



## The Human Dimension of Cyberspace

Ross A. Pigeau, Ph.D.

DRDC Toronto



Defence Research and  
Development Canada

Recherche et développement  
pour la défense Canada

Canada



## Outline

- Cyberspace
- Technology and the Internet
- Nature of data, information & knowledge
- Criteria for truth acceptance
- Thought experiment
- Chaos, complexity & fractals
- Space, time & cyberspace
- Issues for the military

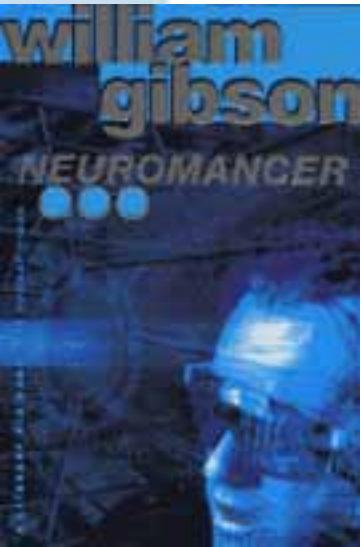


## S&T and Fiction

- Jules Verne
- H.G. Wells
- Phillip K. Dick
- Stanislaw Lem



# What is Cyberspace?



**"Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts...A graphical representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the non-space of the mind, clusters and constellations of data. Like city lights, receding..."** (*[William Gibson, Neuromancer, 1984, page 51](#)*)





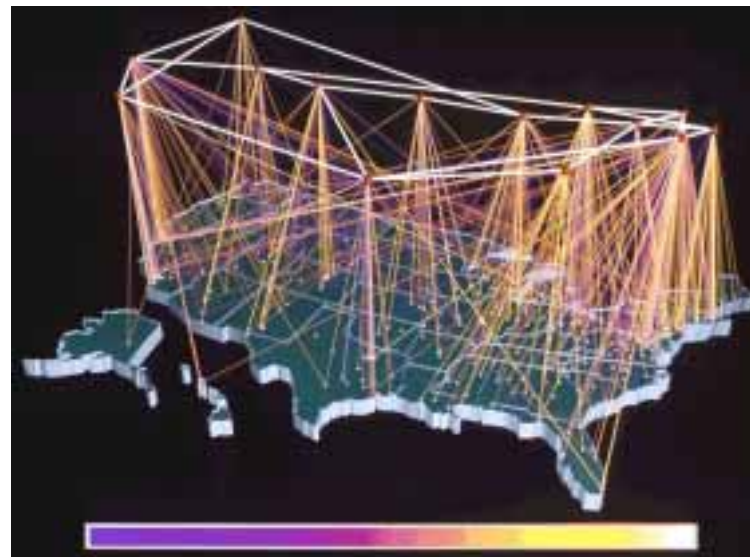
# Cyberspace and the Internet

- Bandwidth (bits/sec)
- No. of interconnected hosts and servers
- No. of humans interacting
- Human/Machine Interface



