**THESIS BRIEF — THEORY-FIRST RESEARCH**

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Smart Technology Investments

# Cognitive Wars: the AI Industrialization of Influence

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**Disclosure & Method Note:** This is a *theory-first* brief. Claims are mapped to evidence using a CEM grid; quantitative effects marked **Illustrative Target** will be validated via the evaluation plan. Where anchors are scarce, this brief is labeled **Anchor-Absent** and any analogical inferences are explicitly bounded.

## Abstract & Theory-First Framing.

**Outline**

## Title, Abstract, and Thesis Statement

Title: Cognitive Wars: The AI Industrialization of Influence

Abstract: Industrialization historically reconfigured the material basis of warfare; this brief argues it also reconfigured warfare's cognitive substrate. As production, logistics, communications, and bureaucratic organization scaled and integrated, the capacity to shape perception, attention, meaning, and decision-making—collectively termed "influence"—became infrastructural. The result is a class of conflicts best described as "cognitive wars": contests in which cognitive processes (perception, attention, attribution, decision-making) are primary strategic objects and outcomes. This thesis presents a theory-first account that links phases of industrialization to distinct cognitive mechanisms, proposes testable hypotheses, and outlines an analytical strategy for comparative-historical process tracing.

Thesis statement: Industrialization transformed warfare not only materially but cognitively: the integration of production, communications, and bureaucratic systems created infrastructural and informational capacities to produce, target, and automate influence at scale—giving rise to cognitive wars distinguished by altered perception, accelerated decision-tempo, routinized targeting, and institutionalized influence operations.

## Theory-First Orientation and Methodological Rationale

This project adopts a theory-first orientation: specifying mechanisms and boundary conditions before committing to empirical measures improves internal validity when tracing historically contingent causal processes. Methodologically, the brief advocates a mixed comparative-historical design combining process tracing (to demonstrate mechanism activation across cases), structured, focused comparisons (to isolate variables linked to industrialization), and conceptual analysis (to operationalize "influence" and cognitive indicators). These choices prioritize causal clarity over purely correlational inference and permit triangulation across archival, doctrinal, and technical evidence.

### Rationale summary:

- Theory-first enables explicit mechanisms and falsifiable propositions.
- Process tracing reveals sequencing (industrial input → infrastructural/informational change → cognitive effect).
- Comparative-historical cases (19th-century industrial wars, world wars, late-20th/21st-century conflicts) show mechanism variation under different technological regimes.

## Foundations

Why these anchors? Selection criterion: anchor sources should be peer-reviewed, non-preprint works offering validated empirical or theoretical foundations for claims about organizational standardization, information flows, and socio-technical systems. Anchors are chosen to (1) establish institutional and doctrinal baselines, (2) ground technical claims about distributed decision systems in validated results, and (3) connect military/organizational history with systems theory. Anchor requirement strengthens confidence that the mechanisms posited are not artifacts of provisional or non-reviewed findings.

Current anchor availability: among the provided sources, there are no clear peer-reviewed, non-preprint social science or historical anchors directly addressing industrialization and cognition in warfare; the set contains preprints on machine learning and distributed optimization and a clinical protocol paper. Consequently, this brief uses the provided technical preprints as supporting, mechanism-relevant references (e.g., multi-agent consensus and distributed optimization literature) while flagging the absence of domain-appropriate peer-reviewed anchors for the historical and sociological claims. Future empirical testing should prioritize integrating peer-reviewed historical sociology, military studies, and communications scholarship as anchors.

Sources used here for mechanisms and technical analogies include computational consensus and distributed optimization literature to ground claims about bureaucratic coordination and distributed decision-making [3][4], and machine-detection literature that provides analogs for automation and detection limits in influence operations [1]. The clinical protocol study is used illustratively for how standardized protocols operationalize high-stakes rapid decision-making in institutions [2].

## Conceptual Definitions and Boundary Conditions

- Cognitive wars: conflicts in which shaping and manipulating cognitive processes—perception, attention allocation, attribution, belief formation, decision heuristics—is a central strategic aim and determinant of outcomes. Cognitive wars foreground informational and infrastructural levers that systematically alter human and machine cognition.

- Industrialization (operationalized): the historical and ongoing integration of (a) mass production capacity, (b) logistics and distribution infrastructures, (c) dense communications networks, and (d) bureaucratic/organizational standardization that permits scaling, templating, and routinization of tasks.

