CIS Design—Limits, Laws and Models

Professor Derek K Hitchins,
Cranfield University at
RMCS Shrivenham, UK

Is *this* Command and Control?

"Orchestrated? You start conducting and then some son-of-a-bitch climbs out of the orchestra stalls and comes after you with a bayonet!"

General Norman Schwarzkopf

- Is Command & Control, *in extremis*, controlled aggression through fear, while excess testosterone and adrenalin make the legs tremble and the palms sweat?.

The Design Issue

- Knowing that…
  - war is generally chaotic
  - any future war will be a dynamic patchwork, not a series of set pieces

…The Task is to…

Design a human-centred decision-support system for

- an unknown rôle, in…
- an unknown situation
- in an unknown area
- to address an unknown opponent, or…
- police an alien culture

The Approach

- Suspect traditional design avenues—they have not worked in the past
- Recognise that C^2/CIS are *Open* Systems
- Adopt/reconcile a variety of *Viewpoints*
- Seek suitable models of Open Systems
- Establish a set of design guidelines
- Test by SE/VR=Open Systems modelling?
- Avoid optimization and jumping to "obvious" conclusions—that's what got us into this state!

Viewpoints

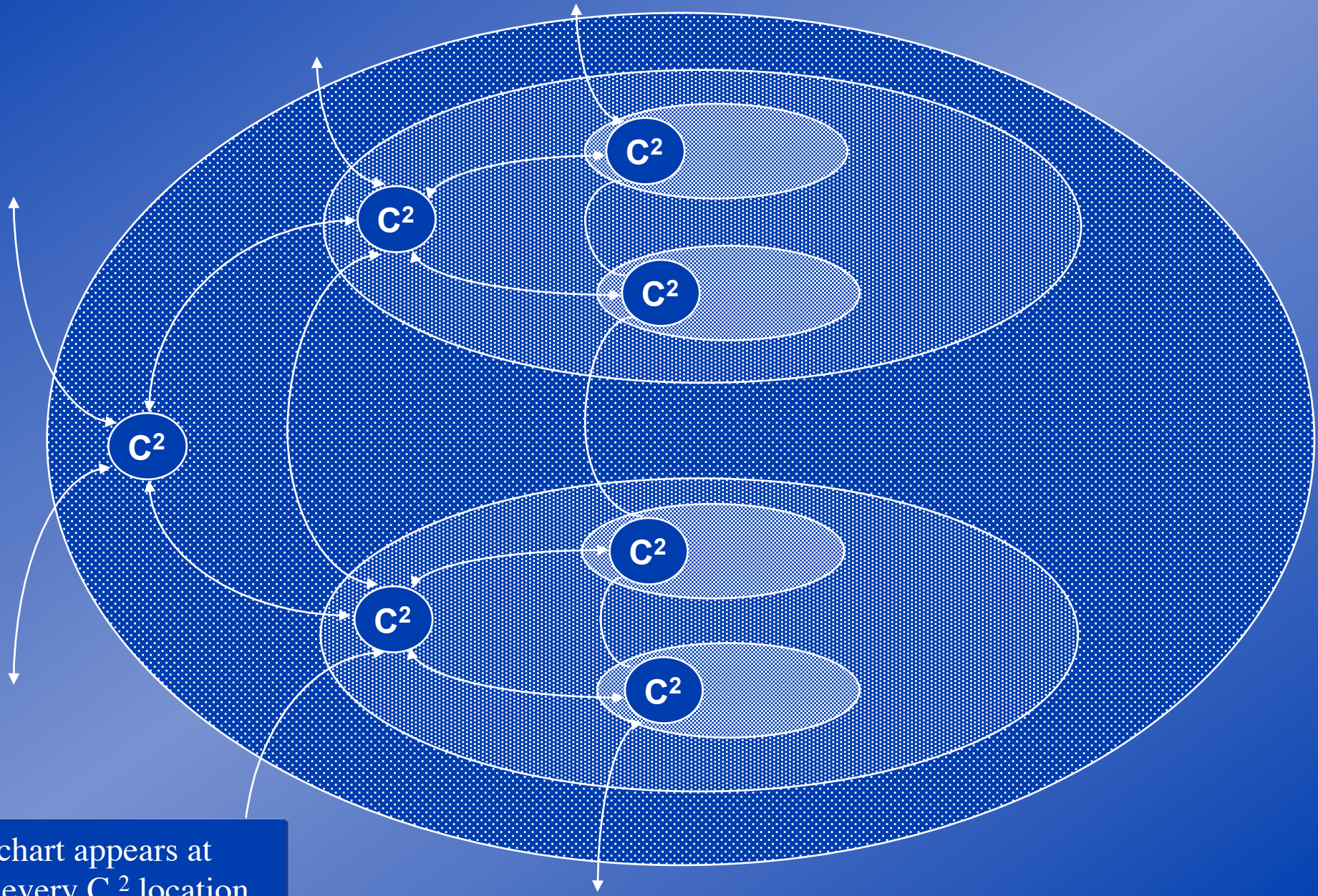
1. Deterministic
   - C^2 is generic, therefore…
   - laws govern the design of CIS
2. Human
   - enemy and environment make situations unpredictable, therefore…
   - only human ingenuity, synergy, training, reactivity can cope
3. Non-linear Dynamical
   - real world is made from open, interacting systems, behaving chaotically, therefore…
   - we must learn to design adaptive systems without clear boundaries

…but, first…

Generic C^2 N^2

Commander	Tasking	Decisions	
Enemy ORBATS, intentions	Intelligence	Enemy ORBATS, intentions	Needs
Operations Plans	Operations Plans	Operations	Needs, priorities
	Constraints	Constraints	Logistics

Fractal C^2

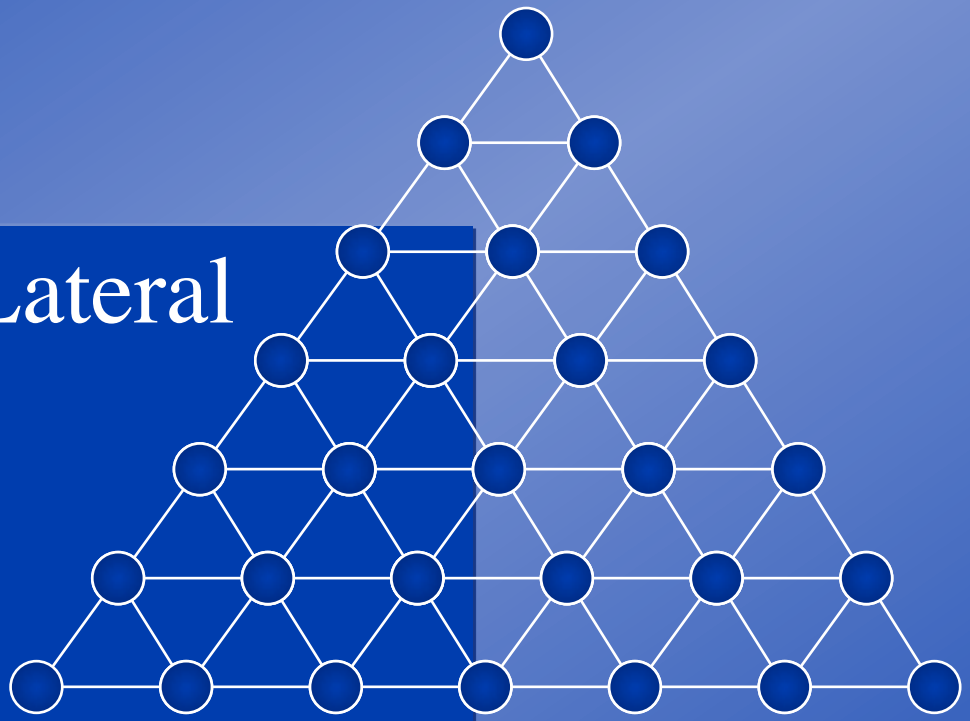


N.B. N^2 chart appears at each and every C^2 location

1. Deterministic Viewpoint

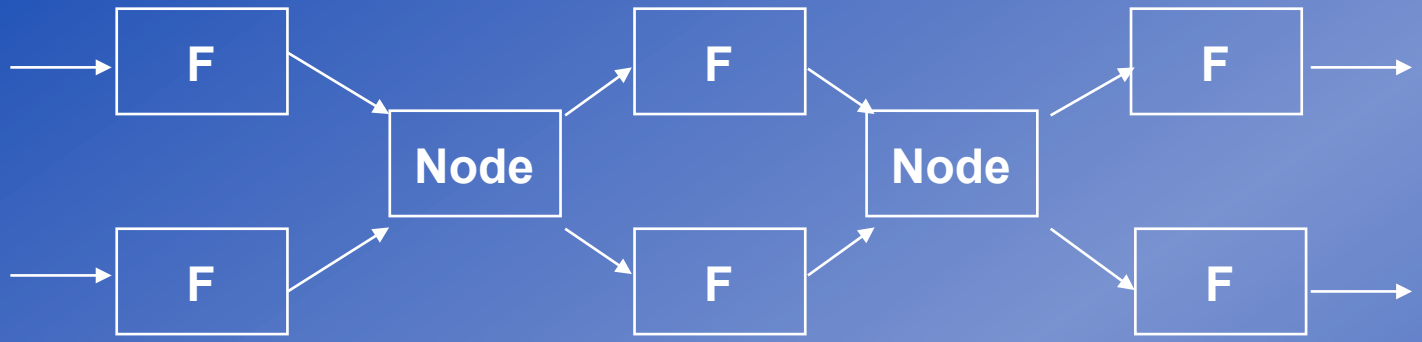
- From "A General Theory of Command and Control"
- Assumes an ideal model
  - perfect pyramidal hierarchy
  - people behave similarly, consistently
- Offers a series of Benchmarks for structure, organization, communications capacity