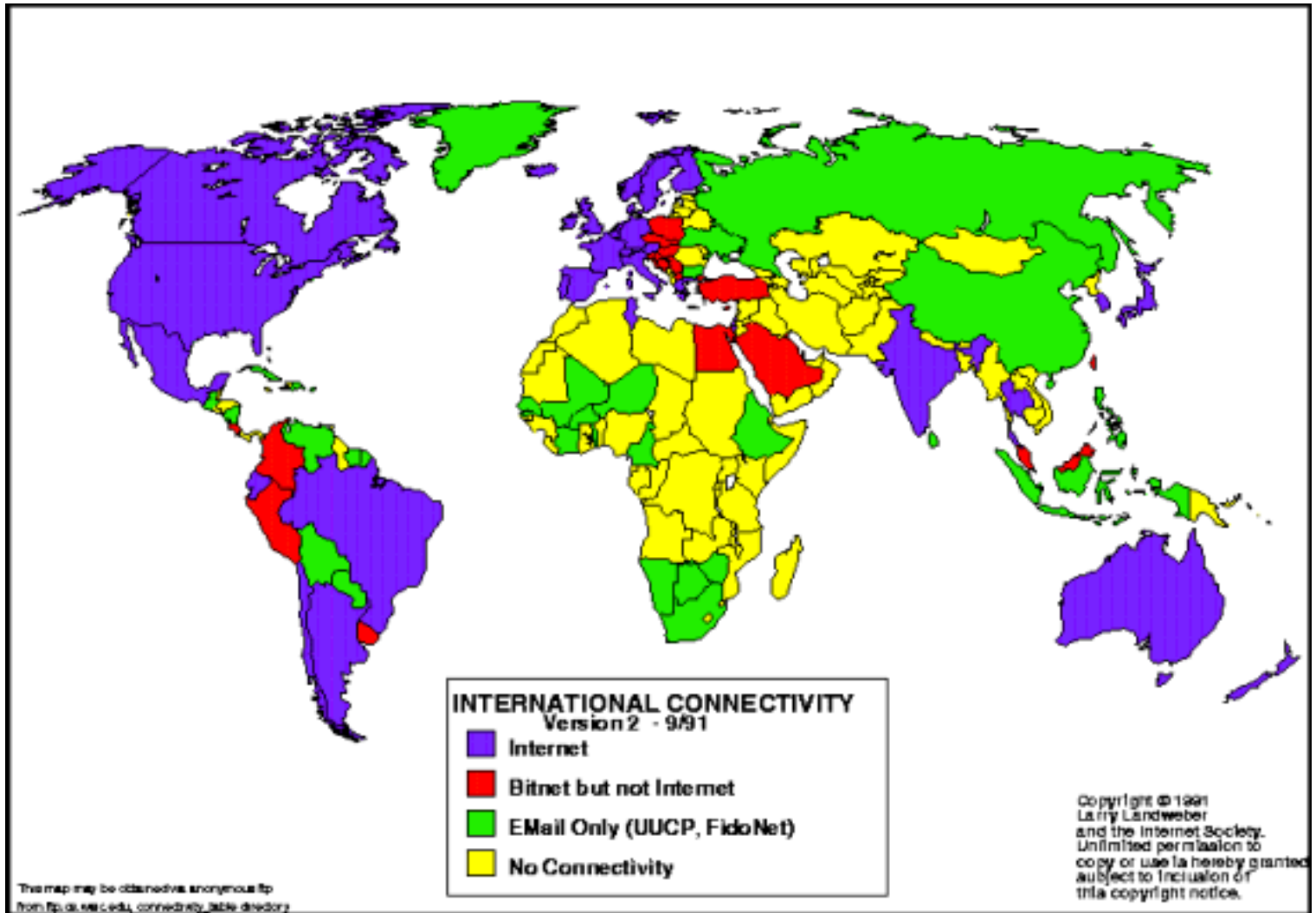
# Bandwidth

- Kilo bits/sec
- Mega bits/sec
- Giga bits/sec
- and beyond...



