering) — indicating that data integrity strongly influences decision relevance; T2–A2 (Analysis/Memory) is entangled with T4–A4 (Execution/Stability) — implying that data processing governs execution quality and system robustness.

Table S2.6-1

Self-Driving Vehicles

	Steps T1 - T2	Blindspots A1 - A2
Step 1	T1 = Object Detection	A1 = Data Validation
Goals Risks	T1+ = Data Gathering T1- = Confusion	A1+ = Simplify A1- = Oversimplify
Syn-thesis	S+: Meaningful detection filtered through pattern validation, e.g. Waymo's multi-sensor fusion system preventing false positives	
Patho llogy	S-: Redundant Monitoring - sluggish decision-making due to over-checking, e.g. early Tesla systems prone to "phantom braking" due to overreaction	
Step 2	T2 = Data Analysis, Object Eecognition	A2 = Data Clearance, Update Priorities
Goals Risks	T2+ = Clear & Effective T2- = Paralysis	A2+ = Clean Start A2- = Complicate
Syn-thesis	S+: Real-Time Prioritization - Instantly clearing data noise to enable fast planning, e.g. Mobileye's RSS model	
Patho llogy	S-: Analytical Bloat - processing everything equally, causing lag, e.g. Low-end AV prototypes that choke on edge-case scenarios due to data overload	

	Steps T3 - T4	Blindspots A3 - A4
Step 3	T3 = Decision Making	A3 = Risk Assessment
Goals Risks	T3+ = Confident T3- = Reckless	A3+ = Prudence, Safeguard A3- = Alarmism
Syn-thesis	S+: Dynamic Caution - Balancing confidence with safety margins in real time Cruise adjusting routes dynamically in San Francisco congestion	
Patho llogy	S-: False Safety Loop - Stops or stalls due to exaggerated risk aversion, e.g. Uber AV fatal crash (2018) — system failed to react after excessive hesitation	
Step 4	T4 = Action, Execution	A4 = Control/Stability Check
Goals Risks	T4+ = Change T4- = No Control	A4+ = Smooth A4- = No Change
Syn-thesis	S+: Seamless Maneuvering with continuous micro-adjustments, e.g. Waymo's predictive braking and turning	
Patho llogy	S-: Status Quo Lock-in - Hesitating to act due to rigid safety buffer, e.g. AVs stuck at 4-way stops — all waiting forever due to over-conservatism	

S2.7 SDD on Inclusive Education Planning

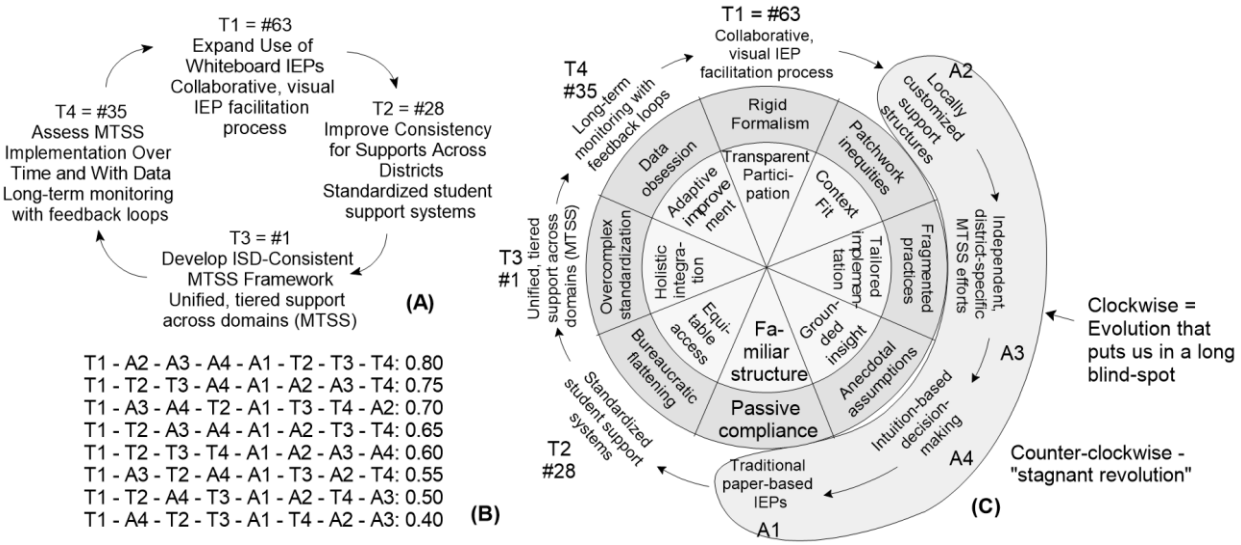


Fig. S2.7-1

Scheme A shows the root-cause cycle obtained by applying Structured Dialogic Design (SDD) to inclusive education planning in a Michigan school district (personal communication, Jeff Diedrich, https://7letters.solutions/). The first proposed intervention was to expand the use of collaborative visual "whiteboard" IEP (Individualized Education Program) planning sessions.

Scheme B shows the estimated feasibility of alternative implementation sequences. Scheme C shows the most feasible sequence, suggesting that a major blind spot may arise immediately after the first implementation step. Rather than proceeding directly to standardized student support systems, the analysis suggests first developing locally customized support structures. Likewise, the third and fourth steps favor context-specific adaptation before district-wide standardization, indicating that substantial local preparation may be required before redesigning educational standards across the school district.

S2.8 Global Problematique

This cycle was obtained by the virtual Structured Dialogic Design (SDD) applied to the climate crisis problematique (Petrauskas, Diedrich, & Christakis, 2025, unpublished data, available from the author): T1 = Inadequate Education → T2 = Lack of Understanding → T3 = Manipulation → T4 = Inadequate Participation → …

Table S2.8-1

Global Climate Problematique

	Steps (T1, T2)	Blindspots (A1, A2)	Steps (T3, T4)	Blindspots (A3, A4)
	CCP13		CCP37	
Step	T1 = Formal education	A1 = Natural learning	T3 = Mainstream Information	A3 = Personal Discrenment
Goals	T1+ = Structured	A1+ = Experiential	T3+ = Alignment	A3+ = Authentic
Risks	T1- = Dogmatic	A1- = Loose	T3- = Manipulation	A3- = Inconsistent
Owner	Mechanistic view	Experiential view	Urbanism, Sociophile	Autonomous lifestyle
Quality	S+ = Mind-over-matter mentality, stewardship		S+ = Conscious Creators, Enlightened Sovereigns	
Quantity	S- = Mechanistic views, consumerism		S- = Exploitative Actors, Merchants and Consumers	
	CCP49		CCP41	
Step	T2 = Formal Logic	A2 = Intuitive systems awareness	T4 = Inadeq. partici-pation, delegation	A4 = Inclusive participation
Goals	T2+ = Analytical	A2+ = Deep Patterns	T4+ = Enablement	A4+ = Engaging
Risks	T2- = Superficial	A2- = Chaotic	T4- = Exclusion	A4- = Paralysis
Owner	Rule-Based Thinking, Determinism	Tradictional Values, Holism, Indeterminism	Centralized Decisions	Decentralized Decision
Quality	S+ = Integrative wisdom, panpsychism		S+ = Dynamic Governance, SDD, Omnicracy	
Quantity	S- = Methodological Orthodoxy, Narrow Specialization		S- = Corporate hierarchy, Deep State	

