Industrial Operations / Information Processing Convergence

Control Chain Management Body Of Knowledge

MI - Intelligence
Real meaning

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Agenda

- Intellectual/Informational hierarchy
- **Biological and artificial intelligence**
- **Product of Complex systems**
- **Enterprise IQ**

Information levels

Syntropic Type	Syntropic Rank	Information type	Representation
Potential	1	Things and Facts	Objective
Potential	2	Data	Objective / Language
Potential	3	Meaning	Subjective / Language
Potential	4	Knowledge	Objective / Language
Potential	5	Consciousness	Subjective
Kinetic	1	Interactions	Objective
Kinetic	2	Communication	Objective / Language
Kinetic	3	Processing	Objective / Language
Kinetic	4	Intelligence	Objective / Language
Kinetic	5	Wisdom	Subjective

Potential Information Level 1: Things and Facts

- **The « reality », the « Truth »**
  - The things as they are
  - The facts as they happen
  - Inherently objective
- **Independent of the observers**
  - Ourselves, Sensors and computers
  - Though Quantum physics tells us otherwise....
- **Cannot be processed as is**

Potential Information Level 2: Data

- **A local representation of disconnected facts and observations**
  - Translation of things and facts by the primary observer, from its narrow local perspective, into communicable information
    - The temperature is -50
    - Riots are going on
  - Tentatively objective, though the selection of data is subjective
- **Data relies on language**
  - Offering conceptual references, symbolisation…
    - Physical measurement
      - *Temperature, pressure*
    - Numbering
    - Social events
      - *Riots, parties, meeting*
  - … implicit in the context of the observer

Potential Information Level 3: Meaning

- **An interpretation of data for use by other**
  - Condition, combine data in order to convey meaning to non-direct observers
    - The temperature is -50 °C at the North pole, on 2010 March 1st 4PM
    - Riots in Teheran, 17M inhabitants, 20000 demonstrators
  - “Interpretation” fills information gaps to pull more meaning
  - Subjective: meaning depends on the observer processing the data
- **Meaning relies on language**
  - Relying on conceptual references
  - Describing the context,
  - Bringing the distant observer closer to facts and things
  - Through the direct observer interpretation and filtering
    - “colouring” the reality on purpose or indidentally

Potential Information Level 4 : Knowledge

- **Knowledge is an objective state of understanding**
  - In the form of experiences, theories, beliefs
  - Trying to explain the Reality: things and facts, looking for “truth”
  - Can be materialized (books, files, painting…) using language and other means or less appropriate to people / machine languages
- **It is independent of its subjective usage**
  - Any entity can interacts with knowledge to influence its behavior in dealing with actual things and facts
    - Interpreting/understanding and “applying” this knowledge
    - Developing / improving objective knowledge
- **Accessibility and confinement**
  - Can be initiated / kept by an individual / machine
  - Can be shared by several individuals / machines
  - Can be more or less publicly exposed to open access

Potential Information Level 5: Consciousness

- **Consciousness is a lasting issue for philosopher**
- **Dictionnaries discard the problem - Oxford:**
  - the state of being conscious.
    - the fact of awareness by the mind of itself and the world.
  - one's awareness or perception of something
- **Is it really a level 5 of Potential Information?**
  - Is knowledge a precondition for consciousness?
  - Would the World be different without consciousness?

Kinetic information Level 1: Interactions

- **The dynamics of the world is through interactions**
  - Actions results of a network of interactions from an initial trigger
  - This trigger itself arise from other interactions and so on
- **Interactions have many forms**
  - At the atomic and subatomic levels, to build more complex material structures
  - Multimedia interactions between people through available senses:: sound, vision, smell, touch, taste, 6th sense
  - Chemical, mechanical electrical, interactions

Kinetic information Level 2: Communication

- **Communication is the abstraction of interactions, making possible**
  - To implement artificial interactions
    - Not naturallly occuring
  - To link separate, distant entities
  - To link dissimilar entities (people and machines)
- **Communication relies on language**
  - Only meaningful interactions are useful
  - A language offers conceptual references for a shared understanding

