

INFORMATION ENVELOPE AND ITS INFORMATION INTEGRITY IMPLICATIONS

(Research Paper)

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Abstract: Physical and informational works are strongly interrelated in a business process. This facilitates modeling a business process as an integral part of a closed loop information and control system. Various uncertainties due to internal and external system environmental factors of complexity, change, communication, conversion and corruption (i.e., 5“C”s) affect this model and raise Information Integrity issue for the same. This complex information and control system delivers a flexible information decision to control business process in a changing environment. The paper argues that a more useful view of information decision is as a process of ‘information origination and processing endogenous to decision situation’ rather than the conventional view of decision as choice between various alternatives identified exogenous to the decision situation. This flexible decision process should have the stages viz. Operable goal setting, Definition of complexity criteria, Construction of opportunity and constrain spaces, Development of information structure dynamics model, Customized planning and design of alternatives and, finally, the Choice of alternative. The conclave of information bases for these information origination and processing stages characterized by their respective contexts is normally not considered for business process *IS* modeling. It is this conclave that the paper defines as ‘Information Envelope’, and shows it to be central to the information and control system to which the business process is integral. More importantly, each of these information bases is affected by uncertainty of the type not encountered earlier. This results in further loss of Information Integrity for a business process operating in a complex and changing environment.

Key Words: Fixed vs. Flexible Automation; Informational and Physical Work Systems; Business process *IS* View; Dynamic Decision Process Stages; Maximal and Minimal Information Processing; Uncertainty; Unstructured and Aperiodic Information Processing; Information Origination and Processing.

1. INTRODUCTION

Research investigations on Information Flow Model (IFM) for Integrity Analysis presented at ICIQ1999 [5] studied Information Integrity (I*I) problem in the context of ‘errors in networked computerized information systems that are made but not corrected.’ The investigations categorized these error components in IS in terms of (a) errors with deterministic descriptions caused by singular events like software failure, and (b) errors with stochastic descriptions caused by general, judgmental, and systems factors. In the process, the investigation proposed a workable approach to developing IFM with capability for information accuracy, consistency and reliability, i.e. Integrity Analysis and Improvement Plan (IAIP), by viewing IFM in its totality. The total view of IFM includes Data Origin Stage activities, Data Conversion Stage activities and Output Stage activities, each of them having further sub-activities. Accordingly, for each of these sub-activities of a computerized information system, the investigation

proposed IFM for achieving I*I through IAIP implementation.

Though they provide a basis for generating error databases for implementing integrity analysis leading to integrity technologies discussed in literature [3], understandably, these information flow models constitute only core information system (*IS*) views for respective *IS* sub-stages for integrity analysis and improvement. This, in turn, calls for developing a systematic methodology for developing a structural model for gathering information to be processed by them and for studying the totality of I*I implications as emerging consequently.

2. BUSINESS PROCESS *IS* VIEW

Traditionally, businesses have computerized information systems (*IS*) developed in isolation, but there is no effort to optimize data or information for improved decision making. The requirement is in terms of automation of functions of 'hard 'components, i.e. of 'mechanical' or 'physical' work, so as to add value to the product produced. However, with data-driven technologies keyed to the flow of digital data throughout an enterprise and on the Net and with pressures of achieving business objectives of effectiveness and efficiency, business enterprise has a further requirement for utilizing data/information decisions 'smarter ' [6,12]. This calls for automation of 'informational work' carried out by the soft components of the enterprise wherein 'data' is seen as raw material, 'data processing or transformation or conversion' as the system function and 'data product' or 'information' as processed data used to trigger information use (decision making stage included) so as to deliver 'information decision ' in the form of information to add value to the product [4,6].

This is an application of flexible automation, which accounts for product innovation, customer needs (product requirements) and constraints of costs and capabilities, and is a structural variant from inflexible automation. Specifically, flexible automation is becoming possible due to (a) availability of on-line computers, (b) computers providing capability for moment by moment optimization of processes and decision-making, and (c) availability of system integration capability so as to yield a computer integrated system for attaining business objectives. What makes it possible now to 'put it all together ' in a total production, delivery and service system is technological reality of digital data as medium of information flow across the enterprise. Further, most importantly, such systems can be applied to both hard components of production like processes, machinery and equipment, and soft components like information flow and data bases, which constitute informational work systems [10,6].

It is within the above framework of interrelationship between informational and physical work systems and based on modeling the information flow, that it becomes possible to reinforce often-articulated proposition that, whatever else a business process does, it necessarily processes information [5]. For the purpose of the research investigation at hand, this business process *IS* view indeed is a very helpful observation. It suggests that system engineering techniques used in understanding the dynamics and responses of physical systems could, therefore, be used for understanding and predicting the operation and performance of more subjective and probabilistic description of business processes controlled by the requirements of flexible information decisions for control implementation (Figure (1)).

In what follows, this paper addresses this research issue in the context of a generic business process. It may be mentioned that as the model emphasizes information, it is applicable to manufacturing, production, or service activity. As a result, choice of any specific activity to represent the business process is only illustrative; the conclusions drawn being applicable to all types of business activities. Further, for understanding the integrity implications, the business process *IS* view can be arranged as per the levels of controls applied. Figure (2) gives this information and control system based model of the business process *IS* view for an environment characterized by uncertainty along with its I*I implications.

