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USING CASE TO ADOPT ORGANIZATIONAL LEARNING AT NASA

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Introduction

The research direction was articulated in a statement of work created in collaboration between two program colleagues, an outside researcher and an internal user. The researcher was to deliver an implemented CASE tool (Casewise™) that was to be used to serve non-traditional (i.e., not software development related) organizational purposes. The explicitly stated functions of the tool were the support of 1) ISO-9000 compliance in the documentation of processes and 2) the management of process improvement. The collaborative team consisted of the researcher (GT), a full-time accompanying student (CRO), and the user (JD). The team originally focused on populating the CASE repository for the purpose of solving the two primary objectives. Consistent with the action research approach, several additional user requirements emerged as the project evolved, needs became apparent in discussions about how the tool would be used to solve organizational problems. These deliverables were contained within the CASE repository:

1) the creation of a 'paradigm diagram'
2) the creation of a context diagram
3) the creation of child diagrams
4) the generation of 73 issues relating to organizational change
5) a compendium of stakeholder interview transcripts

All record keeping was done manually and then keyed into the CASE interface.
An issue is the difference between an organization's current situation (action) and its collective ideals.

Issues were categorized as either 'major' or 'minor,' based on their relevance to change. Major issues relate to radical change, defined as changes to the formal (explicitly stated) organizational memory. Minor issues relate to changes that necessitate modification of the informal (tacitly stated) memory, and not the formal memory. An issues report was generated for the coordinators with the understanding that the information was not to be disseminated outside the group. The collaborative team decided to create an evolutionary prototype exploiting computer aided software engineering (CASE) software. The selected tool was Casewise Modeler 8e™, a product distributed by Casewise Systems.

The colleagues discussed the applicability of embedding organizational learning concepts into the design model to help solve some of the organization's ongoing problems. The discussions about organizational problems were a product of the ongoing collaboration. Three strategic planning elements were used in requirements analysis: the President's Management Agenda (PMA), the Space Act of 1958, and the current myriad of NASA initiatives. The colleagues derived several significant problems from the analysis. The main problem was in controlling the myriad of PMA initiatives as they are incorporated throughout the government agencies. Table 1 summarizes some other significant agency problems: lack of integration, interunit coordination, alignment, and process validity.

Table 1: Systemic Organizational Problems at NASA

Problem	Explanation
Integration	designs are piecemeal; the initiatives are segregated, causing lack of consistency with respect to the achievement of outcomes
Interunit coordination	stepping on toes; operating subunits are segregated and subsequently interpret the initiatives in different ways, operate

	them with different outcomes in mind, do not share resources, and fail to achieve economies of size
Alignment	outcomes are not clear, standardized, nor shared; the initiatives do not achieve a uniform set of outcomes
Process Validity	doing the wrong things; some initiatives are implemented differently from their intended purpose

The problems centered around controlling mandated initiatives as they flowed from the top of the federal bureaucracy to the agency level. At the time of the study, there were five government-wide initiatives (source: President's Management Agenda, 2002) that were being disseminated to the tactical and operational levels:

1. Strategic Management of Human Capital – to retain intellectual capital in the face of government downsizing
2. Competitive Sourcing – capitalizing on competencies readily available in the private sector
3. Improved Financial Performance – improving financial accountability
4. Expanded Electronic Government – achieving greater service at lower cost using electronic delivery of government services
5. Budget Performance Integration – linking 1-4 to performance

