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## READINESS FOR THE TOOLS OF AUTOMATION

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### Premises

Any information system (manual or automatic or a combination) should be a construction of intelligent design to serve--rather than dilute--human intelligence in the performance of purposeful tasks. Any automatic system or tool can only implement order: it cannot create it.

### Introduction

There were the good old days when a man carried his business under his hat and made decisions from the seat of his pants, and when people did what they were told and said, "Yes, sir!" Every event may easily be treated as a unique transaction in such an environment.

But when the first paper form was created, the practicing concept of automation was born. The first quarrel with the adequacy of that form was the first challenge to automation.

### Two Part Structure of the Readiness Problem

The first part deals with indicators of needs for (a) structure in operations and (b) tools to implement the standard parts of the structure. Defined needs precede readiness for structure and tools, but are not the equivalent of readiness. Readiness implies a mood for accepting the changes and constraints required by structure and the tool to be used. Many people in India desperately need protein foods, but are not ready for a solution available in their streets. Great needs are evident in campuses and urban areas, but readiness for solutions is not. So need indicators and readiness indicators are cited separately.

#### A. Indicators of Needs for Structure and Automatic Aids

These indicators may occur in a chronic and worsening state. But they may occur cyclically, so that periods of calm follow turbulence. This enables the conservatives (who want to leave things as they are) and radicals (who want to change things) to polarize their positions. Extended calms reduce psychological sense of threat and may create false security.

Overfilled in-baskets both to clerical people and problem solving people (if that distinction is legitimate). The rate of information coming in exceeds rates of human information processing capacity, and the compounded human costs are increasing more rapidly than the value of the processing operations.

Information seen too late either to be entered into required procedures or as support for short term and long term decisions.

Deteriorating quality of decision either because available information comes in too late, or to the wrong places, or all the necessary decision variables not taken into account, or history of previous failures (as in choosing a given course of action) is not kept or is not available to the decision maker.

No one can remember all the rules that govern design and operational procedures, interfaces, constraints, resources.

Vast selective updating requiring coordination among large varieties of files shared or distributed among diverse departments and departmental functions.

Compounded foul-ups because increasing complexity of relationships among actions and decisions amplifies an error of commission or omission into crisis and potential catastrophe. Progressive increase in non-reversible actions. Cost of erasers outstripping the cost of pencils.

Frequent paralysis because of conflicting information either about status, plan, resource available, purpose, priority, procedure, location of initiative.

Budgets and accounting out of control because of inability to relate actions to function and cost to purpose.

Hours, days spent in futile searching for information in files, libraries, people's heads, wastebaskets.

Bushels of paper forms, miles of storage cabinets, multiplicate copies of voluminous reports.

Dozens, hundreds of clerks doing the same operation

in parallel: large turnover in activities that can be adequately learned as routines in a few minutes.

Overhead services going out of control in size and cost where overhead may compound itself -- i.e., a service agency must be supported by additional service agencies, and so on.

Pervasive feeling of fighting fog in the organization in getting information, decisions, plans, purposes, priorities, assignments really settled, even for the month, week or day. Sense of non-completion of all tasks and of helpless drift even in very local operations.

#### B. Indicators of Readiness for Structure and Tools

Before processing tools can be used, the structure of the operations they must serve will have to be defined. When purpose has been structured, then it is practicable to structure the operations themselves. After these two stages of preparation have been made at least by a conceptual consensus--then the most practicable tools can be selected. But attitudinal and motivational factors must be favorable for change in the organization's way of doing its work and satisfying its people.

These issues can be subdivided more or less as follows.

Organizational Atmosphere of readiness, willingness to participate in (as well as accept) change which will mean acceptance of unaccustomed disciplines in making explicit (in transactional terms) goals, purpose, task, job, responsibility, decision structure, information flow. Readiness to compromise about who sees and does what. And readiness to take some risks by recognizing that no tool is perfect, and some foul-ups will still occur in anything that is designed and operated and used by human beings. This kind of readiness is a big order. Some institutions may not be able to make it even though survival itself is threatened.

Purposes expressed in terms of what the organization is trying to do by its operations must be explicit. Among other things, this establishes what kinds of specific monitoring must be supported at the transactional output level, enabling either automatic control or control by human inspection and intervention.

Flow of procedures and decision sequences -- who does what with what information and in what order. This is equivalent to a flow chart of the information transactions through the organization or through a set of organizations. The greater the proportion of improvisation, impromptu actions and random pathways in the flow sequence, the less the proportion of completely automatic transactions. This does not preclude, however, using automatic aids to select and retrieve information, even though a human executes the operation or decision. In any event, an orderly flow of operations and information enables greater efficiency in selecting the information necessary and sufficient for any given operation. This can cut down irrelevance

(noise) at any given node in the work flow.