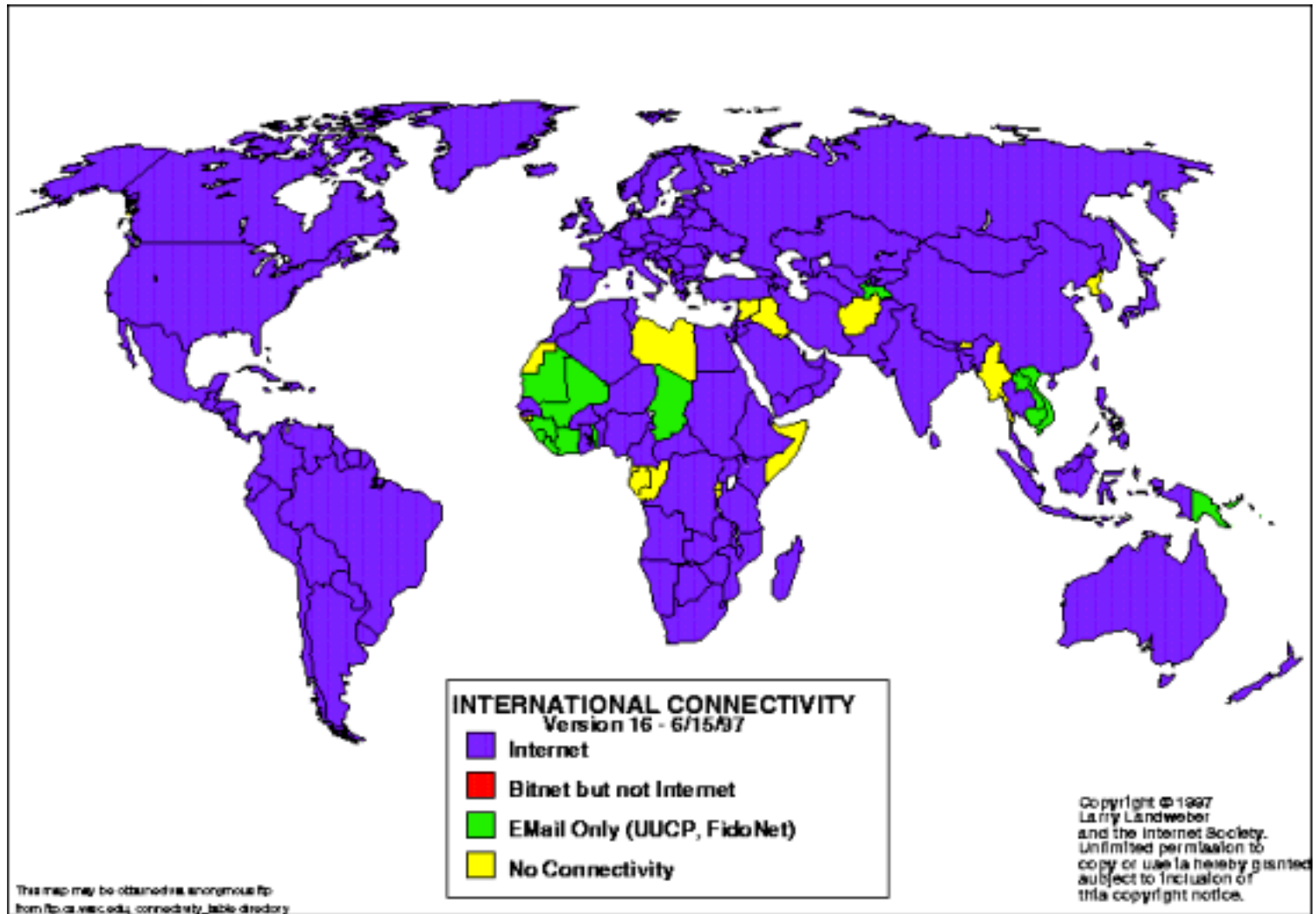


# Internet Growth (1991)





# Internet Growth (1997)





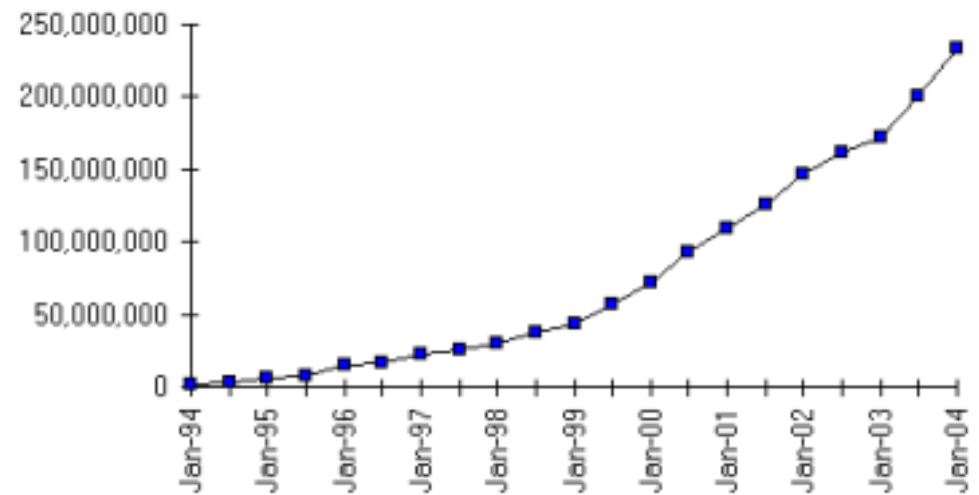


# Internet Users and Hosts

Estimate of  
Internet Users

617.5M (2002)  
827.05M (2004)  
(ClickZ Network)