Hitchins' C^2 "Pyramid Laws"



- C^2 Law of Diminishing Lateral Communication
- C^2 Law of Vertical Data Compression
- Decision Rate Invariance
- Infrastructure is minimized by symmetrical partitioning

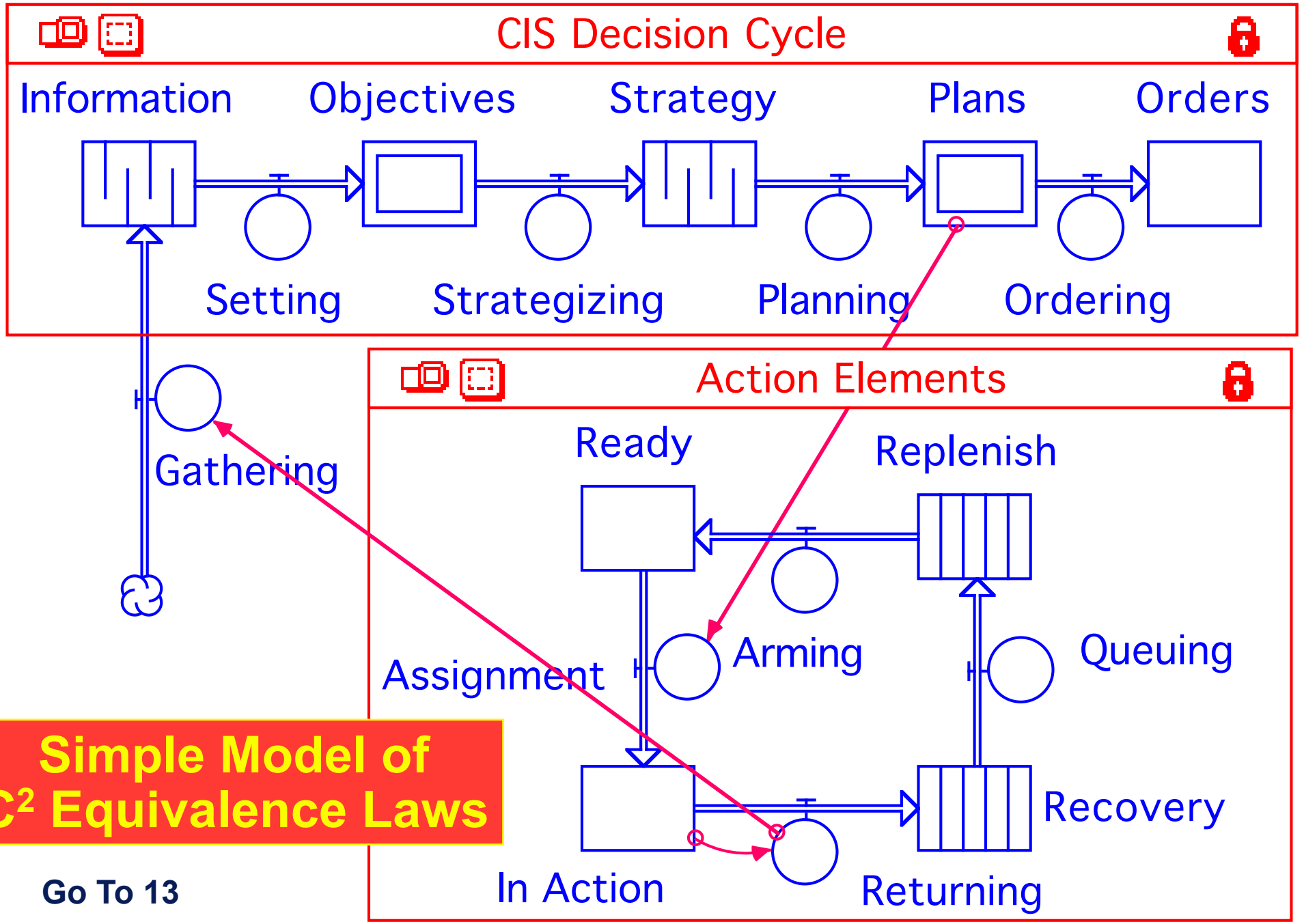
C^2 Law of Survivability



Physical/Functional Architecture

F = function

- Functional survivability is inverse to the number of singular functional architecture nodes, and to the degree of their exposure


CIS Decision Cycle
Information
Objectives
Strategy
Plans
Orders
Setting
Strategizing
Planning
Ordering
Gathering
Action Elements
Ready
Replenish
Arming
Queuing
Assignment
Recovery
In Action
Returning
Simple Model of
C² Equivalence Laws
Go To 13

