Structured Dialectics: A Generative Framework for Systems Analysis, Theory Completion, and Ontology Construction

Abstract

Dialectical reasoning has long been recognized as a foundation of systems thinking, yet it remains largely informal and difficult to operationalize. We introduce Structured Dialectics (SD), an AI-assisted framework that converts every thesis (T) into a bipolar semantic differential revealing both constructive (+) and destructive (-) potentials. The thesis–antithesis (T/A) pair defines the geometric space for transforming the destructive poles (T−, A−) into constructive ones (T+, A+). This facilitates blind-spot identification and the optimization of systems, theories, and ontologies, while supporting epistemic transformation. It also provides a foundation for future quantitative validation and domain-specific adaptation.

Key words: Structured Dialectics; Dialectical Reasoning; Systems Thinking; Theory Completion; Ontology Construction; Semantic Complementarity; Generative AI

1. Introduction

How do we know if a system, theory, or policy is fundamentally complete? Most methodologies either optimize existing parameters for immediate efficiency (exploitation) or map the unknown to discover structural omissions (exploration), but rarely both simultaneously (March, 1991). In systems science, "hard" approaches excel at parameter optimization but remain blind to structural omissions, while "soft" approaches reveal hidden perspectives but offer no clear path to optimize them (Checkland, 2000; Jackson, 2003).

Meadows (1999) demonstrated that intervening at the level of parameters is the lowest-leverage way to change a system, whereas altering the underlying paradigm or ontology is the highest. When a system is stuck in low-leverage optimization, it inevitably develops pathologies where maximizing one variable destroys another. Consider, for example, growing efficiency that eventually suppresses innovation, economic growth that degrades the environment, or security that erodes freedom. Resolving these systemic pathologies cannot be achieved by tweaking existing parameters; it requires constructing entirely new ontologies to transcend the underlying binary conflict.

We propose Structured Dialectics (SD), a generative framework applicable across multiple levels of abstraction, from parameter optimization to ontology construction, depending on the selected thesis (Table 1). Based on modified Hegelian dialectics, SD views opposing viewpoints—Thesis (T) and Antithesis (A)—as bipolar semantic dimensions (Petrauskas, 2025). Much like Polarity Management (Johnson, 1992), each dimension maps both constructive (+) and destructive (−) aspects. When formalized and paired with generative AI, this structure explicitly reveals blind spots and provides transition pathways toward synthesis.

Table 1. Potential contributions of Structured Dialectics (SD) across application levels

Application Level	**SD Contribution**	**Illustrative Use Cases***	**Closest paradigms**
Understanding existing systems	Revealing complementarities, biases, and pathologies	Many natural and artificial systems	Polarity Management
Improving existing systems	Transition matrices & actionable steps	Macondo blowout, Conflict resolution	Systems Dynamics Dialogic Design
Completing existing theories	Transition bridges & compressed ontologies	Ambidexterity, Dialogic Design, Safety Resilience	Dialectics, Integrative theories
Reflecting on fundamental concepts	Child-clear ontologies, hidden obligations, Epistemological shifts	Materialism vs Idealism, Competing vs Complementing	Existential philosophy, Epistemology

***** Many analyses are provided in the Supplementary Material

2. Dialectical Framework

2.1. Simplified View

The framework is based on the three-step procedure illustrated in Fig. 1. The first step identifies the major thesis (T)—what we explicitly assert—and its semantic antithesis (A)—what opposes T even if we are not aware of it. For instance, if we say T = "Follow the rules", we immediately generate the antithesis A = "Question the rules". The semantic antithesis is not optional but an absolute necessity that reveals our blind spots.

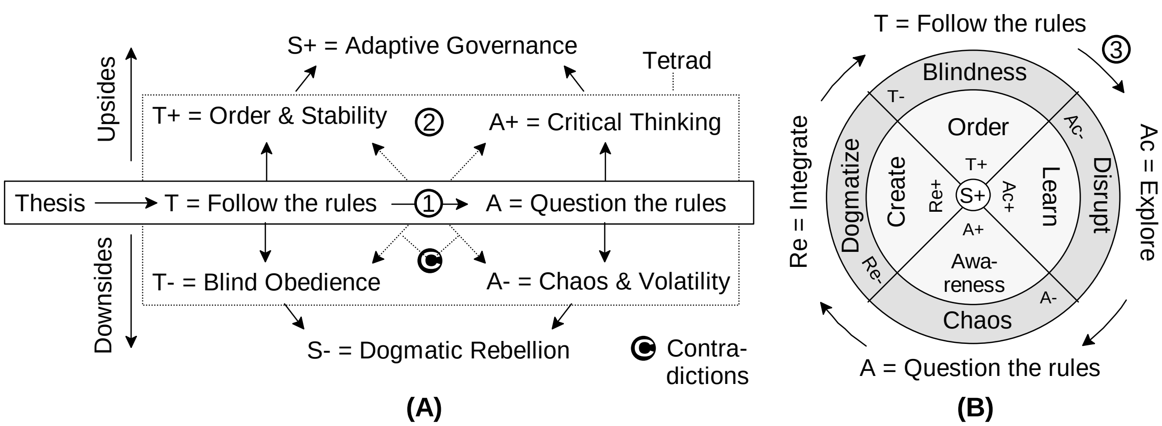


Fig. 1. Construction of the simple wheel.

The second step identifies the constructive and destructive aspects of each pole, which balance one another through the diagonal relationships (dotted arrows in Fig. 1). For instance, T+ = Order & Stability constrains A− = Chaos & Volatility, which cannot be replaced by either a weaker opposition, such as "Uncertainty & Fluidity", or a stronger consequence, such as "Destruction & Collapse". Thus, T+ and A−, as well as T− and A+, form direct contradictions and therefore must possess equal argumentative and affective strengths.

The third step identifies the circular transitions between the poles, indicating the Actions and Reflections required to convert pathology into synthesis. In practice, intermediate steps are often introduced and attention is focused on the (+) components closest to the center of the wheel, effectively transforming it into an action plan.

2.2. Generative Rules

Figure 2 expands the workflow for the analysis of multiple theses. Steps 1–5 can be performed manually, although they are substantially facilitated by generative AI. The remaining steps require AI because they involve multiple interacting theses.

