Information: Its Deceptive, Ambiguous, Exciting Nature

Vijay V. Mandke
Research Leader, Center for Information Integrity Research,
Delhi Center: B-64, Gulmohar Park, New Delhi- 110 049,
Pune Center: Flat A-2, Nikash Skies, Someshwarwadi, Pashan, Pune-411 008.
Visit us at: centerforinformationintegrityresearch.org.

Information Integrity/Integrity Information System/Management Information System
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Lecture # 2
VULNERABILITY OF NETWORKED COMPUTRIZED INFORMATION SYSTEMS

VULNERABILITY OF NETWORKED COMPUTRIZED INFORMATION SYSTEMS

- Computerized information systems of today do make mistakes.
- This alarming reality is requiring **research attention to** questions of:

  -**errors** in information systems that are made but not corrected in spite of application controls,
  -**poor integrity** of information systems and of information therefrom,

  -finding **methods, techniques and technologies for** controlling,maintaining and improving **Information Integrity (I*I).**

Figure: A System's View of an Information System Model incorporating error implications

Note: This system's view is for use in Exercise No. (E5.1). As course progresses more detailed view will be developed.

A Core IS Model based on a view of "Information" as "Processed data"

Consider an model where:

(a) "Data" is seen as raw material,

(b) Data Product or "Information" is processed data used to trigger certain action or gain better understanding of what the data implies,

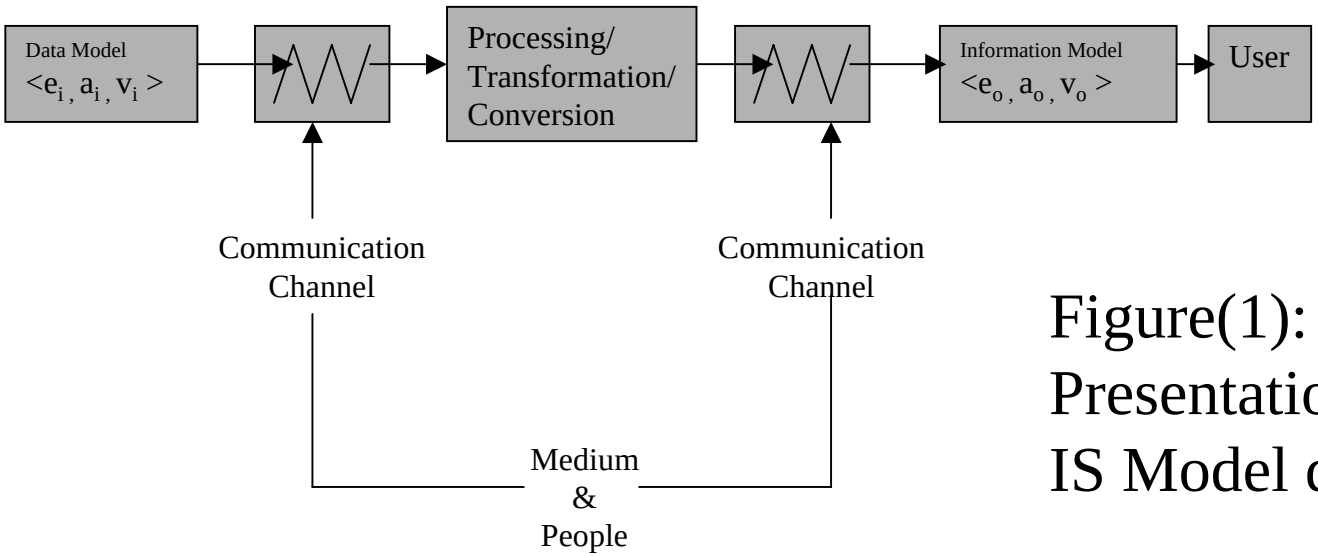
(c) "Processing" is system function,

(d) Data/Information model is represented by triple < entity, attribute, value >,

(e) Computing process includes microcomputers and telecommunication, and

(f) Communication channels comprising data communication and particularly transaction processing network with world wide reach, are components of the IS system.