- Influence (operationalized): the capacity of combined material and informational systems to shape cognition and behavior through (i) signal production and amplification, (ii) architecture of attention (what agents can notice), and (iii) institutionalized decision templates that constrain interpretation and action.

Boundary conditions: The analysis distinguishes cognitive effects (alterations to perception, attention, and decision-making) from purely material effects (e.g., increased range or lethality). A cognitive effect is identified when the mechanism produces systematic changes in information processing, interpretation, or the allocation of attention that are causally necessary for an observed outcome.

## Literature Review: Wars, Industrialization, and Cognitive Dimensions

The literature on industrial transformations of warfare focuses on mechanization, mass mobilization, and logistics; parallel literatures examine bureaucratic organization and doctrine. Cognitive approaches to conflict—psychological operations, information operations, and sensemaking literature—address parts of the problem but rarely link macro-infrastructural change to micro-cognitive processes systematically. Organizational theory and socio-technical systems literatures provide tools to link infrastructure to cognition (e.g., standard operating procedures, distributed decision protocols). Gaps persist: insufficient theorization of the precise pathways by which industrial-scale communications, production, and bureaucratic templating reconfigure perception, decision heuristics, and legitimacy practices in war.

This brief positions itself at the intersection of these literatures: it treats influence as infrastructural and informational, synthesizing studies of organizational standardization with work on informational ecosystems and decision automation. To ground certain mechanism claims about distributed coordination and consensus in technical terms, I draw on multi-agent consensus and distributed optimization literature [3][4], and to illustrate detection/automation limits I reference machine learning survey work [1]. The literature review concludes that a mechanism-rich theory bridging industrial infrastructure and cognitive outcomes is underdeveloped and empirically tractable.

## Historical Synthesis: Industrialization and the Transformation of Warfare

Successive phases of industrialization map onto observable cognitive shifts in warfare:

- Mechanization (late 19th–early 20th centuries): increased tempo and sensory overload for commanders; centralized staff systems emerged to filter information.
- Mass production and logistics (WWI–WWII): routinization of targeting (templates, fire plans), separation between decision-makers and effects producers, and abstraction of targets into categories (e.g., economic nodes) rather than immediate battlefield actors.
- Communications densification and automation (late 20th–21st centuries): acceleration of decision cycles, remote sensing creating new perceptual affordances, and increased delegation to algorithms and standardized rules.

Stylized episodes (e.g., industrial artillery coordination in WWI, strategic bombing campaigns, modern ISR networks) illustrate how scale and tempo produced attention bottlenecks and incentivized templated decision rules that shaped what counted as a legitimate target or credible intelligence. The historical arc shows movement from materially instantiated effects to effects that are produced by shaping cognitive states across populations and adversaries.

## Mechanisms: How Industrialization Influenced Cognitive Wars

This section identifies mechanisms that causally mediate between industrial inputs and cognitive outcomes. Each mechanism is framed to be empirically observable and distinct from pure material capabilities.

1. Information flow amplification: Dense communications and pervasive sensing increase the volume and velocity of signals feeding decision systems. Consequence: attention scarcity—actors must filter and prioritize, creating systematic selection effects about which phenomena are perceived and acted upon.

1. Organizational standardization and templates: Bureaucratic routinization (SOPs, playbooks, protocols) translates complex situations into categories and pre-authorized responses. Consequence: decreased interpretive flexibility and increased reliance on heuristics.

1. Tempo acceleration and synchronization: Industrial temporal coordination (logistics, synchronized strikes, networked ISR) compresses decision windows. Consequence: decisions rely more on rule-following and automated thresholds, increasing the role of preconfigured influence strategies.

1. Abstraction of targets and effects: Production and logistical integration permit treating populations, infrastructures, and cognitive states as system inputs to be modulated (e.g., degrading an infrastructure to cause systemic behavioral change). Consequence: moral and attributional ambiguity as effects are distal and mediated.

1. Delegation to automated agents and templates: As sensing and processing scale, delegation to algorithmic systems becomes operationally attractive; distributed consensus and optimization frameworks illustrate how decentralized agents converge on joint decisions under constraints [3][4]. Consequence: new failure modes (model drift, adversarial exploitation) and shifted responsibility chains.

Distinctive note: These mechanisms are informational and institutional mediators: they alter how agents notice, interpret, and respond rather than only altering physical force. For example, an ISR network's ability to make certain behaviors salient changes attribution and legitimization practices independent of material effects.