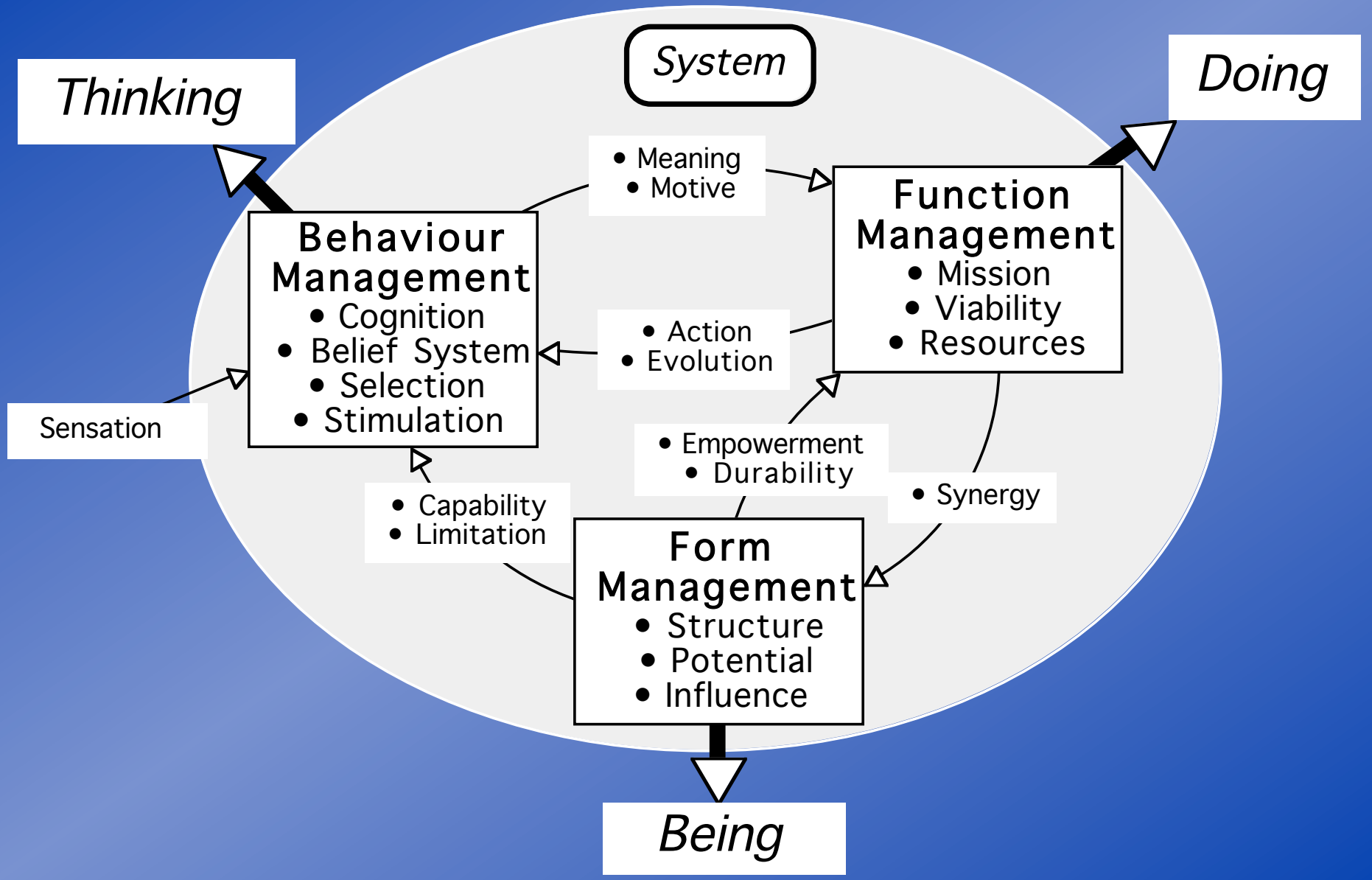
2. Human Viewpoint

- From "Putting Systems to Work"* and "Getting to Grips with Complexity"**

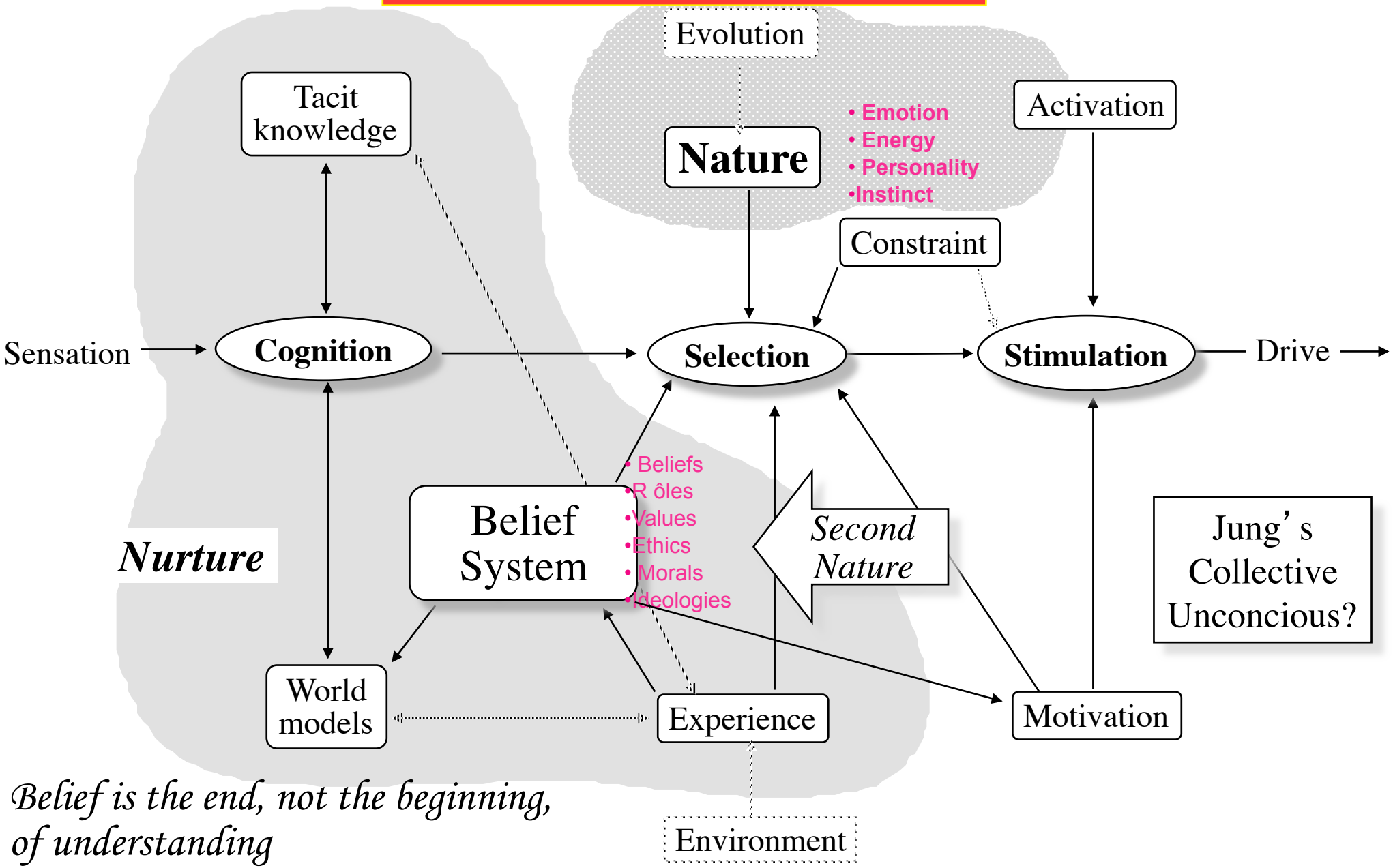
* John Wiley and Sons, Chichester, UK, 1992