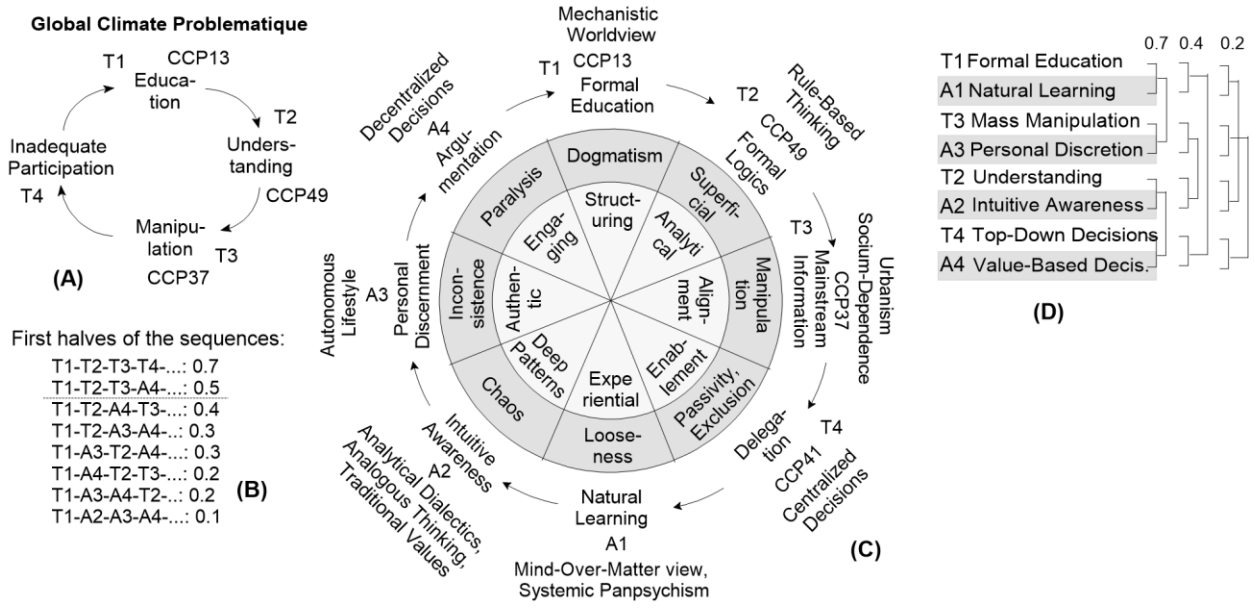


Fig. S2.8-1

Scheme A presents the starting cycle. Scheme B shows the feasibility scores of alternative implementation sequences. Only two sequences exceed the feasibility threshold ($P \geq 0.5$), indicating a relatively narrow set of viable transformation pathways. Scheme C shows the best cycle.

Scheme D reveals two dominant orthogonal couplings: education–experiential learning (T1–A1) with information–personal discernment (T3–A3), and formal reasoning–intuitive systems awareness (T2–A2) with public participation (T4–A4). These relationships suggest that improving media quality depends not only on information policies but also on educational practices and citizens' capacity for independent judgment. Likewise, participatory governance depends on balancing analytical reasoning with broader systems awareness. Consequently, the deepest leverage mechanisms appear to be ontological rather than technological, involving education, sense-making, and governance. Excessive centralization of information, education, and governance reduces personal autonomy, independent judgment, and civic participation, thereby perpetuating the global problematique.

S2.9 Israel – Palestine Conflict

Israel Claims:

T1: Israel must exist as the national home for the Jewish people.

T2: Israel requires robust security measures to protect its population.

Palestinian Claims:

T3: Palestinians must have their own independent sovereign state.

T4: Palestinian refugees should be allowed to return to their ancestral homes.

Table S2.9-1

Israel - Palestine Conflict

	Steps	Blindspots
Step	T11 = Israel must exist as the national home for the Jewish people	A11 = Multinational state for pluralistic coexistence
Goals Risks	T11+ = Cultural preservat. T11- = Ethnic exclusivity	A11+ = Multicultural harmony A11- = Identity dilution
Syn-thesis	S11+ = Cultural Federation (e.g., Belgium's federal system for both Flemish and Walloon identities) S11- = Enforced Homogeneity (e.g., Franco's Spain suppressing Catalan and Basque identities)	
Step	T12 = Israel requires robust security measures to protect its population	A12 = Open borders with reasonable protocols
Goals Risks	T12+ = Civilian protection T12- = Excess. restrictions	A12+ = Free movement A12- = Security vulnerability
Syn-thesis	S12+ = Collaborative Security (e.g., EU's Schengen Area) S12- = Militarized Control (e.g., Soviet-era Berlin Wall)	

	Steps	Blindspots
Step	T21 = Palestinians must have their own independent sovereign state	A21 = Autonomous regions with regional integration
Goals Risks	T21+ = Self-determination T21- = Isolated sovereignty	A21+ = Cooperative governance A21- = Limited authority
Syn-thesis	S21+ = Confederal Partnership (e.g., Switzerland's cantons) S21- = Fragmented Dependence (e.g., Bantustans in apartheid South Africa)	
Step	T22 = Palestinian refugees should be allowed to return to their ancestral homes	A22 = Permanent resettlement of Palestinian refugees with compensation
Goals Risks	T22+ = Historical justice T22- = Demograph disrupt	A22+ = Future stability A22- = Historical erasure
Syn-thesis	S22+ = Heritage Reconciliation (e.g., Post-WWII German reconciliation with Jewish communities) S22- = Imposed Resettlement (e.g., Forced population exchanges between Greece and Turkey in the 1920s)	