## Propositions and Testable Hypotheses

Proposition 1: Greater infrastructural integration (communications density + bureaucratic standardization) increases the centrality of cognitive labor—analysis, sensemaking, and influence design—in achieving military objectives.

Hypothesis 1A: Higher measures of communication density (messages/sec per decision node) correlate with shorter decision latencies but higher reliance on templated responses (operationalized by the fraction of decisions taken under SOP guidance).

Proposition 2: Delegation of decisions to automated or semi-automated systems increases the probability of systematic misattribution when adversaries exploit signal-space vulnerabilities.

Hypothesis 2A: Systems with higher algorithmic-decision share will exhibit greater variance in target attribution error rates under adversarial signal perturbation than low-delegation systems.

Proposition 3: Institutionalization of influence production (e.g., dedicated messaging pipelines, integrated logistics for ISR) increases scale but lowers per-unit interpretive flexibility, raising the likelihood of escalatory attribution errors in contested environments.

Hypothesis 3A: Increased infrastructural coupling between information producers and effectors (e.g., automated strike pipelines) is positively associated with the frequency of contested attribution disputes.

Each hypothesis is measurable via archival metrics (communication logs), doctrinal analysis (SOP prevalence), and simulated perturbation experiments using technical analogues (consensus algorithms and detection systems) [3][4][1].

## Analytical Strategy and Case Selection

Case selection: structured, focused comparisons across three epochs:

- 19th-century industrial wars (e.g., Prussian mobilization paradigms) to capture early bureaucratic templating;
- World Wars (mass production, synchronized logistics) to observe routinized targeting and abstraction effects;
- Late-20th/21st-century conflicts (networked ISR, cyber/information operations) to examine automation, compressed tempo, and contested informational environments.

### Process-tracing steps:

1. Establish industrial inputs (production/logistics/communications metrics) for each case.
2. Identify institutional artifacts (SOPs, command-and-control architectures, delegation rules).
3. Trace causal chain: infrastructure → mechanism activation (e.g., tempo compression) → cognitive outcome (e.g., attention bottleneck) → observable effect (e.g., routinized targeting error).
4. Use counterfactual probes and technical analogues (distributed consensus experiments, adversarial detection simulations) to test mechanism plausibility.

Indicators and data sources: archival military doctrine, communication logs, after-action reports, doctrinal manuals, technical literature on distributed decision systems, and simulations informed by consensus/optimization frameworks [3][4]. Where available, include quantitative indicators (decision latency, proportion of templated responses, attribution error rates).

# Applications (Parameterized Vignettes)

This section presents two parameterized operational vignettes illustrating how industrialized influence infrastructures alter mission outcomes. Each vignette specifies context, parameter ranges, operational metrics (MTTA, failure probability), dominant failure modes, and mitigation levers.

Vignette A — Disaster Response Under Intermittent Communications

Context: A humanitarian disaster in a partially degraded urban network. A civil-military task force employs distributed sensing (drones, social-media scraping), standardized response templates (triage/evacuation SOPs), and an automated alerting pipeline that routes identified high-priority incident reports to response teams. The system was designed for high-volume, low-latency routing in peacetime conditions.

### Parameters (example values):

- Communication density ($\lambda$): nominally 100 messages/min per command node; degraded to 10–25 messages/min under intermittent comms.
- Template reliance (T): fraction of decisions auto-approved by SOPs; baseline 0.7, reduced to 0.4 when human override is engaged.
- MTTA (Mean Time To Acknowledge & Adapt): baseline 120 seconds; under degraded comms increases to 300–900 seconds depending on operator workload.
- Failure probability (Pf) of incorrect prioritization leading to delayed rescue: baseline 0.02; under degraded comms and high template reliance Pf rises to 0.12.

### Failure modes:

- Information fragmentation: partial signal leads to incomplete situational pictures; automated templates misclassify incident severity.
- Over-reliance on stale SOPs: templates assume infrastructure continuity; when breached, scripted responses direct resources suboptimally.
- Latent accountability gaps: automated routing obscures who made final triage judgments, slowing corrections.

Mitigations: implement explicit delegation triggers (see Operational Assumptions section), increase local autonomy at edge nodes when $\lambda$ < threshold (e.g., $\lambda < 20$ messages/min), and deploy redundancy channels and lightweight consensus protocols to enable graceful degradation. Monitoring metric: run-time estimate of MTTA; trigger human-in-loop override when MTTA exceeds 4× baseline.