**To be published shortly

The Generic Reference Model



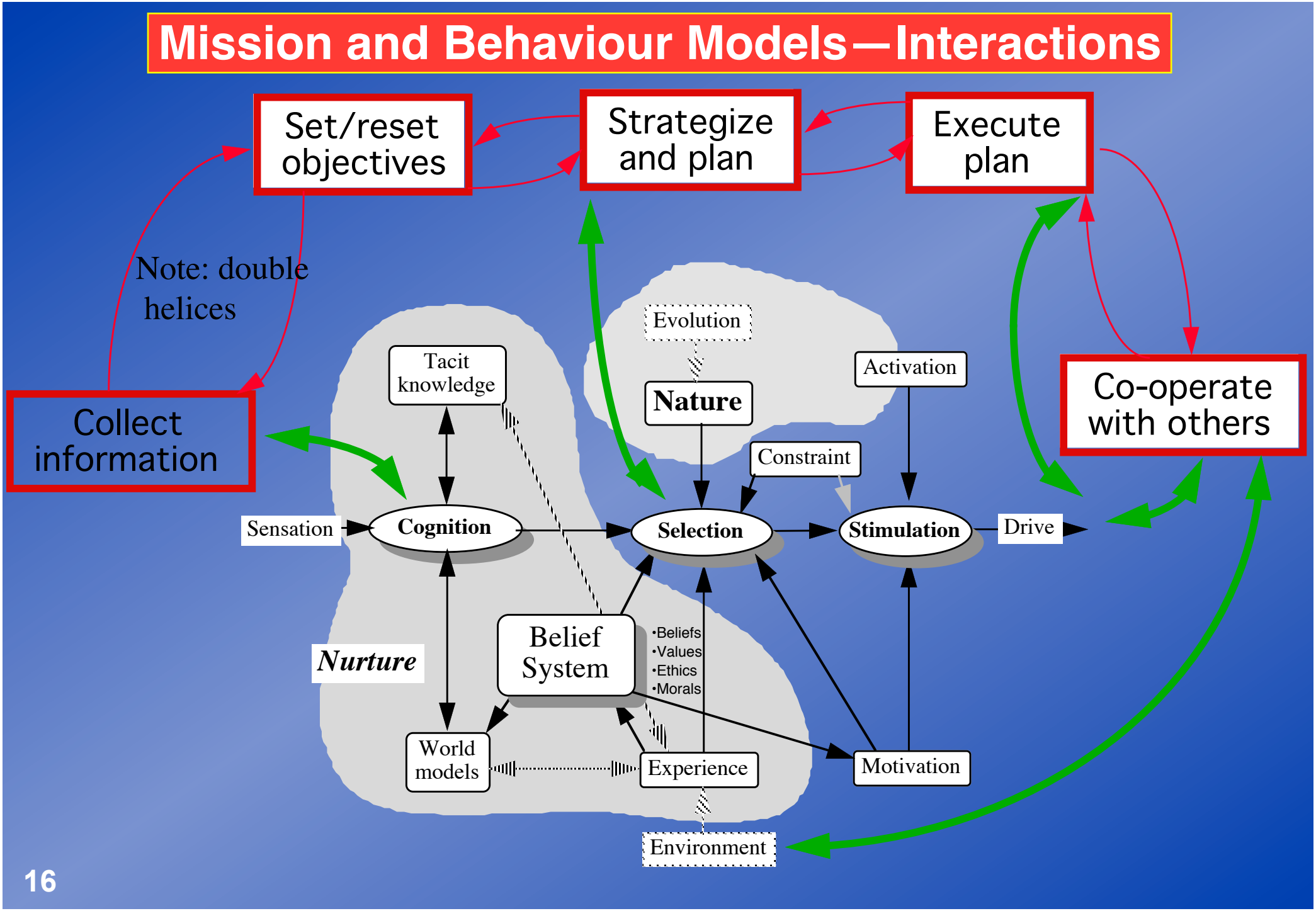
Behaviour Management

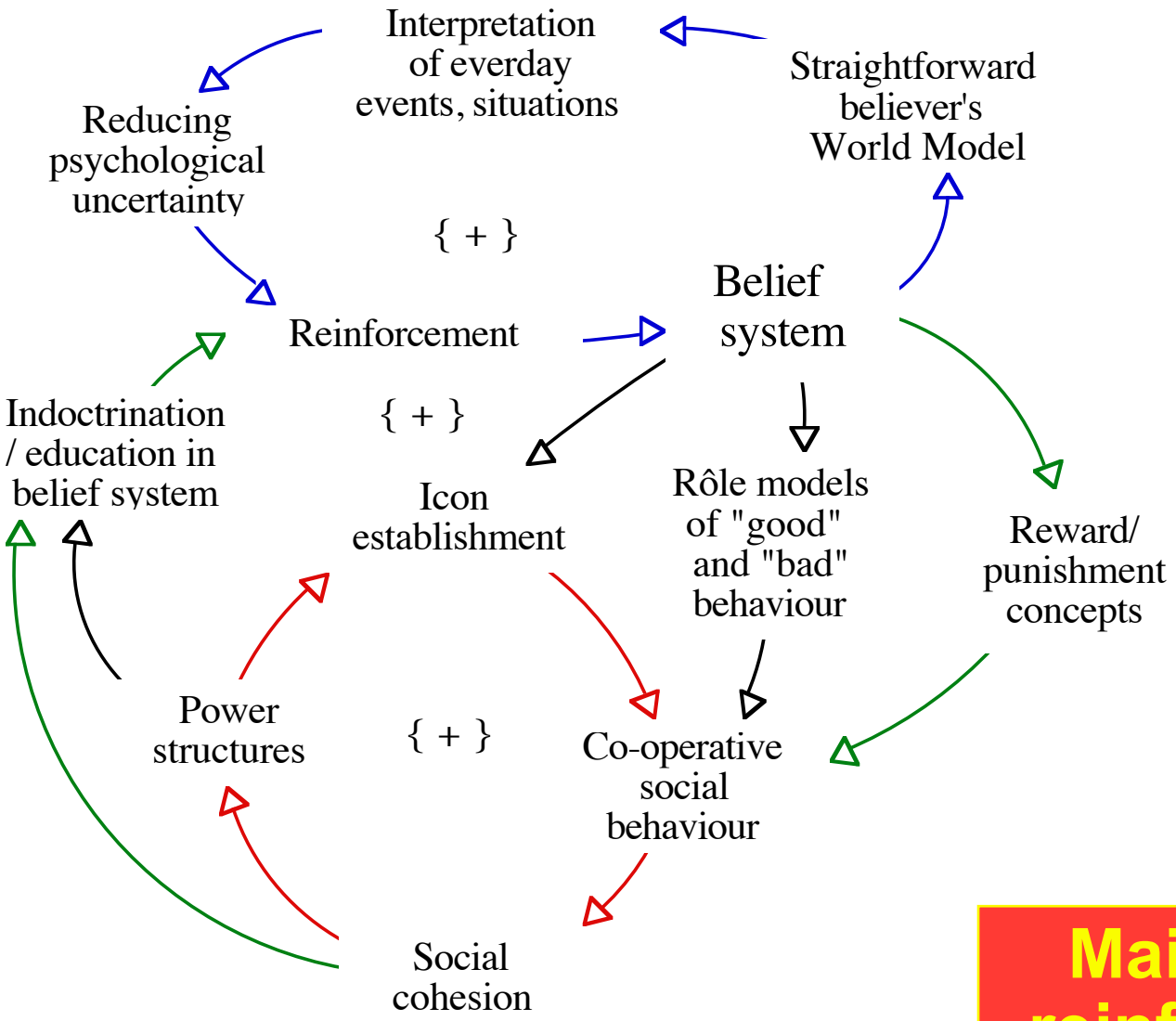


Belief is the end, not the beginning, of understanding

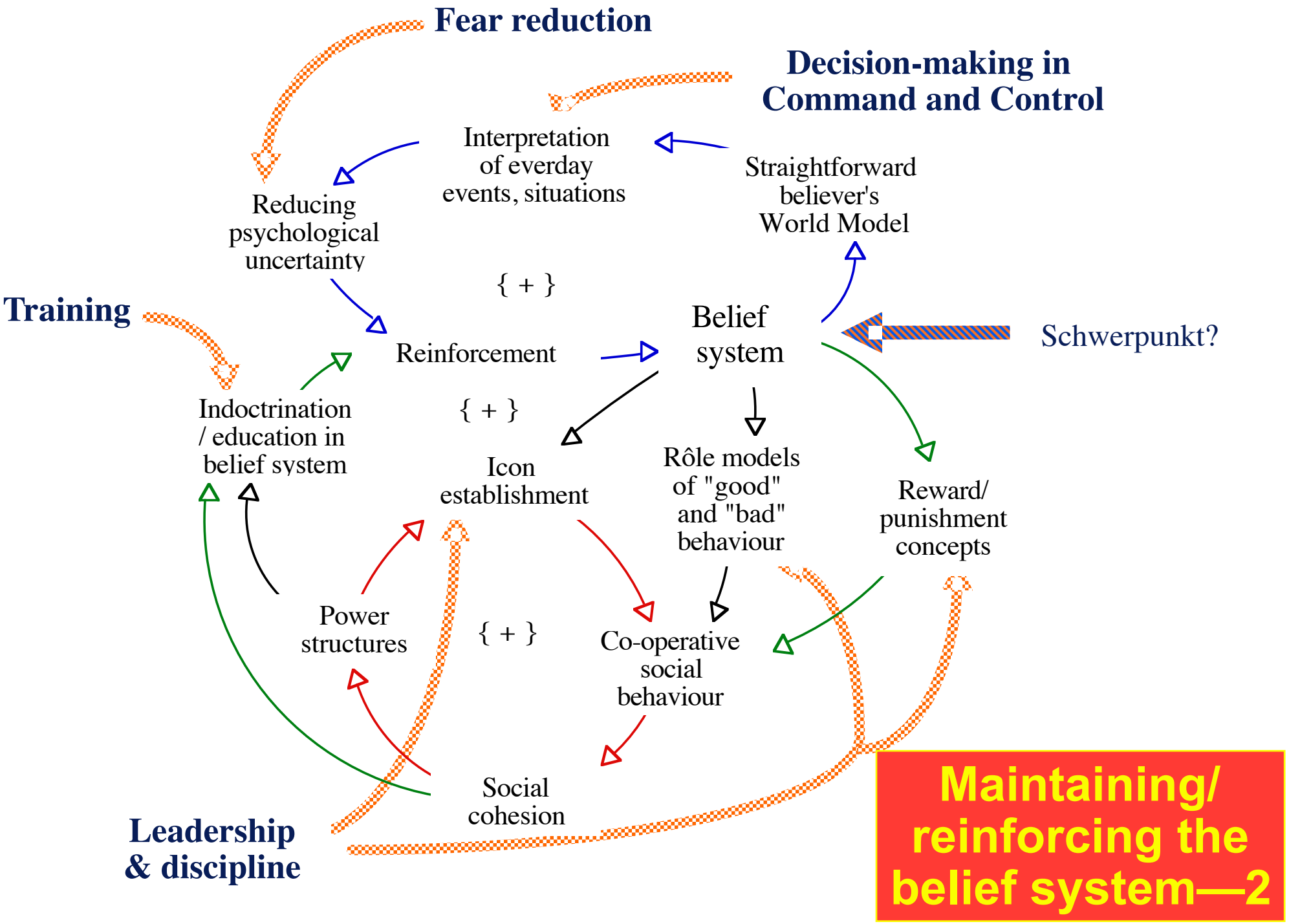
Goethe

Mission and Behaviour Models—Interactions

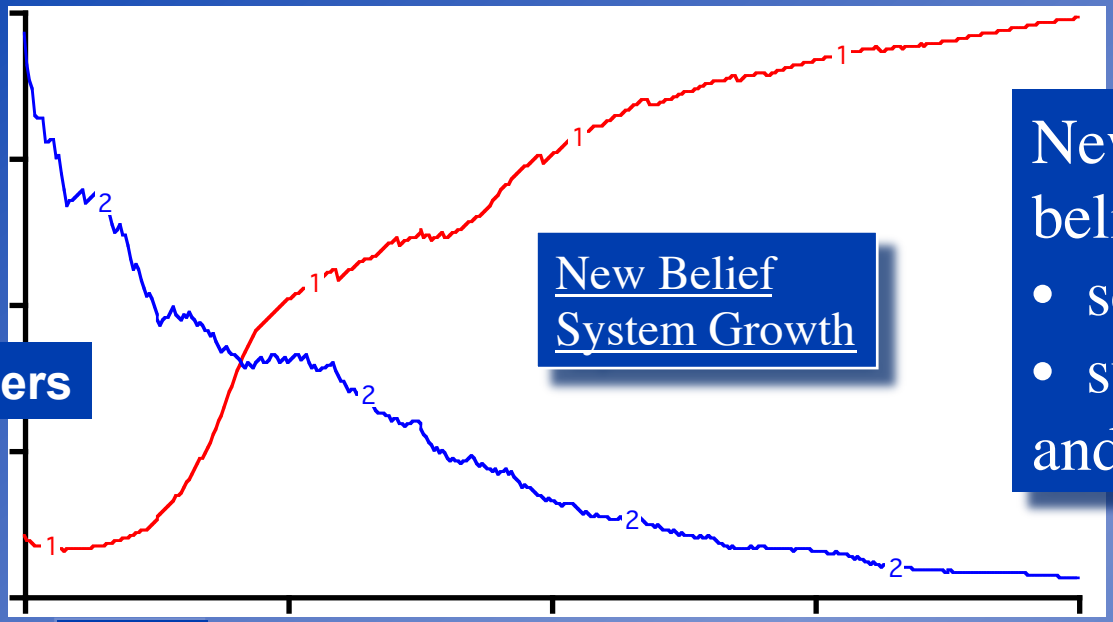




Maintaining/ reinforcing the belief system—1


Fear reduction
Decision-making in Command and Control
Interpretation of everday events, situations
Straightforward believer's World Model
Reducing psychological uncertainty
{ + }
Training
Belief system
Schwerpunkt?
Reinforcement
Indoctrination / education in belief system
{ + }
Icon establishment
Rôle models of "good" and "bad" behaviour
Reward/ punishment concepts
Power structures
{ + }
Co-operative social behaviour
Social cohesion
Leadership & discipline
Maintaining/ reinforcing the belief system—2