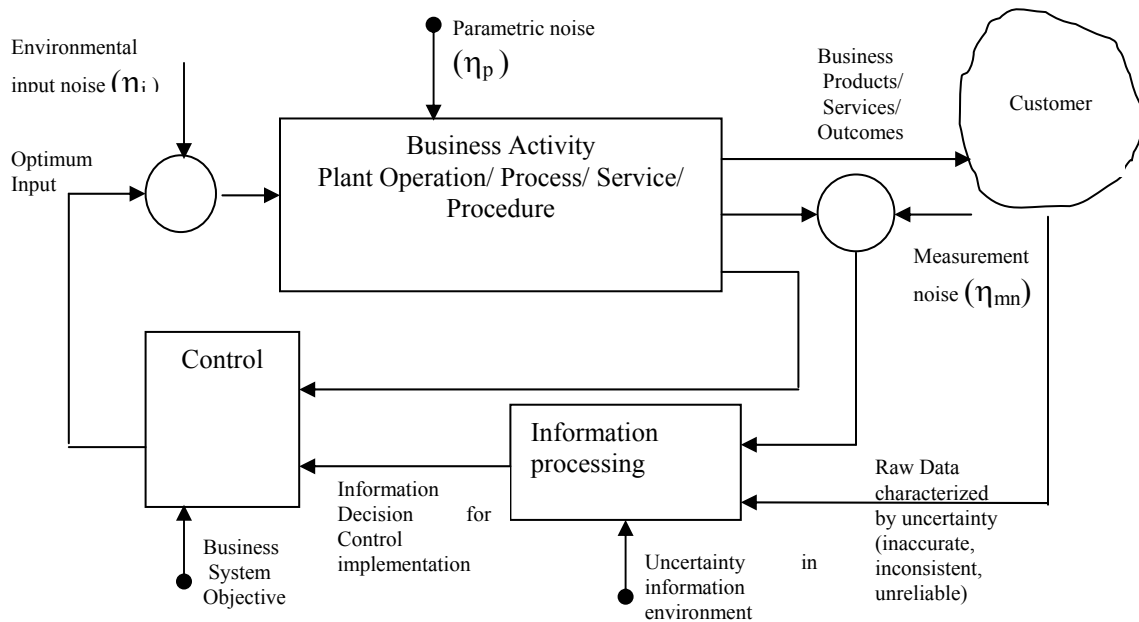


Figure (1): A Business Process IS View - A systems representation of a generic business process as integral to a closed loop information and control system.

3. UNCERTAINTY IN BUSINESS PROCESS IS VIEW AND ITS INTEGRITY IMPLICATIONS

Due to internal and external system environmental factors of change (C1), complexity (C2), communication (C3), conversion (C4), and corruption (C5) (together denoted by 5“C”s), this information and control system constituting business process *IS* view is characterized by uncertainty at various levels as described here [4,8]. Traditional systems, emphasizing individual production machines, exhibit existence of uncertainty at plant operations level and at first control level [Figure (2)]. At plant operation level, uncertainty is in the input (η_i), operations (η_p), and output ($\eta_{C1,2,4}$). At first level of control, uncertainties are due to measurement or observation noise (η_{ob}). Measurement error factors and uncertainty at plant/process operations ($\eta_{C1,2,4}$) may render information observed at plant output to be inaccurate and incomplete, i.e., affected by measurement or observation and/or plant parametric noise.

3.1 Uncertainty types newly emerged due to ‘application’ emphasis with system non-integration

With the advent of computer technology, further impetus for automation initiatives came in the form of higher-level process controls (Figure (2)). Specifically, these were ‘applications’ of computerized information systems justified (a) initially on the cost reduction aspects of processing structured and periodic information, the business work clerical in nature being the obvious choice, and (b) later as

