Error Model Choice – Information Error

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Error Model Choice – Information Error

OVERVIEW - 1

- What is needed then?
- Need for Theory of Errors
- Error and Accident-What is the difference?
- Error Definition
- What is an accident?
- Error Taxonomies
- Viewing Error-What is the limitation?

OVERVIEW - 2

- What is an error in application setting then?
- Example
- Lessons abstracted from the Example

RECALL FROM LECTURE # 12: WHAT IS NEEDED THEN? -1

- In fact there *is* the issue of Information Integrity (I*I) risk that the decision making process in a complex and changing environment experiences.
- Specifically, I*I risk is of making a decision choice *ex ante* which will, according to the *ex ante* estimate of the decision-making process, perhaps turn out to have been sub-optimal *ex-post*.

WHAT IS NEEDED THEN? - 2

- This kind of risk has to be caused by insufficiently full and perfect information, which is either misleading (biased,i.e., distorted) and/or incomplete (noisy).
- Such information is with inadequate integrity, hence with a requirement for additional information value, which improves value of available I*I.

WHAT IS NEEDED THEN? - 3

- Search for *IS* model that helps analyze I*I risk (and uncertainty) and hence value of information and of I*I defined as above is then the concern of study through the rest of the course.

NEED FOR THEORY OF ERRORS

- Information with loss of integrity is insufficiently full and perfect information. This is the question of information error.
- Any pursuit to do something about errors in any application (for example, in banking operations or say in medicine, etc.) would depend directly and strongly on some theory of what an error is, how an error is generated, what happens after an error comes into being, how it is that an error is detected, and what it is that causes damage (minor, acceptable or unacceptable). This is true for errors in physical systems as also in informational systems.

ERROR AND ACCIDENT - WHAT IS THE DIFFERENCE?

- To cure error in any application sector (nuclear power plants, manufacturing industry, banking sector, telecommunications network, medical application, or kitchen), one must know something about faults/irregularities/deviations in that application sector. What is an error? Why do errors occur?
- The causal mechanisms of errors in a given specific application sector of say nuclear power plant, if there are any, must be the same as those of errors in manufacturing sector, or in a medical application, or in the kitchen.
- Although most people use the terms specifying errors from their application sectors, what they talk about are accidents. What is the difference between error and accident? What is required is to give answers to such and other questions?

ERROR DEFINITION-1

- What is an error?
- From the viewpoint of an external observer, an error can be seen as a failure to ensure an optimum, desired, or intended value (for a view, format, variable, or process, etc. as the case may be) that is correct given the circumstances (situation), the cause and form of error not withstanding. An error can occur only if there is an appropriate identified source of value (standard) to ensure on the basis of a documented state of events.

ERROR DEFINITION-2

- An error must *not* be defined as an adverse or serious outcome. An adverse outcome or accident may happen with no antecedent error. This may occur if the intention (standard) was the proper one, the action was properly executed, and the outcome was not certain.
- Examples are playing a game, deciding whether to carry an umbrella, administering a medicine, or performing an operation known to be risky.

WHAT IS AN ACCIDENT?

- An accident is an unplanned, unexpected, and undesired event, usually with an adverse consequence. An adverse outcome after an error, by this definition, must be construed to be an accident.
- An error is an informational event with informational causes, if errors are caused at all (there is always the possibility that causes of all or some errors can not be identified).
- An error may have any of a (possibly large) number of causes. A defined causal mechanism can give rise to a taxonomy of errors. As for almost anything, there are an almost unlimited number of taxonomies of error.

ERROR TAXONOMIES-1

- Of the many taxonomies of error, few that have been found useful are mentioned here.
- **(a) Errors can be classified according to a hypothetical internal causative process.**

- ***Input Error or misconception***. The input data are incorrectly perceived, then an incorrect perception is formed based on that misconception, and the wrong action is performed predicated on the incorrect intention. Thus an action is committed other than that which would have been intended had the input been correctly perceived.

ERROR TAXONOMIES-2

- ***Intention Error or Mistake***. The input data are correctly perceived, an incorrect intention (standard) is formed, and the wrong action is performed predicated on the incorrect intention. Thus an action is committed other than that which should have been intended given that the input was correctly perceived.