This IS model shown in Figure (1) then presents information as processed data.



Figure(1): Conceptual Presentation of IS Model described above

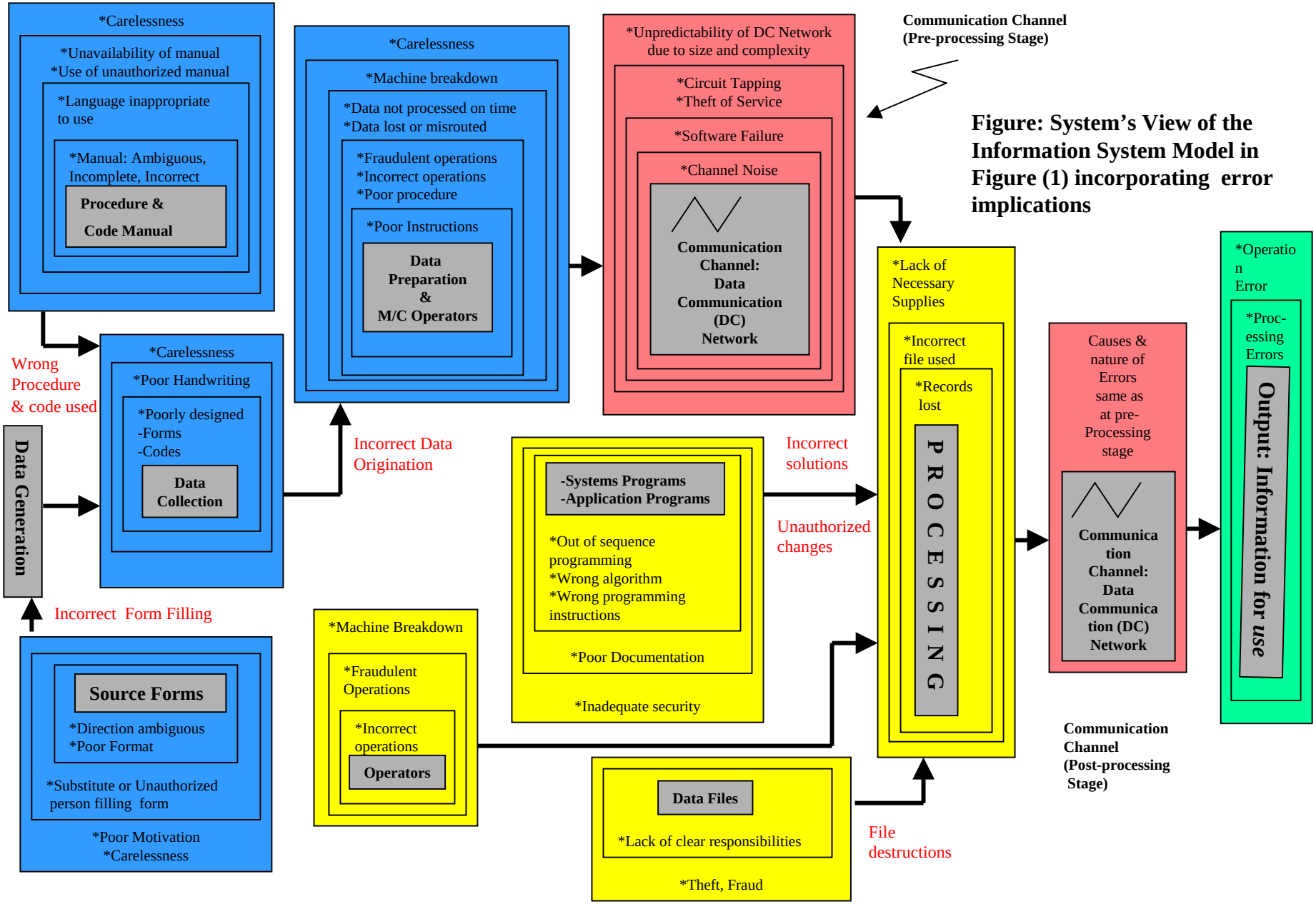


Figure: System's View of the Information System Model in Figure (1) incorporating error implications