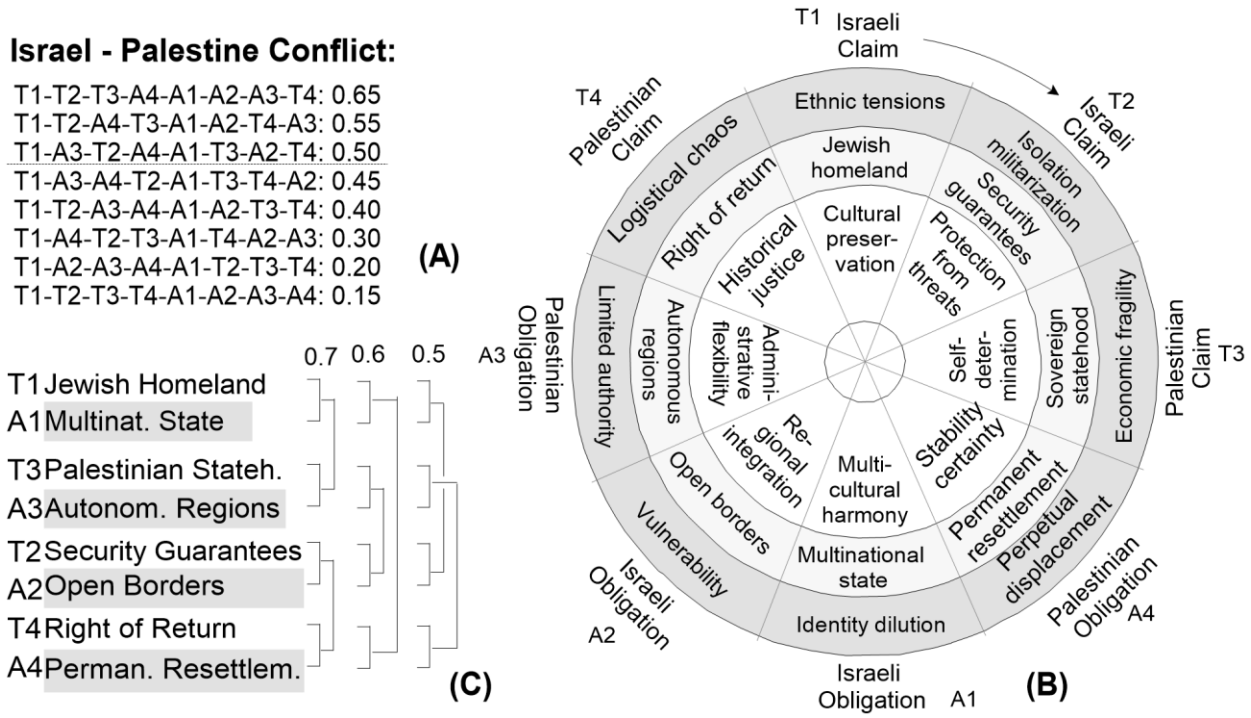


Fig. S2.9-1

Scheme A shows moderately high feasibility across multiple sequences, indicating latent potential for systemic resolution. These values might be improved by reordering the initial claims into a more balanced configuration. Scheme B shows the best sequence for the given T1-T4 arrangement. It moves from Israeli security concerns (T1, T2) to Palestinian statehood (T3), then pivots to refugee resettlement (A4) rather than full return (T4). It then moves through multinational state concepts (A11) and open borders (A12) before addressing historical justice. The compromise positions are interspersed with traditional positions.

All blind spots occur between T3 (Palestinian Statehood) and T4 (Right of Return), perhaps due to the fact that both of Israeli claims were placed as the two starting points.

Scheme C reveals two key entanglement pairs. T1–A1 (Jewish Homeland vs. Multinational State) and T3–A3 (Palestinian Statehood vs. Autonomy) reflect identity–sovereignty trade-offs. T2–A2 (Security vs. Open Borders) and T4–A4 (Right of Return vs. Resettlement) capture the tension between national protection and human mobility.

Non-dialectical AI suggested using international peacekeepers, humanitarian corridors, and phased implementation with international guarantees. The dialectical approach aims to structure bottom-up complementarity instead.