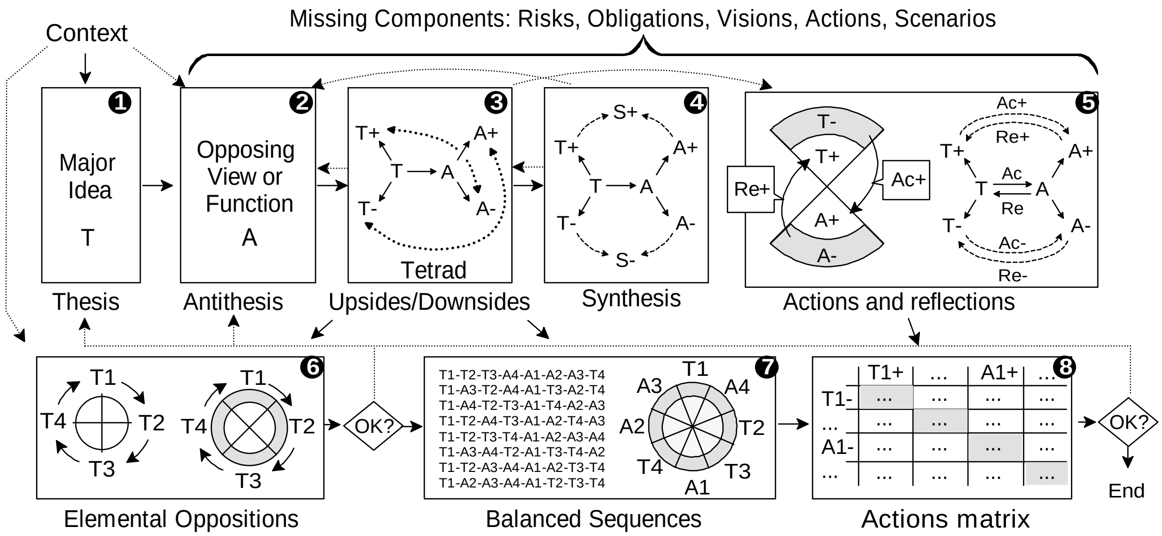


Fig. 2. Steps considered for automation

Table 2 summarizes the generative rules that constrain the analysis. These rules form a mutually dependent network rather than a linear sequence. Much like in Newtonian mechanics—where force, mass, and acceleration gain meaning through their relationships rather than isolated definitions—these concepts are introduced provisionally. Their exact meanings will become clear as we look at how they interact in the following sections.

Table 2. Generative rules for dialectical synthesis prediction

Constraint	**Rule**	**Comments**
1. Thesis (T)	The major idea we rely on for interpreting or acting	Risk of confusing symptoms with causes; Influence Maps can help
2. Antithesis (A) selection	If T is simple assertion, then A is its negation or thesis-lessness	Multiple antitheses possible
	If T implies a system or function, then A is a process with an opposite function (Arousal > 0.4)	Iterative analysis may be needed

3.1 Tetradic	Every T–A interaction yields pairs of complementary upsides (T+, A+) and exaggerations / downsides (T–, A–), such that T+ directly contradicts A- and T- directly contradicts A+	Ideological conviction and/or AI predisposition may distort results; using multiple AI agents may help
3.2 Equal Modalities	Positive synthesis (S+) occurs iff all components have equal absolute modalities (*M*): *M*(T+) = –*M*(T-) = *M*(A+) = –*M*(A-).	Use empirical conditions based on average complementarities K_S which depend on AI model
3.3 Control Statements	The following statements must make sense: T+ without A+ yield T-; A+ without T+ yield A-. Conceptual Coherence (CC) must exceed 0.7	CC indices depend on AI model; use common sense
4.1 Equal Sign Synthesis	Positive synthesis occurs between T+ and A+. Negative synthesis occurs between T- and A-	Often S+ and S- formulations are not “resonant enough”
4.2 Different Sign Isolation	No direct interaction is possible between T/A, T+/A-, T-/A+ (because they are direct oppositions or contradictions), T+/T-, A+/A- (because they are different levels of the same phenomena)	Positive–negative interactions indicate developmental transitions ("spoiled good" or "promising bad") rather than synthesis.
4.3 Positive Synthesis (S+)	A system exhibits positive synthesis iff it increases dimensionality while preserving stability, distinction, and normative coherence.	Genuine synthesis cannot be simulated before it exists—it can only be experienced
4.4 Negative Synthesis (S-)	A system exhibits negative synthesis iff it maximizes existing dimensions through dominance or oscillation, resulting in faster formation but finite lifespan	Optimization-led pathologies are deceptive – claim to seek S+, while in fact suppressing it
5.1 Circular Causality	S+ occurs iff T- is converted into A+ and A- is converted into T+, both acting in sync	Synchronicity is key
5.2 Transitions’ definitions	Ac (T→A), Re (A→T), Ac+ (T−→A+), Re+ (A−→T+), Ac− (T+→A−), Re− (A+→T−).	Ac±, Re± represent a new tetrad obedient to 3.1-3.3 rules
6-7. Multi-Thesis Oppositions	In a circular ordering of the 2n elements {T1 … Tn, A1 … An}, each Ti and Ai must occupy diametrically opposite positions.	Identifying the most relevant theses may require SDD with Influence Mapping
8. Transitions’ Matrix	Given n theses with n antitheses, the optimization solution is found within the (4n^2 - 2n) transitions mapping each negative pole (Ti-/Ai-) to all positive poles (T1+, …, A1+, …).	Finding the most feasible Tr steps may require generating new thesis in the close vicinity

2.3. Thesis and Antithesis Selection

Step 1: Thesis Selection. Choosing the right thesis accounts for perhaps 50% of success of further analysis. Often a simple prompt suffices: "Suggest the major idea or thesis of a given text in just few words". Yet, it is very important to start with a thesis representing the deeper root-cause(s) of reality rather than its surface symptom(s).

Consider the observation "Misinformation is spreading" (T1). It may suggest either *Verify Facts* (symptom-oriented thesis, T2) or *Seek Truth* (root-cause-oriented thesis, T3) (Table 3).

Table 3. Comparative analysis of the observation and successive thesis formulations

	T1 = Misinformation is spreading	**T2 = Verify facts**	**T3 = Seek Truth**
T+	Fact Checking	Evidence	Knowing
T-	Censorship	Formalism	Dogmatism
A	**Misinformation is not spreading**	**Don't verify facts**	**Don't seek truth**
A+	Freedom	Intuition	Open-minded
A-	Gullibility	Gullibility	Ignorance
S+	**Resilience and Discernment**	**Knowing**	**Wisdom**

Note that each synthesis suggests a deeper thesis ($S_1^+ \approx T_2$, $S_2^+ \approx T_3^+$). However, repeated reformulation soon becomes impractical, so the initial thesis should be selected carefully, for example by constructing an Influence Map beforehand. Whenever possible, a thesis should be regarded as a hypothesis rather than a final statement. Conversely, when analyzing existing policies or rules, the thesis is already given, and the subsequent generation of antitheses is usually straightforward.

Step 2: Antithesis Selection. The major prompt is this: "For a given thesis T, suggest its major opposition or antithesis A, such that the positive aspect of T (T+) should contradict the negative aspect of A (A-), and the negative aspect of T (T-) should contradict the positive aspect of A (A+)." It works well in most cases, especially when T represents an assertive binary choice for which direct negation is sufficient (e.g., True vs. False, Approval vs. Disapproval). However, sometimes T may represent a concept with multiple roles, yielding multiple types of antitheses (Fig. 3).

