Variety Dynamics:

Because Systems Science Cannot Address Most Real-World Systems Problems

Presentation 6 November 2025
International Society for the System Sciences Mini-Symposium

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Introduction

- Introduction
- Systems theory considerations
- Variety Dynamics
- Brief case study examples of Variety Dynamics
- Way forward for Variety Dynamics

Variety Dynamics is a new field of Systems Thinking developed over the last 25 years by Dr Terence Love and Prof Dr Trudi Cooper.

Introducing Variety Dynamics

- Variety Dynamics is new Systems approach (25 year History)
- Focus is on variety and locus of power and control
- Not causal
- Addresses complex and hyper-complex real –world situations outside reach of conventional systems methods
- Uses Axioms as foundation
- Fast, easy to use, does not require expertise
- New mathematics of variety space (Set theory, topology, higher category theory, higher topos theory)
- Comports well with AI
- Foundational to Systems methods in general (like set theory is foundational to functional analysis)
- Other Systems methods are instances within Variety Dynamics

Variety Dynamics outputs to date

- 95 publications and presentations related to Variety Dynamics
- More than 55 axioms
- Practical real world case studies
- Mathematics conceptual development
- Website https://variety-dynamics.org
- Ongoing research and applications

ACT 1

The Systems PROBLEM

- Centrality of prediction in Systems Science and Systems theories and methods
- Hyper-complex systems/situations
- Real world situations that conventional systems methods don't apply
- Love's 2 feedback loop limitation law/axiom
- Implications of 2 feedback loop axiom
- Improved definitions of 5 types of system
- COVID-19 example
- Limitations of systems theories and research

Prediction is the primary purpose of Systems Theories and Practices

- All systems methods ultimately serve decision-making
- All decision-making requires prediction of consequences
- Without prediction capability, you cannot justify choice between alternatives, design interventions, evaluate options, or justify actions
- Understanding, communication, intervention design all serve decision-making, which requires prediction

Hyper-complex systems/ situations

The definition of hyper-complex situations is that they do not satisfy the assumptions required of conventional systems methods, e.g.,

- System and subsystem boundaries exist and are stable
- Systems don't overlap/subsystems don’t overlap
- System elements stay within systems
- Purpose, ownership, and functions are stable
- System stays the same system
- Analysis is by causality and causal prediction of consequences of interventions

Examples of hyper-complex situations

- Wars - US/Afghanistan, Russia/Ukraine/Europe/US and similar
- Epidemics (COVID-19) with associated disasters and social breakdowns
- Middle East (Saudi, Iran, Israel, Lebanon, Palestine, US, Russia)
- Climate change control and politics
- Local government planning and corruption
- Managing money laundering in UK political/legal/elite systesm
- Health systems in impoverished countries with low levels of governance or conflicted governance
- State capture by multiple elites
- Sectarianism in India
- Large-scale international business competition
- Improving the government of countries captured by criminal cartels or industry lobbies
- Any system with large number of feedback loops in which the systems structure and ownerships of system elements changes
- International political tension between elites (wars by any means)
- National systems subject to hidden control via psyops or similar

Hyper-complex situation characteristics

- System behaviours, purpose, ownerships, subsystems, subsystem relationships and control mechanisms vary continuously.
- System boundary(ies) do not separate system elements of interest from each other and from environment
- System boundary(ies) not static and not necessarily always owned and controlled by system owner
- Sub-systems are not static in ownership, purpose, roles or relationships
- Control is dynamic and exerted through a variety of changing subsystems and factors; some outside the system
- Multiple feedback loops exist with changing structure, dynamics, purposes, causal relations, existence and ownership
- Coercive situations involving multiple asymmetric power relations unaligned to subsystems
- Control and system behaviours operate outside of the variables being addressed
- Parts of system and environment are chaotic
- Most of the situation and its causal relations are unknown

Love's 2 Feedback Loop Limitation Law

Love's 2 Feedback Loop Limitation Law (2005) :

Individuals cannot mentally predict the behaviour and/or consequences of situations/systems whose behaviour is shaped by two or more interconnected feedback loops.