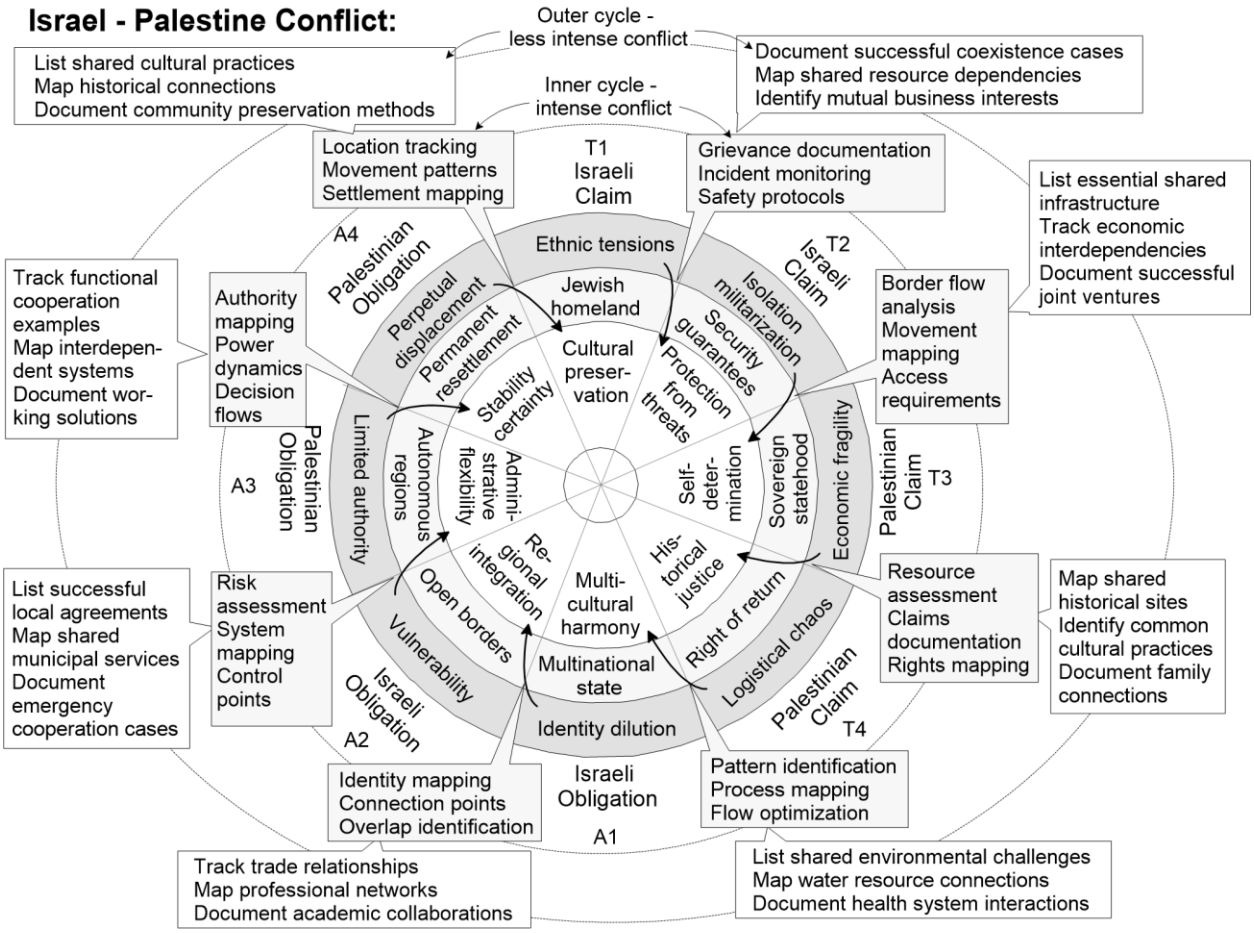


Fig. S2.9-2

S3. Improving Systems

S3.1 Macondo Blowout Wheels

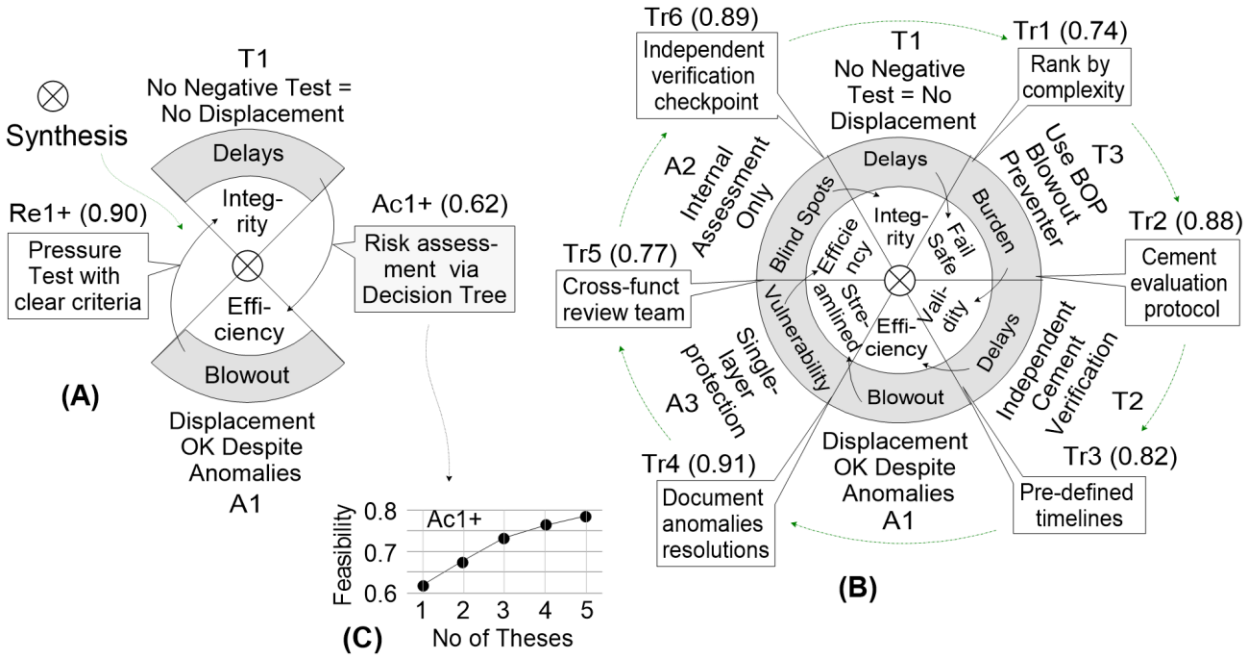


Fig. S3.1-1 Examples of wheels for Macondo blowout case.

Scheme A illustrates a representative tetrad with Ac/Re transitions, showing how a conventional Safety-I recommendation can be reformulated into a self-regulating "wisdom unit" through complementary Action and Reflection steps.

Scheme B illustrates a representative multi-thesis wheel constructed from several tetrads. The actual analysis was performed on a single four-tetrad wheel (not shown for clarity). Here, T1–T3 denote the original recommendations, whereas A1–A3 represent their corresponding violations.

Scheme C presents a GPT-generated hypothesis that the proposed transitions reinforce one another, forming self-regulating behavior (using prompt: “estimate practical feasibility of step x in the presence of steps y1, y2, …”).

S3.2 Conflict Resolution: Mining Corporation vs Community

Consider a conflict between global corporation (T1) and local community (T2) with the following claims:

T1 (Corporation): "We bring jobs and prosperity through legal resource extraction. Environmental concerns are exaggerated."

T2 (Local Community/Advocates): "They destroy our land and water. Their compliance claims hide systematic violations."

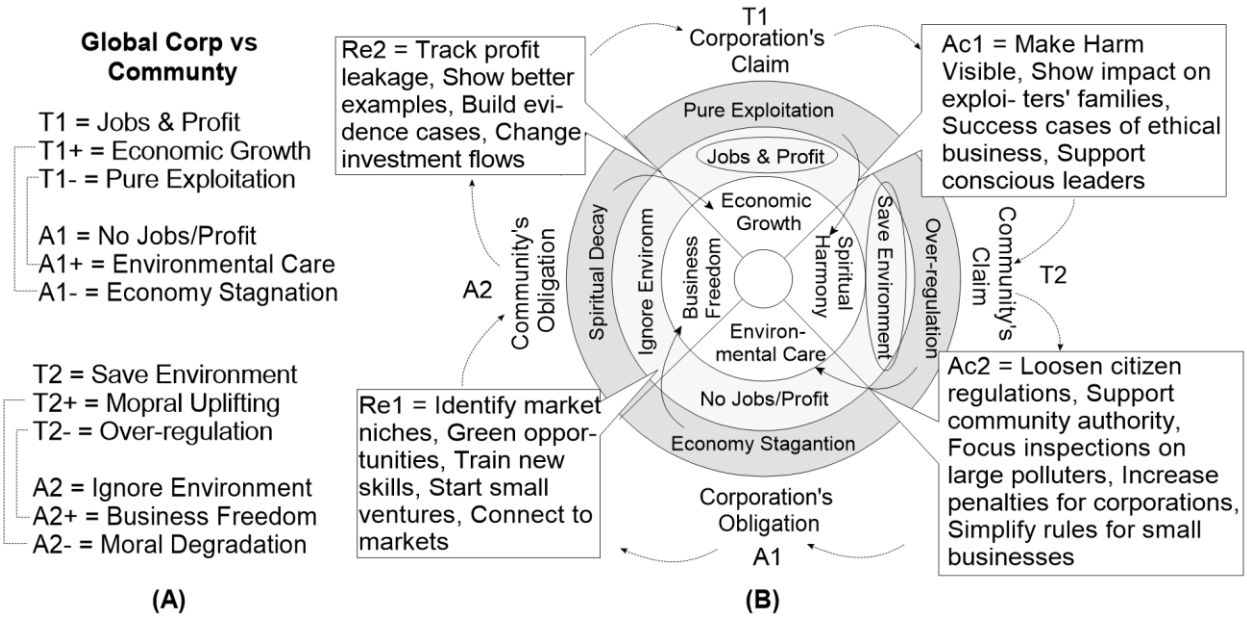


Fig. S3.2-1. Dialectical wheel for two selected tetrads

Scheme A converts the original statements into antithetical domains. Scheme B arranges all domains into dialectical wheel, and suggests resolution steps Ac1, Ac2, Re1, Re2, each converting negative aspects of previous step to positive ones in the subsequent step. This creates an iterative procedure spiraling toward the wheel's center:

Positive synthesis (S+) yields Sustainable Development Partnership that integrates economic growth with environmental stewardship, combining moral responsibility with business autonomy. Corporate operations benefit local communities through transparent monitoring,

accountability mechanisms, and business models treating environmental protection as opportunity rather than cost. This empowers communities as resource management stakeholders, producing outcomes exceeding what either side could achieve independently (1 + 1 > 2).

Conversely, disobeying these transformations or attempting them in reverse order results in Negative synthesis (S-): Deadlocked Deterioration merging corporate exploitation with counterproductive regulations and economic paralysis with ethical compromises. This creates a system achieving neither economic nor environmental goals, wasting resources on legal conflicts rather than solutions. The resulting mutual distrust prevents collaborative problem-solving, producing worse outcomes than either side would achieve separately (1 + 1 < 2) and standardizing an adversarial relationship that blocks innovation.