### Vignette B — Autonomous ISR Swarm in Contested Spectrum

Context: An ISR swarm conducts wide-area surveillance to detect and target high-value mobile assets. The swarm relies on distributed consensus algorithms for target nomination and an automated pipeline for cueing strike assets. The adversary employs electronic attack (jamming, spoofing) and deceptive emissions.

### Parameters (example values):

- Consensus latency (Lc): baseline 2–5 s per consensus cycle; under jamming rises to 10–30 s or stalls.
- Delegation ratio (D): fraction of consensus nominations auto-promoted to engagement cueing; baseline 0.6; safe mode 0.2.
- MTTA (Mean Time To Adjust swarm behavior after anomalous signals): baseline 10 s; under adversarial perturbation 60–300 s depending on diagnostics.
- Failure probability (Pf) of false-engagement (engaging non-target due to spoofing): baseline 0.005; under contested spectrum Pf estimated 0.07–0.2 without robust diagnostics.

### Failure modes:

- Adversarial exploitation of template thresholds: spoofed signals pass simple detection thresholds, producing false positives that propagate through automated pipelines.
- Consensus poisoning: adversary manipulates a subset of swarm nodes or signal channels, biasing consensus outcomes (analogous to Byzantine failures).
- Latency-induced miscoordination: increased consensus latency causes stale nominations to be executed, producing misattribution.

Mitigations: incorporate adversarial-aware consensus algorithms, dynamic delegation policies that reduce D when detection confidence falls below threshold, and multilayer diagnostics (cross-modal sensing, time-series anomaly detectors). Technical analogues and experiments from distributed optimization and consensus literature inform tolerance bounds for node compromise and latency [3][4].

Operational metrics to monitor in both vignettes: MTTA, system-level Pf (failure probability), rate of human override, and proportion of decisions made under automation. Policy levers include delegation thresholds, required ensemble agreement levels for consensus promotion, and fallback modes that expand human oversight when MTTA or Pf cross prespecified thresholds.

(Collectively these vignettes illustrate that industrialized processes—templates, automated pipelines, and dense sensing—raise throughput and scale but introduce concentration of cognitive risk that manifests in measurable system metrics.)

## Limits & Open Questions

This section enumerates key limits, open empirical questions, and operational assumptions necessary to render the theory actionable. Two assumptions are foregrounded and operationalized as diagnostics with triggers and delegation policies.

Operational Assumptions & Diagnostics (bounded-rationality; adversarial comms)

Bounded-rationality assumption: Decision-makers (human or algorithmic) operate under finite attention, limited working-memory, and constrained processing time; information overload and templating are rational responses to bounded cognition. Operational trigger: when incoming signal rate ($\lambda$) exceeds an empirical threshold relative to processing capacity (C)—for example, $\lambda/C > 3$—the system is in an overload regime. Diagnostics: compute a real-time overload index $OI = \lambda/C$; monitor surrogate markers (queue length, average decision latency, frequency of SOP-deployed responses). Delegation policy: implement tiered delegation

- Normal: $OI \leq 1$ — normal automation share (D_base).
- Caution: $1 < OI \leq 3$ — reduce automation by $\alpha$ (e.g., $D := 0.6\times D\_base$), increase human attention allocation and concise summaries.
- Overload: $OI > 3$ — switch to conservative mode: require secondary human confirmation for all high-risk automations, route simplified, prioritized feeds to human operators.

Concrete trigger example: if $OI > 3$ for a sustained window (e.g., 90s), raise an operational alert that forces delegation to human supervisors and initiates a diagnostic protocol (recompute templates, introduce information triage filters).

Adversarial communications model assumption: Communications and sensing channels are subject to active adversarial manipulation (jamming, spoofing, data injection) that can induce false positives, false negatives, and biased consensus. The model assumes adversary capabilities scale with access to low-cost electronics and spoofing toolchains; thus, automated pipelines must treat signals as potentially corrupted unless corroborated.

Diagnostics: estimate channel integrity confidence (CIC) via cross-modal corroboration, anomaly detection on signal characteristics, and node-consistency checks within consensus protocols. Compute $CIC \in [0,1]$; set policy thresholds:

- $CIC \geq 0.8$: normal operations; automated promotion allowed per D_base.
- $0.5 \leq CIC < 0.8$: degraded trust; reduce D by $\beta$ (e.g., $D := 0.4\times D\_base$), require multi-source corroboration.
- $CIC < 0.5$: compromised suspicion; suspend automated engagement pipelines for high-risk actions; enforce human-in-loop confirmation for all engagements.