CONCEPT OF INFORMATION-1

- At the outset, this first brings us to the question of nature of information.
- Information is just one of the categories of inputs to our minds that we work with when we are thinking.
- It takes its place alongside beliefs, interpretations, commands, advice, questions, opinions, theories, forecasts and the products of creative imagination, which by themselves again are also information.

CONCEPT OF INFORMATION-2

- Recently the term '**content**' has come in to use to describe what is to be found in information systems. It is useful because it covers all these categories and includes in verbal (visual or aural), numeric and pictorial form. It also includes such quite different products as music (Michael W. Hill, " The Impact of Information on Society", Bowker- Saur, 1999).

CONCEPT OF INFORMATION-3

- All this suggests there is no such thing as information per say. The word usefully describes a category of concepts.
- There is only information on or about something, some event, some idea. Primary information we receive from seeing an event, touching something, hearing a sound.

CONCEPT OF INFORMATION-4

- Secondary information is the same, or *almost* the same, an input conveyed to us or by us by means of symbols, especially words, numbers and diagrams, which we can interpret or translate into the information intended.

CONCEPT OF INFORMATION-5

- Thus, at a more holistic level, information may be defined as a category of concepts which our minds take in, consciously registers, to which meaning can be attributed and which normally modify our state of knowledge.
- This offers a basis for defining information at three levels (see next slide).

INFORMATION: THREE LEVELS

- Traditionally, information seen as function of "source" only.
  - For example, information in a book. Such information is often termed as "data".
- In communication theory, information refers to transmission of message and is viewed as function of "source" and "medium of communication".
- At higher (holistic) level, information is function of "source", "process" (medium inclusive), and **"recipient".**

RECOGNIZING INFORMATION is for *USE*-1: INFORMATION DEFINITION

- It is common in literature to define information as behavior-initiating stimuli.
- *However behavior can be faked.*
- This calls for a more resilient definition, which accounts for the requirement (read objective) of information (read system) continuity planning.

RECOGNIZING INFORMATION is for *USE*-2: INFORMATION DEFINITION

- I*I takes an *informational view* of system error. Although the various nuances of this view will be discussed in detail as the course progresses, for the purpose of this overview a working definition is required.

RECOGNIZING INFORMATION is for *USE*-3: INFORMATION DEFINITION

- From this point of view, it is more useful to define information as an organizing mechanism, which provides an ability to deal with the (complex and ever-changing) environment.

RECOGNIZING INFORMATION is for *USE*-4: INFORMATION DEFINITION

- Seem from this angle, information becomes:
  - a symbolic description (once again information) having modes of interpreting and interacting with the environment.
  - higher order or derivative of matter and energy on which it depends for its existence.
- At a fundamental level this brings in the realization that information is for *use*.

RECOGNIZING INFORMATION is for *USE*-5: INFORMATION PURPOSE

- Information purposes are:
  - to inform, evaluate, persuade, or organize other information (includes organizing for decision-making).
  - creating new concepts, identifying problems, decision-making, planning, initiating, controlling, and searching are information purposes in business activities.

RECOGNIZING INFORMATION is for *USE*-6: INFORMATION PURPOSE

- Purpose of supplying information (not data) to machines is:
  - to provide instruction or to provide information for stored instructions (software outcomes) to act upon.

SOME INSIGHTS INTO INFORMATION *USE* 1-MODES

- Information comes in different modes:
  - For machines, information modes are:
    - Electrical , chemical inputs
    - Sound activated recorders
    - control devices
    - numerically controlled machine tools
    - voice communication between man and machine
  - Business organizations receive information through visual and aural modes.
  - Humans receive information through human sensory modes.