Implications

- This applies to groups as well as individuals
- If individuals are asked to mentally make decisions and strategies for situations with two or more feedback loops they will produce wrong answers (yet believe they are correct)
- Participatory methods (soft systems methodology, interactive planning, shared mental models etc.) do NOT solve this fundamental limitation.
- Reconceiving situations as having less than two feedback loops (e.g. converting them to linear systems) results in faulty predictions of outcomes
- Two feedback loops provides a better definition of 'complex'

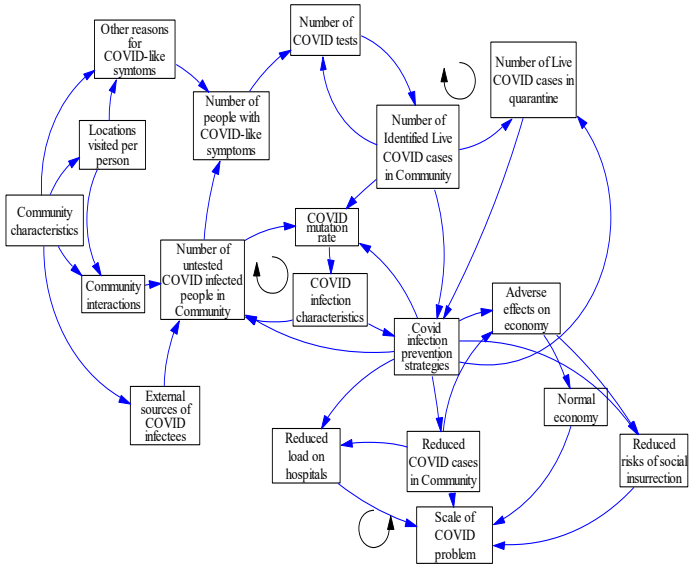
Weak definitions of System Types

- Existing definitions of system types are problematic as they do not exactly specify, e.g.
  - Cynefin categories
  - Boulding's 9 level hierarchy
  - Open/closed/isolated
  - Physical/abstract
  - Deterministic /probabilistic
  - Stacey matrix
  - Purpose/goal classifications (Gharajedagi)
  - CAS
  - IS classification
  - Checkland's System Classes

System Category Definitions

The above leads to coherent definitions of 5 system categories

- **Simple systems:** Few variables and relationships, maximum 1 feedback loop, follows systems thinking assumptions
- **Complicated systems:** Many variables and relationships, maximum 1 feedback loop, follows systems thinking assumptions
- **COMPLEX systems:** Any number of variables and relationships, 2+ feedback loops, follows systems thinking assumptions (simulation works but not mental prediction by individuals or groups)
- **HYPER-COMPLEX systems**: Do not follow conventional systems thinking assumptions (hence causal systems methods do not apply)
- **Chaotic systems:** Mathematically unpredictable



COVID-19 example

Conventional Systems methods failed to predict COVID outcomes

- Massive participatory and research processes
- Best Systems and OR experts and extensive deliberation and modelling
- Predictions consistently wrong (lockdown effects, vaccine uptake, economic impacts, social responses) and had unpredicted second/third order effects

Why did Systems methods for COVID-19 fail?

