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CREATING A STRATEGIC PLAN FOR CONFIGURATION MANAGEMENT USING COMPUTER AIDED SOFTWARE ENGINEERING (CASE) TOOLS

DOE Facilities 2000: Planning For Change

Paper For 1993 National DOE/Contractors and Facilities CAD/CAE User's Group

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Work supported by
U.S. Department of Energy
Assistant Secretary for Nuclear Energy
Under DOE Idaho Field Office
Contract DE-AC07-76ID01570

CONTENTS

FIGURES

ACRONYMS

BAA	business area analysis
BSD	business system design
CAM	Computer Aided Manufacturing
CASE	computer aided software engineering
CM	configuration management
CMP	configuration management program
DMD	drawing missing data
DOD	Department of Defense
DOE	Department of Energy
DOE-ID	DOE Idaho Field Office
ERD	entity relationship diagram
FRD	functional requirements document
IE	information engineering
IEF	information engineering facility
INEL	Idaho National Engineering Laboratory
IS	information system
ISP	information strategy planning
JAD	joint application development
M&O	management & operations
MEL	master equipment list
NIRMA	Nuclear Information Records Management Association
OE	operations engineering
PC	personal computer
SAR	safety analysis report
SSCs	structures, systems, and components
TD	technical design
TSR	technical safety requirement

INTRODUCTION

This paper provides guidance in the definition, documentation, measurement, enhancement of processes, and validation of a strategic plan for configuration management (CM). The approach and methodology used in establishing a strategic plan is the same for any enterprise, including the Department of Energy (DOE), commercial nuclear plants, the Department of Defense (DOD), or large industrial complexes. The principles and techniques presented are used world wide by some of the largest corporations. The authors used industry knowledge and the areas of their current employment to illustrate and provide examples. Developing a strategic configuration and information management plan for DOE Idaho Field Office (DOE-ID) facilities is discussed in this paper.

A good knowledge of CM principles is the key to successful strategic planning. This paper will describe and define CM elements, and discuss how CM integrates the facility's physical configuration, design basis, and documentation.

The strategic plan does not need the support of a computer aided software engineering (CASE) tool. However, the use of the CASE tool provides a methodology for consistency in approach, graphics, and database capability combined to form an encyclopedia and a method of presentation that is easily understood and aids the process of reengineering. CASE tools have much more capability than those stated above. Some examples are supporting a joint application development group (JAD) to prepare a software functional specification document and, if necessary, provide the capability to automatically generate software application code. This paper briefly discusses characteristics and capabilities of two CASE tools that use different methodologies to generate similar deliverables.

BACKGROUND INFORMATION

A facility's structures, systems, and components (SSCs) are functionally arranged to operate for specified design requirements. The functional arrangement and characteristics are defined in the facility authorization basis and are called its configuration. The facility authorization basis is documented in the safety analysis report (SAR) and technical safety requirements (TSRs). The SAR and TSRs assess the original design basis and its degradation by in-service use. A facility basis is not frozen in time; rather, it is constantly changing throughout the facility's entire life cycle. To control these changes, CM processes are applied. CM ensures that facility characteristics, including design requirements, plant configuration, and documentation as shown in Figure 1, are defined and maintained according to the facility authorization basis; and CM ensures that modifications, maintenance, and operational changes do not violate this basis. CM provides controlled management of change and integrates information about the facility into a structured, manageable format.