In essence: The method converts "impossible situations" into manageable, step-by-step transformation processes with clear actions for all parties. Supplementary Material provides more of similar examples.

Table S3.3-1. A more detailed analysis of upsides and downsides

	Global Corporation	**Local Community**
Posi-tions	We bring jobs and prosperity through legal resource extraction. Environmental concerns are exaggerated	They destroy our land and water. Their compliance claims hide systematic violations
T	T1 = New Jobs / profits	T2 = Protect nature
T+	T1+ = Economic growth T11+ = Better infrastructure T12+ = Innovation T13+ = …	T2+ = Spiritual harmony T21+ = Healthy ecosystems T22+ = Community resilience T23+ = …
T-	T1− = Pure exploitation T11− = Wealth inequality T12− = Resource dependence T13− = …	T2− = Overregulation T21− = Development paralysis T22− = Bureaucratic burden T23− = …
A	A1 = No jobs / profits	A2 = Ignore environment
A+	A1+ = Environmental care A11+ = Sustainable livelihoods A12+ = Ecosystem restoration A13+ = …	A2+ = Business freedom A21+ = Entrepreneurial initiative A22+ = Efficient regulation A23+ = …
A-	A1− = Economic stagnation A11− = Unemployment A12− = Outmigration A13− = …	A2− = Spiritual decay A21− = Environmental degradation A22− = Loss of trust A23− = …

Each T/A pair is provided with multiple tetrads, which increases the possibility of identifying the best transition steps.

S3.3 Transitions Matrix Generation Prompt

All prompts are available in this link: https://github.com/dialexity/dialectical-framework

Here are simplified prompts for a quick generation of transitions' matrices:

Given a set of dialectical tetrads, generate a transition matrix. Use all negative poles (T− and A−) as rows and all positive poles (T+ and A+) as columns. For each row–column pair, generate one concise, actionable transition describing how the selected downside can be transformed into the selected upside. Preserve the original labels and return the result as a table. After completing the matrix, compress the transitions in each row into a child-clear principle describing how to overcome that downside, and compress the transitions in each column into a child-clear principle describing how to cultivate that upside.

Alternatively:

Input: a list of tetrads, each containing T_plus, T_minus, A_plus, and A_minus.
Task: create a matrix whose rows are all T_minus and A_minus values and whose columns are all T_plus and A_plus values. For each valid row–column pair, generate one short actionable statement describing how the negative state can be transformed into the positive state.
Output: a table with negative poles as rows, positive poles as columns, and transition statements as cells.

After generating the matrix, compress all transitions in each row into one child-clear principle describing how to overcome that downside, and compress all transitions in each column into one child-clear principle describing how to cultivate that upside.

S3.4 Requisite Variety and Requisite Parsimony

Table S3.4-1 Requisite Variety vs. Requisite Parsimony (Petrauskas and Christakis, 2026)

T = Requisite Variety	**A = Requisite Parsimony**
T1+ Comprehensive Understanding T2+ Shared meaning	A1+ Focused Clarity; A2+ Structured Reasoning
T1– Cognitive Overload; T2– Fragmented Perspectives	A1– Reductionist Oversimplification A2– Mechanistic Formalism

Table S3.4-2 illustrates how exaggerated forms of each dimension can be transformed into constructive developments. Generative AI can assist using simple prompts (e.g., "suggest how to transform T/Ax− into T/Ay+"), producing laconic suggestions while preserving parsimony.

Table S3.4-2. Transitions for Requisite Variety vs. Requisite Parsimony

Negative pole	**→ T1+ Comprehensive understanding**	**→ A1+ Focused clarity**	**→ T2+ Shared meaning**	**→ A2+ Structured reasoning**
T1− Cognitive overload	Organize observations into coherent themes	Prioritize leverage points	Build common vocabulary	Visual influence maps
A1− Reductionist oversimplification	Restore omitted stakeholder viewpoints	Recover essential distinctions	Dialogue across conflicting perspectives	Multi-level system representation
T2− Fragmented perspectives	Integrate stakeholder narratives	Clarify common priorities	Facilitate consensus building	Explicit relationship mapping
A2− Mechanistic formalism	Include experiential knowledge	Simplify excessive mathematics	Connect models with human meaning	Hybrid dialogue–simulation workflow
Child-Clear Principle	Nobody sees the whole picture	Keep only what changes the outcome	Understand before deciding	Everything important is connected

S3.5 Organizational Ambidexterity

Consider the Organizational Ambidexterity that balances Exploitation with Exploration (March, 1991).

Table S3.5-1. Organizational Ambidexterity Analysis

Exploitation / Ac+ (T- → A+)	**Exploration / Re+ (A- → T+)**
T = Refine proven capabilities through disciplined optimization and execution	A = Discover new capabilities through experimentation under uncertainty
T1+ = Operational Excellence T2+ = Reliability and consistency T3+ = Efficient resource utilization	A1+ = Adaptive Innovation A2+ = Organizational learning A3+ = Strategic adaptability
T1- = Stagnation T2− = False certainty T3− = Local optimization trap	A1- = Chaotic Experimentation A2− = Resource dissipation A3− = Lack of operational discipline
Ac1+ = Use inductive tools (e.g., SD) to challenge established assumptions	Re1+ = Root-cause analysis operationalizes promising explorations before scaling

This table can be further expanded through adjacent T/A pairs—for example, Exploitation–Reinvention or Exploration–Consolidation—thereby extending the intervention pathways in the Transitions' Matrix.

Table S3.5-2. Organizational Ambidexterity Transitions' Matrix sample

Negative pole	**→ T2+ Reliability & Consistency**	**→ A2+ Organizational Learning**	**→ T3+ Efficient Resource Utilization**	**→ A3+ Strategic Adaptability**
T2− False certainty	Continuously validate operating assumptions	Challenge successful routines through structured exploration	Eliminate obsolete optimization targets	Establish periodic strategic reframing
A2− Resource dissipation	Define explicit learning priorities	Terminate unproductive experiments early	Allocate resources through staged validation	Scale only evidence-supported innovations
T3− Local optimization trap	Standardize system-wide performance criteria	Exchange learning across organizational boundaries	Optimize value streams rather than departments	Rotate perspectives across functions
A3− Lack of operational discipline	Embed successful innovations into standard practice	Document lessons learned after each experiment	Define operational ownership before scaling	Develop adaptive leadership through guided autonomy
Life Principle	**Keep what works**	**Keep learning**	**Think about the whole**	**Test before believing**

Whereas March framed exploration and exploitation as a resource-allocation trade-off, SD provides a basis for diagnosing system imbalances and suggesting context-specific interventions. The last row compresses each column into a life principle, reducing complex analyses to a simple language.