Kinetic information Level 3: Processing

- **Processing implements existing knowledge**
  - To understand and act on he Reality
- **Information « flows » through systems' components**
  - Communication exchange « meaning » between thinking / processing bodies /.black boxes
  - What happen inside brain and computer is « processing »
    - Which itself results of interactions synapses in gray matter, integrated circuits
- **Processing relies mainly on language**
  - Thinking processes and artificial computing
- **Some local, low-level, basic processing relies on direct interactions**
  - No language is required to make people wlaking
  - No language is required to control to fill up the WC water bin after a flush

Kinetic information Level 4: Intelligence

- **Intelligence**
  - Makes a critical use of knowledge: challenges existing beliefs and theories – trial and error process confronting theories and reality
  - Suggest changes to existing knowledge, develops new theories
    - Intelligence build knowledge - Processing sucks, Intelligence contributes
  - Focuses the limited thinking / processing capabilities toward conscious goals - Beyond survival and reproduction
- **Involves abilities such as**
  - to reason, plan, solve problems, think abstractly – connecting theories to reality, comprehend complex ideas.
  - To be creative, imagining new or amended theories
  - To take benefit (discover, understand) existing relevant theories
  - To learn from experience
- **IQ tests measure more processing abilities than intelligence**

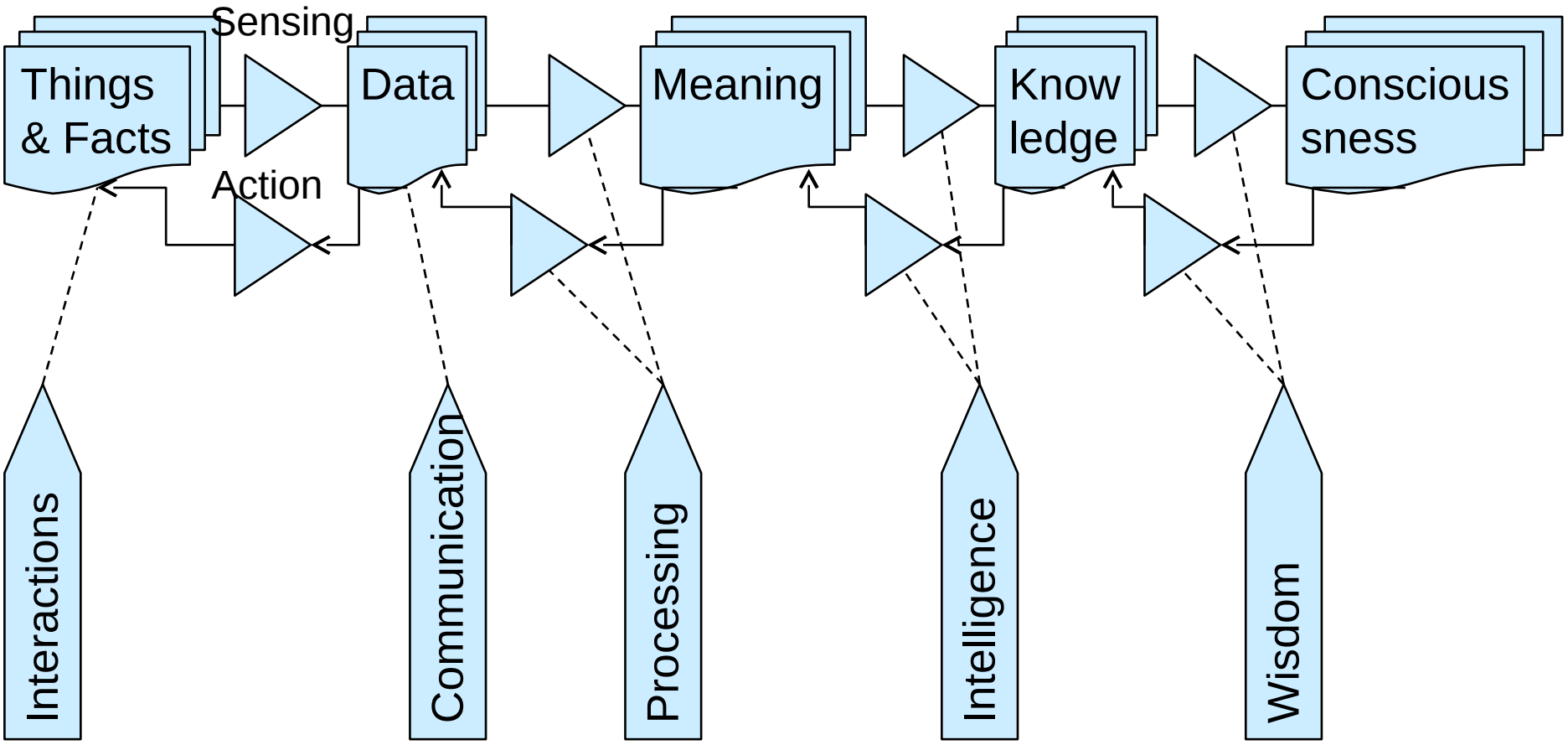
Kinetic information Level 4: Intelligence