SOME INSIGHTS INTO INFORMATION *USE* 2-FORMAT

- Information comes in various formats:
  - For humans formats are
    - verbal material
    - documents and
    - computer (that is today the most acceptable format).
  - Machines receive information through
    - energy patterns
    - tapes, cards, or even written form.

INFORMATION *USE*- ADDITIONAL INSIGHTS

- Semantics and syntactic are concerned with meaning of language and arrangement of words.
- Statistics is concerned with numerical assessment.
- Primary value of communication theory in studying management information lies in the key ideas of probability and reduction of uncertainty and notions of noise, lag and error in transmission.
- Social and clinical psychology involve studies of people's ability to think, process data and perceive.
- Mathematical decision theory is concerned with people's expectations of the likelihood or uncertain future events and the utility they attach to any outcome.

INFORMATION REVOLUTION

- The world is undergoing a major social and economic change, a Second Industrial Revolution, through the new information-processing technology of communications and computers.
- *Information revolution (i.e., information technology revolution) in its strictest sense is the new science of origination, storing, processing, transmitting and discarding information.*

INFORMATION REVOLUTION

- Information is the lifeblood of the complex industrial societies and it is growing in importance. A 1985 study by the British prime minister's IT Advisory panel put the number of people employed in "tradeable" information sector (publishing, consulting, on-line data-services, etc.) at about 5% of the UK workforce.

INFORMATION REVOLUTION

- But on a wider definition of the information sector, taking in the whole of banking and insurance, central and local government, and education and training, it is clear that 40-45 % of the UK workforce is directly involved in the processing of information (1985 statistics).
- Since we all use information at some time or other, in a nation's life there is no one who won't be touched by the information revolution.

INFORMATION REVOLUTION

- In 1997 the National Working Party on Social Inclusion in the Information Society, set up by IBM, defined the Information society as,
  - ‘A society characterized by
    - a high level of information intensity in the everyday life of most citizens, in most organizations and workplaces;
    - by the use of common or compatible technology for a wide range of personal, social, educational and business activities; and
    - by the ability to transmit and receive digital data rapidly between places irrespective of distance’
- (Ref: INSINC Working Party (1997) “The Net Result. Social Inclusion in the information society.” London: IBM).

INFORMATION REVOLUTION

- As we move towards information society as above, there is ever more and more information around. Some merely replaces, corrects or updates earlier information and there is also a huge amount that is new emerging all the time revealing new truths. People are thus concerned with ensuring that they have every possible relevant information; they spend all day, every day, glued to the Internet; and an average middle manager receives or sends about 180 messages every working day (US standard).
- This realization brings in an important question as to what is information?

WHAT IS INFORMATION THEN?-1

- Though this is a very discussed topic, there has not been an agreement on what the precise answer is. Each researcher has his own variant. Put it differently ‘An agreed definition of information is noticeable by its absence from the literature’
  - Ref: Badenoch, D. et. Al. (1994), “The value of information”, in The Value and Impact of Information, ed. M. Feeney and M. Grieves, pp. 9-78, London: Bowker-Saur).
- Here are some of these definitions:

WHAT IS INFORMATION THEN?-2

- Shannon and Weaver were working on the transmission of information as electrical signals when they produced their famous definition of information as ‘ that which reduces uncertainty.’ This definition has the merit of relating information to purpose or value.
- Jungclaussen and Kempe consider information as being the meaning imparted by symbols and signs.

WHAT IS INFORMATION THEN?-3

- Mason and colleagues define information as ‘the symbolic means by which one mind influences another mind’. This gives greater emphasis to the aspect of information as part of the communication process and is a useful supplement to Shannon’s definition. However, it seems to exclude the information which we acquire for ourselves by direct observation.
- Davis and Ohlson offer another wide-ranging definition: ‘data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in current or prospective actions or decisions’.