- COVID situation was ***hyper-complex*** and does not fulfil requirements of conventional causal Systems approaches
- Cognitive limitation failure - mental prediction impossible over **2 or more feedback loops**

Conclusions

Conclusions: *Traditional systems methods do not in general apply for important-real world situations.*

- Systems assumptions in general don't hold for real-world situations
- Even IF systems assumptions hold, mental prediction fails for situations with 2 or more feedback loops (Love's 2-Feedback Loop Limitation Law)

ACT 2

SOLUTION

Variety Dynamics

- **Variety Dynamics** is non-causal, variety-based analysis linking variety distributions and their dynamics to the locus of power and control
- **Core concepts:** varieties (possibilities), variety distributions and dynamics, locus of power/control, structures, transaction costs
- **Central Variety Dynamics insight:** Managing the locus of power and control is the key issue for decision-making in complex and hyper-complex situations. T
- **Axiom-based:** Characteristics of different complex and hyper-complex situations are identified, and practical decision-making strategies revealed via axioms and variety mapping rather than causal modelling.
- **Mathematics:** Variety Dynamics is represented in set theory, topology, higher category theory, higher topos theory rather than causal functional analysis.
- **Note:** Variety Dynamics has foundational relation to causal Systems theories in the same way Set/Category/Topos theories are foundational to functional analysis.

Core Concepts of Variety Dynamics

Core Concepts of Variety Dynamics include:

- Non-causal, variety-based thinking about changing the locus of power and control through modifying variety distributions
- Varieties are potential options, counterfactual possibilities, possible states
- Variety distributions are collections of varieties in variety space
- Locus of power and control is fundamentally shaped by dynamic distribution of variety
- Focus is on managing the locus of power and control by modification of variety distributions
- Decision guidance is based on axioms (rather than retrospective, causally-based prediction of consequences)

Practical Benefits

Variety Dynamics has the following key practical benefits:

- Decision making by variety dynamics to control the locus of power is effective, faster, valid, offers more insights and is within human cognitive limits.
- Decision-making is based on changing the locus of power NOT identifying causal consequences of decisions
- Provides very rapid development of understanding complex and hyper complex situations and identifying appropriate decisions (minutes rather than months)
- Analysis is via variety distributions and dynamics NOT causality and applies validly to both complex and hyper-complex situations
- Is easy to use because axioms and variety mapping quickly provide insight, guidance and leverage for decisions
- Does not require high levels of systems expertise or mathematics
- Variety Dynamics is based on axioms rather than functional analysis
- Working with variety distributions and power/control locus via axioms is straightforward where causally-base analysis is not
- Variety Dynamics is easily supported by AI analysis
- Variety Dynamics subsumes and is foundational to conventional Systems Methods
- Additionally, for merely complex or simple problems, Variety Dynamics identifies issues and solutions outside what conventional systems thinking methods can provide.

Variety Dynamics Axioms

Variety Dynamics is based on over 50 axioms, supported by case studies.

Early Variety Dynamics axioms were extensions to Ashby's Law of Requisite Variety.

The role of Variety Dynamics also extends beyond Systems into other fields to address problems for which causal analyses are not well suited. This is under development.

Axiom 1

Axiom 1: Foundational axiom of variety and control

For complex and hyper-complex systems involving multiple constituencies in which the distribution of variety generation and control variety is uneven across the system at any one time, then the differing distributions and dynamics of generated and controlling variety result in a structural basis for differing amounts of power and hegemonic control over the structure, evolution and distribution of benefits and costs of the system by different constituencies.

This extends Ashby's Law of Requisite Variety into multi-dimensional variety space and multiple domains and disciplines

It applies to socially-constructed power relations, and also to non-animate, virtual, and abstract entities and their relationships.

Axiom 2

Axiom 2: Variety Generation to change locus of power

In complex systems with uneven power distribution, when less powerful constituencies increase the variety that more powerful constituencies must manage, the locus of power moves toward the less powerful.

Examples:

- **Asymmetric conflict:** 9/11 attacks generated security variety (airport screening, freight inspection, intelligence coordination) that consumed massive US resources without overwhelming capacity, reducing American power available for other strategic purposes and changing the locus of power.
- **Labour unions:** Strike threats generate management variety (contingency planning, negotiations, public relations) consuming executive attention even when strikes don't occur, moving the locus of power towards workers and unions.