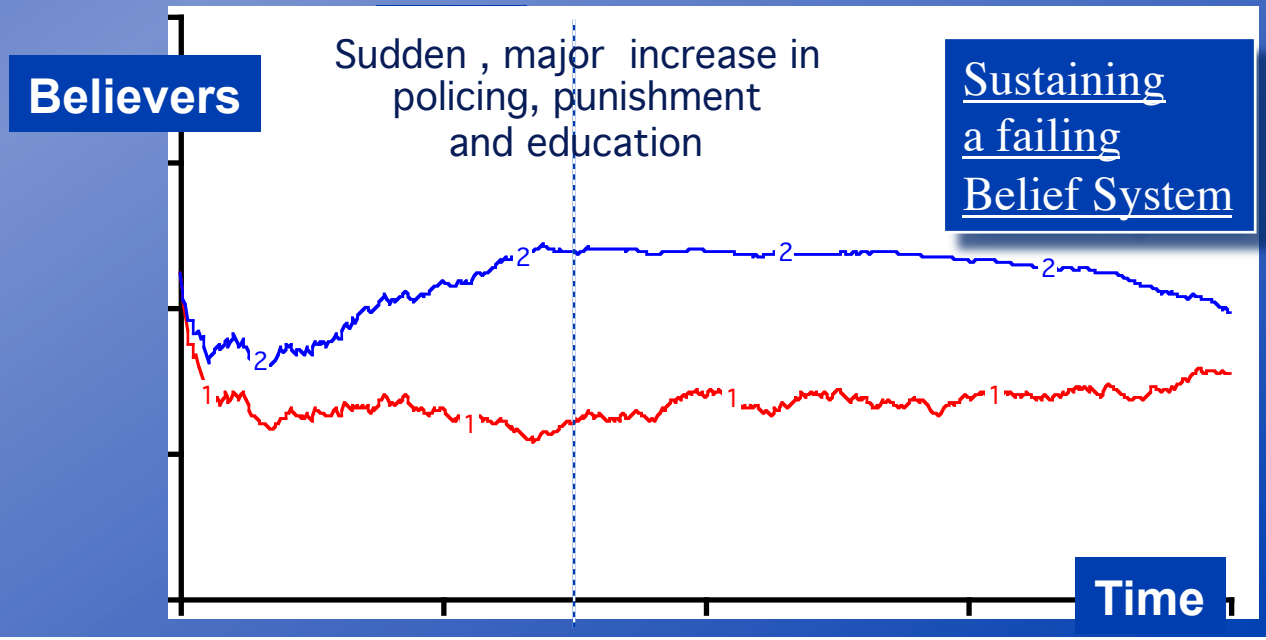
Competing Belief Systems

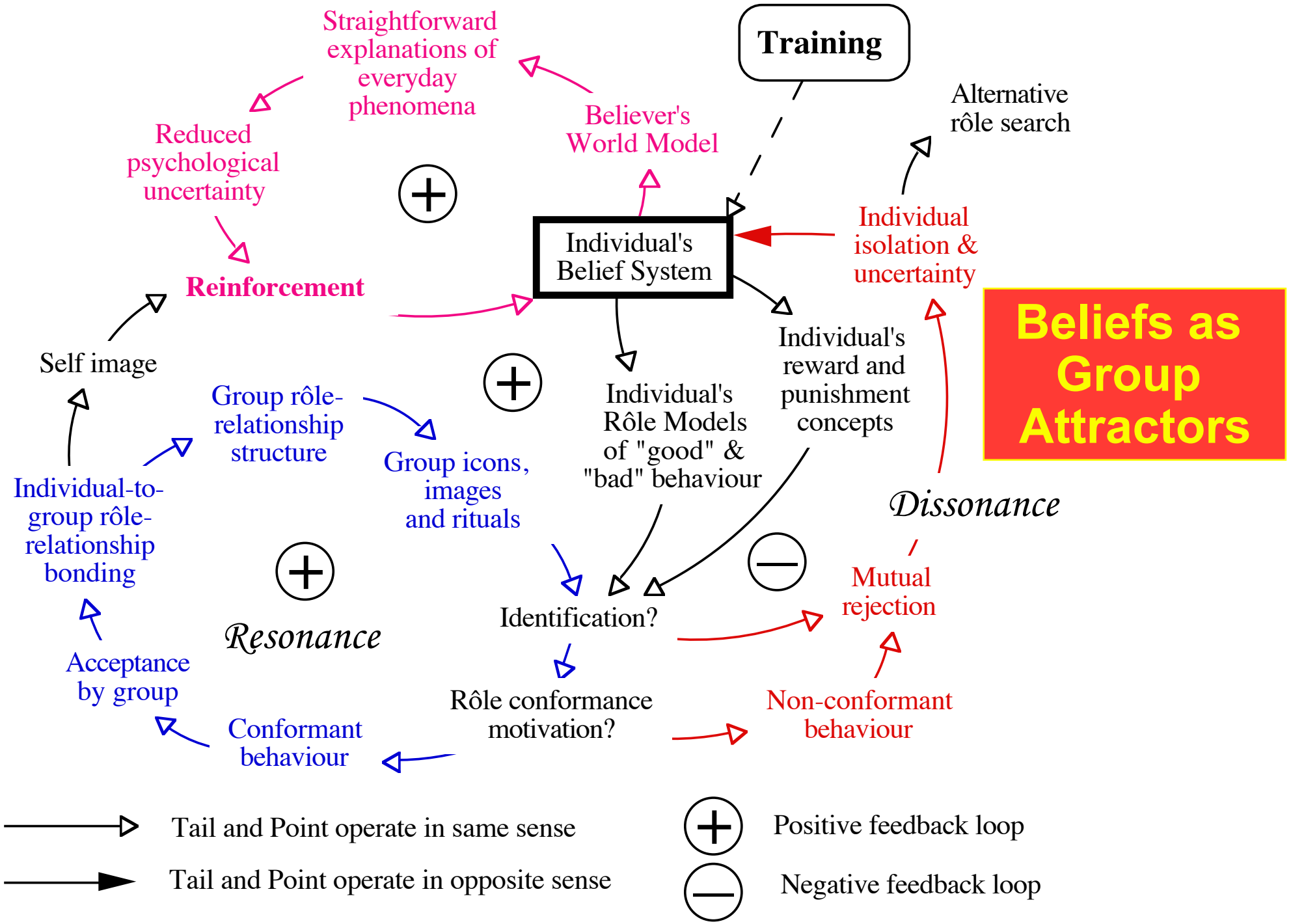


New Belief System attracts believers if it is:—

- self-re-inforcing
- supported by education and regulation

Failing Belief System is v. difficult to sustain once a downward trend is established