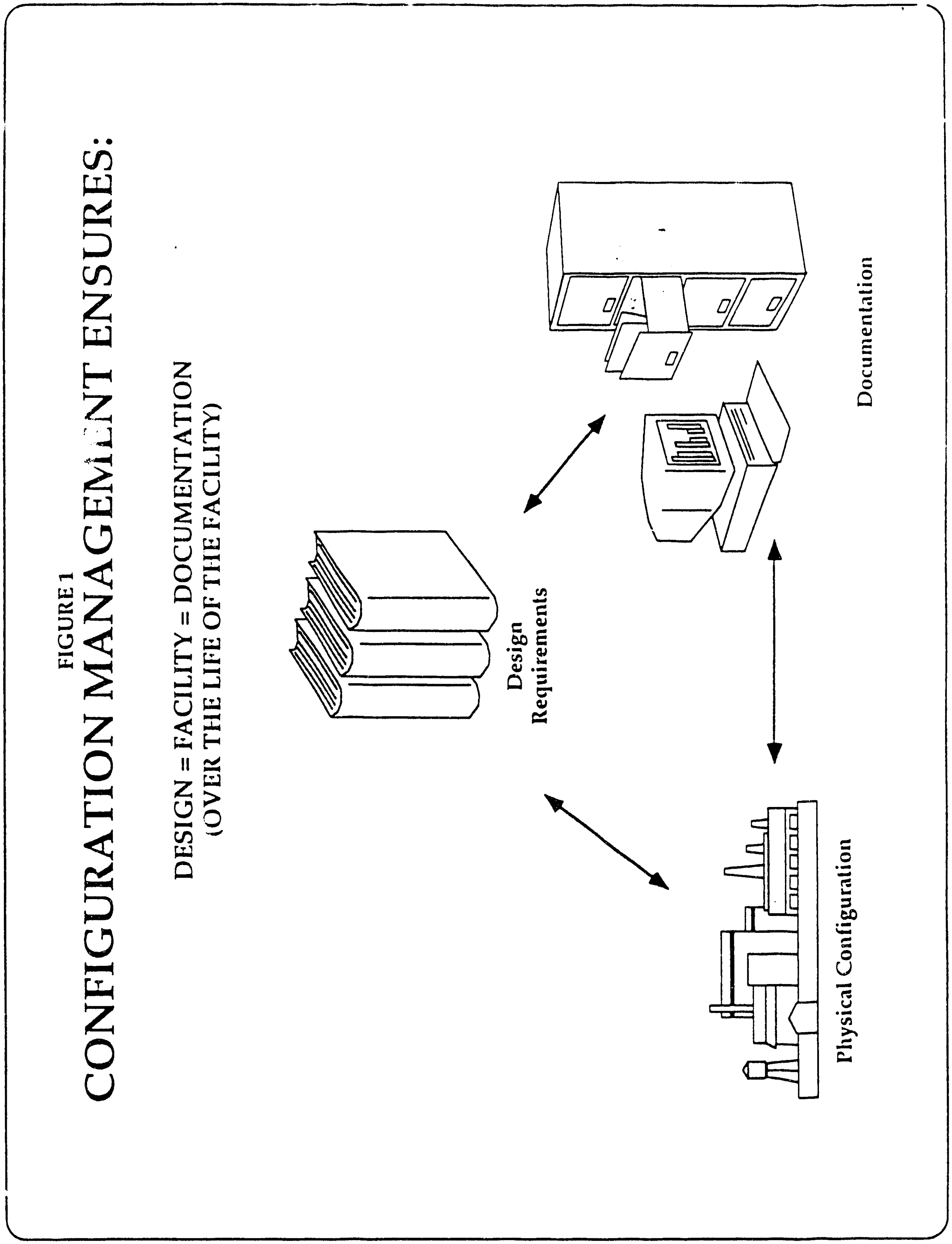

Figure 1. Configuration Management Ensures

CONFIGURATION MANAGEMENT ELEMENTS

A CM program in DOE facilities usually is described in terms of compliance with the CM elements. (Figure 2 shows how these elements interrelate and impact the life cycle of a facility.) A configuration management program (CMP) is developed around the five elements of CM. The CM definitions listed below are abbreviated summaries of those provided in the DOE Orders. These definitions are provided to give an indication of the contents in a CM program and do not give a complete understanding of the topic. Facilities must refer to the definitions in their applicable DOE Order requirements for specific order compliance criteria.

Program Management: The program management element and its related functions provide the traditional program management requirements (program and organizational interfaces) that direct and monitor the development and implementation of the overall CM plan.

Design Requirements: The design requirements element establishes and maintains the design requirements and the associated design basis. This may also include a reconstitution of the design requirements, if determined applicable.

Document Control: The document control element ensures that the program identifies and maintains CM documents consistent with the physical configuration and design requirements.

Change Control: The change control element maintains consistency between the design requirements, the physical configuration, and the facility documentation.

Assessments: The assessments element helps to define CM-specific needs and to measure the effectiveness of the other CM program elements.

In addition to the CM elements, the following adjunct programs are one-time efforts that support the implementation of the CM program:

Design Requirements Reconstitution: This effort is performed to establish, organize, and document design information where existing design information cannot be found. Once the reconstitution effort has been completed, the function of maintaining the design information is accomplished within the design requirements element.

Material Condition and Aging: This effort is performed to determine the effect of age degradation for facility life-limiting components, and the potential associated impact of this aging on facility operations.