The colleagues determined that the use of CASE in implementing an organizational learning paradigm would be a fitting solution to the problems identified. CASE originated in the 1970s to facilitate structure in software development, traditionally an undisciplined process. Recently, CASE tools have accommodated visual programming tools, object-oriented programming, and some organizational development functions (such as quality assurance and ISO 9000 certification). The traditional use of CASE (computer-aided software engineering) is the computer-based support of software development. It is typically used to organize and control large and/or complex projects. While CASE is a tool that supports some activity in the systems development life cycle, I-CASE (integrate CASE) represents a joining of multiple CASE tools in one uniform platform. I-CASE always relies on a specialized database, called a repository, which stores information about the structure (primarily data and processes) of the organization. The repository allows for the ongoing collaboration of a diverse set of project stakeholders (analysts, designers, programmers, testers, users, managers, etc.) using a uniform interface. CASE has the purpose of speeding development, improving quality (by requiring standardization, discipline, and formal problem solving), and lowering costs (especially maintenance) in the software engineering process. The deployment of CASE is based on the premise that including the customer/user early in development, the product is more likely to satisfy requirements, and hence succeed in the marketplace.

Table 2 and the ensuing outline embodies the elements of the design solution.

Change – there are two types of change: radical and incremental:

Radical change – enacted when there is a need to change the explicitly stated FOM

a. Acting Director and Process Owner deliberate issues that might necessitate radical change to the Formal Organizational Memory (a pre-existing example is how processes are explicitly defined in departmental Organizational Work Instructions).

b. Acting Director explicitly and formally states how the FOM Administrator is to change the FOM. The FOM Administrator changes the FOM in one of two ways (either c or d or both)
c. FOM Administrator updates the Process Repository
d. FOM Administrator updates the Logic Repository

Incremental change – enacted within the bounds of the explicitly stated FOM; only the issues repository is updated

a. Process Users *privately* communicate issues to the FOM Administrator
b. FOM Administrator notifies the Process Owner of all updates to the Issues Repository
c. FOM Administrator updates the Issues Repository

Also refer to the NASA-MSFC Continual Improvement website (http://contimp.msfc.nasa.gov/) for other resources. A website depicting the general continuous improvement process at MSFC is available at: http://contimp.msfc.nasa.gov/documents/GeneralContinualImprovementProcessFlow.doc

Social Action – the cognitive and physical behavior intended to achieve organizational outcomes; SA both determines and is determined by one of two types of memory: informal and formal.

Formal Organizational Memory (FOM) – existing descriptions about the organization's structure. The FOM will be captured and managed in the Casewise system by the NAR. An example is the ECA process, which was explicitly defined in the Casewise repository by Cheryl in Summer, 2002. The FOM should describe all organizational processes, such as those that comprise MSFC's Technology Transfer Department:

NTR – New Technology Reporting (Owner: Susan Whitfield)
CA-Commercialization Assistance (Owner: Sammy Nabors)
LP – Licensing of Patents (Owner: Sammy Nabors)
ERNS – External Release of NASA Software (Owner: Caroline Wang)
ECA – External Customer Agreements (Owner: Roger Parisa)

Another FOM resource within MSFC is the *NASA Lessons Learned Database*

Informal Organizational Memory (IOM) – the unstructured and implied knowledge about the process; involves behavioral patterns and knowledge that fits within the guidelines of the FOM; the IOM emerges over time and when captured explicitly (usually in the form of issues), becomes part of the FOM.

Roles – there are four prominent roles during the Action Research Program:

Process user – an individual who operates or interacts with the process as a function of job scope; a common source of issues during incremental change

Process owner – the individual who has the responsibility of maximizing desired process outcomes (such as ROI, efficiency, customer satisfaction, user satisfaction, etc.). This is done through the deliberation of issues intended to improve the process.

Acting Director – manager of several Process Owners in a given organizational subunit (like Technology Transfer).

FOM Administrator – the individual who specializes in populating and maintaining the FOM tool (i.e., Casewise) from which organizational benefits are to be derived. This person should be knowledgeable in the tool and though maintenance, the organization's processes.

A **repository** is a special-purpose database that allows for the graphical manipulation of the data set. The CASE repository does not contain information regarding daily organizational activities (such as transactions). Rather, it represents meta-knowledge about the organization's structure and rarely changes.

Process Repository – representations of formal processes in a centralized, computer-resident location (such as a project file in Casewise™).

Logic Repository – representations of decision logic in a centralized, computer-resident location (such as a project file in Analytica™).