WHAT IS INFORMATION THEN?-4

- Vickery and Vickery feel that information is more than processed data: ‘information in the sense we use the term embraces not only worked up data but all other categories; fact, explanation, theory, law, method, technique, tool, even problem, and more besides: whatever, indeed, that can modify the state of knowledge of the scientist or the other recipient’- a phrase similar to but broader than that of Shannon and Weaver.
- MacKay echoes both Shannon and the Vickerys in his statement that ‘We say we have received information when what we know has changed.’

WHAT IS INFORMATION THEN?-5

- Seen from another angle, the problem seems to lie not so much with the lack of a single definition as with a failure to use a definition appropriate to the level and purpose of the investigation (Ref.: Wilson, T. (1981) On user studies and information needs. Journal of Documentation,37(1),3-15).

FOR OUR PURPOSE WHAT IS INFORMATION THEN?

- Given this (observation at Slide No. 40) and given that our course investigation concerns theory and practice of I*I control for the objective of information continuity planning, for our purpose, then definitions of information as given through Slide Nos. 21, 24,25 emerge to be more useful, acceptable and workable. For the convenience of ready reference, these are:
  - Information is an organizing mechanism, which provides an ability to deal with the environment (Slide No. 24).
  - Information is a symbolic description having modes of interpreting and interacting with the environment (Slide No. 25).
  - Information is function of “source”, “process” (medium inclusive), and “recipient” (Slide No. 21).

LECTURE# 3
PHYSICS AND PHYSIOLOGY OF INFORMATION

PHYSICS OF INFORMATION-1

- When humans perceive some event, then information is present in whatever impinges on one or more of human senses, e.g. the light *waves* which connect the scene to human eyes.
- The same applies to reading text, the translation of the shapes of letters and words into some meaning being a second stage, and, with different *wave*s, it applies to hearing sounds.

PHYSICS OF INFORMATION-2

- These waves are the physical embodiment of the information, which humans interpret as a scene or as sound and then interpret further into a mental picture or meaningful sounds.
- Similarly, the electronic pulses which are communicated between one computer and another over a telecommunication link are also information in physical form.

PHYSICS OF INFORMATION-3

- However, in the human being the only reality of information is a set of electro-chemical reactions in the brain. In the computer the equivalent is the array of bytes on the chip produced by the electromagnetic impulses.

PHYSIOLOGY OF INFORMATION-1

- Stonier points out that ‘information is an intrinsic property of the universe and exists irrespective of whether any human or other forms of intelligence perceive it utilize it.’ Certainly the sun gives out light which reaches the earth even if there is no human being to receive it *as information that the sun is shining* (Ref.: Stonier, T. (1990) Information and the Internal Structure of the Universe: an exploration into information physics).

PHYSIOLOGY OF INFORMATION-2

- But then there is the question whether such information has any reality (meaning, *use*) if there is no form of life (information processing) to receive it. It can not modify knowledge if there is no knowledge to be modified.
- Recall Slide No. 21, which argues that information is function of recipient *also* (recipient could be human, software or even a machine).
- Modern biology theory offers clearer insight into this query.

PHYSIOLOGY OF INFORMATION-3

- Specifically, as per modern biology, information was received when first form of life came into existence.
- Information in the physiological sense is older than mankind.
- All living matter depends on its internal information system: one that makes flowers turn their heads to the sun, that enables seeds to know which direction to send their roots or that enables a newly born mammal to seek nourishment from its mother.

PHYSIOLOGY OF INFORMATION-4

- Animal life has a nervous system which serves to register sensations, to convey information about the sensations to the brain, to send messages from the brain to various parts of the body and hence to simulate responses.
- Information can arrive through any of the five senses

  (touch, taste, feel, see, hear) often through more than one, and usually, when it does, we make some inference by subconsciously comparing it with information/knowledge in our brain.

* The information/knowledge already possessed will have been derived from experience or what we have learnt from others. (Precursor to the concept of standard).

