From Agent Networks to Organisational Architecture

How interaction growth, cognitive limits, and coping strategies give rise to rules, roles, and organisations.

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Abstract

Network science explains how connections between agents scale with group size. Sociology shows that the addition of a third person fundamentally changes group dynamics. Psychology demonstrates that humans face cognitive limits in social interaction, and organisational theory documents the widespread use of rules, roles, and procedures. This article integrates these strands into a single causal account of organisational emergence.

As the number of agents in a network increases, the consequences of their interactions expand far more rapidly than the number of direct links between them. Agents experience this as an expanding *interaction field* that generates rising cognitive and interpretive load. To remain viable participants, they adopt coping strategies that limit attention, participation, and interpretation. When many agents do this, shared interaction rules emerge. When these rules stabilise, alongside the pursuit of reliable need satisfaction and a common purpose, the network takes on the characteristics of an organisation.

Organisational architecture is therefore understood not primarily as a cultural or managerial construct, but as an emergent response to interaction complexity, cognitive limits, and the need to maintain reliable exchanges of satisfiers while minimising contra-satisfiers. This perspective connects network theory, cognitive constraints, and organisational structure into a unified systems explanation.

Keywords: agent networks, organisational emergence, cognitive limits, interaction complexity, systems theory, satisfiers, social structure

1. Agent Networks and the Exchange of Satisfiers

In its simplest form, a network is a set of agents connected by channels through which matter, energy, or information may flow. These agents may be individual people, small groups, organisations, communities, or even nations. All possess needs, or in systems terms, functions that must be sustained for continued viability. The flows between them are therefore not neutral transfers, but exchanges of satisfiers and contra-satisfiers: inputs that either enable or inhibit the performance of those functions. As agents interact, they continually shape one another's capacity to remain viable within their shared environment.

2. From Links to Interaction Fields

With two agents, there is only a single interaction. With three, there are several pairwise exchanges and, more importantly, the possibility that what two agents do with each other affects the third. As numbers increase, agents are no longer responding only to those with whom they directly interact, but to the consequences of what others are doing with each other. The network ceases to be experienced as a mere set of links and becomes, instead, an interaction field in which each agent is exposed to a growing web of direct and indirect effects.
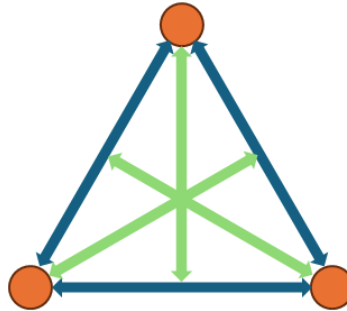
Figure 1. Interaction between two agents.

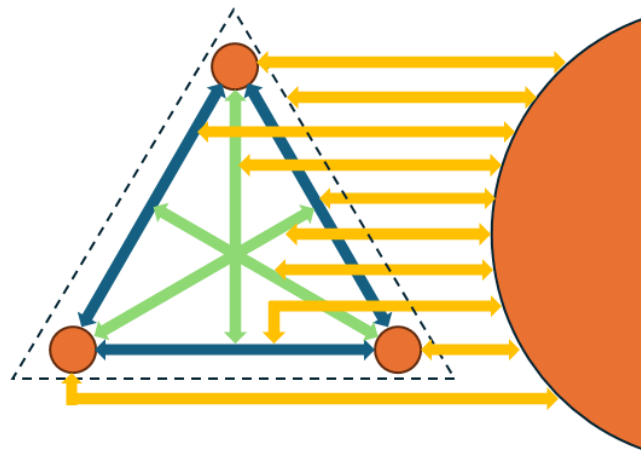Figure 2. All interactions between three agents.

Figure 3. Interactions experienced by any one of four agents.

Figures 1–3 illustrate how a simple network of links is progressively experienced as an interaction field. By the time a group reaches four agents, even when only the effects impinging on a single agent are shown, the pattern of relevant interactions is already markedly more complex than the link structure alone suggests.

3. Why Counting Links Is Not Enough

This shift cannot be understood if we count only links. For **n** agents, the number of pairwise channels grows as **n(n−1)/2**. But each pairwise exchange can generate effects for the remaining **(n−2)** agents, and subgroups of three or more can collectively affect outsiders in ways that cannot be reduced to any single pairwise exchange. Even with four agents, the number of such "interaction-events" quickly exceeds the number of direct links. What emerges are familiar social phenomena: reputation, alliance formation, observation, signalling, inclusion and exclusion pressure, and the need to anticipate how others' relationships may affect one's own position.