- **Other definitions**
  - Judgment, otherwise called good sense, practical sense, initiative, the faculty of adapting one's self to circumstances...auto-critique
  - The aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment.
  - Innate general cognitive ability
  - Goal-directed adaptive behavior
  - Aptitude to survive and reproduce
- **Is language involved?**
  - As a higher processing ability, language might be involved
    - "Artificial intelligence", mental representations
  - "Intuitive" behavior results of an inner appropriation of knowledge that realize a short cut from knowledge to a processible outcome – action, decision / the language might be only involved at the last stage

Kinetic information Level 5: Wisdom

- **Common definitions (I don't like them!)**
  - the inner knowledge and experience needed to make sensible decisions and judgments, or the good sense shown by the decisions and judgments made
  - accumulated knowledge of life or in a particular sphere of activity that has been gained through experience
  - an opinion that almost everyone seems to share or express
  - ancient teachings or sayings that survives to Time
- **Better:**
  - Consciousness of having limited knowledge and poor understanding
    - Data, Information, Knowledge and intelligence are of relative interest
  - Acting for the common interest, being unselfish

Potential/Kinetic Information relationship



Discussion

- **From real world to ultimate wisdom and back, a huge variety amplification / attenuation occurs**
  - The real world is highly complex
  - At the data level, capturing the whole context is impossible
  - By selecting “relevant”, “significant” data, one makes assumptions to summarize a complex situation into an apparently simple one
  - The same filtering occurs at the meaning level, explaining why the very same situation is judged very differently by different people
  - Again, Knowledge builds on a subset of the available “meaningful” information – Mass media play at will with listeners understanding
  - Finally, the overall consciousness consolidates knowledge into a global, simplistic perception of the World, determining choices open by knowledge, based on the subjective meaning of a given situation
  - Walking back to the real world for action, the reverse amplification must occur for actions to match the actual complexity/variety

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Biological Computational capabilities

- **Connection to the World**
  - Perception
  - Motion and manipulation
- **Meaning and Knowledge representation**
  - Pattern recognition
  - Verbal Language and other communication skills
- **Deduction, reasoning, problem solving**
  - Ability to complete missing information
  - Planning
  - Learning
  - Creativity
  - Social behavior
- **Ability to repair**

Biological / Digital computing Comparison (Stonier)