ERROR TAXONOMIES-3

- ***Execution Error or Slip***. The input data are correctly perceived, the correct intention is formed, and the wrong action is performed. Thus an action is committed other than that which was intended.
- **(b) Errors can also be classified according to the assumed locus of the causal process.**

ERROR TAXONOMIES-4

- ***Endogenous Error***. This is an error that arises from processes inside the actor. The elimination or reduction of such errors must involve internal properties, organization and structure.
- ***Exogenous Error***. This is an error that arises from processes outside the actor. The elimination or reduction of such errors involves design of objects and work environments and correction of policies, protocols, and procedures.

ERROR TAXONOMIES-5

- **(c) Errors can also be classified according to the observable nature of the error.**
- If an error actually results in an action, then there is a phenomenon that can be observed. The particular appearance of the error may be called its *mode*. An example of phenomenological taxonomy of error (by mode) is as follows.

ERROR TAXONOMIES-6

- ***Error of Omission***. This is an error characterized by the leaving out of an appropriate step in a process.
- ***Error of Insertion***. This is an error characterized by the adding of an inappropriate step to a process.
- ***Error of Repetition***. This is an error characterized by the inappropriate adding of a normally appropriate step to a process.
- ***Error of Substitution***. This is an error characterized by an inappropriate object, action, place, or time instead of the appropriate object, action, place or time.

Error Taxonomy Classification Category	Purpose of the Classification Category
1. Internal cause category 1. Input Error or Misconception 2. Intention Error or Mistake 3. Execution Error or Slip	Provides theoretical basis for a program of behavioral or neurological research.
1. Assumed locus of the causal process 1. Endogenous Error 2. Exogenous Error	Divides the universe of error into those that can analyzed and cured by engineering, design, societal, and procedural changes, and those that can be analyzed and cured through environmental/ informational/ psychological intervention and modification.
1. Observable nature of error 1. Error of Omission 2. Error of Insertion 3. Error of Repetition 4. Error of Substitution	Provides a basis for the analysis of the consequences that will follow on the expression of the error in a particular working environment (an operating room or a nursing station, for example).

VIEWING ERROR WHAT IS THE LIMITATION?

- Much of the discussion about errors in any application domain (sector), is confusing or confused because of the differences in terminology used by the discussants. One person's error may be other person's accident. One person's slip may be other person's mistake. A generally accepted, standard terminology is yet to be established.

WHAT IS AN ERROR IN APPLICATION SETTING THEN? -1

- How is an Error defined in the context of a given application domain (sector)?
- It is common to discuss errors in a given application setting in terms of their expressions, that is, what went wrong or what was done wrong. It is common to report errors in an application sector (domain) only in terms of their adverse consequences, that is, what happened as a result (for example, in case of a medical setting, what happened to the patient).
- This has serious shortcomings. Only those consequences that result in irreversible damages get reported (in say a medical setting, irreversible damage/consequence may be injury or death).

WHAT IS AN ERROR IN APPLICATION SETTING THEN? -2

- Thus, in reality, what are reported are not errors in a given application domain (sector) but application sector specific accidents consequent on errors for which a process or processor (for this purpose human is considered as a processor) might be held responsible.
- What is not seen are those errors which occurred and were caught before they were completed. For example, in the medical sector, there is no good estimate of the probability of substitution errors on the night shifts, or by physicians, or by pharmacists. Similarly, a coding error in a software may not be located until the program in the course of its execution visits that code; thereby suggesting poor estimate of the probability of substitution errors.

WHAT IS AN ERROR IN APPLICATION SETTING THEN? -3

- It is of great importance to know the modes of errors that are not harmful. The information could, for example, help in estimating the risk of introduction of a new product, a new package, or a new device in to the application domain under consideration. This calls for some kind of better data/information collection process.