Internet Domain Survey Host Count



Source: Internet Software Consortium ([www.isc.org](http://www.isc.org))



# Human/Machine Interface

- Presently still fairly crude
- Keyboard, VTC, voice
- 2D, 3D visualization techniques
- Immersive technologies improving
- Senses are an intermediary



## What is Cyberspace? (revisited)

- A dynamic (wide bandwidth) electronic medium for storing and exchanging distributed bits and bytes among humans.

**But what is the content and function of Cyberspace?**



# Content of Cyberspace

(from a psychological perspective)

- **Data:**
- **Information:**
- **Knowledge:**



# Content of Cyberspace

(from a psychological perspective)

- **Data:** That upon which pattern generation and pattern recognition occurs
- **Information:**
- **Knowledge:**



# Content of Cyberspace

(from a psychological perspective)

- **Data:** That upon which pattern generation and pattern recognition occurs
- **Information:** Patterns of data that reduce uncertainty; “a difference that makes a difference”; novelty
- **Knowledge:**



# Content of Cyberspace

(from a psychological perspective)

- **Data:** That upon which pattern generation and pattern recognition occurs
- **Information:** Patterns of data that reduce uncertainty; “a difference that makes a difference”; novelty
- **Knowledge:** Information accepted as true by an individual and encoded into memory for use in reasoning