PHYSIOLOGY OF INFORMATION-5

- The physics and chemistry of the transmission of senses along our nervous system is now fairly well understood. However, what happens inside the brain is still far from understood though much progress has been made in recent years.
- Research into consciousness, memory, reasoning, etc. continues apace, but there is still a long way to go before we have full information about the way the brain (mind) works.

PHYSIOLOGY OF INFORMATION-6

- Recent research on how mind works seems to show that the information which flows along the nerve system into the brain is processed and stored as nueronal assemblies.
- It now seems fairly clear that continuous processing of information does not involve thinking in words or in pictures as was imagined only a few years ago.
- Those of literary bent have been known to observe that language is the dress of thought and like a dress it does not describe the thought that underlies it but only hints at it.

PHYSIOLOGY OF INFORMATION-7

- Gardener's theory of multiple intelligence indicates the many input/output mechanisms that the mind/brain interaction has. He writes, 'we are a species that has evolved:
  - to think in language,
  - to conceptualize in spatial terms,
  - to analyze in musical ways,
  - to compute with logical and mathematical tools,
  - to solve problems using our whole body and parts of our body,
  - to understand other individuals, and
  - to understand ourselves'.

PHYSIOLOGY OF INFORMATION-8

- All or any of the seven intelligences may be involved in acquiring and understanding a piece of information even if we actually do not think in words or numbers (Reference: Gardner, H.(1993) ‘The Unschooled Mind’, pp.11-13, London, Fontana).
- One cannot help but marvel at the complexity of the brain, not least at its ability to give the capability of marveling.

Lecture # 4
PROPERTIES OF INFORMATION

THREE DOMAINS OF INFORMATION

- Information exists in three discrete domains – biology, culture, and man-made information systems.
- Accordingly, the information, which is transmitted, may generally be classified as genealogical communication, in which conservative structures are transmitted down through different channels.

INFORMATION FLOW LINES: THE GENOTYPES -1

- Such channels could be:
  - DNA,
  - A neural memory, or
  - Artifacts such as books, library, computer storage, or data mine.
- These are information flow lines and are described by term “genotype”.
  - Genotype can ‘mean a matrix, a structure, a mechanism, a rule by which to play the game’.

INFORMATION FLOW LINES: THE GENOTYPES - 2

- It is not necessarily a genome of a living being, it could mean a network of neurons or artificial intelligence devices, information processing hardware and software.
- These categories of the ‘genotype’ given by Dupuy when considered over long time periods correspond to information flow lines.
  - Ref.: (1) Dupuy, J.P. (1985), ‘Autonomy and Complexity in Sociology’, *The Science and Praxis of Complexity* S. Aida (ed) Tokyo, United nations University Press.
  - Ref:. (2) Goonatilake Susantha, ‘The Evolution of Information: Lineage in Gene, Culture and Artefact’, Pinter Publishers, London, 1991

INFORMATION FLOW CHARACTERISTICS - 1

- In the process of ‘flowing’, information exhibits certain characteristics.
- These information flow characteristics can be identified:
  - In the genetic system that describes biological evolution,
  - In the neural and social (i.e., cultural) systems that describe social and cultural evolution, and also
  - In the exosomatic (external, associated, man- made) systems, sub-systems and components.

INFORMATION FLOW CHARACTERISTICS - 2

- Since information has a continuity through time, it structures and arranges into patterns and interacts with the environment in particular, predictable and understandable ways.
- These information lineages (time dependent information threads) have dynamics of their own, with their own characteristic features and properties, which can be traced in each of the three domains.

INFORMATION FLOW CHARACTERISTICS - 3

- These characteristic features and properties are:
  - Differentiation
    - For example genetic, cultural, exosomatic information flow systems,
  - Interaction with environment resulting in
    - Time continuity (in information flow lines),
    - Bifurcation and Spaciation (in information flow lines),
    - Information continuity planning,
  - Conservation resulting in
    - Cognizing in respect of environment by information flow lines,
    - Information flow lines' 'egocentricities',

INFORMATION FLOW CHARACTERISTICS - 4

- Novelty Creation resulting in
  - Self-organizing, ‘autopoietic’ processes becoming part of information flow systems,
- Multi-linearity, Integration and Collectivities,
- Nestedness,
- Varying reaction times of different nests to changes in the environment,
- Differing flexibilities in the nests,
- Differing survival times of information in different nests,
- Co-evolution,
- Time directionality.