WHAT IS AN ERROR IN APPLICATION SETTING THEN? -4

- It is usually the case that if there is no adverse outcome-no accident-the error is not reported and dose not become part of the experience base of the practices in the application domain under consideration.
- However, to understand what accidents are likely to happen in the application domain under consideration, (feedback) information must be obtained about all errors: those that damage, and the near misses or those that have yet to come (detection, estimation and prediction). Then appropriate protective measures can be in place to wait for the error and interdict rather than to be put into place after the incident.

AN EXAMPLE: STRUCTURE FAILURE FROM DRAFTING ERROR –AN INFORMATIONAL VIEW

- **1.1 A Drafting Error**: When people, i.e. clients, decide to construct a house or a structure, above all, they expect a safe, secured and reliable shelter or facility. The roof of the cafeteria of a Junior High School in Charlotte, N. C. had stood for some four years. In January 1968 during a storm it experienced accumulation of four in. of snow and ice (system environmental factor) resulting in the collapse of 4200 ft^2 of roof. Subsequent investigation into the structure failure showed that the roof framed with open web steel joists (supported on intermediate line of girders) had two of the columns under the girders *omitted* when the construction plans were finalized to incorporate fireproofing (change) requested by the insurance division during state review.
- The architects publicly admitted the drafting error when they checked the plans following the accident, which came after the cafeteria had been in use for over three years (note the on-going risk the structure carried through). It is inconceivable how such an omission was not detected in checking of structural plans by various agencies or how the steel could be erected without the necessary number of supports.

AN EXAMPLE: WHAT WENT WRONG

- **1.2** What went wrong through all these chain events? Was it the drafting error, i.e. error in the process of drafting that led to this failure? Or was it the faulty checking process? Or was it the lack of skill or accountability by those participating in plan preparation, drafting, reviewing and construction activities?
- No, all such are post-event observations. In fact what went wrong is, during the drafting-cum-construction-plan-checking-and-finalization-cum-erection phase, drafting information on number of columns under girders was assumed correct, i.e. with integrity, as validated while incorporating the changes for “fireproofing” requirements.

1.3 Information Origination and Processing Errors-1

- To elaborate, error *here* is at various stages.
- 1**.3.1 Resulting in loss of Goal integrity**

  Firstly, the error is *that* of information *origination* during drafting activity while incorporating change. The change is in the form of incorporating fireproofing requirements in construction plan and, hence, in the form of consequent accompanying change in operable planning goal(s). The information-processing flaw *here* is that, in ballistic behavior, taking information decision on reduction in number of columns supporting the girders and not to anticipate, in the wake of change, error(s) in *origination* of information requirements. This points to loss of Information Integrity (I*I) in goal defining, which is aptly termed Goal Integrity.

1.3 Information Origination and Processing Errors-2

- 1**.3.2 Resulting in Loss of Design Integrity**

  Secondly, the error is *that* of information processing during checking-and-finalizing-of-plans. *Here* the information-processing flaw is assuming drafting phase information decision on number of columns under girders correct as validated earlier while incorporating changes for “fireproofing” requirements; that is without its (information decision) validation at the ‘plan finalization’ phase; that is without ensuring required Design Integrity.

- **1.3.3** R**esulting in Loss of Implementation Integrity**

  Finally, the error is *that* of information processing at the phase of erection of steel. Once again, *here*, the information-processing flaw is of assuming plan review phase information decision or final design decision on number of columns under girders correct as validated earlier; that is without its (information decision) validation at the ‘steel erection’ phase; that is without ensuring required Implementation Integrity.

1.4 Resulting in Delivery of Unsafe Roof Structure: Information processed as function of Condition of Recipient

- Instead of the expected safe roof that the construction was to deliver to the client, *this* resulted in making the roof structure vulnerable, rendering it unsafe and unreliable. That is, in addition to (a) drafting work, which in *this* example is the source or point of *origination* of information (on number of columns in the wake of change due to "fireproofing" requirements) and (b) in addition to the construction-plan-checking-and-finalization-cum-erection departments, which *here* represent the processors of information (i.e., information decision) for *use*, the information processed turned out to be *function* also of (c) condition of the recipient, which *here* is the roof with two supporting columns *omitted*.
- After being in use for over three years and after four years' since its erection (i.e. with delay), it is on *that* day in January 1968, when, due to a storm, four in. snow and ice (system environmental factor) accumulated on *so* erected roof, that it led to its collapse.