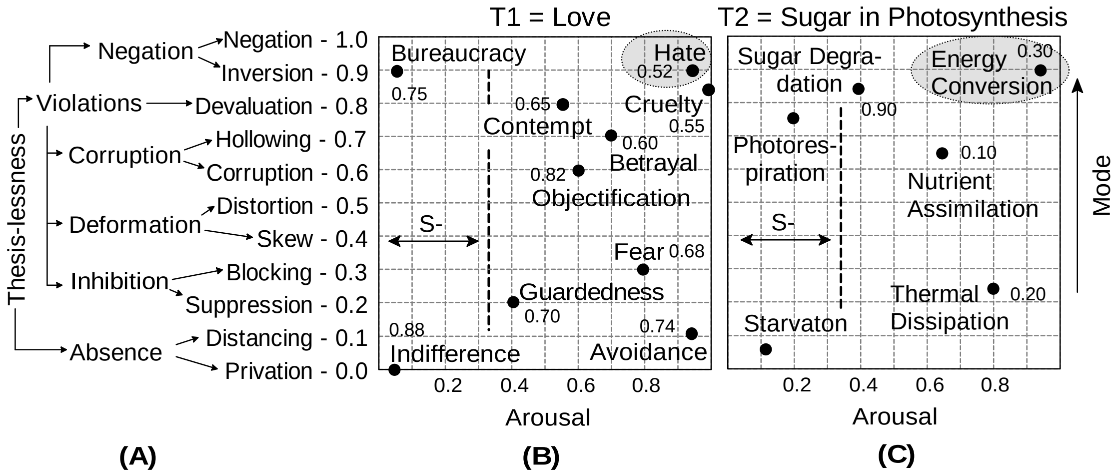


Fig. 3. Taxonomy of antitheses. Dashed ovals represent the most potent choices. Supplementary Section S1.1 provides analogous plots for two additional theses.

Scheme (A) groups antitheses into a potentially universal taxonomy, assuming that every functional antithesis arises either from the absence of the thesis or from its violation. Rather than asking *"What negates T?"*, the proposed approach asks *"What functionally opposes the role played by T?"* The remaining branches represent progressively stronger mechanisms of functional violation.

Schemes (B, C) plot antitheses along two axes: Mode (interaction mechanism) and Arousal (activation level). We hypothesize that the latter coordinate plays an essential role in distinguishing between *true antitheses*, which possess sufficient potential to generate S+, and *void antitheses*, which instead trap the system in S−. Table 4 compares different types of antitheses for various Ts together with their S− and S+ outcomes.

Table 4. Comparison of antitheses with S− and S+

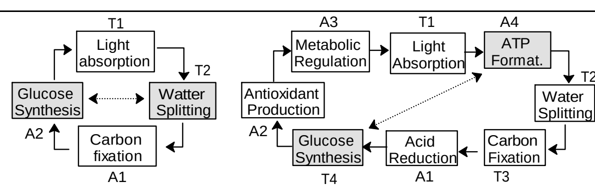
Thesis	Top-right*	Bottom-Left*	Occupied by S-**	Emergent S+	Optimum A***
Love	Hate	Indifference	Indifference (0.2; 0.1)	Wisdom	Hate (0.9; 0.9)
Truth	Falsehood	Ignorance	Ignorance (0.1; 0.1)	Future	Imagination (0.5; 0.8)
Life	Death	Inertia	Cancer (0.2; 0.8)	Growth	Stress (0.6; 0.7)
Order	Chaos	Randomness	Dogmatism (0.2; 0.8)	Life	Chaos (0.6; 0.7)

Democracy	Dictatorship	Heteronomy	Orwellian (0.3; 0.9)	Self-Governance	Theocracy (0.5; 0.7)
Sugar	Energy Conversion	Starvation	Photorespiration (0.2; 0.7)	Biomass Production	Energy Conversion (0.9; 0.9)

* Top-right = active negation: Arousal → 1.0, Mode → 1.0, Bottom-left = passive privation: Arousal → 0.0, Mode → 0.0. ** Void occupied by Pathology. *** Suggested by AI based on S+ and tetrad coherence.

The top-right corner always represents the active negation of T, whereas the bottom-left corner represents its passive privation. We hypothesize that the latter attracts latent pathologies (S−), which occupy the void left by the missing thesis while imitating its progression toward S+. Thus, the fourth column lists typical pathology (S−) that either coincide with, or arise from, the corresponding privation. (Although Indifference and Ignorance are not conventional pathologies, they inhibit S+ by creating the illusion that it has already been achieved.) The fifth column specifies the desired emergent synthesis (S+), which serves as the optimization target. The last column lists the optimum antithesis (A), selected to maximize the coherence of the T/A tetrad and the likelihood of realizing the envisioned S+. Based on this sequence, Table 5 summarizes steps when optimum antithesis is not immediately obvious.

Table 5. 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 2).

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.

2.4. Constructing Balanced Tetrads

Step 3.1: Tetradic constraints are generated using the following prompt: "For a given pair of thesis T and antithesis A, suggest positive / constructive (+) and negative / exaggerated and destructive (-) sides of each pole, such that T+ directly contradicts A-, T- directly contradicts A+." One may also add requirements that are summarized in Table 6.

Table 6. Determining T+, T-, A+, A- components

N	Constraint	T = Sugar, A = Energy conversion	CC*
1	T+/A+ are constructive, balancing developments that enhance upsides of opposition	Energy storage (T+) enhances Energy sufficiency (A+), which is an upside of Energy conversion (A)	0.72
		Energy Sufficiency (A+) enhances Energy storage (T+), which is an upside of Sugar formation (T)	0.95
2	T-/A- are overdevelopments and exaggerations of the parent concept, and simultaneously underdevelopments of its opposition	Resource depletion (T-) is overdeveloped Sugar formation (T) & underdeveloped Energy Conversion (A)	0.85
		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. 3A)	Energy storage (T+) directly contradicts Energy dissipation (A-)	0.88
		Resource depletion (T-) directly contradicts Energy sufficiency (A+)	0.90

* Conceptual Coherence estimated by GPT 5.2. Supplementary Section S1.2 provides CC values for another T.

CC indices provide an empirical quality-control that may be used to reject inconsistent tetrads.

Step 3.2: Modality Alignment. Each concept possesses an argumentative strength and affective intensity, constituting its Modality (M), such that in a balanced system absolute modality values are all equal:

$$M(\mathrm{T+}) = -M(\mathrm{T-}) = M(\mathrm{A+}) = -M(\mathrm{A-}). \qquad (1)$$

Modalities can be approximated *via* average complementarities to the Thesis (K_T) and Antithesis (K_A) which can be estimated by a simple prompt (e.g., “for each component estimate its numeric complementarities to T and A, each varying from 0 to 1”):

$$K_S = (K_T + K_A)/2 \qquad (2)$$

For a more elaborate prompt, see Supplementary Section S1.3. Fig. 4 illustrates typical values for balanced and distorted systems, suggesting simple symmetry rules in Table 7.