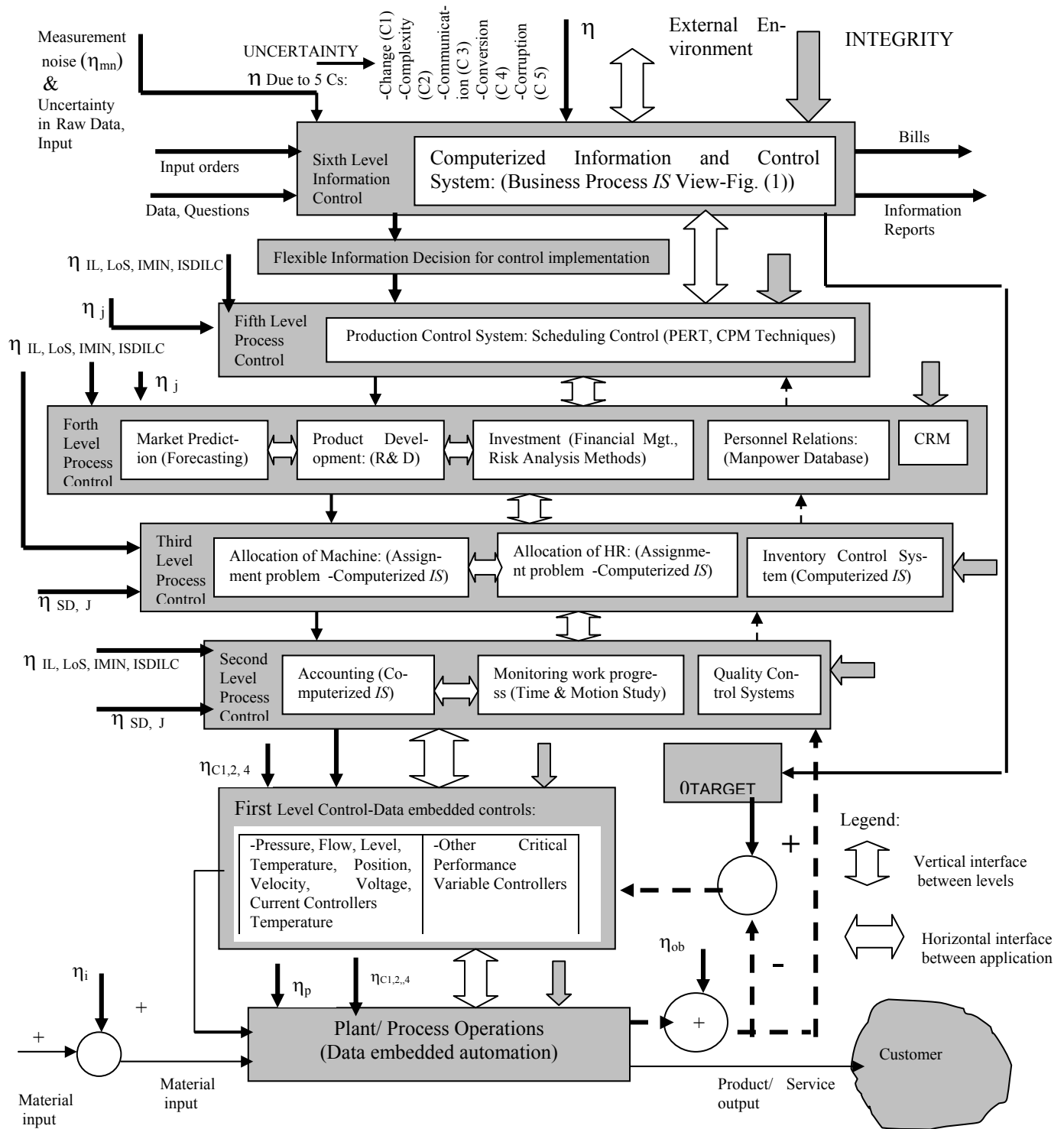


Figure (2): Business Process IS View Model describing a generic business process as integral to an information & control system for a business environment characterized by uncertainty and its Information Integrity Implications.

management tools for planning, direction and control [6,7]. Figure (2) shows different process control

levels - higher than the first level control, with the feedback information from lower level control to the higher level, and the reference, i.e. feed-forward information, from higher level to lower level. For reasons mentioned, businesses developed more and more of these ‘applications’, each with its own terminology, procedures and data sources giving rise to new uncertainties. Further at these higher levels, human-machine interface is also prevalent. Within this framework, following uncertainties are identified.

3.1.1 Uncertainty types present at all process control levels ($\eta_{IL, LoS, IMIN, ISDILC}$)

- a) Uncertainty due to information overload (η_{IL}),
- b) Uncertainty due to lack of standardization (η_{LoS}),
- c) Uncertainty due to lack of relationship between data in several applications (problems arising from emphasis on integration minimization) (η_{IMIN}),
- d) Uncertainty due to errors in hardware, software, data entry, or accidental or intentional failures (including human failures, etc.), i.e., uncertainty due to errors in information system development and implementation life cycle (η_{ISDILC}).

3.1.2 Uncertainty types at process control levels 2 & 3

Process control levels 2 & 3 deal with managerial decisions at middle level (Figure (2)). In addition to types of uncertainties identified above, these levels are also characterized by uncertainty due to incomplete knowledge of system dynamics (η_{SD}) and due to judgmental errors at human-IS interface (η_j) (Section (1)). These levels are characterized in much more rudimentary and uncertain way by the deterministic and stochastic models of linear and non-linear programming decisions as against the plant/process and first-level controls that can be fully described by deterministic model.

3.1.3 Uncertainty types at process control levels 4 & 5

Process control levels 4 & 5 deal with higher management level decisions (Figure (2)). Understandably these levels are characterized by human-machine systems in which humans start playing dominant part in decision-making. Particularly, process controls at level 4 are often based on decision theory models. Against this, process control level 5, which may comprise production and scheduling controls (planning control included), differs from conventional control in that it includes humans as part of the process to be controlled. All this adds to uncertainty at process control levels 4 and 5 (η_j).

3.1.4 Uncertainty type at information control level 6

Above production process is put in operation emphasizing non-integration (see Item 3.1.1–(c)). Accordingly, while automating (i.e., optimizing) it with the help of five control levels as above, what has not been possible is to optimize design continually, i.e. in *on-line* fashion. This continuity is the basis for production line delivering mass-customized products for continually changing business environment (product innovation included) with emphasis on integration maximization across the supply chain.

The technological reality of the sixth level information control makes this possible. Specifically, the sixth level control is a business process *IS* view, and it comprises human-machine systems. Very little is understood about physical structures governing sub-systems and components of the sixth level control system. As a result this level is normally described by an inductive model, which is developed based on observations made on the real-world business operations. The problem is that these observations are invariably noisy and distorted. In other words, one is faced with the problem of implementing sixth level information control, when data available to develop the control model is characterized by uncertainty (η_{mn} and uncertainty in raw customer data) (Figure (1)).

3.2 Uncertainty types due to increased complexity

And, even as, there is increased emphasis on ‘applications,’ microprocessors and data driven technology keyed to the flow of information across the enterprise have led to total shift toward system integration. Resulting reduction in information processing costs and competitive advantage of the systems developed have further accelerated this shift [7]. Thus, on one hand, one sees a dramatic increase in use of computers

in the form of ‘embedded systems’ over a widest range of systems [11]. On the other hand, the business enterprise has its goal shifted from that of ‘cost minimization’ to that of ‘financial optimization’. At every level all this has, understandably, led to use of components and systems, which are complex in nature. This has further added to the uncertainty due to system integration as follows ($\eta_{C1,2,3,4,5}$):

3.2.1 Uncertainty in plant operations

Process failures may occur due to complex error mechanisms coming from design, manufacturing, commissioning and maintenance phases and acting with delay ($\eta_{C1,2,4}$).

3.2.2 Uncertainty in plant and first and higher level control operations due to failure of ‘embedded systems’

Traditionally, hardware has been considered to be reliable. However, with embedded systems all this has changed. This failure can emerge due to inadequate tests undertaken; due to incompatibility between electrical components; and due to maintenance errors. It is these failures of ‘embedded systems’ that then result in uncertainty in plant and first (and higher) level control operations (η_{C2}).

3.2.3 Uncertainty due to presence of system interfaces ($\eta_{C1,2,3,4,5}$)

System integration impacts all the six levels of controls as also the plant/process operation by introducing system interfaces (Figure (2)). These interfaces call for the specification of each IS module to include details of its interaction with other modules. This interaction may be formalized in an interface design specification (IDS), which sets out the data or messages sent between modules, and any protocols used. As the levels of information and control system in Figure (2) interact laterally and vertically (figure does not show interactions in full), it follows that modules that are internal will also have interfaces with modules at the boundary and, therefore, with external system and vice versa. In the wake of emphasis on system integration maximization, more often than not the resulting interactions will be complex, thereby introducing further uncertainty at all levels (plant operation inclusive).