S3.6 Resilience Engineering

Table S3.6-1 Resilience Engineering & Safety Science (Hollnagel, 2014)

Safety-I / Ac+ (T- → A+)	**Safety-II / Re+ (A- → T+)**
T = Prevent failure through rule-based control	A = Understand and reinforce successful adaptation
T1+ = Controlled Certainty T2+ = Compliance and accountability T3+ = Clear boundaries	A1+ = Adaptivity A2+ = Learning and continuous improvement A3+ = Intelligent autonomy
T1– = Rigidity T2− = Bureaucracy T3− = Fear of making mistakes	A1– = Uncontrolled Variability A2− = Normalization of deviance A3− = Arbitrary behavior

Ac1+ = Make all rules advisory by default, mandatory only by exception	Re1+ = Explicit zero-tolerance boundaries ("child-clear" red lines)

For the Safety-I versus Safety-II debate, DWs suggest replacing the traditional rules-versus-flexibility dilemma with the principle "advisory by default, mandatory by exception." Rules should remain advisory unless they protect clearly defined red-line conditions, whereas Safety-II should identify and continuously refine these exceptional boundaries. Consequently, operational procedures become continuously testable hypotheses rather than immutable prescriptions.

Table S3.6-2 Transitions' matrix for Resilience Engineering (two tetrads)

Negative pole	**→ T2+ Organizational learning**	**→ A2+ Contextual judgment**	**→ T3+ Clear boundaries**	**→ A3+ Intelligent autonomy**
T2− Bureaucratic rigidity	Continuously revise obsolete rules	Balance compliance with purpose	Simplify unnecessary procedures	Delegate operational discretion
A2− Normalization of deviance	Learn from weak signals	Periodically recalibrate acceptable risk	Reinstate critical safety barriers	Detect unsafe adaptations early
T3− Fear of making mistakes	Review incidents without blame	Train principled risk assessment	Clarify essential safety rules	Encourage local decision-making
A3− Arbitrary behavior	Share successful adaptations	Reinforce ethical responsibility	Establish non-negotiable safety limits	Coach adaptive decision skills
Life Principles	**Learn from success**	**Adapt responsibly**	**Protect red lines**	**Use freedom wisely**

S3.7 Developmental Psychology

Table S3.7-1 Developmental Psychology: Subject-Object Theory (Kegan, 1982)

Thesis / Ac+ (T- → A+)	**Antithesis / Re+ (A- → T+)**
T = Socialized Mind	A = Self-Authoring Mind
T1+ = Relational Interconnectedness T2+ = Shared Responsibility	A1+ = Independent Self-Determination A2+ = Authentic Autonomy
T1- = Loss of Autonomy / Individuality T2- = Conformity without Reflection	A1- = Hyper-individualistic Isolation A2- = Self-Centered Independence

Ac+ = Question positive and negative aspects of every institutional suggestion	Re+ = Express autonomy through shared obligations

Table S3.7-2 Developmental Psychology: Transitions' matrix

Negative pole	**→ T+ Relational interconnectedness**	**→ A+ Independent self-determination**	**→ T2+ Shared responsibility**	**→ A2+ Authentic autonomy**
T− Loss of autonomy / individuality	Build relationships through voluntary participation	Practice independent decision-making	Negotiate shared commitments	Express personal values respectfully
A− Hyper-individualistic isolation	Reconnect through empathic dialogue	Recognize legitimate personal boundaries	Participate in mutually beneficial cooperation	Develop purpose beyond social approval
T2− Conformity without reflection	Listen to diverse perspectives	Question inherited assumptions	Encourage constructive disagreement	Form independent judgments
A2− Self-centered independence	Appreciate interdependence	Accept responsibility for consequences	Balance personal and collective needs	Integrate autonomy with compassion
Life Principles	**Care**	**Think**	**Share**	**Be Yourself**

S3.8 Theory of Relativity

Distinctly from other theories analyzed, the Theory of Relativity does not contain clear opposite poles inside itself. Hence, we start with investigating its antithesis as shown in Fig. S1.2-1. Below we analyze two candidate antitheses.

Table S3.8-1. Theory of Relativity vs de Broglie-Bohm and Bohm's Implicate Order

	T = Thery of Relativity	**A1 = de Broglie-Bohm**	**T = Th of Relativity**	**A2 = Implicate Order**
1+	Lorentz Covariance	Nonlocal Dynamics	Local Causality	Holistic Connection
1-	Locality Constraint	Preferred Foliation	Fragmentation	Non-local Indeterminacy
2+	Space-time Geometry	Quantum Potential	Observable structure	Hidden Wholeness
2-	Geometric Closure	Non-geometric dynamic	Surface Appearance	Unverifiable

Fig. S3.8-2. Transitions Matrix for T = Theory of Relativity; A1 = de Broglie-Bohm formalism

From ↓ / Toward →	**T1+ Lorentz Covariance**	**A1+ Nonlocal Dynamics**	**T2+ Spacetime Geometry**	**A2+ Quantum Potential**	**Principle**
T1− Locality Constraint	Replace strictly local formulation with manifestly covariant field/relational variables	Introduce configuration-dependent nonlocal coupling consistent with observable no-signalling	Encode interactions through global geometric structure rather than only local propagation	Introduce a wave-amplitude-dependent potential coupling spatially separated degrees of freedom	Extend locality without losing covariance
A1− Preferred Foliation	Construct foliation-independent or dynamically covariant guidance laws	Derive nonlocal correlations without externally fixed simultaneity slices	Replace preferred slicing by dynamically generated spacetime geometry/foliation	Derive the effective foliation from the wavefunction or quantum-potential structure rather than impose it externally	Eliminate imposed simultaneity
T2− Geometric Closure	Extend covariant geometry with additional covariant quantum degrees of freedom	Couple spacetime geometry to explicitly nonlocal quantum variables	Generalize the geometric field equations to incorporate quantum structure	Introduce quantum-potential terms as additional sources/modifiers of geometric dynamics	Open geometry to quantum dynamics
A2− Non-geometric Dynamics	Express quantum guidance in Lorentz-covariant spacetime form	Formulate nonlocal dynamics through invariant relational structures	Geometrize the quantum dynamics by representing guidance/nonlocality through spacetime or an extended geometry	Derive quantum-potential dynamics from, or embed them within, an underlying geometric structure	Geometrize quantum dynamics
Principles	Make quantum dynamics covariant	Preserve nonlocal quantum coupling	Give quantum dynamics geometric form	Incorporate quantum effects into geometry	

This implies Covariant Nonlocal Geometry that can be compressed into 3 mathematical requirements:

1) Covariantly couple quantum dynamics to geometry.
2) Geometrize nonlocal quantum guidance.
3) Preserve Lorentz covariance without imposed foliation.