Delegation policy under adversarial suspicion: require k-of-n independent corroborations for target nomination (k chosen based on adversary model and acceptable Pf). Example default: require 3 independent sensors or human confirmations for high-value engagement when $CIC < 0.8$.

Note on human-in-loop and adversarial threat: Moving these claims from 'future work' to present assumptions acknowledges that any operationalization must assume both bounded cognition and an active adversary. Recognizing these as present conditions changes experimental design: simulations must include capacity constraints and adversarial perturbations; doctrinal recommendations must prescribe explicit delegation and diagnostic thresholds rather than leave supervision undefined.

### Open empirical questions:

- How to calibrate OI and CIC thresholds across heterogeneous organizations?
- What is the optimal tradeoff between automation share and robustness under adversarial perturbations?
- How do institutional cultures (risk tolerance, legal frameworks) shape delegation choices and error correction practices?

These questions require mixed methods: experimental simulations with adversarial signal injection (informed by machine-detection limits) [1], field studies on decision latencies and SOP reliance, and historical process-tracing across different industrialized military systems.

## Theoretical Contributions and Implications

### Contributions:

- Mechanism-rich theory linking industrialization to cognitive warfare: identifies how infrastructural integration alters attention, decision templates, delegation, and attribution.
- Reframes "influence" as both infrastructural (logistical/communications coupling) and informational (signal architectures that shape cognition), making it an operationalizable construct for empirical work.
- Bridges technical literatures on distributed consensus and detection with historical and organizational analyses to illuminate new failure modes introduced by scale and automation [3][4][1].

### Implications:

- Military doctrine: prioritize diagnostics and explicit delegation policies that are sensitive to overload and adversarial comms; redesign SOPs to include dynamic confidence-weighting.
- Policy: securing information infrastructures (spectrum resilience, cross-modal sensing) becomes a strategic priority because influence flows ride these infrastructures.
- Ethics & law: cognitive harms (manipulation of belief, opaque automated attribution) require updated accountability frameworks and transparency standards for automated decision pipelines.

## Conclusion, Limitations, and Research Agenda

Conclusion: Industrialization has a cognitive dimension: by scaling production, communications, and bureaucratic standardization, it created infrastructures of influence that systematically reshape what actors perceive, how they prioritize, and which decisions are delegated. Cognitive wars are not merely about information operations but about institutional and infrastructural arrangements that make cognitive manipulation possible at scale.

Limitations: This brief is conceptual and mechanism-focused; empirical validation requires archival case work, doctrinal analysis, and adversarial simulation. The present reliance on technical preprints for mechanism analogues highlights the need for peer-reviewed historical and social science anchors. Confounders include political-ideological constraints and adversary asymmetries that may modulate mechanism activation.

### Research agenda:

- Operationalize cognitive indicators (attention scarcity, template reliance, attribution error rates) and collect comparative case data.
- Simulate adversarial perturbations in distributed consensus and detection pipelines to quantify robustness bounds [3][4][1].
- Empirically calibrate OI and CIC thresholds across organizations and domains.
- Explore governance frameworks to assign accountability for automated cognitive influence operations.

Coda: Recognizing cognitive wars as infrastructurally enabled reframes questions of strategy, policy, and ethics: influence is not just a set of messages, it is an engineered outcome of integrated systems.

[1]: See source 1 for machine-detection and automation limits. [2]: See source 2 for an example of institutionalized standard protocols in high-stakes operational settings. [3]: See source 3 for theoretical underpinnings of consensus in multi-agent systems. [4]: See source 4 for applied consensus ADMM techniques and distributed optimization considerations.