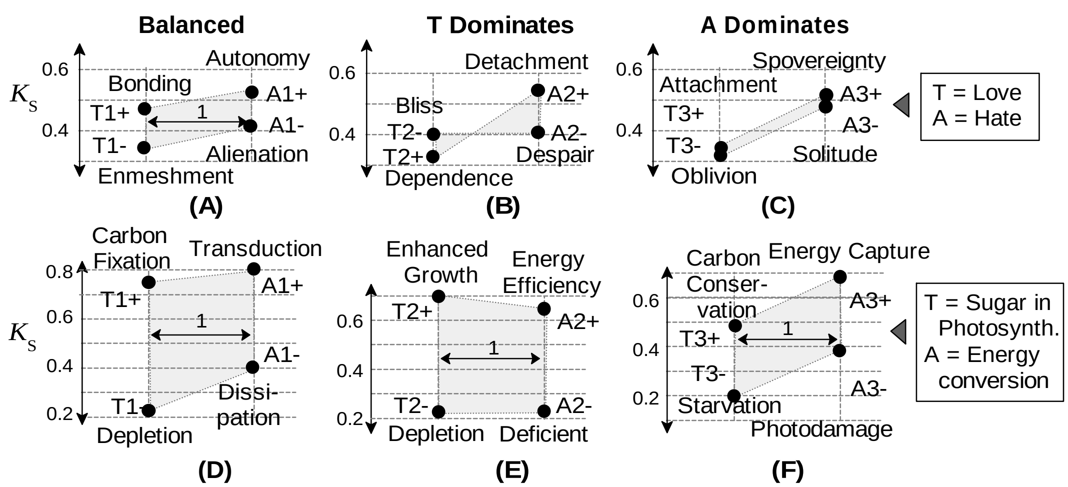


Fig. 4. Complementarity diagrams. (A-C) T = Love, A = Hate. (D-F) T = Sugar, A = Energy Conversion. For more diagrams, see Supplementary Section S1.4.

Each rule in Table 7 can be assigned with empirical weight for identifying the best tetrad using specialized AI agents. Corresponding modalities are obtained by the simple linear correction $M(\mathrm{X}) \approx K_S(\mathrm{X}) - (K_S)_{\mathrm{Avg}}$.

Table 7. Quantitative criteria for evaluating dialectical tetrads. For additional criteria, see Supplementary Sections S1.5 – 1.8.

Rule	Expression	Rationale	Pathologies
Maximum Complementarity	max K_S (T+), max K_S (A+), K_S (T+) ≈ K_S (A+)	S+ potential	$K_S(+) \leq 0.5$ $\lvert K_S(T+) - K_S(+)\rvert > 0.1$
Maximum Rectangularity	min $[(K_S (T+) – K_S (A+))^2 + (K_S (T-) – K_S (A-))^2]$	Eq. (1)	Skewed shape (Fig. 4B, C, F)
Maximum Area	max $[K_S (T+) + K_S (A+) – K_S (T-) – K_S (A-)]$	Dialectical "work"	K_S(T-/A-) ≈ > K_S(T+/A+)

Step 3.3: Control Statements. Components of balanced system must generate logically coherent statements of the following form (Table 8):

T+ without A+ yields T-, while A+ without T+ yields A-

Table 8. Control Statements

Case	T = Sugar, A = Energy conversion	CC*
(A) Balanced system	Carbon fixation (T_1^+) without Regulated transduction (A_1^+) yields Resource depletion (T_1^-)	0.90
	Regulated transduction (A_1^+) without Carbon fixation (T_1^+) yields Oxidative dissipation (A_1^-)	0.93
(B) Biased toward T	Enhanced Growth (T_2^+) without Energy Efficiency (A_2^+) yields Resource Depletion (T_2^-)	0.85
	Energy Efficiency (A_2^+) without Enhanced Growth (T_2^+) yields Energy Deficit (A_2^-)	0.70
(C) Biased toward A	Resource Conservation (T_3^+) without Strong Energy Capture (A_3^+) yields Carbon Starvation (T_3^-)	0.87
	Strong Energy Capture (A_3^+) without Resource Conservation (T_3^+) yields Photodamage (A_3^-)	0.94

* Conceptual Coherence estimated by GPT 5.2. Supplementary Section S1.9 provides CC values for another T.

Note: The above criteria do not prevent from obtaining equally balanced tetrads with fundamentally different ideological or existential assumptions. Resolving such differences generally requires addressing paradigm assumptions directly (Liht and Savage, 2013).

2.5. Modelling Synthesis and Pathologies

Steps 4.1 – 4.2: Synthesis. Unlike the remaining steps, Step 4 defines what constitutes constructive development rather than how to achieve it. AI can infer transitions directly, whereas humans require explicit criteria distinguishing synthesis from optimization pathology.

Figure 2 (step 4) illustrates that synthesis occurs exclusively between like-signed components. Positive synthesis takes place between T^+ and A^+, while negative synthesis occurs between T^- and A^-. No direct interaction is possible between undifferentiated or oppositely signed poles—such as T and A, T+ and A-, or T- and A+—because these represent direct oppositions or contradictions. Similarly, no direct interaction is possible between T^+ and T^- or between A^+ and A^-, as these correspond to different developmental levels of the same phenomenon.

Steps 4.3 – 4.4: Outcome Classification. Positive synthesis (S+) produces a new emergent quality, whereas negative synthesis (S−) merely maximizes specific quantities. While both types theoretically complement each other, in practice S− imitates the appearance of S+ while actively suppressing it. Table 10 illustrates that S+ and S- can be viewed as developmental trajectories of both healthy maturation and optimization pathology, respectively.

Table 10. Typical modes of Positive and Negative Syntheses for T = Sugar Formation [8].

	Sa+ (Process)	**Sb+ (Structure)**	**Sc+ (Normative)**
Core Principle	Self-Regulation and Resilience	Bounded Coupling	Invariant Preservation:
General Schema	Remaining stable under shocks	Preserving distinction while creating new relations	Preserving core values while creating new meanings
Sugar formation in photosynthesis	Homeostasis between the Light Reactions and the Calvin Cycle	Thylakoid Membrane enabling H^+ gradient and e- transport	Stable ATP/ NADPH production despite fluctuating light
Sa- (Distortion via dominant T)	Rigidity (frozen order) – Photoinhibition	Care becomes control – Membrane Hyper-polarization	Moral absolutism, dogmatism – Metabolic Locking

Sb- (Erosion via dominant A)	Loss of feedback, burnout – Photobleaching	Detachment, alienation - Lysis / Uncoupling	Value hollowing, instrumentalism - Dissipative Leakage
Sc- (Deregulation via T/A oscillation)	Crisis recovery cycles - Stomatal Oscillations	Push-pull bonds, cling withdraw – Antenna Quenching	Cynicism, disenga-gement – Retrograde Signalling

For alternative taxonomies, as well as similar S+/S- models of other theses, see Supplementary Sections S1.5, S1.6, and S1.10.