Fig. S3.8-3. Transitions Matrix for T = Theory of Relativity; A2 = Bohm's Implicate Order

From ↓ / Toward →	**T_1+ Local Causality**	**A_1+ Holistic Connection**	**T_2+ Observable Structure**	**A_2+ Hidden Wholeness**	**Principles**
T_1− Fragmentation	Trace local causal relations across separated parts	Identify relations that make apparently separate parts behave as a whole	Integrate fragmented observations into a coherent empirical structure	Search for a deeper order connecting apparently separate phenomena	**Don't lose the whole in the parts**
A_1− Nonlocal Indeterminacy	Identify locally testable consequences of nonlocal relations	Model nonlocality as structured interdependence rather than indeterminate influence	Derive observable predictions from proposed nonlocal effects	Identify the deeper organizing structure behind nonlocal correlations	**Make connections causally traceable**
T_2− Surface Appearance	Explain appearances through explicit causal mechanisms	Relate apparently separate observations through an underlying whole	Test whether apparent patterns remain invariant across observations	Infer latent structures capable of generating the observed appearances	**Seek stable principles beneath observations**
A_2− Unverifiability	Derive locally testable causal consequences from the proposed deeper order	Identify observable manifestations of holistic organization	Translate hidden-order claims into measurable predictions	Constrain the hidden ontology by requiring consistency with observable phenomena	**Don't believe what cannot be tested**
Principles	**Everything has a traceable cause**	**Everything is connected**	**Trust what can be observed**	**Look beneath appearances**	

This implies the Empirical Deep Ontology that can be compressed into 3 requirements:

1) Seek deeper order beyond observable structure.
2) Preserve causal traceability within holistic connection.
3) Ground deeper interpretations in observable reality.

SD exposes reciprocal obligations between competing ontologies that are usually investigated separately. For example: seek deeper order without losing empirical constraint; preserve empirical structure while remaining open to deeper interpretations. This resonates with an idea

attributed to Nikola Tesla: "Life has an infinite number of forms, and the duty of scientists is to find them in every form of matter." From an SD perspective, physics must therefore not only measure and mathematically model reality, but also imagine its possible deeper forms and contribute to human sense-making and meaning-making; otherwise, empirical precision becomes a pathology that suppresses synthesis.

S3.9 AI and SD Integration Ideas

Consider tighter integrations of T = AI (Statistical Generation), A = SD (Dialectical Guidance)

Table S3.9-1. Five representative AI–SD tetrads

N	**T = AI (Fast)**	**A = SD (Wise)**		**T = AI (Fast)**	**A = SD (Wise)**
1+	Rapid generation	Wisdom guided	4+	Massive Scalability	Context Sensitivity*
1-	Superficiality	Rule ambiguity	4-	Resource consumption*	Narrow case localities
2+	Convenient	Deep Learning	5+	Political financial gains	Peaceful cooperation
2-	Cognitive laziness	Cognitive burden	5-	Oppressive applications	Weak / delayed incentives
3+	Pattern recognition	Theory completion			
3-	Local optimums	Unrealistic idealism			

*Large-scale resource consumption is driven by the large data centers, whereas SD enables many tasks to be redirected toward less demanding local computations.

Table S3.9-2. Transitions from AI downsides (Tx-) to SD upsides (Ax+)

AI downside (T−)	**→ A1+ Wisdom-guided**	**→ A2+ Deep reflection**	**→ A3+ Theory completion**	**→ A4+ Perso-nal dilemma sensitivity**	**→ A5+ Peaceful cooperation**	**Technology Principle**
Superficiality	Ask what really matters	Think before answering	Look for what is missing	Consider peop-le's situations	Seek common good	**Don't stop at the first answer.**
Cognitive laziness	Challenge assumptions	Reflect deeply	Continue learning	Think about consequences	Listen to others	**Keep thinking.**
Falls into loc-al optimums	Broaden objectives	Explore alternatives	Discover new truths	Respect context	Build together	**See the bigger picture.**

Resource consumption	Solve meaningful problems	Reduce unnecessary computation	Reuse knowledge	Personalize instead of scaling blindly	Share instead of duplicate	**Use only what is needed.**
Military / surveillance	Ask whether it serves life	Reflect on ethics	Seek higher purpose	Respect every person	Prefer cooperation	**Use power to help.**
Simplified principle	**Think wisely.**	**Think before acting.**	**Ask what's missing.**	**Everyone is different.**	**Help each other grow.**	

Table S3.9-3. Transitions from SD downsides (Ax-) to AI upsides (Tx+)

SD downside (A−)	**→ T1+ Rapid generation**	**→ T2+ Convenient**	**→ T3+ Pattern recognition**	**→ T4+ Massive scalability**	**→ T5+ Political / financial support**	**Child-clear principle**
Rule ambiguity	Automate procedures	Make SD easy to use	Learn common patterns	Standardize implementation	Demonstrate practical value	**Make it clear.**
Cognitive burden	Draft first versions	Reduce manual effort	Detect repeated structures	Automate routine analysis	Reduce implementtation costs	**Make hard things easier.**
Unrealistic idealism	Test ideas rapidly	Produce working examples	Validate with evidence	Scale successful ideas	Build support gradually	**Prove it works.**
Narrow case localities	Generalize solutions	Create reusable tools	Compare domains	Apply globally	Expand adoption	**Reuse good ideas.**
Weak economic incentives	Create valuable products	Increase accessibility	Identify useful applications	Reach many users	Attract investment	**Create value for everyone.**
Child-clear principle	**Start before you're ready.**	**Make it simple.**	**Learn from experience.**	**Share what works.**	**Show the value**	

The last column and row can be converted into more specific business or R&D ideas by prompting AI to do so.

Table S3.9-4. Sample of transitions' matrix with R&D suggestions

AI downside	**→ T1+ Rapid generation**	**→ T4+ Massive scalability**	**→ A1+ Wisdom-guided**	**→ A4+ Personal dilemma sensitivity**	**Potential R&D Technologies**

T1− Superficiality	Generate many alternatives before judging	Compare answers across many cases	Ask what really matters	Consider the person's unique situation	**Hypothesis Explorer**
T4− Resource consumption	Generate only what is needed	Share reusable solutions instead of recomputing	Solve meaningful problems	Personalize instead of scaling blindly	**Compute Optimizer**
A1− Rule ambiguity	Turn SD rules into prompts and workflows	Build reusable SD libraries	Clarify concepts before reasoning	Adapt rules to each situation	**Ontology Compiler**
A4− Narrow case localities	Rapidly test across many domains	Generalize successful cases	Extract universal principles	Compare similar dilemmas	**Analogy Engine / Pattern Generalizer**
Reasoning capabilities	**Hypothesis generator (create alternatives)**	**Collective memory (reusab-le experience)**	**Principle Discovery**	**Decision Navigator**	

Each cell suggests a specific functionality. The last row summarizes reusable reasoning capabilities, while the last column identifies candidate computational modules. Together, they outline an opportunity space for developing a higher-level Reasoning System. While much of current AI research emphasizes larger models and greater computational scale, the proposed approach emphasizes improvements in reasoning quality and transparency.

After several prompting iterations AI suggested these 5 modules:

Hypothesis Explorer should compile taxonomies of candidate T/A pairs linked to validated tetrads, associated S+/S− case studies, and calibrated scoring prompts (e.g., KS, MMI, and other empirical parameters).

Ontology Builder should focus on clustering validated tetrads into recurring ensembles, constructing Transition Matrices, and compressing them into hierarchical life principles.

Principle Discovery should identify invariant principles shared across different ontologies, thereby facilitating analogy generation and theory completion.

Collective Memory should organize validated S+/S− case studies, ontologies, and transition patterns into reusable knowledge libraries.