3.3 Information Integrity Implications

The presence of uncertainties as above at all levels of information and control system leads to errors in business process *IS* view, which are made but not corrected in spite of application controls [5, 4]. This results in loss of integrity at the data processing stages, thereby, rendering data and information processed inaccurate, incomplete, not up to date, and unreliable. Figure (2) indicates at critical points the noise inputs discussed above, and acknowledges the presence of systems interfaces. For the purpose of presentational simplicity, the vertical interfaces between levels are shown in complete, while the lateral interfaces between applications at a level are shown nominally.

4. IMPROVED BUSINESS PROCESS *IS* VIEW AND CONSEQUENT UNCERTAINTIES AND INFORMATION INTEGRITY IMPLICATIONS THEREOF FOR COMPLEX AND CHANGING ENVIRONMENT

In the study of a business process operating in an environment characterized by uncertainty, the identification of an information and control model as in Figure (1) has made it possible to consider applying system engineering techniques to research the I*I problem at hand. As shown in Figure (2), what one is dealing with is a multi-level control problem. Though a large system problem, the problem is tractable.

4.1 Applicability of classical control theory techniques at plant/process operation level and at first control level

At the lowest level, one is concerned with plant operation and processes, which primarily comprise individual production machines, and microprocessor based data embedded systems that are describable by deterministic mathematical models. Similar is the case with first level control models. These models are deductive and are arrived at by having complete understanding of physical structure of the system and either by analytical consideration or by experiment. Such models are susceptible to being controlled in accordance with the principles of classical theory of automatic control.

4.2 Applicability of system engineering techniques at process control levels 2-5

As mentioned in Sub-sections (3.1.2 and 3.1.3), the controls at levels 2-5 are amenable to quantitative treatment through various models covered by systems engineering tools and techniques scanning a wide range of interdisciplinary areas. Thus, based on knowledge of system engineering tools and techniques, the Figure (2) problem of information and control system modeling of a business process, looks tractable even as one grapples up to 5th level control, which include product innovation, planning and design stage requirements.

4.3 Implications of 6th level information control – Shift from structured to unstructured information processing

However, methodological inadequacy creeps in as one deals with the information control at level 6. As pointed out in Section (2) and Sub-section (3.1.4), now, it is possible to optimize design continually, i.e. in *on-line* fashion (continuous product innovation), as a basis for production line delivering mass-customized products and services for continually changing business environment. In other words, in order not to be blind-sided in rapidly changing markets, the search and relevant information decision must not be restricted to diagnostic routines and procedures ballistic in nature. Instead, senior management needs a measurement and decision system more like the one used by the national weather service. Ground stations all over the country monitor temperature, barometric pressure, relative humidity, cloud cover, wind direction and velocity, and precipitation. Balloons and satellites provide additional data. These are monitored continuously and fed to central location where they can be used to search for patterns of change. Based on these intelligence data, forecasts of impending conditions can be made or revised (flexible information decision) in the light of changing circumstances [9].

As mentioned in Section (1) and Sub-section (3.1.4), in the form of information control at the 6th level, thus one has inductive modeling exercise at hand based on real world business observations. This exercise (a) involves multiple goals, many factors, and a large number of interdependent information variables, varying with time, and not completely and correctly observable, and (b) its system dynamics is not well understood. This is a complex problem solving exercise, and significantly the complexity is not of the *order*, but of the *organization* [1,2]. In other words, the information control at 6th level involves processing of unstructured (maximal) information as against structured (minimal) information as has been the case up to 5th level control [6, 9]. To that extent the 6th level information control dramatically distinguishes itself from information processed at lower levels by mainly acquiring an open system character. In fact when system integration is complete, all levels acquire open system character, the degree of openness being directly proportional to the order of the level; and in the process the system at its all levels assumes a high degree of complexity.

4.4 Goal Setting with integrity: A critical information origination requirement of information control

One of the unique properties of an open system is it has a purpose or goal or direction. As a result,

activities of continual operable goal setting and implementing so as to deliver correct action, i.e., implementing with integrity become critical to the satisfactory functioning of the open system in a constantly changing environment. And as it should be these goal setting and implementing activities in themselves work out to be information origination and processing activities characterized by their own brand of uncertainties; thereby making integrity of information processed through various stages an additional necessary requirement (to the integrity implications as already identified under Figure (2)).

4.5 Goal Types, Multiple Criteria, Many Factors, Interdependencies and Uncertainties [Figure (3)]

System's research suggests that goals can be of various types: general, specific, positive, negative, clear, unclear [2]. Unclear goals are further characterized by implicit goals, which often may come with time delay. A system can have multiple goals, and, depending on type, goals can be multi-criteria or a single (few) criterion. In multiple goal situations, goals can be independent or interdependent. Further, goals are characterized by many factors that may lead to a large number of information variables which within themselves may be independent or interdependent (linked positively or negatively). It so works out that complex systems are invariably characterized by multiple, interdependent, conflicting and often unclear goals described by multiple criteria and by many factors and large number of interdependent and time varying information variables. Even seemingly simple open systems are complex; e.g., a simple user interface can add substantial uncertainty and hence complexity.

4.6 Planning and Design Opportunity and Constraining Spaces and Uncertainties therein [Figure (4)]

There is yet another aspect. Specifically, as shown through Figures (3(a)) and (3(b)), the information processing for the operable goal setting is characterized by its own uncertainty; thereby ensuring, in the goal set, ambiguity for strategic uncertainty. This indeed is a welcome requirement as it is this ambiguity that provides a basis for constructing an acceptable opportunity space for business for continuous innovation in a changing environment [2,9]. However, this ambiguity may also constitute an entry point for such planning and design processes and procedures (human behavior included), which may not fit the core business values, and, hence, may not be acceptable. In other words, the ambiguity in goal set would bring in strategic uncertainty and, therefore, a risk element. As a result, the methodology for operable goal implementation would also need to develop information systems for constructing acceptable opportunity (innovation) and constraining (process and procedure) spaces in order to increase the benefits of the positive risk (acceptable opportunity) and reduce the implications of the negative risk (unacceptable procedures and processes) (Figure (4)).