1.5 Complex Error Mechanism coming with Delay

- Stated differently, building failure then can be seen as the informational error in building construction setting. It is the combination of such information errors under the information *origination* and processing stages that in a delayed combination with the system environmental factor formed a complex error mechanism. This as described above led to the collapse of the roof (adverse event (AE)), rendering the roof unsafe.
- Of course, the reality was *the* roof was a candidate for this failure right from the day when (in the process of incorporating change in the manner of the “fireproofing” requirements) the desired Safety Goal Integrity was not ensured.

1.6 What was needed?

- For construction of a safe structure (roof in this case), therefore, what was needed was:
- Given the situational factors of (a) change requirement in the manner of “fireproofing” objective, and (b) in that case the difficulty (i) in ensuring adequate Goal Integrity, and (ii) of the system environmental factors such as storms:
- o To *originate* at drafting phase, construction-plan-checking-and-finalization phase and at erection phase the information requirements (I) in respect of: respective operable goal set, fireproofing requirements, and the roof structure (recipient) safety condition, and
- o To obtain (originate) and control (improve) to desired level Goal Integrity (at drafting phase while accommodating “fireproofing” requirements), Design Integrity (at construction-plan-checking-and-finalization phase) and Implementation Integrity (at Erection Phase) for information (I).

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1.7 Lessons abstracted from the Example: 1.7.1 Industrial Accident Statistics and Causes of Observed Failures-1

- The example describes a case of a structure failure resulting from a chain of information errors that were committed in the setting of a construction project.
- Occurrence of the information errors leading to loss of information integrity at various stages *here* had adverse consequences for (a) *the* occupants of the facility *that* day at *the* time of the roof failure, (b) for *the* owners of the facility and *their* business service interests, and (c) for the professional reputation and *the* business interest of *the* architects of the construction project.

1.7.1 Industrial Accident Statistics and Causes of Observed Failures-2

- Accidents statistics are telling indicators of the extent to which industrial places pose dangers. If one were to talk of say construction industry and the question of say the worker safety, the National Institute for Occupational Safety and Health (NIOSH) reports indicate that, on the average, between 1980 and 1993, 1079 construction workers were killed on the job every year.

1.7.1 Industrial Accident Statistics and Causes of Observed Failures-3

- Some contributing factors to this condition are obvious: incomplete structural connections, temporary facilities, tight work areas, varying work surface conditions, ever-changing work sites, multiple operations, and crews working in close proximity.
- However, several easily overlooked informational factors, such as ballistic processing of decisions, lack of preplanning, inability to recognize the informational (environmental) anomalies that come with delay, inadequate selection of personnel, laissez faire attitudes etc. are significant contributors to these statistics.

1.7.2 Informational Failures and causes of accidents -1

- In classifying causes as above, there is no real need to distinguish rigorously between direct, indirect and contributing causes of accidents, but it is important to recognize that accident might be the result of two (or more) concurrent events (see Section (1.5)), neither of which necessarily be dangerous in itself.

1.7.2 Informational Failures and causes of accidents -2

- Some analysts distinguish between mechanical and human failures as causes of accidents. Material defects and equipment failures are thus considered mechanical causes, and errors of judgment or illness as human causes. But is it a mechanical or human failure when an inspector fails to observe something that is wrong with a machine?
- Why is it that in the drafting error example enumerated in Section (1.1), the goal, design and implementation integrity were not ensured? Why is it that the architects noted the error when they checked the plans following the accident, which came after the cafeteria had been in use for over three years?

1.7.2 Informational Failures and causes of accidents -3

- Seen critically, as observed in Section (1.3), these indeed are information *origination* and processing errors.
- Requirement for information *origination* and processing comes into play as field (real world) operations are impacted by ever-present environmental factors – internal as well as external.
- For example, in the structure failure case considered in the example, the external environmental factor of change requirement of “fireproofing” at the state review stage necessitated the need to *originate* the drafting information and process it. It is at this point the loss of safety goal integrity and of design integrity occurred.