Decision Navigator should transform the selected ontologies and Transition Matrices into context-specific intervention strategies by comparing alternative decision pathways and implementation options, integrating insightfulness–proactiveness taxonomies and the Greimas square (Supplementary Section S1.12).

These descriptions emerged through iterative human–AI collaboration, illustrating how dialectical interaction can distribute cognitive effort more effectively than either extreme.

S3.10 Examples of Ontologies

Table S3.10-1. Examples of ontologies derived from different domains

Domain	**Conflict**	**Life Principles / Ontologies**
Complexity	Requisite Variety vs Requisite Parsimony* (Christakis, 2025)	Nobody sees the whole picture • Everything is connected • Understand before deciding • Keep only what changes the outcome
Moral	Global Corporation vs Local Community (this work)	Tell the truth • Share fairly • Protect life • Build together
Epistemological	Organizational ambidexterity (March, 1991)	Keep learning • Test before believing • Think about the whole • Keep what works
Behavioral	Safety-I vs Safety-II* (Hollnagel, 2014)	Learn from success • Adapt responsibly • Protect red lines • Use freedom wisely
Developmental	Subject vs Object Theory* (Kegan, 1982)	Care • Think • Share • Be Yourself
Research	AI vs. Structured Dialectics *(this work)*	Explore hypotheses • Discover principles • Reuse knowledge • Think by analogy

Each ontology can be viewed as a lesson in how to think beyond binary constraints, addressing the classical tension between Requisite Variety (*Ashby, 1956*) and Requisite Parsimony (*Miller, 1956*). This topic is examined in more detail elsewhere (Petrauskas & Christakis, under review). Repeatedly executing this process closes an induction–deduction loop (*Piaget, 1975*), establishing the structural conditions required for post-formal cognitive growth (*Basseches, 1984*) and double-loop learning (*Argyris & Schön, 1978*).

S3.11 SD's Potential Applications

Table S3.11-1. SD's potential applications on methodological level

Method	**What it Does**	**SD Extension**
Polarity Management (Johnson, 1992)	Maps a polarity into four quadrants showing the upsides and downsides of each pole	Evaluates quality of each tetrad, combines several tetrads, generates transitions matrices
TRIZ (Altshuller)	Seeks to resolve a fundamental system contradiction (where improving parameter X degrades parameter Y)	Suggests semantic blind spots, leverage mechanisms, and transition matrices
Competing Values Framework / CVF (Quinn & Cameron)	Maps human/system values along two bipolar axes (Flexibility vs. Stability, Internal vs. External Focus), creating 4 competing quadrants (Clan, Adhocracy, Market, Hierarchy)	Generates transition states and candidate ontologies
Greimas Square / Semiotic Square	Maps logical relationships between opposing semantic terms.	Extends semantic oppositions into executable rules (Not-A ≈ Ac, Not-T ≈ Re)
Soft Systems Metho-dology (Checkland / Jackson)	Uses qualitative human discussion to draw consensus pictures of messy problems.	Identifies biases, blind spots, pathologies, and synthesis conditions.
Meta-Synthesis & WSR Methodology (Qian / Gu / Tang)	Aims to combine hard physical models (Wuli), cognitive models (Shili), and human/relational worldviews (Renli) through Yin-Yang harmony	Provides computable bipolar differentials, tetradic contrains, and transition rules
SODA & Cognitive Mapping (Eden)	Uses bipolar cognitive mapping (e.g., *Concept A ... rather than Concept B*) to capture how stakeholders structure their thinking	Extends cognitive maps with tetradic rules, transition matrices, and ontology generation
Formal Concept Analysis (Ganter & Wille)	Derives formal concepts from object–attribute relationships	Introduces destructive poles (A−, B−) to analyse structural failure modes alongside shared features
Morphological Analysis (Zwicky)	Enumerates combinations of design parameters to explore feasible solutions	Models causal trade-offs and feedback loops between design options instead of enumerating static combinations
C-K Theory *(Hatchuel & Weil)*	Develops new concepts through interactions between concept and knowledge spaces	Derives new concepts by evaluating antithetical spaces and generating tetrads

Table S3.11-2. SD's Potential Applications across domains

Application Domain	**Example SD Contribution**
Discovery & innovation	Predict missing concepts, mechanisms, paradigms
Knowledge integration	Reconcile competing conceptual frameworks
Strategic consulting	Identify hidden trade-offs, blind spots, and synthesis strategies.
Organizational design	Balance competing objectives and transition pathways.

Systems engineering	Reveal failure modes and synthesis conditions.
Conflict resolution	Identify mutually beneficial synthesis conditions.
AI reasoning	Generate candidate ontologies and executable reasoning structures.
Public discourse & policy	Detect ideological bias, blind spots, and one-sided reasoning.
Education	Teach dialectical reasoning and systems thinking.

S3.12 Estimating Perceived Complementarity

Table S3.12-1. Example Tetrads considered in the Conceptual Shifts Table

N	**T = Truth**	**A = Falsehood**	**N**	**T = Truth**	**A = Imagination**
1+	Clarity	Creativity, Flexibility	2+	Objectivity, Reality	Innovation, Beauty, Insight
1-	Conformity, Imitation, Rigidity	Confusion	2-	Dogmatism, Ugliness	Delusion, Subjectivity
N	**T = Logics**	**A = Intuition**	**N**	**T = Logics**	**A = Irrationality**
1+	Realism	Holism, Insight	2+	Order	Intuition
1-	Reductionism	Mysticism	2-	Absurdity	Chaos
N	**T = Success**	**A = Failure**	**N**	**T = Certainty**	**A = Uncertainty**
1+	Achievement	Learning, Humility	1+	Confidence	Openness
1-	Arrogance	Despair, Resignation	1-	Rigidity	Confusion
N	**T = Optimization**	**A = Deterioration**	**N**	**T = Optimization**	**A = Randomization**
1+	Enhancement	Acceptance	2+	Efficiency	Exploration
1-	Perfectionism	Decay	2-	Rigid fixation	Chaos

Table S3.12-2. AI suggested Perceived Complementarity (PC)

Prompt: "Estimate the extent [0, 1] to which the commonly perceived meaning of T fosters A+".

Values represent averages across GPT 5 and Gemini models (*ca*. ±0.1).

Concept (T)	**Antithesis (A)***	**Obligation (A+)***	**PC**	**Common Perception**
Dialectics	Linear thinking	Clarity of objectives	0.6	Seek synthesis
Truth	Imagination	Creativity & Beauty	0.3	Reality
Success	Failure	Learning & Adapting	0.3	Achieve goals
Science	Mysticism	Holism, Reality design	0.3	Discover truth
Technology	Self-adaptation	Natural Harmony	0.2	Enhance capability

AI	Natural Intelligence	Experiential Synthesis	0.4	Benefit humankind
Ethics	Amorality	Understand Nature	0.3	Do right
Business	Non-profit	Social Impact	0.4	Create value
Politics	Anarchy	Simplicity & focus	0.3	Serve people
Peace	War, conflict	Inner growth, discipline	0.3	Reduce conflict

* Selected without comprehensive exhaustive analysis