# Hierarchical in Structure

- Data



- Information

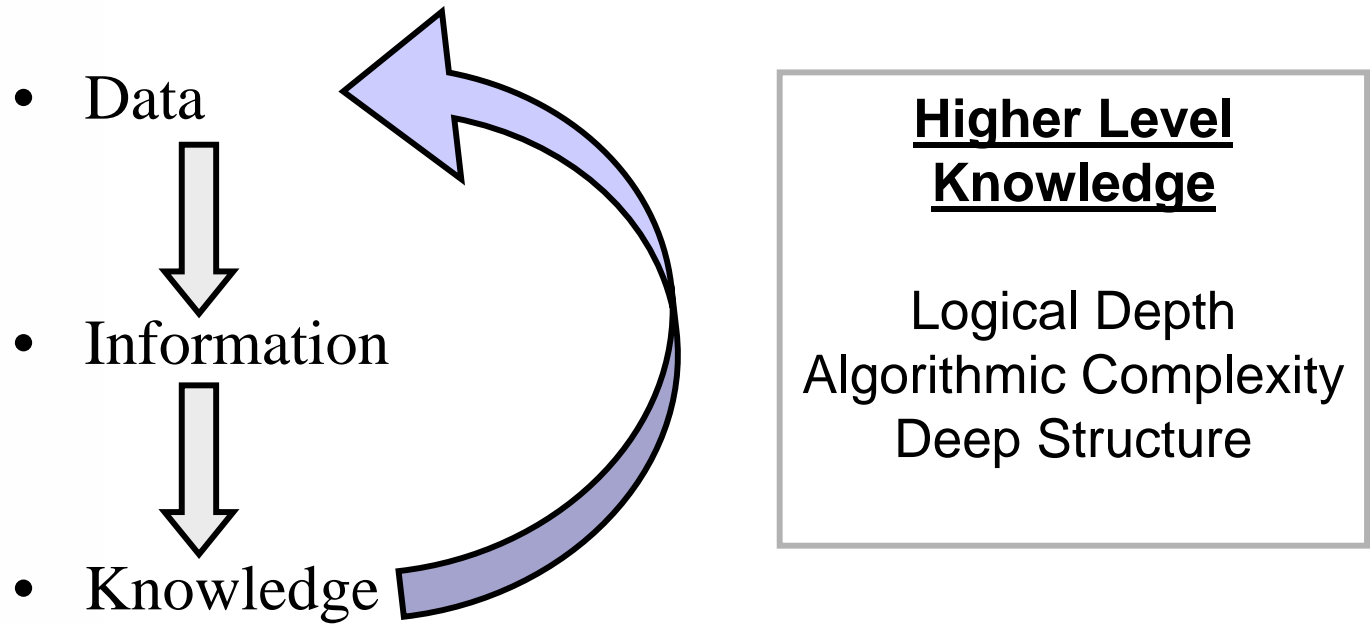


- Knowledge



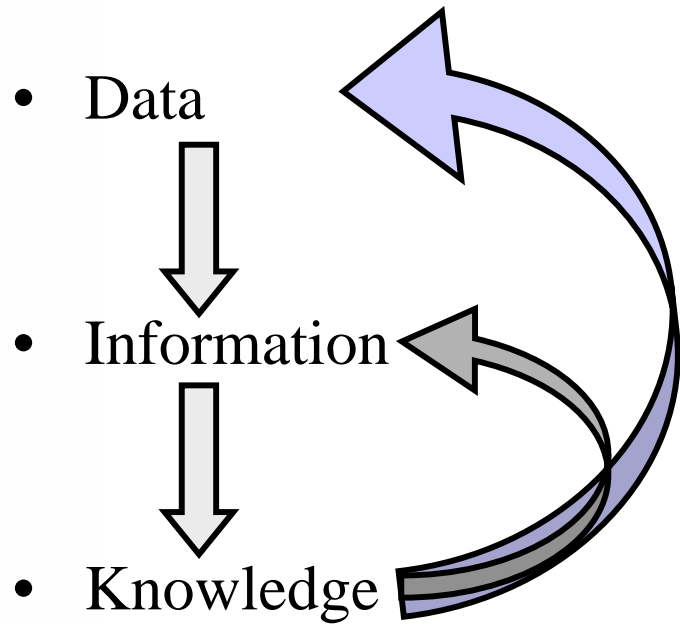


# Hierarchical and Recursive in Structure





# Hierarchical and Recursive Structure



**Knowledge Stored  
As Information**

Books,  
Encyclopedias,  
Information on Net,  
Etc.



# Criteria (or Justification) for Truth Acceptance

*Knowledge: Information accepted as true by an individual and encoded into memory for use in reasoning*

- **Perception** (with senses)

## **Primitive & Fundamental**

“Seeing is believing”

“I heard it with my own ears”

“If it looks like a duck...”

Etc.



# Criteria (or Justification) for Truth Acceptance

*Knowledge: Information accepted as true by an individual and encoded into memory for use in reasoning*

- **Perception** (with senses)
- **Authority** (with a source)

**Efficient source of truth acceptance**

Parents, Teachers  
Law makers & enforcers  
Religious texts  
Etc.



# Criteria (or Justification) for Truth Acceptance

*Knowledge: Information accepted as true by an individual and encoded into memory for use in reasoning*

- **Perception** (with senses)
- **Authority** (with a source)
- **Consensus** (with others)

## **Social interaction**

Cultural morals & values  
Peer pressure  
Common experiences  
Etc.



# Criteria (or Justification) for Truth Acceptance

*Knowledge: Information accepted as true by an individual and encoded into memory for use in reasoning*

- **Perception** (with senses)
- **Authority** (with a source)
- **Consensus** (with others)
- **Coherence-in** (with existing knowledge)

## Internal Consistency

Sense making  
Fits with internal knowledge  
Criteria for logic  
Etc.



# Criteria (or Justification) for Truth Acceptance

*Knowledge: Information accepted as true by an individual and encoded into memory for use in reasoning*

- **Perception** (with senses)
- **Authority** (with a source)
- **Consensus** (with others)
- **Coherence-in** (with existing knowledge)
- **Coherence-out** (with external world)

## **External Consistency**

With physical environment  
Basis for Darwinianism  
Scientific method  
Pragmatism  
Etc.