Axiom 3

Axiom 3: Hierarchical Stable Location of Subsystems

For complex and hyper-complex, layered and hierarchical systems that have multiple possible stable structural states, the structural configuration toward which the system evolves depends on the relative locations of subsystems generating variety and the control subsystems able to regulate overall system variety.

Explanation:

Spatial and hierarchical relationships between variety-generating and variety-controlling subsystems determine which stable configuration a system evolves toward. System evolution is governed by **topology** of variety distribution, not just variety quantities.

Axiom 5

Axiom 5: Variety Control is linked to Transaction Costs

In complex and hypercomplex systems with multiple interacting sources of variety generation and control, the relative effects of different varieties and controls on system behaviour depend on their relative transaction costs.

Explanation:

The transaction costs of deploying different varieties and controls determine which actually shape system evolution, regardless of their nominal magnitude or formal authority.

Low transaction-cost varieties dominate system behaviour because they get deployed frequently. High transaction-cost varieties, though potentially more effective, get deployed rarely or not at all.

Axiom 8

Axiom 8: Systems Incapable of Variety Generation

A system incapable of generating variety is constrained to a fixed, pre-existing possibility space and cannot exhibit evolutionary change, learning, or adaptive transformation.

Explanation

The locus of power and control is not amenable to change through variety modification for,

- Systems that navigate fixed variety spaces dynamically but cannot expand them (planetary orbits, routine processes, algorithmic computation)
- Static systems have fixed variety with no state transitions (catalogues, archives)

Variety Dynamics Foundation to Systems Science Theories and Methods

Variety Dynamics provides a foundational mathematical and theoretical basis for all systems methods

- Prediction is foundational and central to all systems methods
- All activities can be seen as a sequence of choices of options
- Systems methods are essentially concerned with consequences of choices of options (variety) regardless of their focus on causality
- Variety Dynamics provides insights and guidance for the majority of real-world situations (complex and hyper-complex) including those beyond the reach of existing systems methods.
- Mathematically Variety Dynamics represents reality in terms of set, higher category and higher topos theories regarded as foundational to all mathematics and hence all the theories and methods that are dependent on causal functional theories (including Systems theories and methods).
- This indicates
  - Variety Dynamics is central to Systems Science
  - Existing systems methods are special cases within the Variety Dynamics framework
  - Variety Dynamics provides the underlying theoretical foundation of all of Systems Science