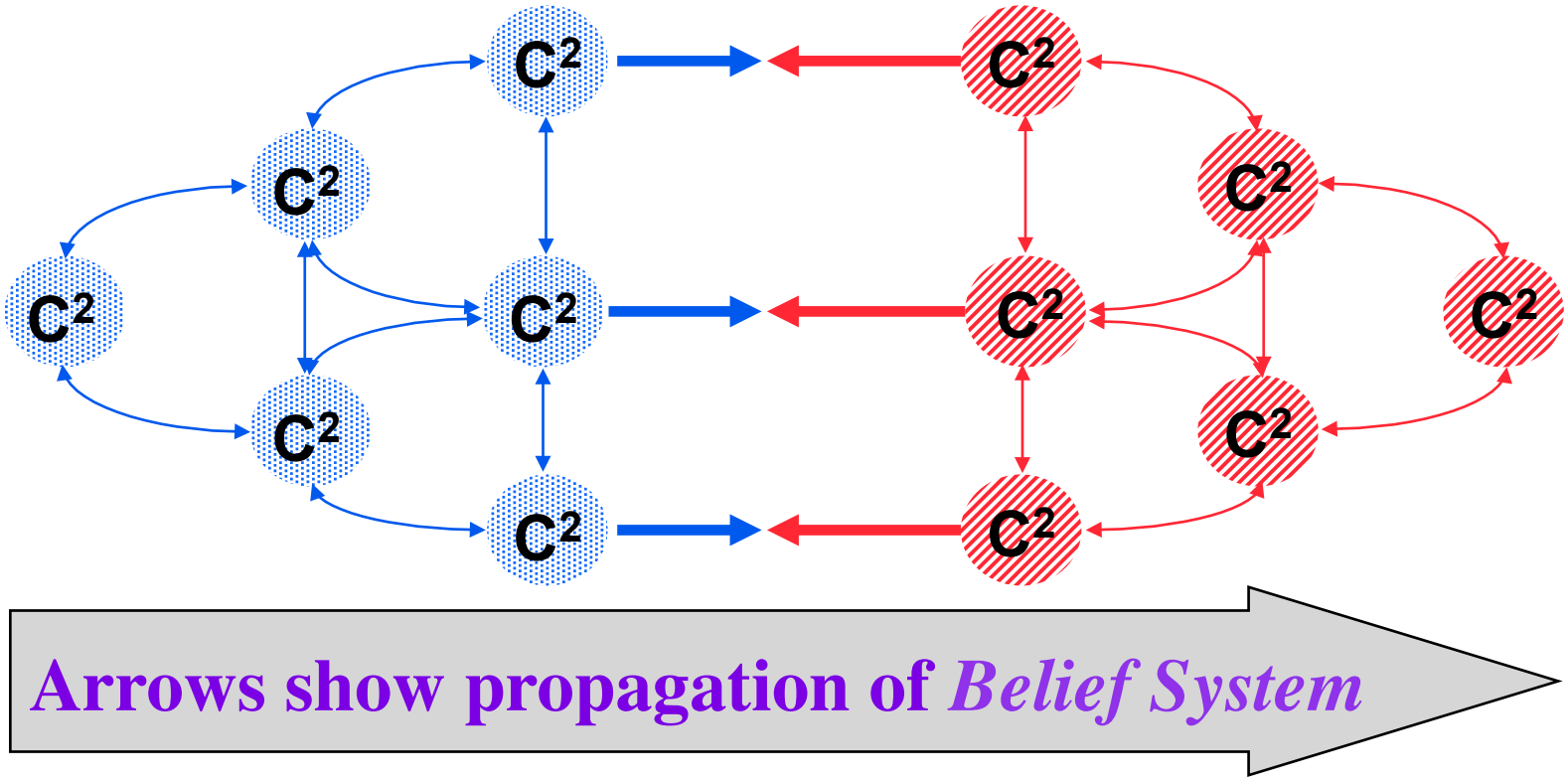

Straightforward explanations of everyday phenomena
Training
Alternative rôle search
Reduced psychological uncertainty
Believer's World Model
Individual's Belief System
Individual isolation & uncertainty
Reinforcement
Beliefs as Group Attractors
Self image
Individual's reward and punishment concepts
Group rôle-relationship structure
Individual's Rôle Models of "good" & "bad" behaviour
Group icons, images and rituals
Dissonance
Individual-to-group rôle-relationship bonding
Mutual rejection
Resonance
Identification?
Acceptance by group
Rôle conformance motivation?
Non-conformant behaviour
Conformant behaviour
Tail and Point operate in same sense
Positive feedback loop
Tail and Point operate in opposite sense
Negative feedback loop

Belief System Battle

Assyrians besieging a city

—from the Assyrian Marbles, British Musem

Conclusion from Models



- Command and Control is about *two* distinct Struggles

1. The Struggle within **Blue/Red Force to maintain its own Belief System**

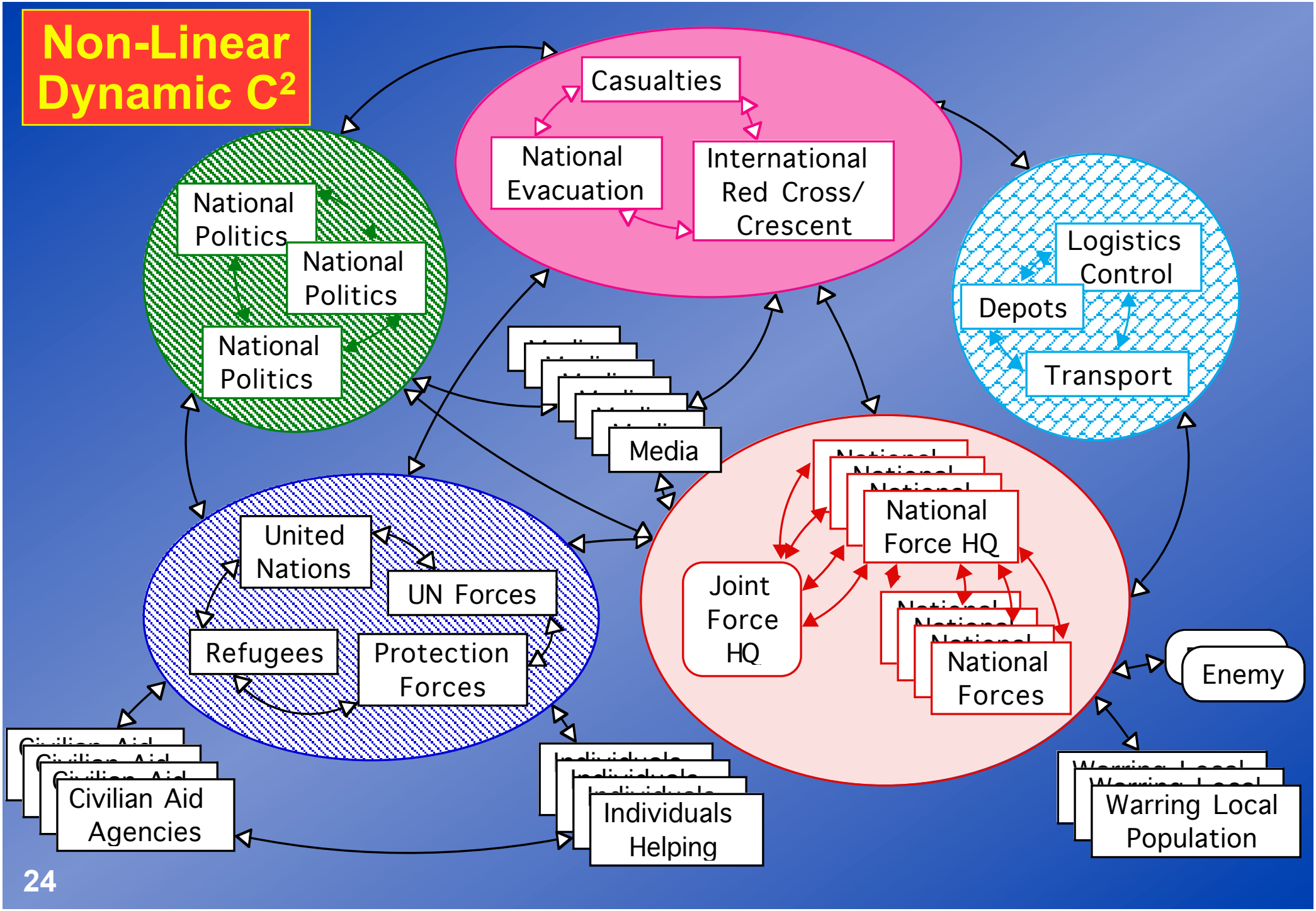
2. The struggle between **Blue Force's Belief System and Red Force's Belief System**

3. Open Systems Viewpoint

"Curls"—Julia Set, showing the interwoven, boundless, but well behaved nature of complex system behaviour

From "Putting Systems to Work", "Getting to Grips with Complexity" and "The Unified Systems Hypothesis", Systems Practice, December 1993

Non-Linear Dynamic C²



Open System Behaviour

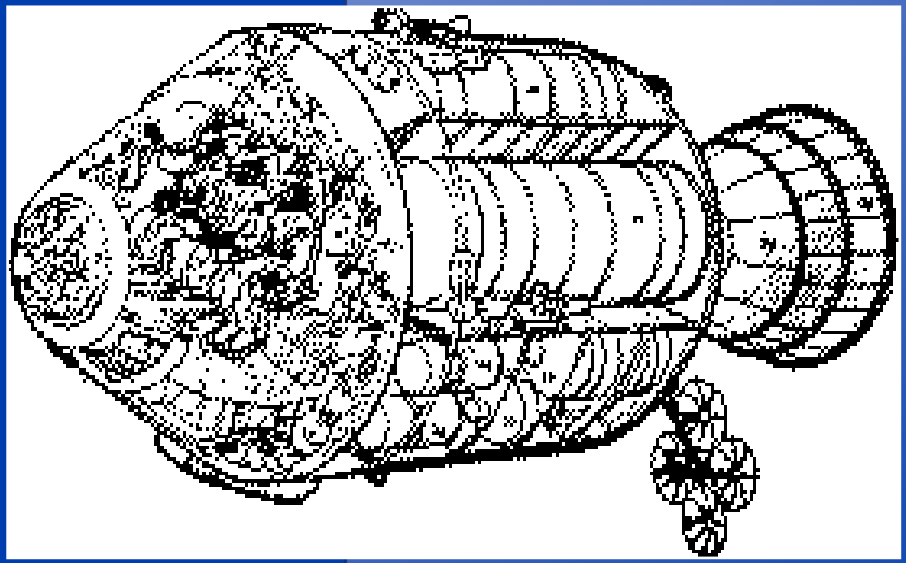
- Stabilize without feedback
- Stabilize at high energy, not low
- Oscillate without feedback
- Generate complexity
- Generate order spontaneously
- Exhibit cyclic behaviour
  - disorder, order, disorder, order
- Exhibit chaotic stability
  - (e.g. free market economies)
- Not clearly bounded

A Unified Systems Hypothesis (HUSH)