# Criteria (or Justification) for Truth Acceptance

*Knowledge: Information accepted as true by an individual and encoded into memory for use in reasoning*

- **Perception** (with senses)
- **Authority** (with a source)
- **Consensus** (with others)
- **Coherence-in** (with existing knowledge)
- **Coherence-out** (with external reality)

**All are  
Fallible!**





# Criteria (or Justification) for Truth Acceptance

*Knowledge: Information accepted as true by an individual and encoded into memory for use in reasoning*

- **Perception** (with senses)
- **Authority** (with a source)
- **Consensus** (with others)
- **Coherence-in** (with existing knowledge)
- **Coherence-out** (with external reality)

**Together,  
provide strongest  
justification for  
truth acceptance**



# Criteria (or Justification) for Truth Acceptance

*Knowledge: Information accepted as true by an individual and encoded into memory for use in reasoning*

- **Perception** (with senses)
- **Authority** (with a source)
- **Consensus** (with others)
- **Coherence-in** (with existing knowledge)
- **Coherence-out** (with external reality)

**Often in conflict**



## Large Individual Differences

- In ability to apply criteria for truth acceptance
  - e.g., perception, authority and consensus may be sufficient as criteria for some but not others
- In motivation to apply truth acceptance criteria
- In weighting of truth acceptance criteria
  - Weightings may depend on context



# Individual Differences Yield Differences in Knowledge Structures (given the same data & information)

- Potentially huge number of degrees of freedom for knowledge structures
- Societies expend large amounts of energy reducing degrees of freedom to ensure stability
  - E.g., national policies, religions, organisations, militaries
- For many societies and organisations, Authority is the most efficient method for (imposing) truth acceptance



## Tension between individuality and the need for affiliation

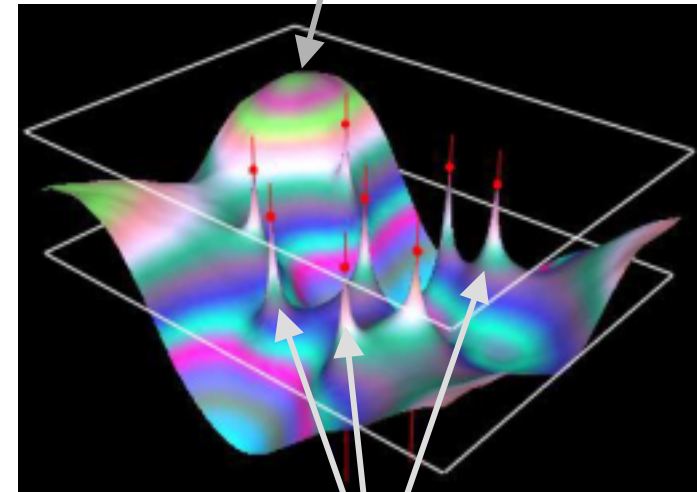
- Individual differences in knowledge structures is balanced with a need to share one's knowledge structure
  - Indeed, is the basis of one of the criteria of truth acceptance (consensus)
- Individuals, left to themselves, will gravitate towards other individuals with similar knowledge structures



# Social Groups based on Similar Knowledge Structures

- Emergent social groups almost inevitable
- Do not need to be mutually exclusive
- Dynamic

**Societally sanctioned knowledge structure**



**Emergent (reactionary?) knowledge structures**



## What is Cyberspace? (revisited again)

- A dynamic (wide bandwidth) electronic medium for storing and exchanging distributed bits and bytes among humans.
- An environment for creating and maintaining dynamic societies of humans with similar knowledge structures.



## But, This Concept is Not New!

**Cyberspace:** *A environment for creating and maintaining dynamic societies of humans with similar knowledge structures.*

- Describes most of human history
  - Language
  - Writing
  - Telephone
  - Email





## Recall Internet Characteristics

- Bandwidth (bits/sec)
- No. of interconnected hosts or servers
- No. of humans interacting
- • Human/Machine Interface



# Thought Experiment

- Human/machine interface solved
- Experience no longer mediated through senses
- Surfing the net becomes as natural as surfing the central nervous system





# What is Reality?

- Totally immersive
- Time and Space altered
- Laws of physics (can appear to be) violated
  - E.g., conservation of mass and volume, gravity





# Truth Acceptance in Totally Immersive Environment

Criteria	Relevance
<b>Perception</b> (with senses)	
<b>Authority</b> (with sources)	
<b>Consensus</b> (with others)	
<b>Coherence-in</b> (with existing knowledge)	
<b>Coherence-out</b> (with external world)	