2.6. Circular Causality and Transitions

Step 5.1: Circular Causality. Positive synthesis (S+) arises if and only if two complementary transitions occur simultaneously (Fig. 2, step 5): an exaggerated thesis (T-) is transformed into a constructive antithesis (A+), and an exaggerated antithesis (A-) is transformed into a constructive thesis (T+). This follows directly from the definition of synthesis as the emergence of a new self-regulating organization that requires a closed loop of reciprocal causation (Fig. 5).

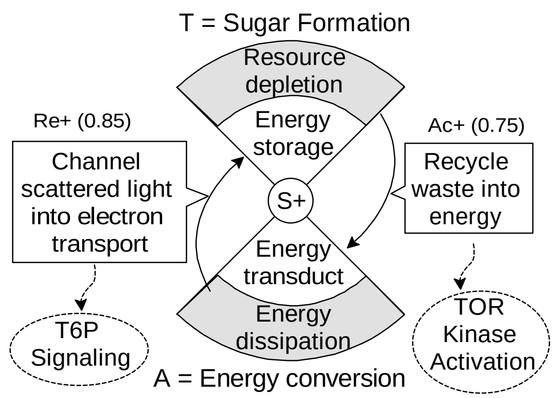


Fig. 5. Minimum self-regulatory cycle turning T = Sugar Formation into S+ = Photosynthesis Effect

Transitions are shown by the continuous curved arrows. They can be generated by simple prompts, e.g. "suggest how to transform T− into A+ and A− into T+". Dashed arrows denote optional recursive prompting that elaborates the proposed transitions. Different transitions can be obtained by specifying the desired levels of proactiveness and insightfulness (Fig. 6).

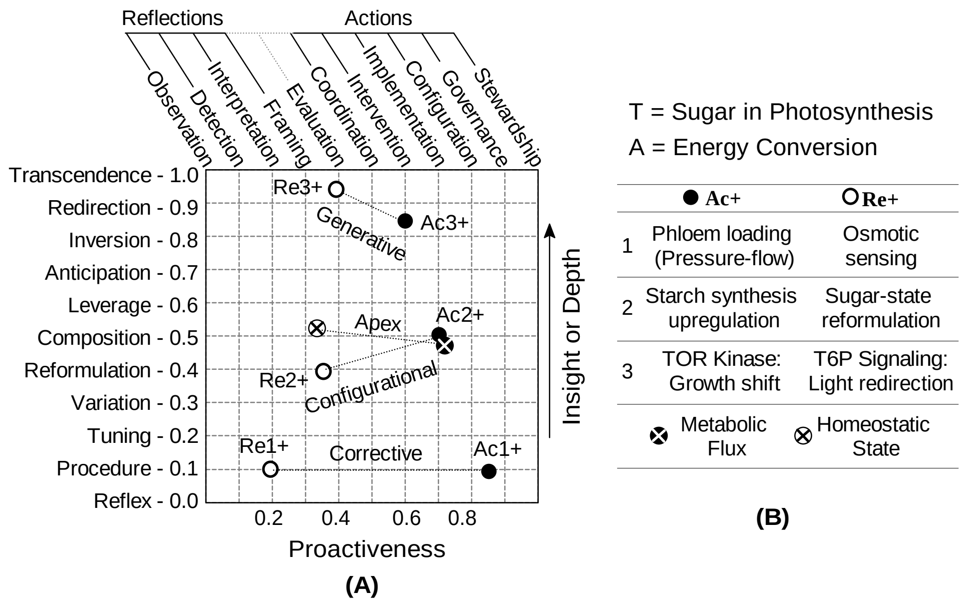


Fig. 6. Possible taxonomy of Ac/Re+ transitions.

A similar plot for another T/A pair is provided in Supplementary Section S1.11.

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.

Step 5.2: Balanced Transitions. Sometimes both positive and negative transitions are relevant (as illustrated in Fig. 1B). Then, the analysis must consider the full tetrad of transitions: Ac+, Ac−, Re+, and Re−. Here, Ac− transforms T+ into A−, whereas Re− transforms A+ into T−. These components must satisfy the same symmetry rules applied to the T/A tetrads in Steps 3.1–3.3. Thus, Ac+ must directly contradict Re−, while Ac− must directly contradict Re+. In addition, Ac+ without Re+ degenerates into Ac−, whereas Re+ without Ac+ degenerates into Re−. Accordingly, a more elaborate prompt may be used, for example: "Suggest intermediate steps Ac that transform T into A, and Re that transform A into T, such that Ac+ opposes Re− and Ac− opposes Re+."

Steps 6 – 7: Multi-Thesis Wheels. When two or more theses interact, each must be converted into optimum tetrad and arranged into optimum causality sequence. This sequence must preserve each tetrad's geometry, so that thesis and antithesis must be placed diagonally to each other. For instance, Fig. 7 illustrates a two-thesis photosynthesis cycle with T1 = Sugar Formation and T2 = Light Absorption.

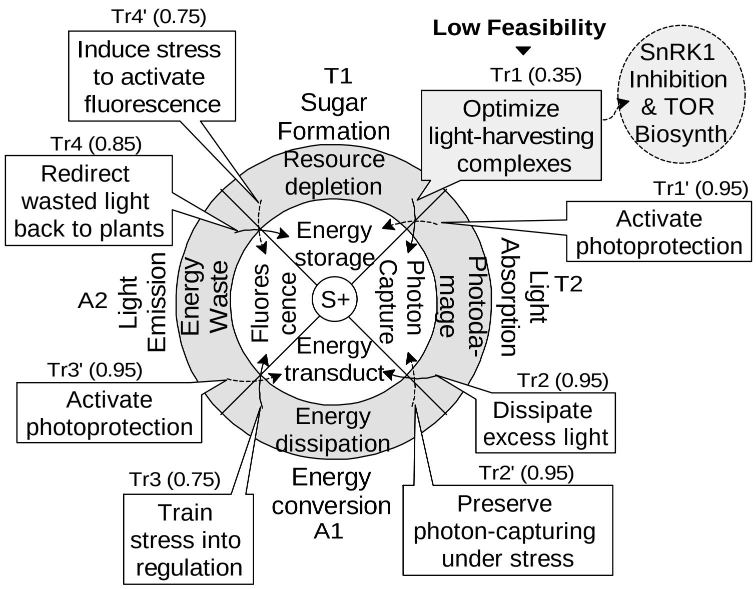


Fig. 7. Some transition steps for T1 = Sugar Formation, A1 = Energy Conversion, T2 = Light Absorption, A2 = Light Emission (Calvin cycle).