Consider a small project meeting. With two people, discussion is straightforward: each responds directly to the other. When a third person joins, the dynamic changes. If two participants agree with each other, the third may feel excluded or pressured. If two disagree, the third may be drawn into a mediating role. Even without speaking, each person must now monitor not only what is said to them, but what others say to each other, and how that may affect their own position.

When a fourth person joins, the situation becomes noticeably more complex. Side agreements may form. Participants may speak with one person "through" another. Individuals begin to lose track of who supports which idea and why. The conversation becomes harder to follow, interruptions increase, and misunderstandings multiply. At this point, someone typically says, "Let's go round the table," or "Can we stick to the agenda?" Without consciously intending it, the group begins to introduce interaction rules to reduce complexity and restore clarity.

The same process is visible in formal committees or boards. In a group of ten or more members, it is impossible for everyone to speak freely in an unstructured manner without confusion and frustration. As a result, such groups invariably develop chairs, agendas, speaking orders, minutes, and voting procedures. Subcommittees are formed so that not everyone must interact with everyone else. Members often specialise into roles: some speak frequently, others observe, some focus on detail while others consider the broader picture.

These arrangements are not primarily cultural preferences or matters of tradition. They are practical responses to the interaction load experienced by participants. The rules and roles allow the group to function by simplifying the interaction field and ensuring that useful contributions (satisfiers) are more reliably exchanged while disruptive interactions (contra-satisfiers) are reduced.

4. Interaction Load and Cognitive Limits

Agents embedded in such interaction fields must continually track exchanges, infer intentions, anticipate consequences, and protect the satisfaction of their own needs. Beyond a certain point, this interaction load exceeds what individuals can comfortably manage. The limitation is not merely social preference or time availability, but cognitive and interpretive capacity. This connects directly with the work of Robin Dunbar (1992), who demonstrated cognitive limits on the number of meaningful social relationships humans can sustain, and with Herbert Simon's (1947) insight that organisations exist because individual rationality is bounded. What has been less clearly articulated is *why* interaction complexity grows so rapidly as group size increases, and how this leads directly to organisational form.

5. Coping Strategies Adopted by Agents

When interaction load approaches or exceeds cognitive capacity, agents cannot remain fully open and responsive to all aspects of the interaction field. They therefore adopt coping strategies. These include focusing attention only on the most relevant ties, adopting consistent roles such as mediator or observer, using heuristics that simplify judgements about others, aligning with coalitions to reduce interpretive burden, withdrawing from interactions that generate excessive strain, limiting the number of active contacts, and preferring interactions to occur sequentially rather than simultaneously. Such behaviours are not necessarily deliberate; they arise naturally as adaptive responses to overload.

6. From Coping Strategies to Interaction Rules

When many agents adopt similar coping strategies, these behaviours begin to stabilise into shared expectations about how interaction should occur. Turn-taking becomes normal. Agendas are introduced to limit topic spread. Moderators or chairs appear to manage the flow of discussion. Subgroups appoint representatives so that not everyone must interact with everyone else. Norms develop regarding what should be said publicly or privately. Boundaries are drawn around who participates. Decision procedures are adopted to prevent endless

negotiation. Roles become differentiated so that attention, coordination, and record-keeping are externalised from the group as a whole.

7. The Emergence of Organisational Structure

At this point, the network of agents changes character. It is no longer simply a collection of interacting individuals. It becomes an organisation: a stabilised agent network whose rules, roles, and structures exist primarily to keep interaction complexity within cognitively manageable limits. Committees, hierarchies, procedures, and governance mechanisms are not arbitrary cultural inventions. They are complexity-management devices that arise naturally from the need to make large interaction fields navigable.