# Truth Acceptance in Totally Immersive Environment

Criteria	Relevance
<b>Perception</b> (with senses)	Low
<b>Authority</b> (with sources)	
<b>Consensus</b> (with others)	
<b>Coherence-in</b> (with existing knowledge)	
<b>Coherence-out</b> (with external world)	



# Truth Acceptance in Totally Immersive Environment

Criteria	Relevance
<b>Perception</b> (with senses)	Low
<b>Authority</b> (with sources)	
<b>Consensus</b> (with others)	
<b>Coherence-in</b> (with existing knowledge)	
<b>Coherence-out</b> (with external world)	Low



# Truth Acceptance in Totally Immersive Environment

Criteria	Relevance
<b>Perception</b> (with senses)	Low
<b>Authority</b> (with sources)	
<b>Consensus</b> (with others)	Hi
<b>Coherence-in</b> (with existing knowledge)	
<b>Coherence-out</b> (with external world)	Low



# Truth Acceptance in Totally Immersive Environment

Criteria	Relevance
<b>Perception</b> (with senses)	Low
<b>Authority</b> (with sources)	
<b>Consensus</b> (with others)	Hi
<b>Coherence-in</b> (with existing knowledge)	Hi
<b>Coherence-out</b> (with external world)	Low





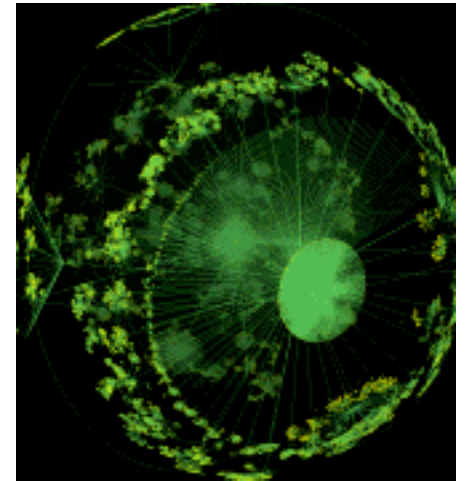
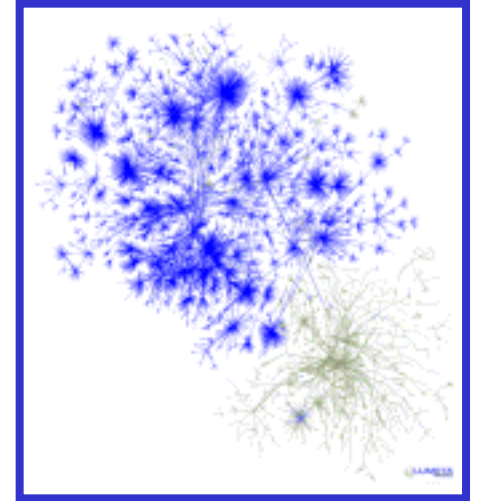
# Truth Acceptance in Totally Immersive Environments

Criteria	Relevance
<b>Perception</b> (with senses)	Low
<b>Authority</b> (with sources)	Med-Hi
<b>Consensus</b> (with others)	Hi
<b>Coherence-in</b> (with existing knowledge)	Hi
<b>Coherence-out</b> (with external world)	Low