The obtained causality is T1→ T2 → A1 → A2 → (clockwise) or T1 → A2 → A1 → T2 → (counterclockwise), such that T1 and T2 are always diagonal to their counterparts A1 and A2. The example of prohibited sequence is T1 → A1 → T2 → A2 →. Given *n* theses (T1, …, T*n*) with *n* antitheses (A1, …, A*n*), this restriction reduces the number of permutations from (2*n*)! to $(2^{\wedge n}\, n!/2n)$, *i.e.* roughly $3n^{\wedge n}$ times.

Step 8: Transitions' Matrix. The obtained multithetical wheel must be provided with actionable recommendations on how to turn each negative pole (Tx- or Ax-) into all positives (T1+, …, A1+, …). Note that Ac+ and Re+ from individual tetrads become ordinary transitions of the type Acx+ = Tr(Tx-→Ax+) and Rex- = Tr(Ax-→Tx+).

In Fig. 7 each node shows only 2 transformations, but there are two more (Tx- or Ax- to Tx+ and Ax+). Examples of full transition matrices will be given below. Generally, *m* tetrads yield $m^{\wedge 2}$ transformations, ensuring enough space for finding feasible transformations.

3. Applications

The following examples illustrate the qualitative generative capabilities of Structured Dialectics as outlined in Table 1. Our objective is to demonstrate its applicability to systems analysis, theory completion, and ontology construction, while exploring its potential for epistemic transformation. Quantitative evaluation is deferred for future work.

The framework was explored using the prototype Dialexity application (formerly Eye Opener [9], available at https://dialexity.com/), based on the Claude Sonnet 4.5 engine, together with direct interactions with other generative AI models (GPT-5 and Gemini). Both the implementation and the prompting strategies are still evolving. Accordingly, the examples should be regarded as illustrative analyses rather than definitive quantitative evaluations. The project is being developed as an open-source framework, with code and prompts available at https://github.com/dialexity/dialectical-framework.

3.1. Understanding Systems: Photosynthesis

Often, we have so much information about the given system or phenomenon, that it is hard to decide what is most important. In such cases we can first obtain a simple wheel based the single most important thesis (like we have done in Fig. 5 for T = Sugar in photosynthesis), then add the second thesis (Fig. 7), and so on. Alternatively, we can start from the minimum cycle of the 4 major steps reflecting the most essential cycle of a given system (Fig. 8A).

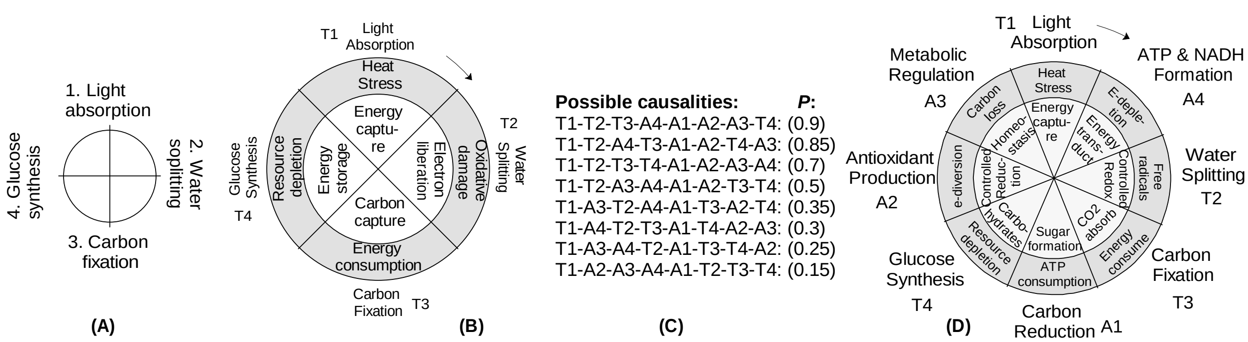


Fig. 8. Dialectical wheels for Photosynthesis analysis

A typical prompt: "suggest 4 major steps T1 – T2 – T3 – T4 – describing a given system in terms of circular causation, such that T2 opposes T3 and T2 opposes T4". Scheme B makes sure that diagonal positions balance each other: T1+ opposes T3-, T3+ opposes T1-; same for the T2/T4 pair. Scheme C shows all possible causalities with antitheses, while retaining both the original sequence of theses (T1 – T2 – T3 – T4 –) and geometries of all respective tetrads (such that each Tx – Ax pair defines a diagonal line).

P denotes the practical feasibility (or probability) of a given sequence, estimated by a simple AI prompt (e.g. "Estimate P from 0 to 1 for each sequence"). Although these estimates are approximate, the number of feasible sequences ($P \geq 0.5$) appears to provide a rough indicator of the system's self-regulatory capability (Fig. 9). Natural systems generally admit many feasible complementary pathways, whereas purely mechanical systems tend to rely on only one or two dominant sequences. Consequently, identifying only a few feasible pathways in a natural system often reflects limitations of our understanding rather than limitations of the system itself.

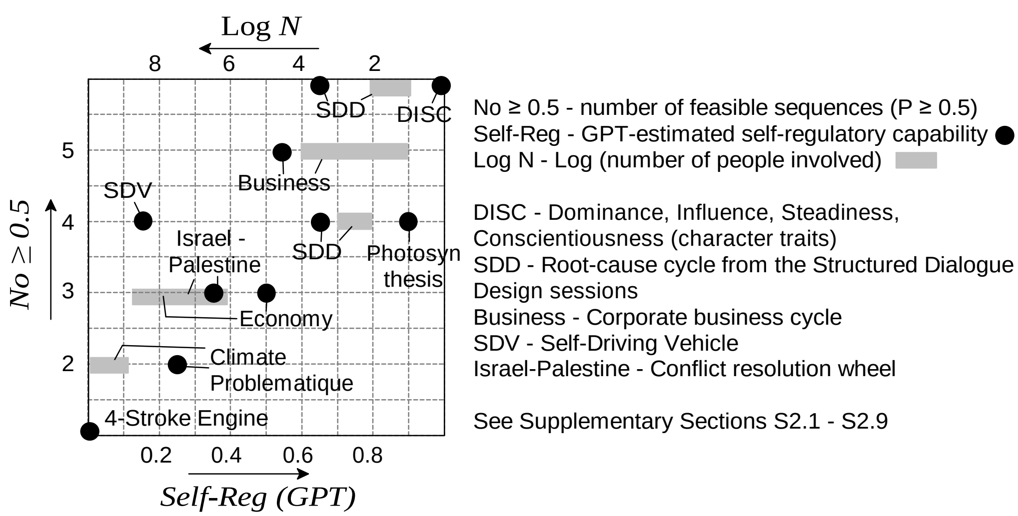


Fig. 9. Systems with higher self-regulatory capability tend to admit more feasible dialectical pathways.