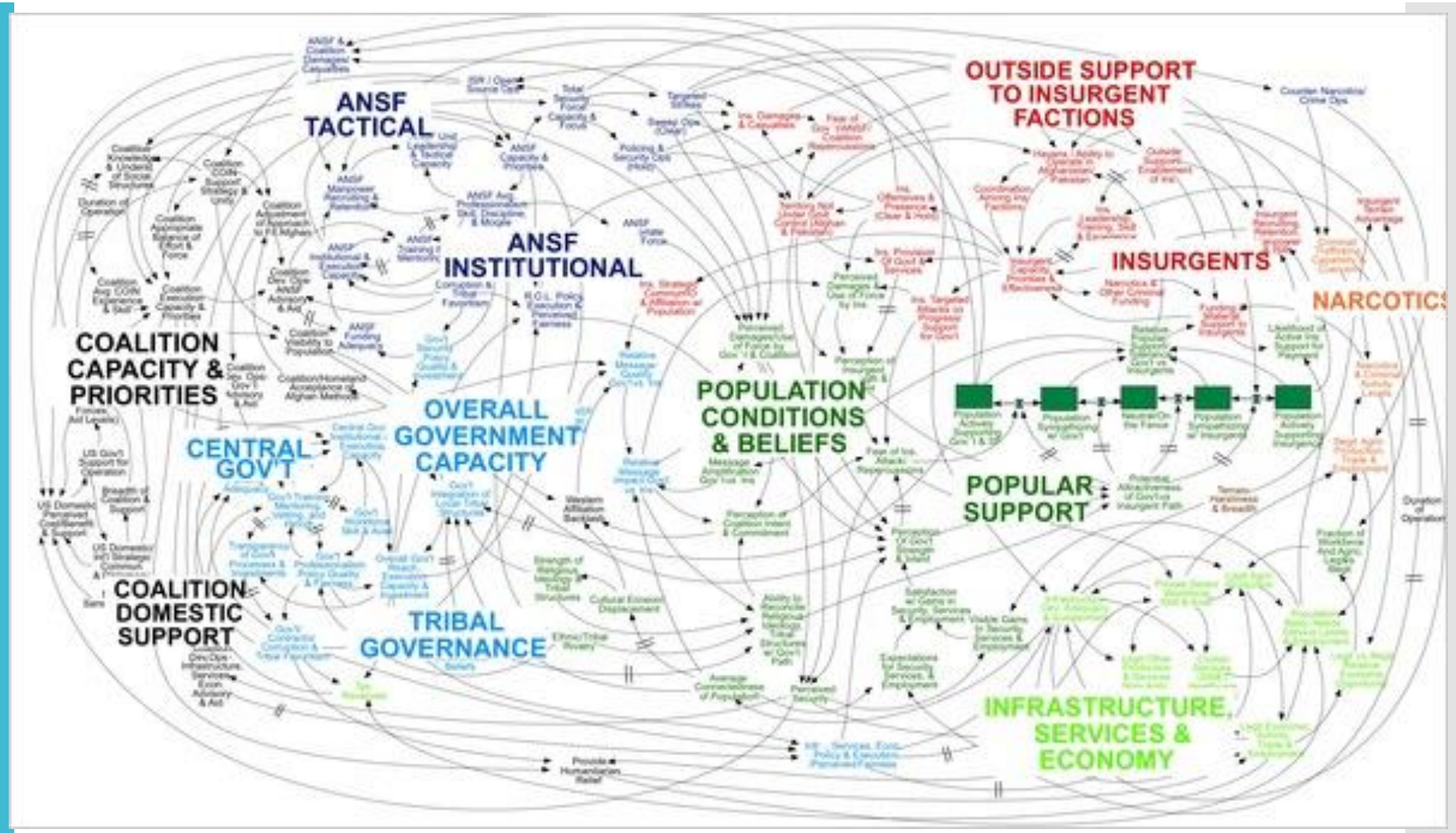
ACT 3

Short Case Studies

- Afghanistan/McChrystal
- Apple/Jobs turnaround
- University managerialism with remedies
- CSH and University Performance Management