Computer	Human Brain
Digital information processor based on circuits of binary switches	Analogue information processor involving a complex nervous system with scores of chemical neurotransmitters and modifiers
Information transported as pulses of electrons along conductors and across semiconductors	Information transmitted as pulses of depolarization along membranes and as neurotransmitters across synapses
Speed of pulses transmission approximately 108 m/sec	Speed of pulses transmission approximately 10 m/sec
Relatively simple circuitry but increasing in complexity	Extremely complex circuitry: 1011 neurons with up to 1015 connections

Biological / Digital computing Comparison (cont'd)

Computer	Human Brain
Crystalline structure, extremely stable	Biotissue, vulnerable to damage
Can operate under a wide variety of conditions	Needs carefully regulated environment to operate
Computer system may be shutdown indefinitely with no damage	Brain requires continuous energy inputs in order to maintain the living system
No self-repair. Some self-correction and by-pass of faulty areas	Tissue capable of significant self-repair. Also extensive capability to transfer function to other circuitry
Memory based on patterns of binary switches	Memory based on patterns of neural connections

Intelligence in artificial systems

- **To simplify the following sections, an artificial system is considered to only exhibit intelligence at the level it has a purpose on its own:**
  - The marketing department or the production facilities have a lot of processing capabilities,
    - I can fire the production department and outsource the manufacturing activity
  - but only the company itself exhibit intelligence from the proper coupling of all its entities
    - Nothing subsists if I kill the company
    - Except saleable assets without any proper responsibility outside a living company

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System intelligence

- **Intelligence is an emergent property of complex systems**
  - resulting of complex interactions
  - between behaving components
    - brain synapses, silicon gates, talking people, assembled machines
- **Processing and Intelligence residence**
  - Processing can be localized in computing areas
    - Monism: Intelligence is integrally embedded in the system
      - *Control loops, servo-mechanisms*
    - Dualism: Intelligence is a well defined decision making entity
      - *Recipe sequencer, decision maker*
  - Intelligence is a diffused characteristic of a complex system
    - At its different levels of recursion
      - *see section 4 “Make intelligence actionable”*

Conflicts and Intelligence

- **Intelligence is carried on by complex system/sub-systems**
  - With proper references and individual goals,
  - Having a certain level of autonomy
    - Regarding other components and environment
    - Subject to priorities / positioned in decision hierarchies
- **Conflicts are inevitable**
  - A perfectly stable system may be immune for some time
  - Any change may trigger conflicts, Any conflict may trigger change
  - Survival has timing and altruistic dimensions:
    - Component interest may contradicts other components' / system's itself

Conflicts and Intelligence

- **Conflicts reveal lacking/failing/inappropriate interactions**
  - Communication issues,
  - Structural and behavioural unfit
  - System / Subsystems goals mismatch
  - More generally bad variety/complexity management
- **Conflict resolution is a critical aspect of intelligence**
  - Leads to improved interactions ad growing knowledge

Cooperation and Intelligence: 1+1 > 2 or <2

- **Cooperation is the intended purpose of interactions**
  - Called in this case « relationships »
- **Intelligence results of efficient cooperative relationships**
  - 1+1 > 2 : globally positive impact
    - A football team succeed when the players interact best during the game
  - 1+1 < 2 : globally negative impact
    - The best French player at the 2010 World cup form a disastrous team

Feedback: The Power of information

- **Interactions imply that sub-systems**
  - Receive information / ***sense*** from other sub-systems / environment
  - Process information Performing local « processing » - functionnal role
  - Send new information to / ***act on*** other sub-systems / environment
- **The sub-systems being « complicatedly coupled », their actions**
  - spread to many other sub-systems directly/indirectly, themselves processing and spreading this information
  - Hit them back at some point
  - Intelligence results of these complex interactions and processing
  - Intelligence is a direct factor of appropriate filtering/amplification of information
- **Feedback loops**
  - Positive: Productivity enhancement
  - Negative: Traffic control