DIFFERENTIATION

- Information flow systems are present in different forms, namely,
  - The genetic information flow systems,
  - The neural and social information flow systems, and
  - The exosomatic information processing systems.

INTERACTION WITH ENVIRONMENT
Time Continuity

- Information flow lineages have existed from the beginning of life on earth.
- As mentioned they correspond to the genetic system, to the cultural system and to the exosomatic system.
- Flow lines associated with each system have an historical continuity; they course through time.

INTERACTION WITH ENVIRONMENT
Bifurcation, Spaciation, and Continuity Planning

- As they flow onwards (in time), they bifurcate and speciate as they interact with their environments.
- In interacting with the environment those flow systems that cannot adjust to the environment are eliminated; and those that adapt well and/or are neutral to the environment survive and continue (a pointer to the search for information continuity planning mechanism).
- Spaciation in flow lines does not necessarily develop smoothly. Sometimes there are disjunctures and sudden breaks at the speciating points.

INTERACTION WITH ENVIRONMENT
Cognizing and Egocentricities

- The flow lines interact with the environment and hence deal with it and cognize it. This is a decision situation.
- A flow line at a given time has a particular cognition of the environment, a particular ‘world view’.
- The set of flow lines is therefore a set of particular views of the world, a set of changing ‘egocentricities’.

CONSERVATION AND NOVELTY CREATION

- The flow lines have history. Particular means of dealing with the environment have become (are) engrained in them through history.
- These characteristics are conserved and passed onwards into the future.
- On the other hand, with changing environment (circumstances), novelty is also created within the flow systems.
- Self-organizing, ‘autopoietic’ processes thus form part of the characteristics of these flow systems.

MULTI-LINEARITY, INTEGRATION AND COLLECTIVES - 1

- As the flow systems differentiate (within themselves), they form multi-linear systems.
- These multi-linear systems and bundles of flow lines (spaciation; this also suggests information is an envelope, a set) are integrated at any given time through cross-information flows.

MULTI-LINEARITY, INTEGRATION AND COLLECTIVES - 2

- These cross-information flows flow synchronically form information bundle to information bundle, from information line to information line.
- Such circular information flows help integrate the flow lines and help form collectives of in the flow lines.

NESTEDNESS

- Different flow line systems, whether they be genetic, cultural or exosomatic, form a nested hierarchy.
- The genetic information flow line is nested within the cultural, and latter is nested within the exosomatic.
- Corresponding to to information transmission across these nests are cross-boundary phenomena, exhibiting general characteristics of their own.

VARYING REACTION TIMES OF DIFFERENT NESTS TO CHANGES IN ENVIRONMENT

- Nested flow lines have, in their interactions with the environment, differing time perspectives.
- The cultural system adapts to an environment much more rapidly than a genetic core; and in turn, the exosomatic nest reacts more rapidly than the cultural.

DIFFERING FLEXIBILITIES IN THE NESTS

- The flow lines vary as to their degrees of rigidity and flexibility.
- The inner cores are less flexible than the outer ones. The outer cores respond to the environment more rapidly than the inner core.
- The inner core, however, limits the nature of responses of an outer core to the changes in environment.

DIFFERING SURVIVAL TIMES OF INFORMATION IN DIFFERING NESTS

- Given that the outer core adapts to environment more rapidly and is more flexible than the inner core, the survival time of unchanged information is longer in an inner core than in an outer core
  - (However, with emphasis on system integration maximization, particularly under exosomatic information systems, situations are arising where flow lines in corresponding inner and outer cores are demonstrating comparable time constants).