Case Study US in Afghanistan – 1

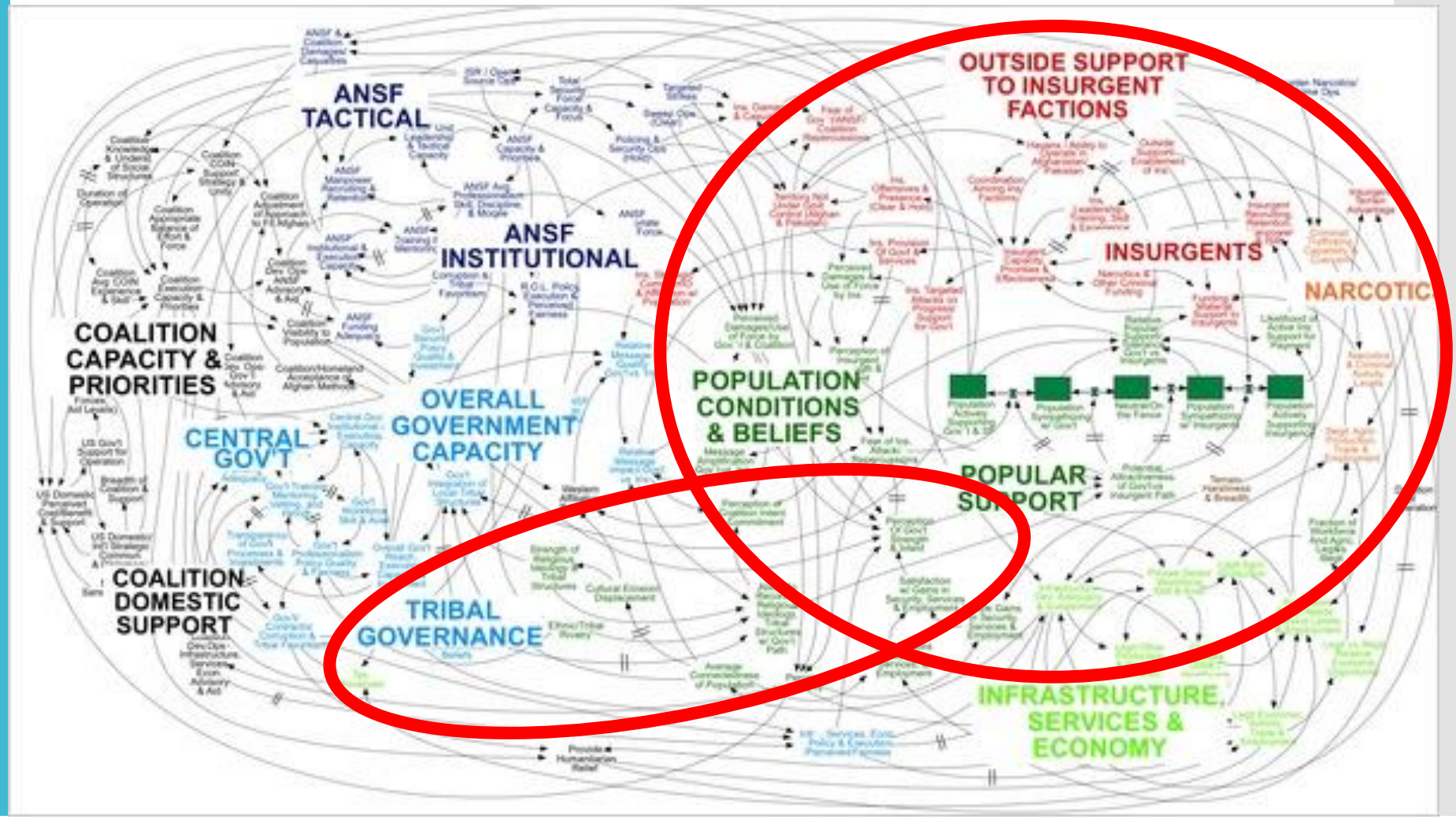
Feedback loops



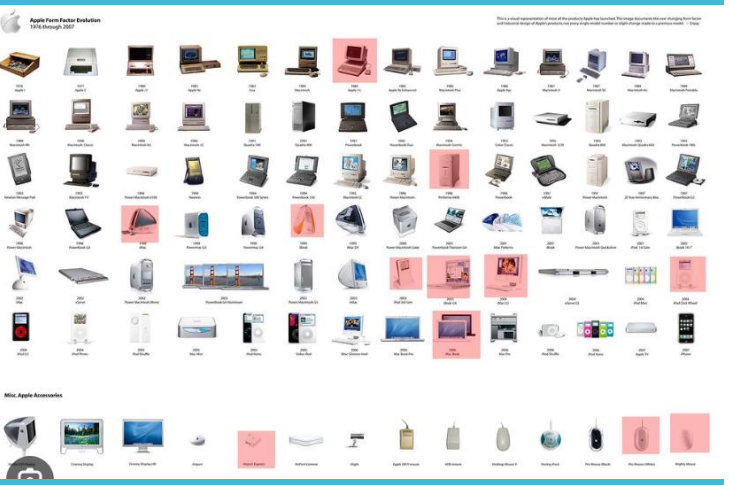
Gen. McChrystal Powerpoint (2009) Afghanistan Stability/COIN Dynamics – Security