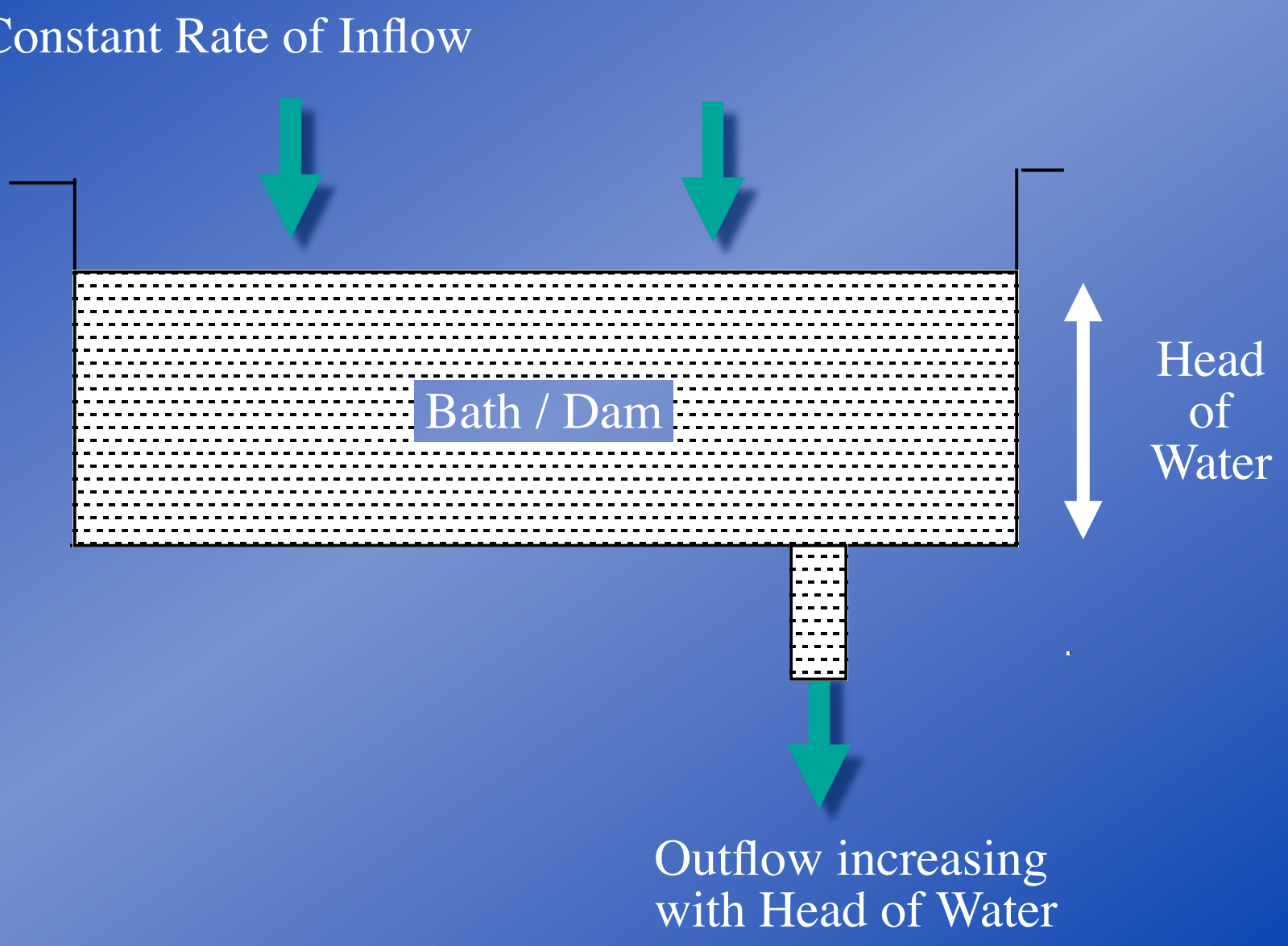
Set of rules addressing all open systems.

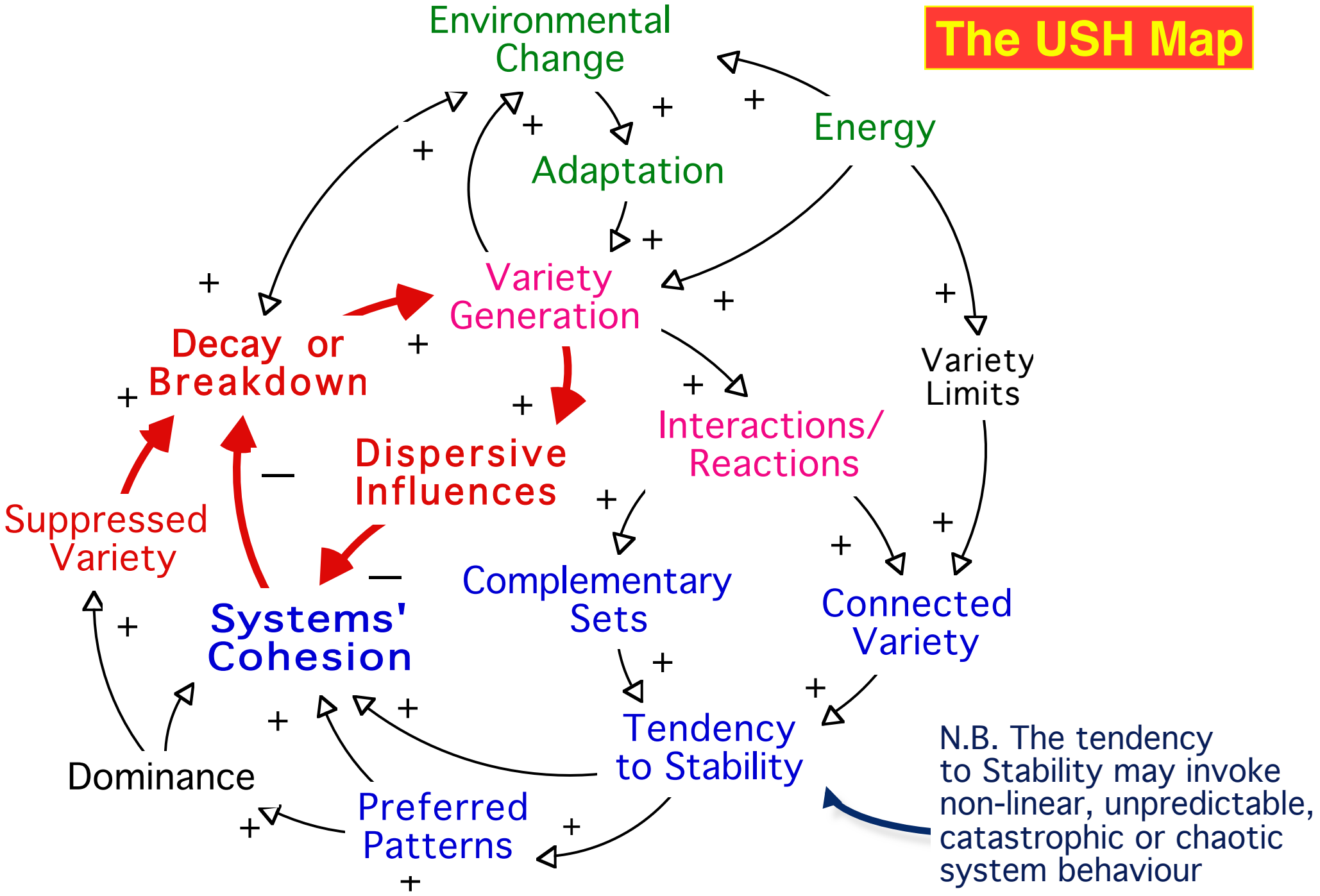
- Scale and type independent, i.e. any size of system, any kind of system

- Principle of Reactions
- Principle of Connected Variety
- Principle of Limited Variety
- Principle of Preferred Patterns
- Principle of Adaptation
- Principle of Cohesion
- Principle of Cyclic Progression



Open System Stability




The USH Map
Environmental Change
Energy
Adaptation
Variety Generation
Decay or Breakdown
Variety Limits
Dispersive Influences
Interactions/ Reactions
Suppressed Variety
Systems' Cohesion
Complementary Sets
Connected Variety
Tendency to Stability
Dominance
Preferred Patterns
N.B. The tendency to Stability may invoke non-linear, unpredictable, catastrophic or chaotic system behaviour

Open System Design Guidelines

Step 1 Establish CIS objectives and requirements by reference to Containing System(s) (look *outwards*)

Step 2 Establish sibling systems and their interactions to be perturbed by new/altered CIS

Step 3 Conceive complementary systems to neutralize unwanted perturbations

Step 4 Design CIS as an Open System to complement siblings in contributing to Containing Systems' objectives (i.e. design *outwards* first)

Step 5 Partition CIS, promoting internal connected variety, limiting dominance (*then* inwards)