Issues Repository – issues are represented as elements on the process diagrams in Casewise™. An issue is a deviation from the formal system and the informal system. Issues are brought to the attention of the Process Owner when they are discovered. Issues can lead to either incremental or radical system changes.

Cognition skills:

Ideals – the vision, mission, strategies, etc. from which the processes originated. In MSFC-TT, some of the most important ideals are embedded in the Space Act of 1958.

Standards – written performance goals, such as process procedures, structures, and desired outcomes. Standards are set from prior measures of outcomes (VNO and quality). Another MSFC resource on standards is available at: http://standards.nasa.gov/.

Decision Making – deciding between radical or incremental change, and the deliberation within each.

Knowledge Acquisition – acquiring feedback from the operation of processes; see https://msfcsma3.msfc.nasa.gov/dbwebs/apps/qualcomm/nuqualc.taf?function=form for how MSFC uses the Internet for KA on customer satisfaction

Performance criteria:

Resources – any time, money, tool, method, or other investment made in the process(es)

Outcomes – any result that can be attributed to the process(es), such as customer satisfaction (see http://www.theacsi.org/ and https://msfcsma3.msfc.nasa.gov/dbwebs/apps/qualcomm/), user satisfaction (Moore and Benbasat), and return on investment (Phillips).

Process Effectiveness = Outcomes/Resources

Process Efficiency = see Hofer et al.

Balanced scorecard – the balanced scorecard concept implies the use of multiple perspectives in measuring organizational success. It allows management to monitor comprehensive organizational performance over time, as opposed to using a single perspective. See Kaplan and Norton, 1992 and MSFC's balanced scorecard website: http://ntf-2.msfc.nasa.gov/bsc2002.nsf

Table 2: Precursors, Contexts, and Consequences of Organizational Learning
(Source: Templeton and Snyder, 2000)

Factor	Examples
Precursors	
Structure	
Structural Stimulants	structural informality, structural simplicity, information technology infusion
Structural Impediments	structural formality, structural complexity, functional specialization, authority relations, quality of internal communication processes, quality of external communication processes, extent of interdisciplinary teamwork, bureaucratization, a procedural culture, appropriateness of reward systems, and management attitude
Culture	shared beliefs, shared norms (Miles and Snow, 1978), and shared assumptions
Cultural Stimulants	cultural complexity, Cognitive norms, behavioral norms (dialogue and management practice)
Cultural Impediments	member homogeneity, barriers to communication
SLL Precursors	need for incremental change, SLL-facilitory conditions, stable task, environment, repetitive channel functions, SLL stimulants, organizational memory performance standards
DLL Precursors	need for radical change, DLL-facilitory conditions (a turbulent environment and nonrepetitive channel functions), DLL stimulants (practicing unskilled learning, striving for failure, achieving collaborative inimitability, organizational memory information system (OMIS)
Contexts	
Internal	the extent of interunit diversity, the presence of proactive strategies, strategy, coordination, incentives to learning, resources devoted to learning, centrality of R&D, diffusion of learning, perceived success
External	environmental turbulence, contradictory information about organizational rules, interfirm trust
Consequences	

Responses to Environmental Turbulence	market-based events, events by competitors
Behavioral Change	implementation of proactive strategies, continuous innovation, seek alternative forms, employee turnover, technology maintenance behaviors, existence of an adaptive component in OMIS
Technological Change	technological complexity, exigencies of speed, global responsiveness, constant innovation
Responses to Competitive Necessity	organizational performance, organizational survival, organizational flexibility, global strategic alliance longevity
Competitive Advantage	technological capability, continuous improvement, price and volume, to quality, to speed, then to mass customization, competent change
New Organizational Technologies	attainment, development, implementation
Enhanced Organizational Knowledge Base	organizational memory, new organizational knowledge, information equivocality
Organizational Effectiveness	planning capabilities, strategic option recognition rates, investment patterns, technology range of choice, facilitation of varying products, product development cycle, integration, economies of scope, employee awareness, energy