4.7 Structural model of interdependent information variables and information system dynamics model – Information Origination and Processing in presence of uncertainties [Figures (5-7)]

It is based on these goal setting and opportunity and constraining space defining activities that the subsequent stages in goal implementation can be carried out. Specifically, one can develop the structural model for information variables by observing the changes that the information variables (identified from the operable goal setting exercise) undergo over time and/or through study of their co-variances with time delays. This requires identification and integration of information over time, and thus becomes an information origination and processing activity (Figures (5-6)). This needs to be followed by developing time sequence development trends, i.e., information dynamics model (Figure (7)); so as to model the information structure dynamics. As described through Figures (5-7), respectively, their own types of uncertainties characterize both of these information origination and processing stages.

4.8 Origination of Alternatives and Selection of Flexible Information Decision Endogenous to decision situation and uncertainties therein [Figure (8)]

Given the customer requirements for products and/or services at any time 't', the business process IS view, in the form of 6th level control, would then need to develop (based on the model of information structure dynamics obtained as above) the flexible information decision for control implementation. Specifically, this would have to be achieved within the boundaries of the opportunity and constraining spaces (see Figures (4) and (8)). This then gives the framework for removing the inadequacy in methodology for undertaking the inductive modeling exercise at the 6th level information control.

The task of delivering the flexible information decision as a result of the information processing at the 6th level in Figure (2) cannot be seen merely as that of forecasting (prediction), evaluation of alternatives and selection exogenous to decision situation (as traditionally suggested under system engineering techniques as also in literature [7]). It must be seen as that of dealing with maximal information involving a process of information origination and processing, which leads from the initial recognition of a problem, i.e. operable goal setting followed by subsequent stages as shown in Figures (3-7) and ending in Figure (8). In other words, decision alternative and information have to be originated endogenous to decision situation. This indeed is an important observation as it offers a workable method for an inductive exercise to identify unstructured information processed by an open system. It also helps develop an improved business process IS view model over what has been suggested in Figure (2). And, as shown in Figure (8), this information processing delivering flexible information decision is characterized by uncertainties.

4.9 Loss of Information Integrity at Information Origination and Processing stages

Figures (3-8) are information origination and processing stages. As each of these stages is impacted by respective uncertainties, all through, there is loss of integrity as the maximal information gets processed. This results in inaccurate, inconsistent and unreliable processing of operable goal set and of information through subsequent stages, thereby so rendering the flexible information decision *also*.

It is within this framework that the improved business IS view (incorporating the maximal information processing stages from operable goal setting to flexible information decision and its control implementation for customized product/service delivery) need to be researched for uncertainties therein and for their I*I implications. Needless to say, each maximal information processing stage as these, by itself, is also a complex system, thereby increasing the complexity of the business IS view by that order. As a result exhaustive I*I studies for each of these stages offer areas of separate research investigations and are beyond the scope of the present research query. However, to tie the knots together in respect of the components, sub-systems (elements), structure and information variables of the improved business IS view, Figures (3-8) describe systems representations of these maximal information processing stages along with uncertainties and I*I implications.