Scheme D shows one particular T/A sequence that helps visualize non-obvious leverage points. If the system is in a pathological state, it operates in the outer ("destructive") layer (T1− = Heat Stress → A4− = Electron Depletion → …), where each step is primarily influenced by its orthogonal T/A pair (here, T2− = Free Radicals and A2− = Energy Diversion), as required by the symmetry constraints. In a healthy state, the system moves into the constructive layer (T1+ = Energy Capture), where it can freely transition to A2+, A3+, A4+, or T2+, making its behavior less dependent on any single T/A pair. Such considerations could benefit systems biology

(Kitano, 2002) and systems dynamics (Sterman, 2000), where bottom-up modeling frequently suffers from a "hairball effect" that obscures the true levers of systemic control. Supplementary Sections S2.1 – S2.9 provide more examples.

3.2. Improving Systems: Macondo Blowout

The 2010 Macondo oil spill [10] is widely regarded as a benchmark offshore engineering failure. Table 10 summarizes four core safety recommendations extracted from the 380-page Commission report [11].

Table 10. Starting Theses and Antitheses

Uploaded Theses	**Antitheses (suggested by Eye Opener)**
T1 = Halt displacement if pressure tests are anomalous	A1 = Displacement permitted despite test anomalies
T2 = Cement integrity must be independently verified before proceeding	A2 = Proceed based on operator’s internal assessment
T3 = Blowout preventer (BOP) must meet verified functional redundancy standards	A3 = Relay on single-layer protection without verification
T4 = Formal stop-work authority with mandatory escalation protocol	A4 = No stop-work authority

Each thesis was paired with its antithesis that represents a potential rule violation. Each T/A pair was expanded into a tetrad (Fig. 10A) and then integrated into the larger wheels exemplified in Fig. 10B.

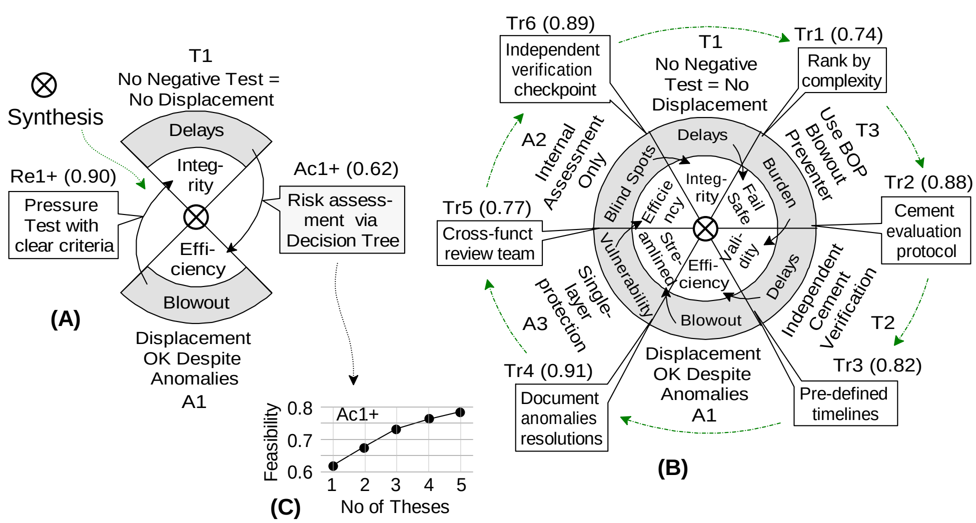


Fig. 10. Examples of wheels for Macondo blowout case.

T1–T3 represent the original recommendations, and A1–A3 their antitheses (violations). The eight tetrads yield 64 theoretically possible transitions. For illustrative purposes, only 24 transitions were analyzed, of which 4 were judged by GPT to be both feasible and novel (Table 11).

Table 11. Actionable additions to existing recommendations

Suggested Tr step	**Baseline Gap (Commission Report)**	**Dialectical Logic (Value-Add)**
A4- to T1+: Mandatory pre-shift briefings where anyone can raise concerns (0.93)	Report suggests "culture," but lacks a timed protocol.	Converts vague intent into a mandatory time-locked mechanism.
T3- to T4+: rapid safety teams with delegated authority (0.81)	Accountability is noted, but not delegated real-time authority.	Reduces the latency between anomaly detection and decision.
A2- to A3+: checklist fast, escalate automatically (0.84)	Focuses on barrier failure, not standardized handled triggers.	Removes reliance on hierarchy/improvisation during crises.
T2- to T3+: parallelize cement verification with BOP testing (0.87)	Safety is treated as a sequential bottleneck.	Preserves integrity while removing the "pressure to skip" (A+)

The novelty of these transitions was not confirmed by experts, as our purpose was simply to illustrate the generative potential. Likewise, Fig. 10C 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, …").

3.3. Improving Systems: Conflict Resolution

SD facilitates conflict resolution by presenting any concept as a bipolar dimension capable of both constructive realization and destructive exaggeration. Consider a conflict between two stakeholders with remarkably different worldviews (Table 12). A global mining corporation claims to create jobs (T1), while a local community claims that corporation destroys environment (T2).

Table 12.

	Global Corporation	**Local Community**
Theses	We bring jobs and prosperity through legal resource extraction. Environmental concerns are exaggerated (MMI ~ 0.2)	They destroy our land and water. Their compliance claims hide systematic violations (MMI ~ 0.8)
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. Table 13 presents the “first level” of Transitions’ matrix based on the apex tetrads, but it can be enlarged using other tetrads.

Table 13. Transitions Matrix (First level)

Negative pole	**→ T1+ Economic growth**	**→ A1+ Environmental care**	**→ T2+ Spiritual harmony**	**→ A2+ Business freedom**
T1− Pure exploitation	Fair revenue sharing	Independent environmental audits	Respect indigenous values	Responsible innovation with transparent standards
A1− Economic stagnation	Green investment and local employment	Community-led conservation projects creating jobs	Eco-tourism and cultural enterprises	Simplified permits for sustainable businesses
T2− Overregulation	Risk-based permitting	Adaptive environmental regulation	Continuous dialogue instead of blanket prohibitions	Streamlined compliance with measurable outcomes
A2− Spiritual decay	Invest in local education and heritage	Restore damaged ecosystems	Cultural co-management and stewardship	Ethical entrepreneurship respecting local identity

Life Principle	Share fairly; Be just	Protect life; Be caring	Build together; Be cooperative	Tell the truth; Be honest

The last row of Table 13 compresses all suggestions into memorable ontological principles that can have continuous impact beyond the SDD session. Each principle unites two statements that we often separate. For instance, the mining company obviously will insist that they care for environment (the A1+ column), yet they do not extend this care to protecting living nature. Such a discrepancy is reflected in the low MMI value of the starting claim (Table 12) and it demonstrates the need of a deeper epistemic shift that will be discussed below. Supplementary Section S3.1 provides a similar analysis for Requisite Variety vs. Requisite Parsimony.