8. Related Work Across Disciplines

Elements of this picture have been recognised across several disciplines. Over a century ago, Georg Simmel (1908) showed that the transition from two to three people introduces coalitions, mediation, and exclusion, demonstrating that group dynamics cannot be reduced to pairs. Network theorists such as Mark Granovetter (1973), Albert-László Barabási (2002), and Duncan Watts (1999) have described how links form and scale, revealing hubs, clusters, and small-world effects. Organisational scholars such as James March and Johan Olsen (1976) have analysed the roles of agendas, procedures, and institutional rules. Each of these contributions illuminates part of the picture. What has been missing is a single causal thread linking network growth, interaction consequences, cognitive limits, coping behaviour, and the emergence of organisational architecture.

9. Organisations as Responses to Interaction Overload

Seen in this light, organisations are not primarily defined by their goals, authority structures, or cultural norms, but by their function as stabilised responses to the combinatorial growth of interaction consequences in agent networks. Organisational architecture is the emergent solution to the problem of interaction overload.

10. Purpose, Satisfiers, and Organisational Stability

At the same time, it is not only the simplification and structuring of interactions that drives the emergence of organisation. A common purpose is also necessary. Agents seek arrangements in which the exchange of satisfiers is reliable and the production of contra-satisfiers is minimised in pursuit of that purpose. Stable rules, roles, and procedures therefore serve a dual function: they reduce interaction complexity to cognitively manageable levels, and they create conditions under which need-satisfying exchanges are more predictable and disruptive exchanges less likely to occur.

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Appendix A – Needs, Satisfiers, Contra-Satisfiers, and Examples Across Scales

The terminology of *needs* and *satisfiers* draws on established work in human development and motivational theory. Manfred Max-Neef (1991) distinguished between fundamental human needs and the culturally variable *satisfiers* through which those needs are met. Earlier, Abraham Maslow (1943) and later Clayton Alderfer (1969) described structured sets of human needs (physiological, social, developmental), showing that behaviour is strongly shaped by the pursuit of conditions necessary for continued functioning and growth. Here, these ideas are expressed in systems terms: needs are the conditions required for a system's viability, satisfiers are inputs that enable those conditions, and contra-satisfiers are inputs that undermine them.

The terms *needs*, *satisfiers*, and *contra-satisfiers* apply equally to agents at very different scales.

For an individual person, needs include physiological survival, social belonging, and the ability to act effectively in the world. Food, income, reliable information, trust, and social support act as satisfiers. Stress, misinformation, hostility, exclusion, or resource deprivation act as contra-satisfiers because they undermine the person's ability to function.

For a team or small group, needs include coordination, shared understanding, trust, and access to resources. Clear communication, agreed goals, mutual support, and access to tools and information are satisfiers. Conflicting instructions, interpersonal conflict, ambiguity, and resource shortages are contra-satisfiers.

For an organisation, needs include stability, effective information flow, reliable role performance, and access to material and human resources. Procedures, governance structures, training, funding, and institutional memory act as satisfiers. Bureaucratic confusion, unclear authority, misinformation, staff turnover, and internal conflict act as contra-satisfiers.

For a society or nation, needs include social cohesion, economic viability, governance, security, and shared norms. Infrastructure, law, education, trade, and trustworthy institutions act as satisfiers. Corruption, disinformation, conflict, inequality, and institutional breakdown act as contra-satisfiers.

Across all these scales, agents interact through exchanges that either enhance or degrade the capacity of others to meet their needs. Organisational structures can therefore be understood not only as ways of simplifying interactions, but as arrangements that increase the reliability of satisfiers and reduce exposure to contra-satisfiers.

Appendix B – Examples of the Interaction Coping Strategies Adopted by Individual Agents

- **Selective Attention / Prioritisation** — Agents focus only on the interactions most relevant to their own needs or goals, ignoring many others in the interaction field.
- **Role Adoption** — Agents simplify decision-making by adopting a consistent posture (e.g., mediator, technical expert, critic, supporter), reducing the need to evaluate each situation afresh.
- **Heuristics and Simplified Judgements** — Agents compress complexity into coarse categories (e.g., trust/distrust, ally/opponent), enabling faster but less nuanced responses.
- **Observation Rather Than Participation** — Agents reduce outgoing commitments by watching interactions rather than actively engaging in them, remaining informationally coupled while limiting exposure.
- **Coalition Anchoring** — Agents align themselves with a subgroup, allowing them to rely on shared interpretations and reducing the need to independently process the entire interaction field.
- **Avoidance or Withdrawal** — Agents limit participation in interactions that generate excessive contra-satisfiers or cognitive strain.
- **Reduction of Active Contacts** — Agents restrict the number of people with whom they directly interact, even within a larger group.
- **Serialising Interactions** — Agents prefer interactions to occur one at a time rather than concurrently, reducing simultaneous processing demands.