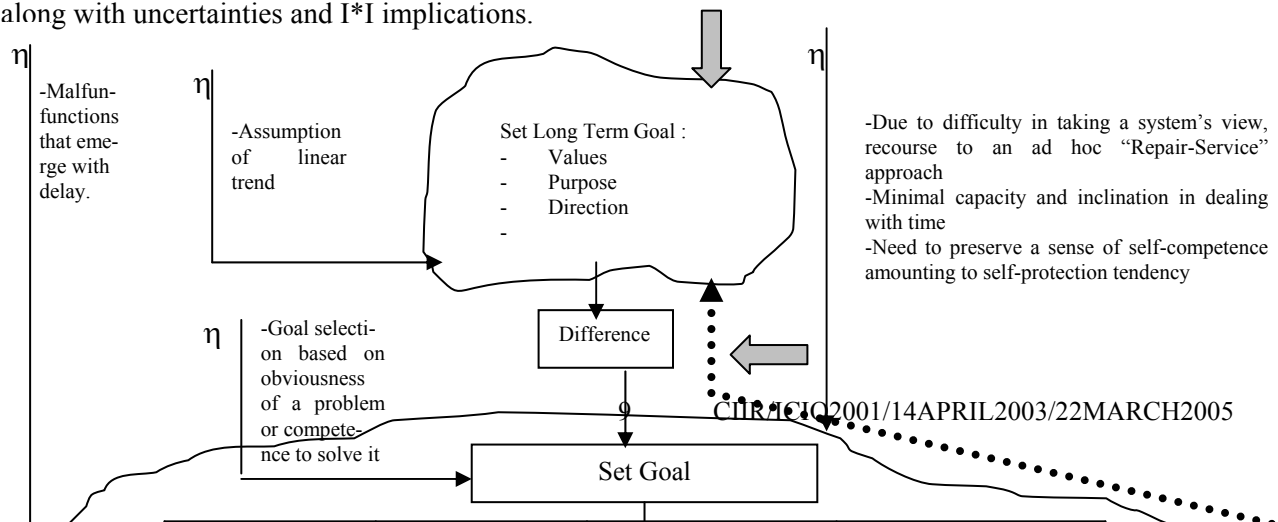


FIGURE (3 -A): SYSTEMS REPRESENTATION OF INFORMATION BASE AND ITS PROCESSING FOR SETTING OPERABLE GOAL – FROM

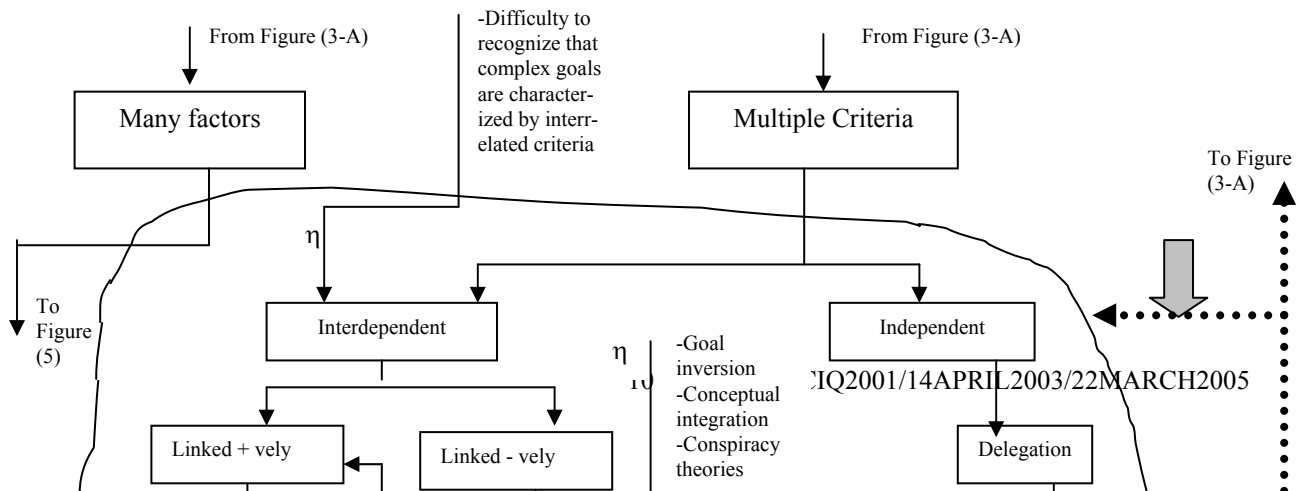


FIGURE (3 - B): SYSTEMS REPRESENTATION OF INFORMATION BASE AND ITS PROCESSING FOR SETTING OPERABLE GOAL – FROM ‘MANY

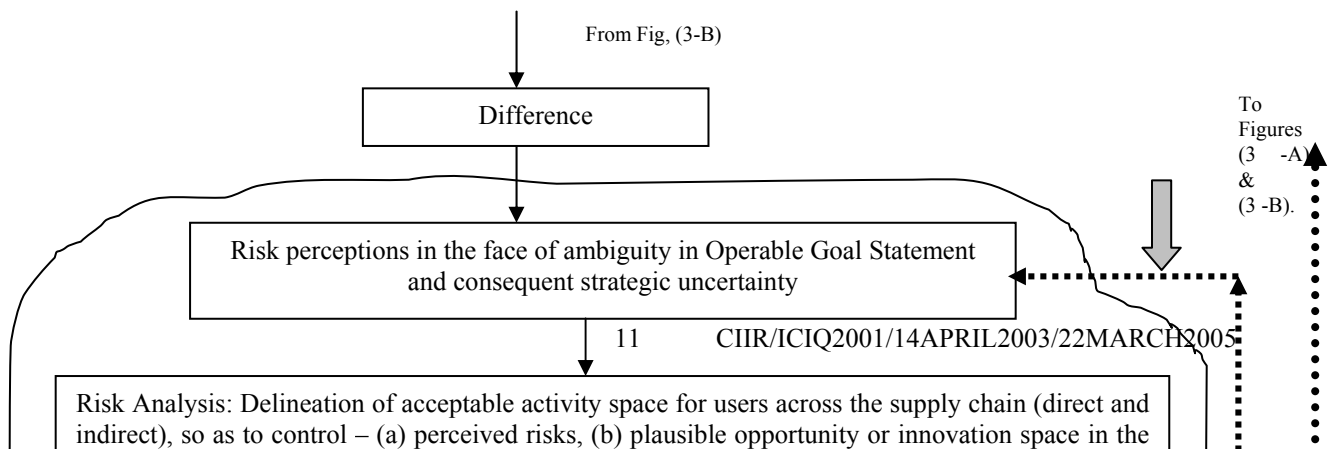
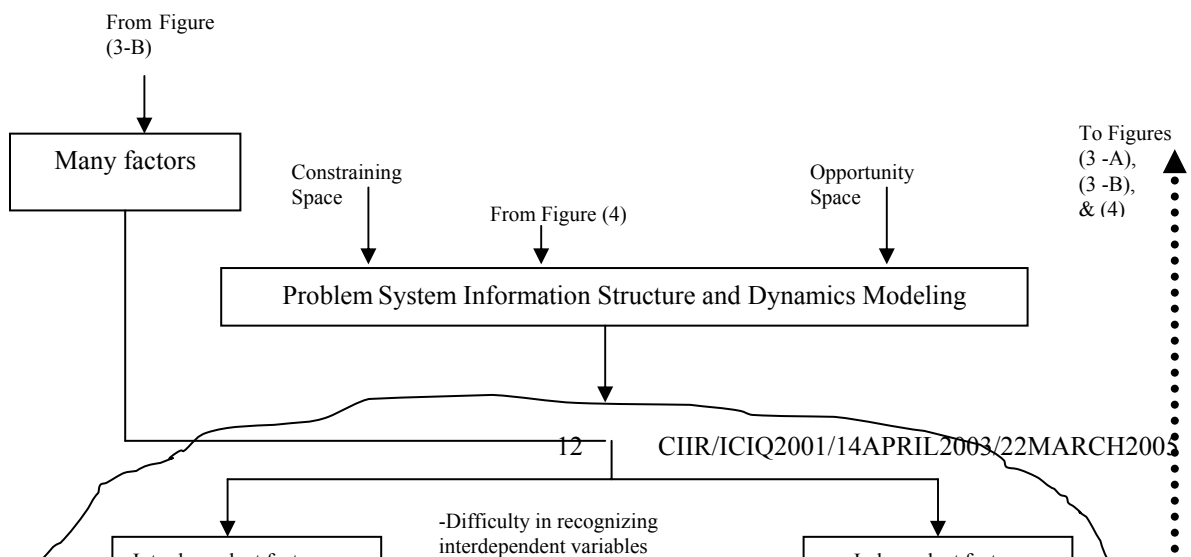


FIGURE (4): SYSTEMS REPRESENTATION OF RISK ANALYSIS INFORMATION BASE AND ITS PROCESSING – FROM OPERABLE GOAL



From Figure (6)



Problem Information Structure Model

To Figures
(3 -A),
(3 -B),
& (4)