Decision structures in general will have to be established. By decision structure is meant the relevant variables in (a) status (b) goals, priorities in objective, (c) classes of response option, (d) policy for preferring given classes of response. Note the term above, variables relevant to the decision. It is assumed that in many cases, data will be incomplete, ambiguous or even incorrect so that the human decision maker's role will be that of making tradeoffs and judgments.

Of course, where the information is standardized and a rule is established, the decision can be made automatic. The key concept here is who makes what class of decisions with what variables of information and with what response options available to him. It is difficult to get individuals to structure their processing operations this explicitly. Unless this is done, only an infinite data base operating at infinite speeds can satisfy any individual.

The combination of the foregoing disciplines that establish each person's domain of decision-making responsibility in terms of data categories enables his appropriate criteria of relevance to be set up. These criteria act as filters for delivering only such data categories as are necessary for selecting action. He need not be deprived of other classes of data, and should be able to get details or statistical summaries, but only according to demand and "extra cost".

Definition of clerical and numerical tasks that can directly be automated, assuming that rules can adequately be defined for them, and that exceptions can be automatically identified and routed to a human agency for handling an exception.

Organizational interfaces defined, as implied by preceding statements, a systems analysis of information flow from node to node in the organization is part of the discipline necessary to the design of information supports that transmit what is essential, filter what is irrelevant, and do so according to a timely schedule that fits the work to be done rather than the time available. But this requires that organizations define their role, operations and dependencies to a greater degree than is customary.

Category structure and nomenclature standardized, the names given to the organization's work activities, functions, product characterizations, attributes, transmission channels. All of the things, processes and properties about which data are collected, transmitted, combined, stored, retrieved and used in the whole range of operations from executive office planning to supplies ordering. The decisions must apply to (a) what to identify as a category of data and (b) what name to give it. The glossary thus created enables a standardized filing and searching reference for communications among humans, and between humans and a data base content.

Input information characterized and structured,

this refers to input data to the organization that constitutes its work, its operating rules and policies and so forth. These are the data that feed the operations of the enterprise. Clearly, a discipline that controls source channels, formats, categories, frequencies or rates, all need to be established.

In summary, readiness to use information processing tools for organizational needs depends on having a well-defined and structured control system that is accepted by the entire organization, and on a willingness of its personnel to accept and participate in the discipline of a control system.

#### Types of Uses of Information

Major classification: current information is used for control purposes; historical information, combined with current information, may be used for predictive purposes and hypotheses about future states and responses appropriate to future states. This latter is the essence of planning.

Here is an annotated listing of human problem-solving tasks—aside from numerical operations, of course—that can be supported by information processing aids operating in the batch mode or conversational mode:

Briefing: comparing planned status against actual status according to pre-established sets of categories; or by impromptu interrogation in order to obtain context for further planning, intervention or decision making.

Exception detection: an outcome of briefing with the intent to determine whether deviations of actual from planned event demand intervention.

Diagnosis: making a series of tests in a strategy leading to the identification of a causative agent or the choice of a remedial action. The tests may pinpoint the cause by logical exclusion, or by multiple attribute matching of a pattern of found symptoms with the pattern of symptoms exhibited by a known failure agency (e.g., a disease organism).

Planning and choosing by pattern match: Planning by projecting values or variables of projected status and purpose and by selecting a matching pattern of resources; choosing by setting up a profile of desired values of relevant variables (such as a job position) and seeking best matches—with aid of human judgment and tradeoff making—with profiles of candidates (such as job candidates).

Evaluating/Optimizing: by simulation modelling, determining output parameters from samples or values of input parameters; or, holding input parameters constant, modifying the pathway and magnitude of facilities in order to optimize or satisfy output criteria requirements.

Constructing: testing the correctness of design operations against sets of constraints, rules and other factors of legitimacy in effecting a design

intended as a set of "build instructions" or procedural instructions.

Research: browsing in data leading to hypothesis formation and thence to hypothesis testing on the basis of existing data, or data to be obtained. Examination of relationships among arrays of data summarized variously in graphic and tabular form.

Instruction/learning: of facts, procedures, concepts, principles, system dynamics.

#### Concluding Comment

It would seem presumptuous to estimate the size required of an automation facility until quantitative descriptions of the work it would have to do have been reasonably completed. The growth of information systems, after successful installations, suggests that the design of the application should enable modular growth, both of the extended application and of extended facilities. The alternative is to throw in very large "safety factors." Careful selection of organizational and functional priorities in the design of the application, treated as a kind of task discipline, should save both costs and disappointments.

Creating a data-based information service for an organization that will be useful and efficient (in terms of any kinds of costs involved) requires massive participation, and is likely to produce, as well as be produced by, profound changes in the traditional style, attitudes and procedures of the organization. There is always some training associated with constructive growth either in size, technique or wisdom. The pain may be less when the time for change and growth is deliberately chosen rather than when change is forced by circumstance and crisis.