Case Study US in Afghanistan – 2

Ability to change Variety Distributions



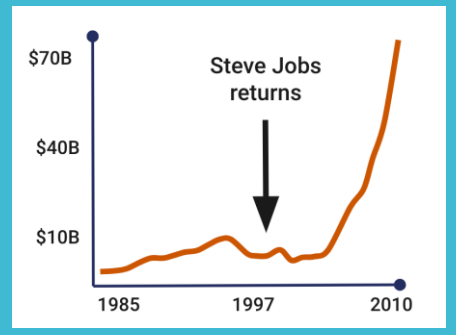
Variety distributions in Gen. McChrystal Powerpoint (2009) Afghanistan Stability/COIN Dynamics – Security



Case Study Apple/Jobs Turnaround -1

Steve Jobs returned to Apple (1997)

- **Apple's Hyper-Complex Problem Situation**
  - Apple near bankruptcy and sales falling
  - Industry dominated by Microsoft/Intel/PC manufacturers
  - Apple many products and cross manufacturing/sales agreements
  - Apple controlled almost nothing → powerless
  - Situation hyper-complex with fluid boundaries, multiple feedback loops, unpredictable dynamics – causal analysis difficult
- **Variety Dynamics analysis** (takes minutes not months) :
  - OS/processor variety low and owned by Intel/Microsoft
  - Hardware variety controlled by others
  - High variety of products and hence high transaction costs
  - Variety distributions of sale and supply chains managed by others



Case Study Apple/Jobs turnaround -2

Jobs' variety interventions to save Apple

Jobs changed locus of power towards Apple by reducing variety owned by others, bringing variety distributions in house:

- Killed Apple clones → stopped others controlling Mac variety
- Reduced products variety→ reduced transaction costs and increased control
- Developed integrated hardware/software thus owning all product variety
- Apple stores being only way to buy Apple products

Changing variety distributions resulted in locus of power changing towards Apple and away from competitors and others.

Image: https://unwrittenbusinessguide.com/how-a-simple-2x2-matrix-saved-the/

Case Study University Managerialism - 1

Variety Dynamics analysis of University Managerialism

- **Reduced variety for academics:** Standardized metrics, KPIs, compliance requirements, audit culture
- **Increased variety for administration:** More reporting, assessment systems, rankings to manage
- **Attenuated variety that might oppose management/government:** Courses in philosophy, history, social sciences, politics etc closed or made expensive (variety attenuated). Reduced ability for unions to resist (variety attenuated)

Result: Locus of power and control shifted TO administrators and government, and away from academics, critical thinkers and citizens.

Effects predicted by Variety Dynamics

- Resources flow to administration and managers' salaries and away from teaching/research
- Academic autonomy and academic power reduced
- Metrics/compliance varieties multiplied and this additional workload placed on academic staff
- Critical thinking and social resistance reduced in society in general. Critical thinking education made unaffordable or inaccessible

Case Study University Managerialism - 2

Variety Dynamics reveals constructive remedies to change locus of power

- Increase decision making power and autonomy of departments/faculties and academics (increase variety controlled by academics and reduce variety controlled by management)
- Reduce administrative metrics, reports (increase variety of administration and reduce variety faced by academics)
- Increase academic autonomy (increase variety of approaches to teaching/research)
- Restore affordable access to critical thinking education (increase variety available to citizens)
- Restore politics, sociology, critical humanities disciplines (increase variety available to citizens and academics)
- Restructure to favour scholarly work over compliance (increase variety available to academics)

Benefits of using Variety Dynamics

- **Variety analysis reveals how the locus of power can be changed** - easy and rapid to see who controls what and who is excluded
- **Exposes variety change as control mechanism** – e.g. government/admin using fees to exclude potential critics, closing courses, adding to academic workloads
- **Provides actionable remedies** –to restructure variety distributions to change locus of power
- Applies easily and fast in hyper-complex situations such as the university problem context - and does so where causal analysis fails or is slow and outside mental predictive ability

Case Study: Performance Management by CSH

Prof Dr. Roelien Goede's development of CSH 2.0 for performance management systems reveals the Variety Dynamics foundation of CSH:

Performance management meetings: managers assess staff against organizational KPAs and staff present work favourably to secure employment and bonuses.