CO-EVOLUTION - 1

- The informations streaming down through time structure themselves internally in particular ways, corresponding to interactions with the environment as well as to interactions between the flow lines themselves.
- The flow lines also co-evolve with each other, the development of one flow line being influenced by another.

CO-EVOLUTION - 2

- There is also a co-evolution of nested systems, with a feedback of signals from an inner core to an outer one – and vice versa – influencing this co-evolution.

TIME DIRECTIONALITY

- The dynamics of the flow systems can thus be described broadly through these general information flow properties, which – above all – impart the time directional property to information flow.

KNOWLEDGE BASE DESCRIBING INFORMATION FLOW SYSTEMS - 1

- The characteristics of these flow lines are also described through the conventional disciplines that cover the biological, social and exosomatic information science and technology fields. These disciplines include:
  - The areas of new synthesis of complex systems and Molecular Biology in the genetic sphere,
  - Psychology and several social sciences in the cultural sphere, and

KNOWLEDGE BASE DESCRIBING INFORMATION FLOW SYSTEMS - 2

  - Science and engineering areas (computer science, communication theory, information system science) supporting exosomatic information handling (origination and processing).
- Finally, flow systems by themselves are governed by deeper physical laws such as those relating to the thermodynamics of open systems.

EXRECISES - 1

- (E5.1) “Networked computerized information systems of today do contain errors”. Discuss based on the system’s view of the information system model incorporating error implications.
- (E5.2) From the area of interest (manufacturing, healthcare, facility planning, education, etc.) develop a case example explaining/illustrating the system’s view of the error infested *IS* model in Exercise (E1).
- (E5.3) “Information may be defined as a category of concepts which our minds take in, consciously registers, to which meaning can be attributed and which normally modify our state of knowledge”. Discuss this definition by taking a view of the human mind as an information processing system.

EXERCISES - 2

- (E5.4) What is the technological significance of viewing/ modeling/ defining “information as an organizing mechanism, which provides an ability to deal with the (complex and ever-changing) environment”.
- (E5.5) With the help of example show that information is a higher order or derivative of matter and energy and that it depends on them for its existence. What are the technological implications of this?
- (E5.6) It is invariably seen that corporations talk about importance of people but when it comes to cost cutting to remain competitive, it is the people cost that is cut first. Also, invariably corporations see EDP centers as cost centers and not as profit centers. What are the design information definition/ modeling limitations, which lead to such strategic approaches? What factors support and what factors oppose continued adherence to them?

EXERCISES-3

- (E5.7) In this lecture, we emphasize “recognizing” that information is for *use* and that it has purpose. Like “storing”, “retrieving” or “transacting/ processing/ converting” of information, it is not common in information processing to emphasize *this* “recognizing” function. *Here*, why this emphasis then? What do you understand by it?
- (E5.8) Describe various information purposes. Elaborate how decision-making can be viewed to be the dominant purpose of using information.

EXERCISES-4

- (E5.9) Briefly articulate how information revolution has contributed to increased importance of information in complex economic societies.
- (E5.10) Survey various definitions of information reported in the literature.
- (E5.11) Which information definition is more suitable to study I*I? Why?
- (E5.12) “The physics and chemistry of the transmission of senses along our nervous system is now fairly well understood. However, what happens inside the brain is still far from understood though much progress has been made in recent years”. Briefly comment.

EXERCISES-5

- (E5.13) “Information, which is transmitted is a genealogical communication”. What is the nature of channels through which this genealogical communication is transmitted? What are genotypes? Do they represent a genome of a living being or go beyond it? What are information flow lines? How are they formed? Are they present in each domain of genealogical communication and across them? Briefly comment.
- (E5.14) What are the characteristics of information flow dynamics, which are now information flow systems?

  Describe briefly.

EXERCISES-6

- (E5.15) Briefly discuss the interdisciplinary knowledge base describing information flow systems.

THANK YOU