Uncertainty and Intelligence

- **Some systems are subject to standard Gaussian deviations**
  - Future is somewhat predictable
  - Exception are rare or of limited impact
- **Others are subject to extreme events that can arise without computable probability**
  - Our modern World tends more and more to favour this kind of environment
- **Intelligence implies**
  - The knowledge of the real Gaussian domains
    - Exercising classic risk Mitigation management
  - The consciousness of the lack of knowledge of the uncertainty
    - Be ready to address unpredictable, but very likely large impact events
    - Bad or Good

Deterministic Intelligence

- **Example:**
  - Comissionning manager strategy
  - FDA regulations, TQM
- **Decision hierarchy**
  - Classical Strategy / Tactic / Operations decision process
- **HR management**
  - Stimulations, conflicts resolution
- **Linear Feedback loops**
  - React on predictable events based on knowledge gathering and development
- **Process improvement**
  - Performance measurement, KPIs
  - TOC, 6Sigma, Lean…

Opportunistic Intelligence

- **Example**
  - Best performing companies are lucky..
- **Noise and useful information**
  - Distinguish unimportant / important events
- **Mitigate risk**
  - Uncertainty and Risk
- **Leverage the Luck factor**
  - Be imaginative, Develop creativity
  - Recognize opportunities
  - Be adaptive
  - Decide and act fast
  - Make mistakes, fix and learn (don’t do the same twice)

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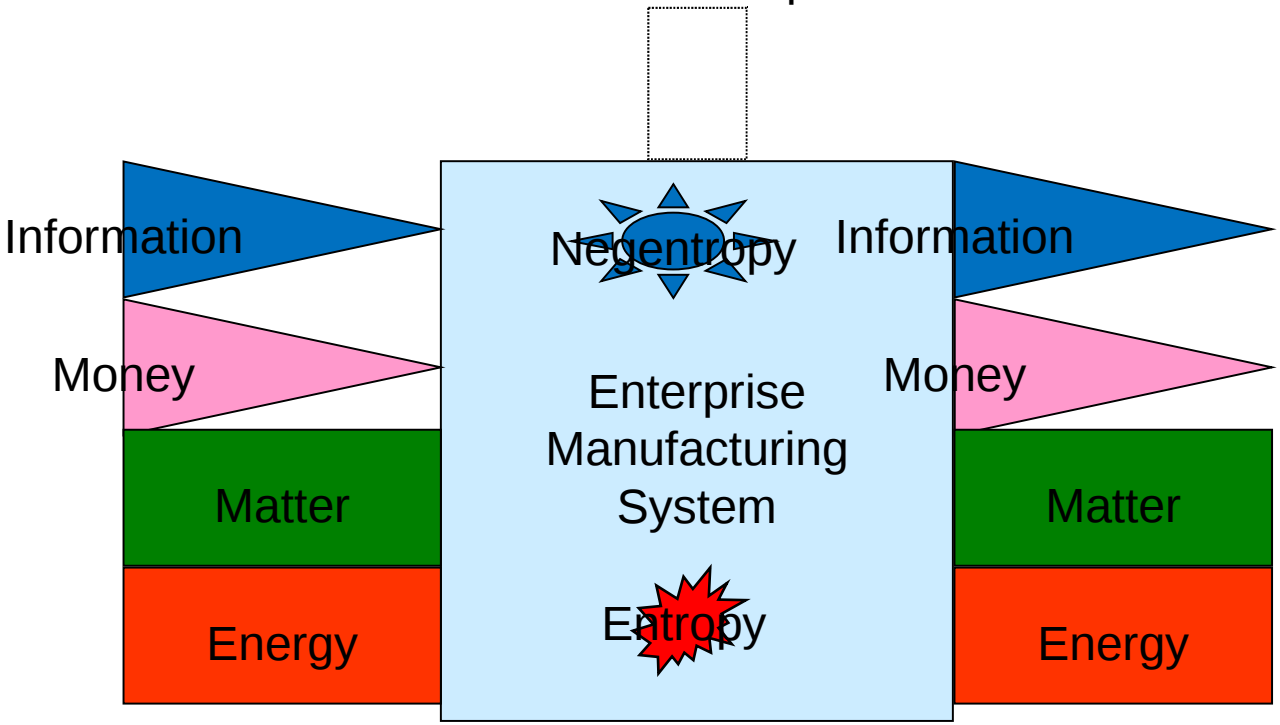
Intelligence measure