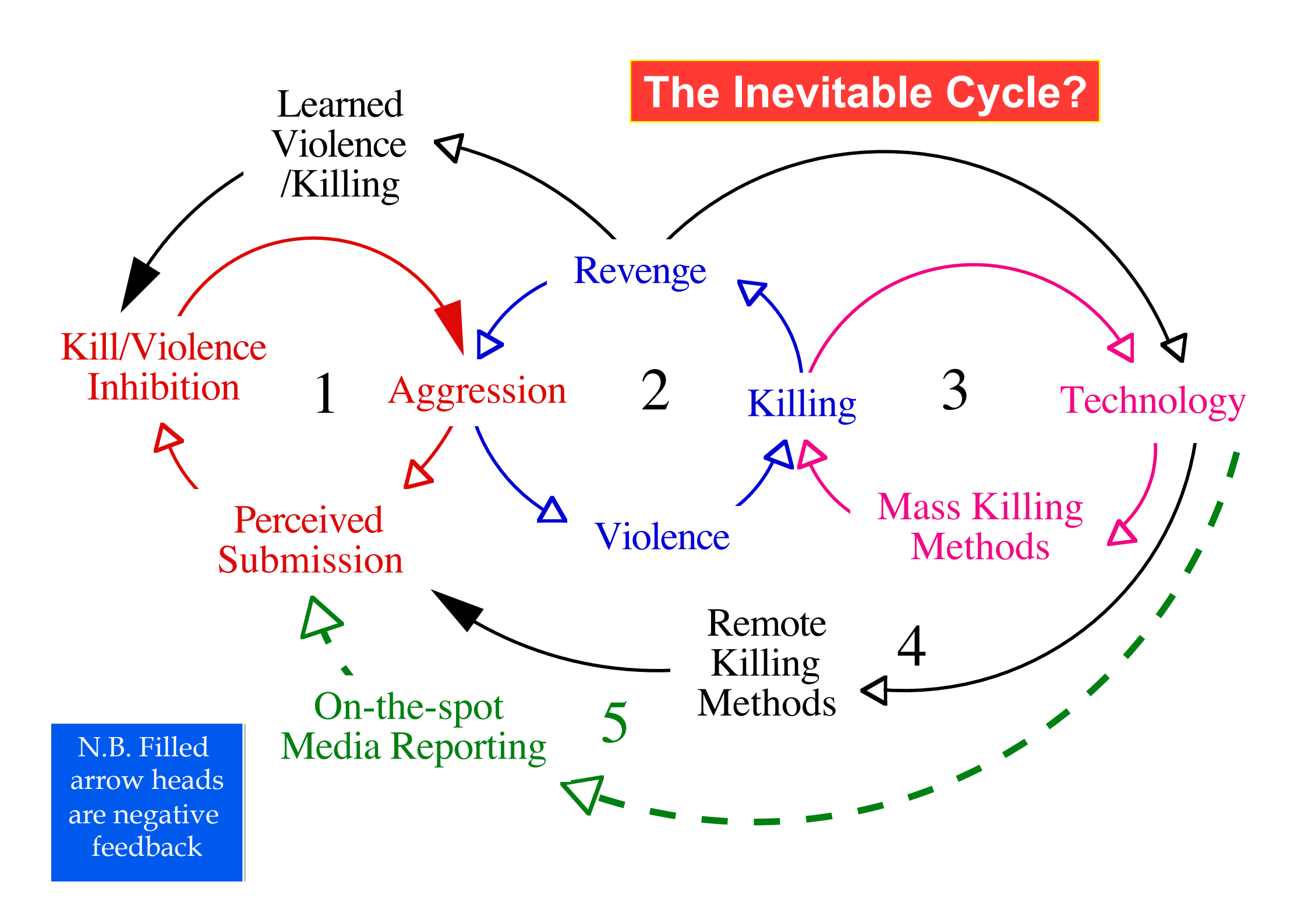
Step 6 Enhance SOI cohesives, diminish dispersives

Step 7 Interconnect the variety to promote sibling stability, mutual self-reward

Conclusions

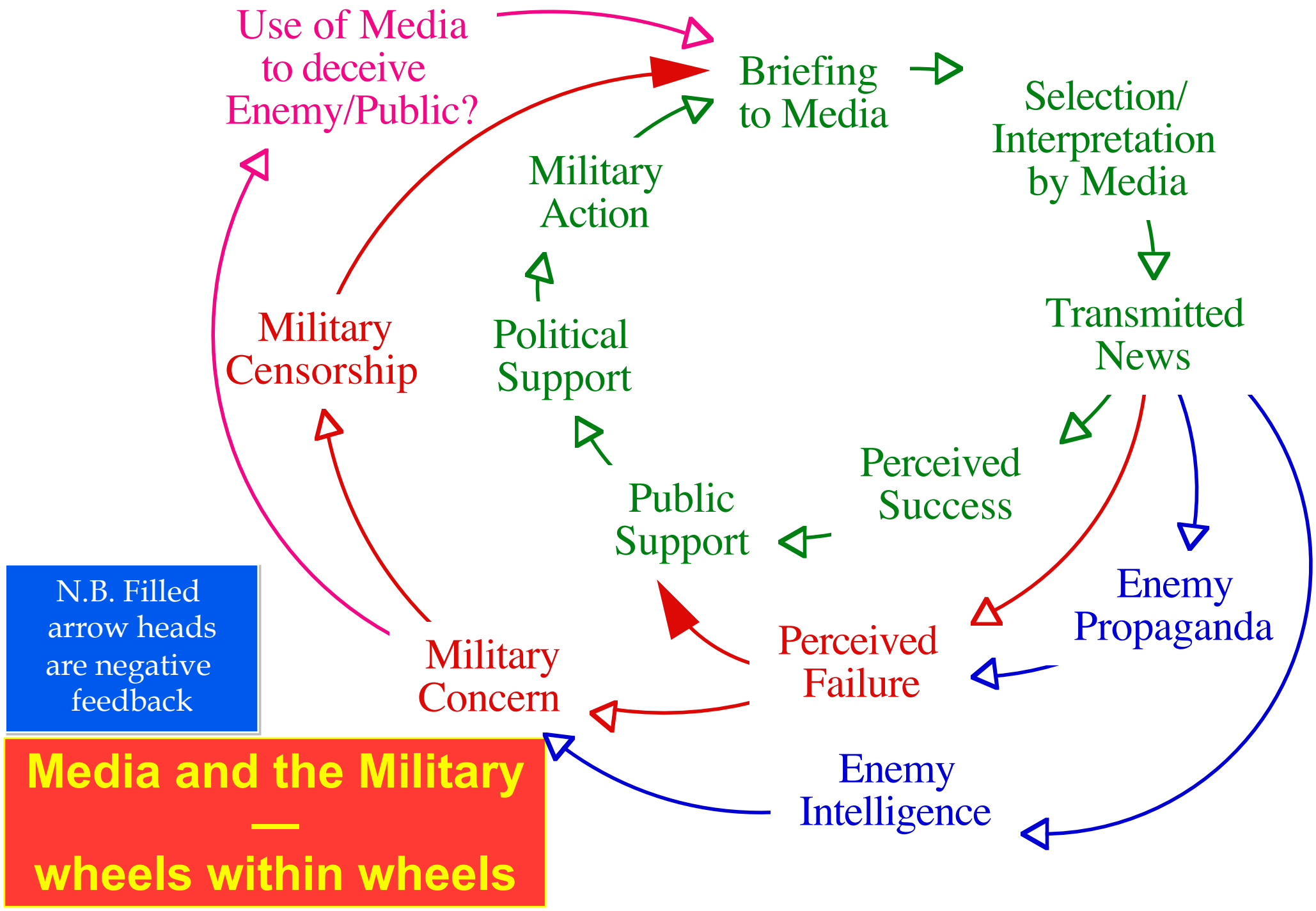
- As many viewpoints as "experts"?
- C^2—linear, controlled, predictive system in chaotic, unpredictable, unknowable world?
  - Predetermined C^2/CIS solutions *may* apply to some situations (e.g. SDI, AD?)
- Some C^2 can only be developed *in operation*
  - must connect with evolving range of alien systems
  - e.g. Peacekeeping/enforcing
    - » conventional ethics, morals, methods, tools, techniques *inapplicable*
- Are these *really* about technology?
- …or, more about human talents for being smart and adaptable?

…and finally…


The Inevitable Cycle?
Learned Violence /Killing
Revenge
Kill/Violence Inhibition
1
Aggression
2
Killing
3
Technology
Perceived Submission
Violence
Mass Killing Methods
Remote Killing Methods
4
On-the-spot Media Reporting
5
N.B. Filled arrow heads are negative feedback

Media—Risk and Temptation

- Show public "back home":—
  - invoke kill/violence inhibition
  - invoke public sympathy, weaken public support, weaken political resolve, neutralize own military activity
- Show public "too much"—provide Intelligence to enemy—endanger own forces


Use of Media to deceive Enemy/Public?
Briefing to Media
Selection/ Interpretation by Media
Transmitted News
Perceived Success
Enemy Propaganda
Perceived Failure
Enemy Intelligence
Military Concern
Public Support
Political Support
Military Action
Military Censorship
N.B. Filled arrow heads are negative feedback
Media and the Military — wheels within wheels

Catch–22

- Tell all—fail to prosecute, risk to own forces.
- Select/manipulate Intelligence—go against fundamental democratic principles—basis for operation
- Catch–22 for military officers in the field
  - Exercise with officers at Captain/Major level suggested "optimum" approach—
    - » create briefing system which *appears* to be thoroughly open, honest and above board, but presents Intelligence massaged to suit military purpose.
    - » Some officers saw no alternative to this approach.