These behaviours reduce cognitive load for individual agents.

Appendix C – Examples of the Interaction Rules Adopted by Groups of Agents

- **Turn-Taking Protocols (Serialisation)** — Only one agent speaks or acts at a time. This reduces concurrent interaction demands and allows participants to process exchanges sequentially.
- **Agenda Setting** — Interactions are constrained to predefined topics, preventing the interaction field from expanding unpredictably.
- **Moderation / Facilitation Roles** — A designated agent manages the flow of interaction, externalising the burden of attention control from the group.
- **Representation (Many-to-One Compression)** — Subgroups appoint representatives or spokespeople, reducing the number of active participants in direct exchanges.
- **Norms of Disclosure** — Shared expectations about what should be communicated publicly versus privately, limiting informational noise and ambiguity.
- **Boundary Rules (Membership Constraints)** — Clear rules about who is included in the interaction space, directly limiting the number of agents contributing to the interaction field.
- **Decision Procedures** — Voting, consensus rules, escalation paths, or authority structures that prevent endless open-ended negotiation.
- **Role Differentiation** — Stable assignment of functions (e.g., chair, secretary, expert, observer) that reduce the need for every agent to process every aspect of the interaction.

These reduce cognitive load for the group of agents.

Appendix D – Definitions

D1 — Needs (systems sense)
The set of conditions that must be met for a system to maintain its viability, stability, and capacity to perform its functions within its environment.

D2 — Agent Interaction
A reciprocal exchange between two agents involving satisfiers or contra-satisfiers in the form of matter, energy, or information.

D3 — Satisfier
Any input of matter, energy, or information that contributes to meeting a system's needs by enabling, sustaining, or enhancing its functions.

D4 — Contra-Satisfier
Any input of matter, energy, or information that undermines a system's needs by inhibiting, disrupting, or degrading its functions.

D5 — Pairwise Interaction Channel
A persistent relational pathway through which agent interactions may occur.

D6 — Third-Party Interaction Effect
An effect on a non-participating agent arising from a pairwise interaction between others.

D7 — Polyadic Interaction Effect
An effect on an agent arising from the collective dynamics of a subgroup of others.

D8 — Interaction Field
The total set of direct and indirect interaction effects to which an agent is exposed.

D9 — Interaction Load
The cognitive and interpretive burden placed on an agent by the interaction field.

D10 — Interaction Coping Strategy
An adaptation adopted to reduce interaction load.

D11 — Interaction Rule
A shared constraint that structures or limits interactions.

Appendix E – Propositions

P1 — Growth of Pairwise Channels
In a group of **n** agents, pairwise channels scale as **$n(n-1)/2$**.

P2 — Growth of Third-Party Effects
Each pair generates effects on **$(n-2)$** outsiders.

P3 — Growth of Polyadic Effects
Subgroups of **k** agents generate effects on **$(n-k)$** others, scaling as **$C(n,k)(n-k)$**.

P4 — Interaction Load Escalation
Interaction consequences grow faster than direct links, escalating load.

P5 — Cognitive Load Threshold
A point is reached where load exceeds cognitive capacity.

P6 — Emergence of Coping Strategies

Agents reduce effective complexity through adaptive behaviours.

P7 — Emergence of Interaction Rules

Shared constraints arise when many agents experience overload.

P8 — Emergence of Organisational Structure

When rules stabilise, the network becomes an organisation.

P9 — Functional Role Differentiation

Roles externalise attention and coordination functions.

P10 — Organisation as Stabilised Network

An organisation is a network whose interaction field is kept within manageable limits by rules and roles.

P11 — Conditions for Organisational Emergence

Organisational structure emerges when three conditions are simultaneously present:

1. The interaction field of agents exceeds individual cognitive capacity, requiring the stabilisation of interaction rules and roles;

2. Agents experience a need for reliable exchange of satisfiers and reduced exposure to contra-satisfiers;

3. Agents share a common purpose toward which their interactions are directed.

Only when all three conditions are met does a network of agents stabilise into an organisation rather than remaining a loosely structured group.