- **Intelligence a single global capability of a system**
  - influences many performance domains
- **Systemic performance indicators assess system's intelligence**
  - Shall be global to the system (taken as a black box)
  - Local smart behaviour are not a valid measures
  - However, being smart locally might impact positively the systemic performance – releasing higher intelligence
    - Not necessarily!
- **Performance can be measure on system's I/Os**
  - For each (category of) external interactions
    - Type of flow : **in**formation / **mo**ney / **ma**tter / **en**ergy
    - Type of party: **S**hareholder / **E**mployees / **G**overnment, Citizen, Society, / **N**ature, environment / **P**artner, suppliers, customers / **C**ompetitors

The enterprise black box

Government, Society, citizen
Employees
Shareholders
Nature, Environment

Partners
Suppliers, Customers
Contractor
Bank, Insurance
Competitors



Industrial Enterprise Systemic Performance Dimensions

Relationships	Information	Money	Energy	Matter
Shareholder	Ps.in	Ps,mo		
Employees	Pe,in	Pe,mo	Pe.en	
Government	Pg,in	Pg,mo	Pg,en	Pg,ma
Nature	Pn,in	Pn,mo	Pn,en	Pn,ma
Partners	Pp,in	Pp,mo	Pp,en	Pp,ma
Competitors	Pc,in			

Exercise: IESPD Example

Pi	
Ps.in	
Ps,mo	
Pe,in	
Pe,mo	
Pe.en	
Pg,in	
Pg,mo	
Pg,en	
Pg,ma	
Pn,in	
Pn,mo	
Pn,en	
Pn,ma	

Exercise: SCOR - Performance Attributes and Associated Level 1 Metrics / IESPD

Performance Attribute	Performance Attribute Definition	Level 1 Metric	Impacted IESPD
Supply Chain Reliability	The performance of the supply chain in delivering: the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer.	Perfect Order Fulfillment	
Supply Chain Responsiveness	The speed at which a supply chain provides products to the customer.	Order Fulfillment Cycle Time	
Supply Chain Flexibility	The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.	Upside Supply Chain Flexibility Upside Supply Chain Adaptability Downside Supply Chain Adaptability	
Supply Chain Costs	The costs associated with operating the supply chain.	Supply Chain Management Cost Cost of Goods Sold	
Supply Chain Asset Management	The effectiveness of an organization in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.	Cash-to-Cash Cycle Time Return on Supply Chain Fixed Assets Return on Working Capital	

Example of Industrial Enterprise Systemic IQ

- **Shall mesure the ability to improve the systemic performance**
- **Like human IQ tests, analytical results seldom match individual global, actionable intelligence**
- **Also, performance seen from the system might often contradict party's interests**
  - Might favor short term performance
  - But condemn long term survival

Calculation example

- **Given**
  - IQ: Enterprise systemic intelligence factor
  - KiPi: weighed individual systemic performance measurement
    - Ps,mo = Monetary performance for shareholders
- **IQ = 100+d(□KiPi)/dt**
  - IQ = 100 = steady performance
  - IQ > 100 performance increases
  - IQ <100 performance decreases
- **Issues:**
  - Not an absolute measurement – can perform poorly or nicely at 100
  - Do not guarantee survivability – Depend on the weighing
  - Single value: terrible, deadly performance can be offset by outstanding's

Exercise: Your proposal

- **Give a definition of an Industrial system intelligence**
- **Propose a method for assessing its IQ**
  - Based on the Industrial Enterprise Systemic performance dimensions
  - Imagine other assessment methods

Thank You !