# Impact: Greater Likelihood for Non-linear Behaviour

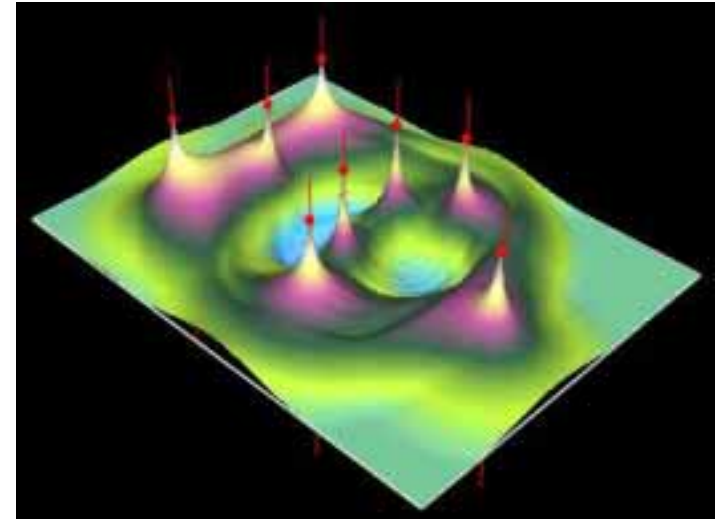
- Fractal
  - Self-similarity





# Impact: Greater Likelihood for Non-linear Behaviour

- Fractal
  - Self-similarity
- Complexity
  - Emergent behaviour





# Impact: Greater Likelihood for Non-linear Behaviour

- Fractal
  - Self-similarity
- Complexity
  - Emergent behaviour
- Chaotic
  - Sensitivity to initial conditions

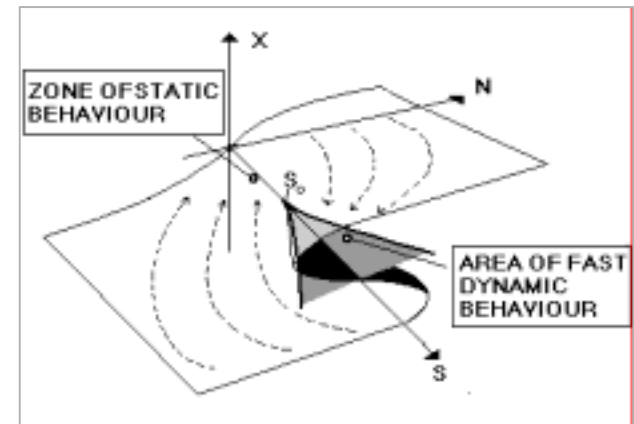
## **Butterfly Effect**

Fads  
Fashions  
Stock market crash  
Riots  
Etc.



# Impact: Greater Likelihood for Non-linear Behaviour

- Fractal
  - Self-similarity
- Complexity
  - Emergent behaviour
- Chaotic
  - Sensitivity to initial conditions
- Catastrophe
  - Hysteresis





## Results

- Social stability in cyberspace may be at risk
- Nations and organisations may need to impose external authority
- Amount of imposed authority may be proportional to success of human/machine interface technology



## What is Cyberspace? (revisited yet again)

- A dynamic (wide bandwidth) electronic medium for storing and exchanging distributed bits and bytes among humans.
- An environment for creating and maintaining dynamic societies of humans with similar knowledge structures.



## What is Cyberspace? (revisited yet again)

- A dynamic (wide bandwidth) electronic medium for storing and exchanging distributed bits and bytes among humans.
- An environment for creating and maintaining dynamic societies of humans with similar knowledge structures.
- A fabricated world where consensus with others and coherence with internal knowledge structures determines reality; and where authority may be necessary to achieve social stability.

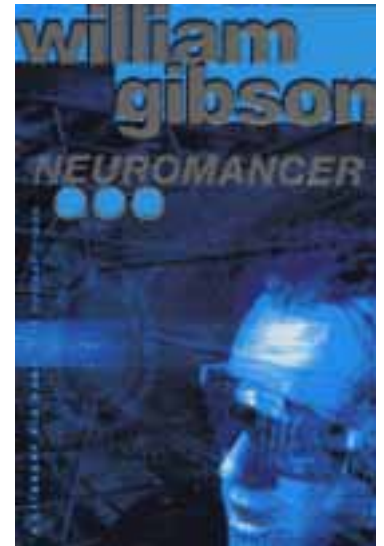




## What is Cyberspace?

A fabricated world where consensus with others and coherence with internal knowledge structures determines reality; and where authority may be necessary to achieve social stability

**"Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts...A graphical representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the non-space of the mind, clusters and constellations of data. Like city lights, receding..."**  
*([William Gibson, Neuromancer, 1984, page 51](#))*





## Issues for Military

- To what extent will Network Centric Warfare (NCW) involve cyberspace?
- What authority structures will be necessary within a NCW 'power to the edge' (Alberts) philosophy?
- How much energy will militaries expend to ensure common knowledge structures among its personnel?
- Can coalition partners match this energy expenditure?

DEFENCE



DÉFENSE