1.7.2 Informational Failures and causes of accidents -4

- The construction industry identifies following information *origination* and processing issues as factors causing these failures: incompetent men in charge of design, construction, or inspection; supervision and maintenance by men without necessary intelligence; assumption of vital responsibility by men without necessary intelligence; competition without supervision; lack of precedent; lack of sufficient preliminary information; economy in cost, in maintenance; lapses and carelessness; and catastrophic occurrences: earthquakes, extreme storms, fires, etc.

1.7.3 Absence of a systematic process to originate and process information locally -1

- Catastrophic failures certainly cause serious losses. However, in normal times, catastrophic incidents that are the subject of front-page news such as the collapse of 4200 sq. ft. of the roof of the cafeteria of a Junior High School in Charlotte, N. C. in January 1968 is not the sort of occurrence that is the source of the majority of losses suffered by the stake holders.
- The losses that are crippling the economies and those that most seriously impact the majority are the multitude of minor errors that occur on regular basis.

1.7.3 Absence of a systematic process to originate and process information locally -2

- The most cause of the majority of losses *is* in the absence of a systematic process to identify and mitigate field level hazards and unsafe operational practices.
- It's the result of the failure of systems, their sub-systems and their components to recognize the impact of ever present external and internal local environmental factors on integrity of informational stages of system life cycle and to effectively "*originate* and process information" in the context locally.

1.7.3 Absence of a systematic process to originate and process information locally -3

- Further, it's also the result of their failure to communicate:
  - the importance that requirements such as safety, security, reliability have on the continued economic viability of the organization employing them, and
  - the importance of maintaining the workforce, material and machine health so that there are qualified individuals, quality material, and reliable machines to do the structural design and construction work effectively.

1.7.4 Defining Application Failure – Not Observed Application Failure but rather Information Error in Application Setting, Information Failures far more than Observed Application Failures - 1

- As pointed out under Sub-section (1.3), the issue is then of information *origination* and processing errors. This recognition warrants paradigm shift in defining construction failure.
- If construction failure is defined as observed collapse, there would be few failures. But construction informational failure, where the observed failure, i. e. observed collapse, i. e. accident or adverse event has yet not occurred, is defined by nonconformity with design/drafting/plan review/erection specifications or expectations or defined standards, and this is more scientific approach, and …..

1.7.4 Defining Application Failure – Not Observed Application Failure but rather Information Error in Application Setting, Information Failures far more than Observed Application Failures-2

..... if one takes the trouble to measure the shape, position, and condition of structural products (intermediate products inclusive) at the delivery of each of informational products and services delivered during construction system life cycle stages, there are many failures – far more than the list of incidents that are covered by the media, both technical and public.

- This statement is more applicable to the complicated space framings than to the simple or pin-connected structures. Unwanted displacements, unexplainable deformation, are often found and it is questioned whether they are failures or normal (but unexpected) strains or merely “incidents,” using a foreign term to describe the unexpected results.

1.7.5 Defining Construction Failure 1 – An Informational Error

- For the purpose of clear distinction of this informational view of failure as against the observed view, informational failure may be designated as “informational error.”
- This informational view permits defining application failures – in the example considered structure failure is an application failure - as behavior not in agreement with the standard conditions of stability or as lacking freedom from necessary repair or as noncompliance with the desired *use* and occupancy of the completed structure.

1.7.5 Defining Construction Failure 2 – Ignorance of System Boundary

- Informational errors occur in all types of structures, small and large, low and tall, minimal and monumental, whether framed or wall bearing, whether with timber, steel, or concrete as the basic supporting material.
- Continuous pressure for greater economy, from private financial competition as well as from public demand that budgets be met, both in design and construction, has resulted in safety being reduced below the minimum sufficiency.
- Failure of part or even serious collapse of a structure usually comes during construction, when the latent uncalculated space frame strength is not yet available. The boundary between stability and instability, between sufficiency and error, is a thin line. Ignorance of the boundary is no excuse when a error occurs.

THANK YOU