## Assumptions Ledger

| Assumption | Rationale | Observable | Trigger | Fallback/Delegation | Scope |
|---|---|---|---|---|---|
| The processes and infrastructures of industrialization (mass production, dense communications, logistics, bureaucratic standardization) created durable, scalable capacities to produce and target cognitive effects (influence) across populations and organizations — i.e., influence became infrastructural. | Industrialization materially enabled mass signaling, routinized procedures, and distribution channels; historically states and large organizations used these capabilities to shape public opinion, mobilize attention, and routinize decision-making, so it is plausible that the same integration supports large-scale influence operations. | Documented use of industrial infrastructures for influence in primary sources (doctrines, SOPs, communications plans), archival evidence of coordinated signaling using production/distribution/logistics channels, measurable shifts in attention/attitudes following infrastructure-enabled campaigns, and procedural artifacts (templates, playbooks) showing institutionalized influence activities. | Observed cases where outcomes are better explained by changes in perception/decision-making than by material force alone; comparative case selection that shows correlation between industrial-capacity indicators and evidence of systematic influence operations. | If the infrastructural claim fails, restrict the claim to specific infrastructures or time periods (e.g., communications rather than production), treat influence as a contingent capability rather than infrastructural, and delegate further analysis to historians of communications and political sociologists to re-assess causal pathways. | Applies primarily to state-level and large organizatio actors from the late 19th century onward where industrial infrastructures exist; does not assume the same dynamics hold for pre industrial societies, small-scale nonstate actors, or contexts lacking distribution/communicatio scale. |
| Organizational standardization (SOPs, playbooks, bureaucratic templates) translates complex situations into routinized categories and pre-authorized responses, thereby reducing interpretive flexibility and producing routinized influence operations. | Organizational theory and historical practice show that formal procedures and templates are adopted to manage complexity and ensure coordination; this reduces on-the-spot interpretation and makes behavior more predictable and template-driven, which in turn enables repeatable influence strategies. | Presence of formalized SOPs and playbooks in archival or doctrinal records, training materials that emphasize template responses, statistical or qualitative evidence that units apply the same templates across diverse contexts, and examples where templates produced systematic cognitive effects (e.g., framing, target abstraction). | When encountering repeated, similar responses to diverse stimuli across units or time; when archival research reveals widespread adoption of standardized procedures tied to decision outcomes. | If standardization is not evident, treat standardization as a variable (degree rather than binary) and use ethnographic or organizational case studies to measure variation; delegate deeper organizational-process analysis to scholars of bureaucracy and military sociology. | Relevant to hierarchical, bureaucratic organizations (militaries, large administrations); less applicable to highly decentralized, improvisational, or networked insurgent actors where templates are less pervasive. |
| Densification of communications | Higher signal volume and | Operational logs showing shorter decision intervals, adoption of | Detection of increased data | If tempo compression is not driving increased | Applies where high-bandwidth, low-latency |

| Assumption | Rationale | Observable | Trigger | Fallback/Delegation | Scope |
|---|---|---|---|---|---|
| and automation compress decision windows (accelerated decision-tempo), increasing reliance on heuristics, automated rules, and preconfigured thresholds in operational decision-making. | velocity create attention scarcity and coordination demands; theory and evidence from socio-technical systems indicate that organizations cope by automating decisions and codifying thresholds, which shifts the locus of action toward preconfigured rules and algorithms. | algorithmic decision aids or automated triggers in doctrine, contemporaneous accounts describing acceleration of operational tempo, and empirical links between higher data throughput and increased use of rule-based decision processes. | throughput, real-time ISR/networking deployment, or explicit doctrinal changes that emphasize speed and automation; when tempo-related variables correlate with changes in decision patterns. | automation, consider alternate coping strategies (e.g., delegation to human specialists, buffer institutions) and examine political or cultural constraints that slow tempo; delegate technical network analysis to communication engineers or military operations researchers. | communications and sensi are available (modern ISR, networked forces); limited applicability in low-tech, communication-poor, or politically constrained environments. |
| Formal and computational models from multi-agent consensus, distributed optimization, and machine-detection literatures provide valid analogies or heuristics for understanding bureaucratic coordination, distributed decision-making, and limits of automated influence operations in historical and organizational contexts. | These technical literatures formalize coordination properties (convergence, failure modes, sensitivity to noise) that map onto general features of distributed bureaucratic systems; such models can illuminate structural limits and trade-offs relevant to influence operations. | Empirical correspondence between predicted failure modes from models (e.g., consensus failure, adversarial detection errors) and historical/organizational case evidence; successful use of these models to generate testable hypotheses that are supported by archival or experimental data. | When invoking computational results to justify causal mechanisms or to generate expectations for empirical cases; whenever a technical analogy underpins a historical claim. | If analogies fail, cease relying on the computational literature for causal claims, replace with domain-specific theories from organizational sociology or military history, and commission bespoke models calibrated to historical data; delegate modeling work to computational social scientists. | Analogies are heuristic and best for high-level structura insights (coordination, sensitivity to noise); they ar not literal mappings for fin grained social, cultural, or political dynamics and should be treated as complementary rather thar definitive. |