- Difficulty in perceiving – recognizing, dealing, arranging in time.
- Tendency to treat successive steps in temporal development as individual steps.
- Reliance on only few mechanisms of prognostication to gain insight in to the future.
- Limited focus on the present.
- Fixation with the characteristics of the moment brings with danger that too much significance ascribed to present circumstances.
- Fixation on linear future development

η

η

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- Difficulty in dealing with non-linear configurations like “exponential growth.”
- Tendency to interpret numbers solely on the basis of their size.
- Tendency to rely on “feelings” or “intuition”- even professionals demonstrate this strait.
- Reliance on magical hypothesis as a result of overgeneralization.
- Misjudging non-linear growth.
- Fallacy of “progressive conditionalizing” resulting in action completely devoid of reality.
- Fallacy of metahypotheses.
- Absence of learning mechanisms in the form of

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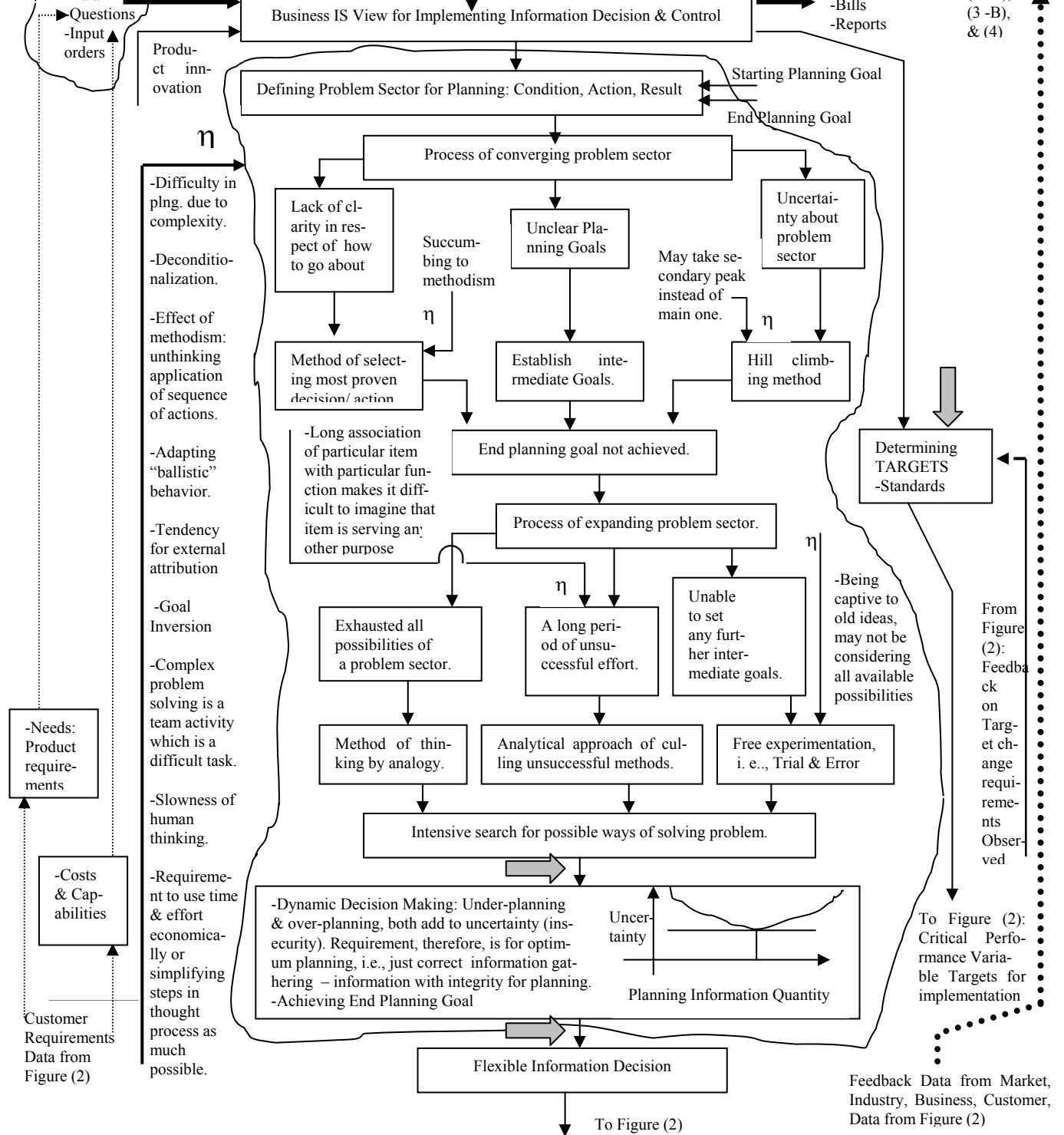


FIGURE (8): SYSTEMS REPRESENTATION OF INFORMATION BASE FOR FLEXIBLE INFORMATION DECISION

5. DEFINING THE INFORMATION ENVELOPE

Modeling business process as integral to an information and control system facilitates application of modern control techniques for improved business performance for strategic advantage. Of course this requires means for acquiring process data and information on current basis. The latter requirement can be met with advances in computer-integrated systems and with realization of relevant data and information driven technologies. Indeed, it is here that one sees the shift from ‘information technology’ to ‘information’ in dealing with the desired objective of strategic business advantage.

Traditionally, with emphasis being on standard products and cost reduction for strategic advantage, business reality model has been viewed as a closed system having structured and repetitive information requirements wherein information content is minimal. Information models were thus developed for meeting the functions of forecasting, evaluation of alternatives, and selection exogenous to the decision-making requirements at various levels of management [1,7].

However, as argued through the paper, this reality model of business process is inadequate. Business process *IS* view is an open system and, as a result, for strategic advantage emphasis required is not so much on cost reduction in isolation but on maximization of informational value. This requirement in turn goes to suggest a more workable structure for information model comprising information bases as identified through Figures (3-8) in addition to that from Figure (2).