3.4. Completing Theories: Organizational Ambidexterity

Many existing theories are bipolar in that they involve two competing paradigms. Consider the Organizational Ambidexterity that balances Exploitation with Exploration (March, 1991). Table 14 lists upsides and downsides of both sides, while table 15 shows transitions' matrix.

Table 14. 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

Table 15. 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**

The last column summarizes all advices into epistemological principles that simplify orientation and gradually lead toward more balanced existential worldview, as discussed below. Supplementary Sections S3.2 – S3.3 provide similar analyses for Resilience Engineering (Hollnagel, 2014) and Subject-Object Theory (Kegan, 1982).

4. Toward Epistemological Transformations

The previous applications demonstrated that SD progressively compresses complex systems into simpler ontologies, thereby addressing the apparent contradiction between Requisite Variety (Ashby, 1956) and Requisite Parsimony (Miller, 1956). Table 16 summarizes representative examples from different domains.

Table 16. Examples of ontologies derived from different domains

Domain	**Conflict***	**Child-Clear Life Principles**
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
Epistemiological	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

* Supplementary Sections S3.1-S3.3

Figure 11(A) illustrates how these ontologies are generated. A given model, theory, or dialogue design provides the initial theses, whereas dialectical analysis compresses them into ontologies.

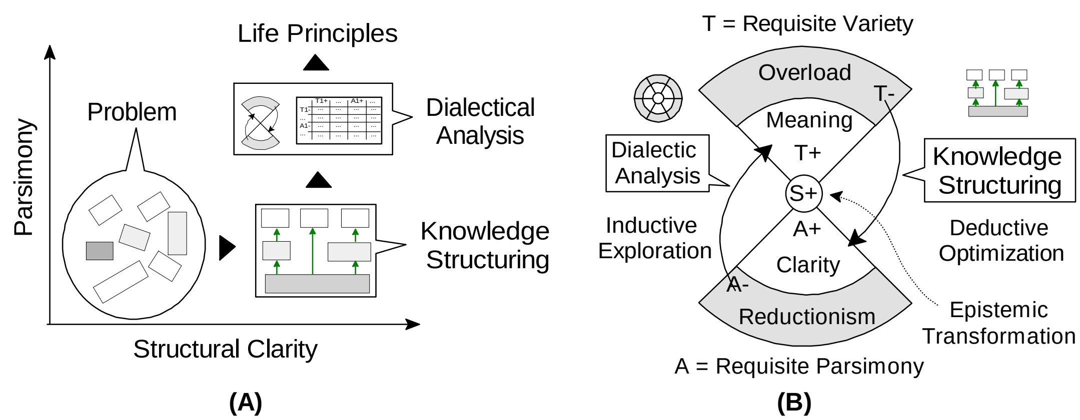


Fig.11. Complementarity between knowledge structuring and dialectical analysis.

Fig. 11(B) suggests that repeated iterations of this process close an induction–deduction loop, potentially triggering post-formal cognitive growth (Basseches, 1984) and double-loop learning (Argyris & Schön, 1978). By continuously forcing empirical observation (induction) to confront structured systemic logic (deduction), the framework triggers a cognitive equilibration process (Piaget, 1975). The mind is forced to accommodate structural contradictions, systematically dismantling binary, scalar biases and shifting the researcher toward a dialectical worldview. Table 17 illustrates the epistemic transformations that can be expected from this iterative cognitive acceleration.

Table 17. Epistemological Shifts Toward Dialectical Synthesis

Criterion	**Epistemological Shift**	**Additional Insight**
Truth	Truth is a process rather than a fact	T is true if and only if it fosters A+

Success	Focusing on qualitative change	DG* → 1 = practical growth
Failure	Focusing on numbers	DG* < 0.5 = theoretical speculation
Logics	1 + 1 > 2 (sum of 2 vectors yields the 3rd)	1 + 1 = 2 holds only for 1D scalar arithmetic.
Certainty	The only absolute certainty is uncertainty	Seek invariant principles rather than results
Reduction	Reduce detail only to reveal polarities	Once identified, shift attention to A+

* DG = Dialectical Goodness – the extent of fostering A+ (0 to 1)

These shifts follow from the principle that T+ without A+ yields T−. Accordingly, S+ depends on the extent to which T fosters its constructive opposite (A+). This parameter, termed *Dialectical Goodness* (DG) and ranging from 0 (pathology) to 1 (synthesis), can be estimated using prompts such as: "Estimate the extent (0–1) to which the commonly perceived meaning of T fosters A+." Table 18 illustrates DG estimates for several publicly accepted concepts generated independently by Claude 3.5 Sonnet and GPT-5.2 (average values consistent within *c.a.* ±0.1).

Table 18. AI suggested Dialectical Goodness (DG)

Concept (T)	**Antithesis (A)***	**Obligation (A+)***	**DG**	**Common Perception**
Dialectics	Linear thinking	Clarity of objectives	0.5	Seek synthesis
Truth	Imagination	Beauty	0.3	Reality
Science	Mysticism	Reality design	0.3	Discover truth
Technology	Self-adaptation	Natural Harmony	0.2	Enhance capability
AI	Natural Intelligence	Experiential Synthesis	0.3	Benefit humankind
Ethics	Amorality	Understand Nature	0.3	Do right
Business	Non-profit	Social Impact	0.4	Create value
Politics	Anarchy	Simplicity & focus	0.2	Serve people
Peace	War, conflict	Inner growth, discipline	0.3	Reduce conflict

* Selected without comprehensive analysis

The consistently low DG values suggest that our society is preoccupied with imitating change (S−) rather than actually seeking it (S+). The last column of Table 18 shows societal purposes that differ markedly from the third column (our obligations A+). This discrepancy is consistent with rapid, automatic System 1 thinking (Kahneman, 2011) and binary, "all-or-nothing" cognitive distortions (Beck, 1976). Structured Dialectics diminishes these biases by increasing integrative complexity (Fearon & Boyd-MacMillan, 2016), linked to effective conflict resolution and resilient decision making (Suedfeld, 1992; Rosler et al., 2022).

5. CONCLUSION

Structured Dialectics transforms abstract dialectical reasoning into an explicit, generative framework that can be systematically implemented with the assistance of AI. Representing every thesis as a bipolar semantic differential makes complementary obligations explicit, enabling the construction of balanced dialectical structures, transition pathways, and compressed ontologies applicable across diverse domains.

The illustrative applications demonstrate that the same framework can support multiple levels of analysis, including understanding and improving existing systems, completing existing theories, and extracting transferable ontological principles. Repeated application progressively compresses complex domain knowledge into increasingly simple life principles, providing a potential mechanism for epistemic transformation through recursive induction–deduction cycles.

The present work is primarily qualitative and intended to establish the underlying conceptual framework. Future work should focus on quantitative validation, objective quality measures for dialectical structures, and domain-specific adaptations. If further validated, Structured Dialectics may provide a common generative language for systems analysis, theory completion, ontology construction, and AI-assisted knowledge development.

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