| Assumption | Rationale | Observable | Trigger | Fallback/Delegation | Scope |
|---|---|---|---|---|---|
| A mixed comparative-historical design using theory-first process tracing, structured comparisons, and conceptual analysis can empirically establish causal chains from industrial inputs to cognitive outcomes across cases. | Process tracing is well-suited to demonstrating mechanism activation and sequence; structured comparisons isolate variables across different technological regimes; concept clarification improves measurement validity, so together they can produce internally valid causal inferences about historically contingent processes. | Availability of archival sequences, doctrinal materials, technical logs, and multiple independent sources that can be triangulated to show mechanism activation; successful replication of process-tracing logic across several well-documented cases. | When attempting to validate the thesis empirically, selecting cases, or encountering contested causal claims that require mechanism-level evidence. | If archival evidence is sparse or inconclusive, narrow the empirical scope to better-documented cases, supplement with oral histories, simulation, or quantitative proxies, and collaborate with historians or area specialists to fill gaps; if process tracing proves weak, adopt alternative approaches (e.g., comparative statistical analysis) where appropriate. | Effective where sufficient documentary or observational evidence exists; limited by archival survival, access restrictions selection bias, and interpretive uncertainty; stronger for state-level, documented conflicts than for clandestine or poorly recorded operations. |

## Notation

| Symbol | Meaning | Units / Domain |
|---|---|---|
| $n$ | number of agents | $\mathbb{N}$ |
| $G_t=(V,E_t)$ | time-varying communication/interaction graph | — |
| $\lambda_2(G)$ | algebraic connectivity (Fiedler value) | — |
| $p$ | mean packet-delivery / link reliability | [0,1] |
| $\tau$ | latency / blackout duration | time |
| $\lambda$ | task arrival rate | 1/time |
| $e$ | enforceability / command compliance | [0,1] |
| $\tau_{\text{deleg}}$ | delegation threshold | [0,1] |
| **MTTA** | mean time-to-assignment/action | time |
| $P_{\text{fail}}$ | deadline-miss probability | [0,1] |

## Claim-Evidence-Method (CEM) Grid

| Claim (C) | Evidence (E) | Method (M) | Status | Risk | TestID |
|---|---|---|---|---|---|
| Primary: Industrialization reconfigured warfare cognitively — giving rise to 'cognitive wars' in which infrastructural capacities to produce, target, and automate influence are central determinants of outcomes. | Thesis synthesis and theoretical argument; technical analogies from multi-agent/optimization and ML literature [3]; explicit statement in brief noting lack of peer-reviewed historical anchors [2]. | Comparative-historical process tracing across anchor cases (late-19th c., WWI/WWII, late-20th/21st c.); structured, focused comparisons; triangulation with archival doctrine and technical analyses; complementary computational models to illustrate scaling of influence infrastructure. | E cited (theory + technical preprints); M pending empirical historical anchoring and cross-case process tracing. | If false, the central framing (cognitive wars) is wrong — policy and research focused on infrastructural/informational countermeasures would be misprioritized; theoretical generalizations across cases would be invalid. | T1 |
| Primary: Information flow amplification (denser sensing and communications) creates attention scarcity that systematically filters what actors perceive and act upon, producing selection effects in wartime decision-making. | Mechanism described in brief; analogical support from consensus/graph-theoretic and distributed systems literature on signal propagation and bottlenecks [3]; ML survey on detection limits used as an analog for sensing/automation constraints [1]. | Formal models and simulations of information volume/velocity and filtering policies; empirical tests via process tracing and archival analysis of documented attention bottlenecks in case studies (e.g., WWI artillery coordination, modern ISR logs); possibly controlled experiments on attention allocation under high information rates. | E cited (theoretical + technical preprints); M pending simulation and archival/empirical validation across historical cases. | If false, interventions aimed at mitigating attention scarcity (e.g., better filters, prioritization protocols) may not change outcomes; misdiagnosis could leave other causal factors unaddressed (e.g., doctrine, organizational culture). | T2 |
| Primary: Organizational standardization and templates (SOPs, playbooks, protocols) routinize interpretation and responses, reducing interpretive flexibility and increasing reliance on heuristics/automated rules. | Conceptual argument in brief; clinical protocol example illustrating routinization under time pressure [2]; distributed optimization/consensus literature as analogy for formalized, distributed decision rules [4]. | Archival process tracing of doctrinal change and SOP adoption in historical cases; field/archival comparisons of outcomes pre- and post-standardization; experiments or simulations assessing decision quality under templated vs. flexible procedures. | E cited (clinical protocol and analogical technical literature); M pending systematic archival/didactic evidence from military doctrine and empirical evaluation. | If wrong, reforms seeking to alter SOPs or training to reduce cognitive vulnerabilities may be ineffective; overemphasis on templates could obscure other determinants like professional judgment or decentralized initiative. | T3 |
| Secondary: Tempo acceleration and synchronization (networked ISR, logistics, synchronized strikes) compress decision windows and increase reliance on preconfigured influence strategies and automation. | Historical narrative in brief linking communications densification to accelerated decision tempo; technical analogies from multi-agent consensus and distributed optimization on synchronization requirements and | Simulation of decision timelines under varying latency and synchronization parameters; comparative-historical analysis of cases exhibiting compressed decision cycles (e.g., modern ISR-driven engagements); interviews/archival records on decision levers | E cited (theory + technical preprints); M pending simulation experiments and archival/empirical corroboration. | If false, predicted dangers from automation and preconfigured influence strategies under high-tempo conditions may be overstated, leading to misplaced emphasis on de-automation or tempo-control policies. | T4 |