From Figures (2-8), in the form of improved information model, thus, one has a conclave of information bases and the same is termed as 'Information Envelope'. In view of open system character of the business process *IS* view, it is *for* this Information Envelope that information is required to be continuously originated and processed. This enables to equip the information and control system model of business to meet the challenges of customization and financial optimization for competitive advantage in a complex and changing environment; in turn making the Information Envelope based informational view of the generic business process a critical requirement. Figure (9) gives systems view of an Information Envelope as above characterizing an open, complex system.

6. EMERGENT ALL ENCOMPASSING VIEW OF INFORMATION INTEGRITY

And, as shown through Figures (2) and (3-8), it is for this Information Envelope that information origination and processing for each of its information bases is affected by uncertainties of the type not encountered traditionally, resulting in loss of I*I. This makes I*I, i.e. accuracy, consistency and reliability of Information Envelope, the key factor in determining the strategic business advantage.

Research investigations suggest I*I design basis by incorporating automatic feedback control systems [4,6]. Activity of goal setting is an important requirement in the functioning of open systems. Systems techniques have considered learning mechanism as a workable method to deal with uncertainty in a changing environment [6,13]. Also, as the concept of 'feedback' is implicit in 'learning' mechanism design, literature suggests that the 'automatic feedback control system' conceptualization of I*I Technology can be further extended to develop an adaptive learning based I*I planning framework for complex and changing *IS* environment characterized by uncertainty [6].

Details of these I*I Technology implementation aspects are outside the scope of the present investigation.

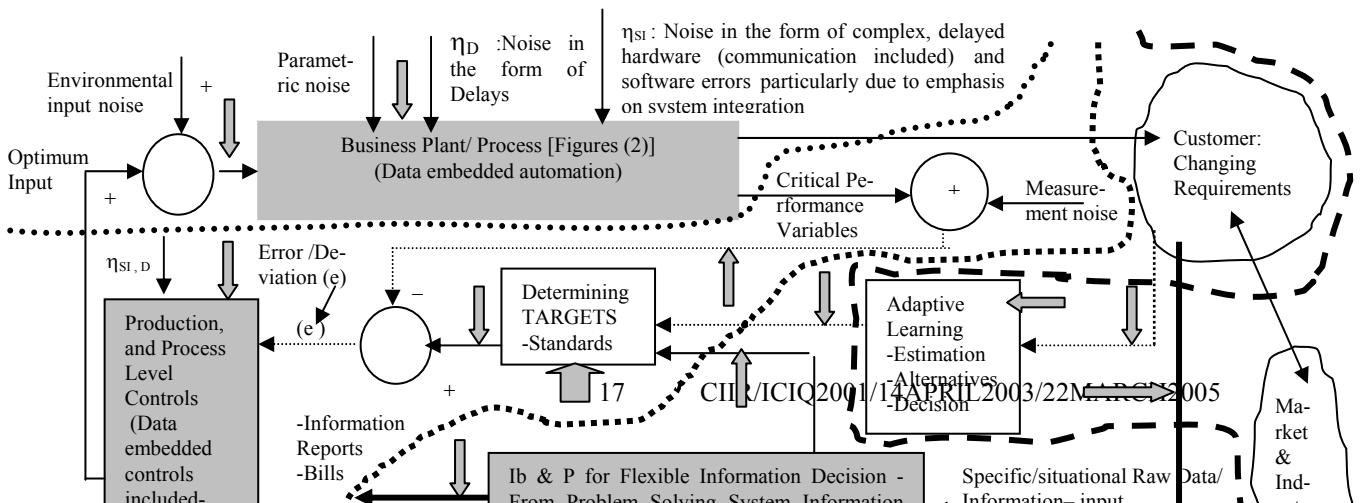


Figure (9): For a complex, changing environment, Systems View of a generic business process as integral part of a closed loop information and control system characterized by Information envelope and its processing in the presence of uncertainty and the emergent all encompassing view of INFORMATION INTEGRITY.

However, within their framework and based on the view of the improved business *IS* model and of uncertainties therein developed in this paper so far, I*I implications can be conceptually indicated for different information bases and their respective processing stages under the Information Envelope (Figures (2-8)). In the process what emerges is an all encompassing view of I*I as it applies across the information and control system model of the business process operating for competitive advantage in a complex and changing environment, and the same is given in Figure (9).

7. CONCLUSION

Generic business process covers entire supply chain from concept to delivery. A competitive business strategy calls for a good understanding of business process, which in turn requires choice of a good business model. Depending on research need such models could emphasize different facets as material, flow, equipment, money, information, etc. With advances in computer integrated systems and in data and information driven technologies, it has become possible to obtain process data and information on current basis and to manipulate it 'smarter' for strategic advantage. Specifically, what this leads to is an information and control system based model of which generic business process is an integral part. Therefore, competitive advantage can be achieved in a complex and changing business environment by systematically controlling the information processing under this business process *IS* view.

This requires a clearer perception of the nature of information processing. Most information processing involves some type of data conversion to information in use and, therefore, is closely related to a decision process with an objective. Even when the information is transmitted without changing form, as in a communication system, the issue is to decide the purpose or objective of the transmission.

Traditionally, within the system-engineering framework, decision process is viewed to comprise stages of forecasting (prediction), evaluation of alternatives and selection. However, information and control system based model of a business process is an open system. For it a more workable model of a decision process spans multiple stages. They are: initial problem recognition (goal setting); identifying information variables for a complex problem system; constructing problem solving opportunity and constraining spaces; developing information structure, and information structure dynamics models; and undertaking customized planning & design for development of alternatives for the evaluation of final choice for delivery of flexible information decision for control implementation.

What is significant is all of the above stages from goal setting to final choice of flexible information decision for control implementation are, by themselves, complex information processing stages and, therefore, involve information origination and processing activities with reference to their respective information bases. And of still greater implication is the reality that at each stage these information origination and processing activities are affected by uncertainties; resulting in errors in information processed from stage to stage.

The Information Envelope comprising the information bases is thus characterized by loss of I*I at all levels; thereby making Information Integrity a key factor determining the strategic business advantage in a complex and fast changing environment.

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