Managers surface variety via CSH:

- *Who ought to be beneficiary?* surfaces variety including. senior management seeking control, staff seeking bonuses, students needing quality teaching, research communities' quality outputs.
- *What ought to be the purpose?* surfaces variety in purposes - accountability, staff development, resource allocation, motivation, compliance demonstration.
- *Who ought to be decision-maker?* surfaces variety across HR systems, line managers, senior leadership, and potentially staff themselves or peer groups.
- *What ought to be the expertise?* surfaces variety in knowledge types - managerial judgment, self-assessment capability, peer evaluation, objective metrics, contextual understanding.
- *Who ought to witness representing affected?* surfaces variety in affected parties - assessed staff, students receiving teaching, research collaborators, administrative colleagues.

CSH and CSH 2.0 reveals the varieties dominating the system (managerial control), the varieties excluded (e.g. collegial development varieties, student learning varieties, research quality varieties), and practical benefits of how variety distributions could change to change the locus of power and control.

Performance management via CSH is **management of varieties of control, benefit, and legitimacy** across stakeholders, NOT a causal mechanism producing improvement.

Case Study Critical System Heuristics

- Variety Dynamics provides perhaps the most obvious theoretical foundation for Critical Systems Heuristics (CSH), making explicit that CSH is fundamentally concerned with identifying and surfacing varieties and variety distributions.
- Though not explicit in CSH's original formulation, the boundary questions of CSH systematically surface different varieties rather than establish causal relationships.
- Attempts to reinterpret CSH in causal terms misunderstand this core function of managing via variety distributions.

ACT 4

WAY FORWARD

- Theoretical developments
- Practical developments
- Education and training programs
- Adoption in Systems Science

Variety Dynamics:

Theoretical issues under current development

Under current development:

- Variety dynamics case studies across wide range of real world domains and problems
- Variety Dynamics axioms (and associated case studies) in :
  - Leadership/organizational styles and variety distributions
  - Culture, law, religion and variety distributions
  - Integration
  - Specific applications: patronage, merit-based, community-based systems, democratic, pseudo-democratic, autocratic etc.
- Ethics of Variety Dynamics
- Standards for use of AI in practical Variety Dynamics analyses and decision guidance
- Mathematical formalization via set theory, cardinality, topology, higher category theory, higher topos theory.
- Reinterpretion of all existing Systems Thinking methods into Variety Dynamics terms

Variety Dynamics Publications and Training

Outputs in development:

- Axioms and case studies in development
- Online Variety Dynamics professional training and certification
- Book on formal theory of Variety Dynamics with axioms and ethical analysis.
- Paper for Transactions of Royal Society (mathematics)
- Book for managers and system decision makers
- Research into use of Variety Dynamics to decompose AI decision making (neural net/transformer analysis)
- Book on using Variety Dynamics in critical events (e.g. disasters, epidemics, warfare
- Paper on ethical dimensions of Variety Dynamics (Prof Dr. Trudi Cooper)

Call for adoption of Variety Dynamics in Systems Science

Call for adoption of Variety Dynamics into Systems Science

Reasons:

- Variety Dynamics offers a new fast and effective method of Systems analysis and decision making for the important real-world complex and hyper-complex situations that existing Systems methods and theories are unable to address.
- Variety Dynamics also offers a role as a theoretical foundation for Systems Science. This parallels how set theory and category theory are foundational to Mathematics especially function – based mathematics such as in used in Systems Science and many systems methods (including the first order logic used in soft systems methods, CSH etc).

Questions

For more information on Variety Dynamics and is application

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