| Claim (C) | Evidence (E) | Method (M) | Status | Risk | TestID |
|---|---|---|---|---|---|
| | latencies [3]; ML detection survey as supporting example of automation pressures [1]. | used under compressed tempo. | | | |
| Secondary: Abstraction of targets/effects — industrial integration enables actors to treat populations, infrastructures, and cognitive states as system inputs to be managed at scale (industrial-scale influence and templated targeting). | Argument and historical synthesis in brief (e.g., routinized targeting, strategic bombing); ML and detection literature used as an analog for automated targeting and scale effects [1]; distributed coordination literature offering systemic perspectives [3]. | Empirical case studies (strategic bombing, mass propaganda/information campaigns, modern influence ops) with process tracing to show reification/abstraction of targets; computational diffusion models to test whether industrial-scale capabilities enable/manage cognitive state distributions at scale. | E cited (theory + technical preprints); M pending archival casework and computational validation. | If wrong, legal, ethical, and operational frameworks premised on the system-level management of populations' cognitive states may mischaracterize actors' capacities and constraints; countermeasures could be ill-specified. | T5 |

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## Sources


**[1]**
An Investigation into the Performances of the State-of-the-art Machine Learning Approaches for Various Cyber-attack Detection: A Survey
Arxiv.Org, 2024-02-26. (cred: 0.50)
http://arxiv.org/abs/2402.17045v2

**[2]**
OA1-AM23-SN-05 | Canadian Pediatric Massive Hemorrhage Protocols: A Survey of National Practice and State-of-the-Art Review
Doi.Org, 2023-10-01. (cred: 0.50)
https://doi.org/10.1111/trf.52_17554

**[3]**
On graph theoretic results underlying the analysis of consensus in multi-agent systems
Arxiv.Org, 2009-02-24. (cred: 0.50)
http://arxiv.org/abs/0902.4218v1

**[4]**
A Brief Tutorial on Consensus ADMM for Distributed Optimization with Applications in Robotics
Arxiv.Org, 2024-10-02. (cred: 0.50)
http://arxiv.org/abs/2410.03753v1


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### Research Roadmap

- **Phase 1 (Theory)**: Formalize claims, extend proofs, validate against canonical results
- **Phase 2 (Simulation)**: Implement stress tests, sweep parameter spaces, measure convergence/scaling
- **Phase 3 (Empirical)**: Deploy in controlled environments, collect field data, validate predictions
- **Phase 4 (Integration)**: Operationalize with human-in-loop, adversarial hardening, production deployment

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**Confidence Methodology:** Confidence = 0.3·SourceDiversity + 0.25·AnchorCoverage + 0.25·MethodTransparency + 0.2·ReplicationReadiness, where SourceDiversity reflects unique publishers & types, AnchorCoverage reflects share of primary claims with Type-1 anchors, MethodTransparency reflects CEM completeness & assumptions ledger, and ReplicationReadiness reflects sim plan & datasets/params specified.

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Prepared under the STI Research Program — theoretical framework subject to revision as data accumulate.