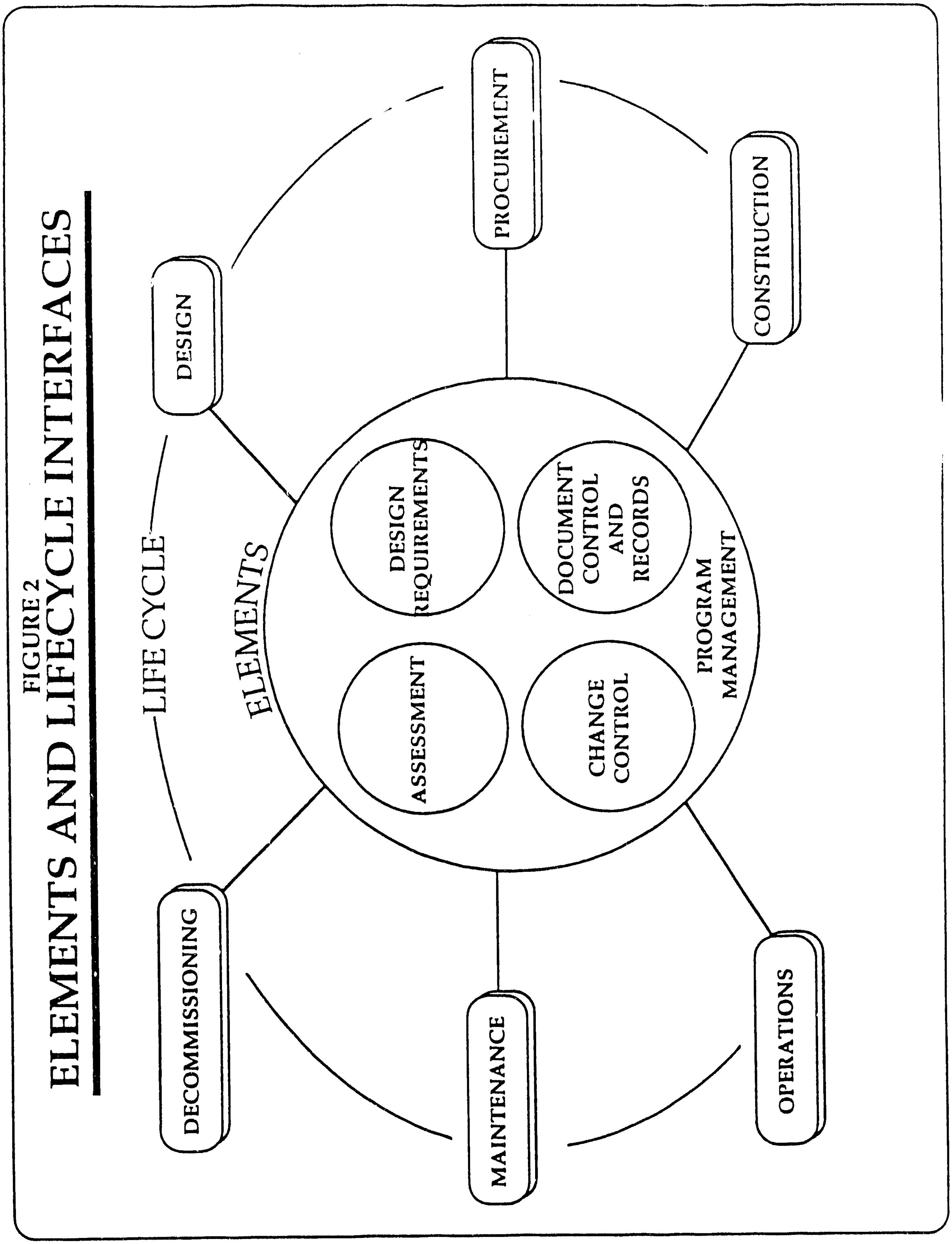

Figure 2. Elements and Life Cycle Interfaces

CM PROGRAM ORGANIZATION

Many DOE-ID sites, such as the Idaho National Engineering Laboratory (INEL), have nuclear and nonnuclear facilities. DOE-ID has decided to have one configuration management program for the facilities under its direction. This configuration management program will dictate how all contractors and facilities comply with CM. To implement a single configuration management program, DOE-ID established an INEL steering committee comprised of representatives from DOE-ID and all management & operations (M&O) contractors under the jurisdiction of DOE-ID. The CM steering committee establishes policies and practices for the INEL under the leadership of a single M&O organization and recommends a single implementation program to be supervised by the INEL's CM Program Manager.

The INEL CM program was established and has participants from all M&O contractors under DOE-ID. The INEL CM Program Manager, with participants from all M&O contractors under DOE-ID's jurisdiction, leads the development of an INEL CM strategic CMP plan. Some elements of this plan are outlined in the following sections.

ORGANIZATIONAL ANALYSIS

In a DOE site, it is important to identify the information that is used to make decisions at the senior management level. The organizational analysis should be conducted in a top-down manner with the emphasis being placed on what information is received, consumed, and shared by each facility. In CM, the first step is to identify what information supports strategic decisions. The next step is to determine what processes, within each facility, provide the necessary information to support these decisions.

To develop a strategic plan for a DOE facility, one must first determine what facilities will be included in the plan, what processes are conducted within each facility, and what information is shared among facilities. The processes to support a strategic CM plan are very important and must be given the highest priority when reviewing the business. Processes that do not support the strategic plan should also be reviewed to determine if they support the current business plan or if they are carried over from past strategic plans and were not disposed once the mission had been completed.

The organizational structure brings together technologies and management, but the structure must work within the culture of the organization. Organizational analysis is a method to determine what functions, processes, activities, etc., an organization performs. Figure 3 shows the functions that could be contained within a CM organization (NIRMA PP14-1992). Organizational analysis is required because organizations usually evolve over time or are established without a sound management and technological evaluation of their current business. An organization can be described by the way it handles information. This information-handling capability is described in its hierarchical structure which can be broken into functions to better understand how the organization performs business. A complete process is usually composed of a number of functions that are conducted by numerous

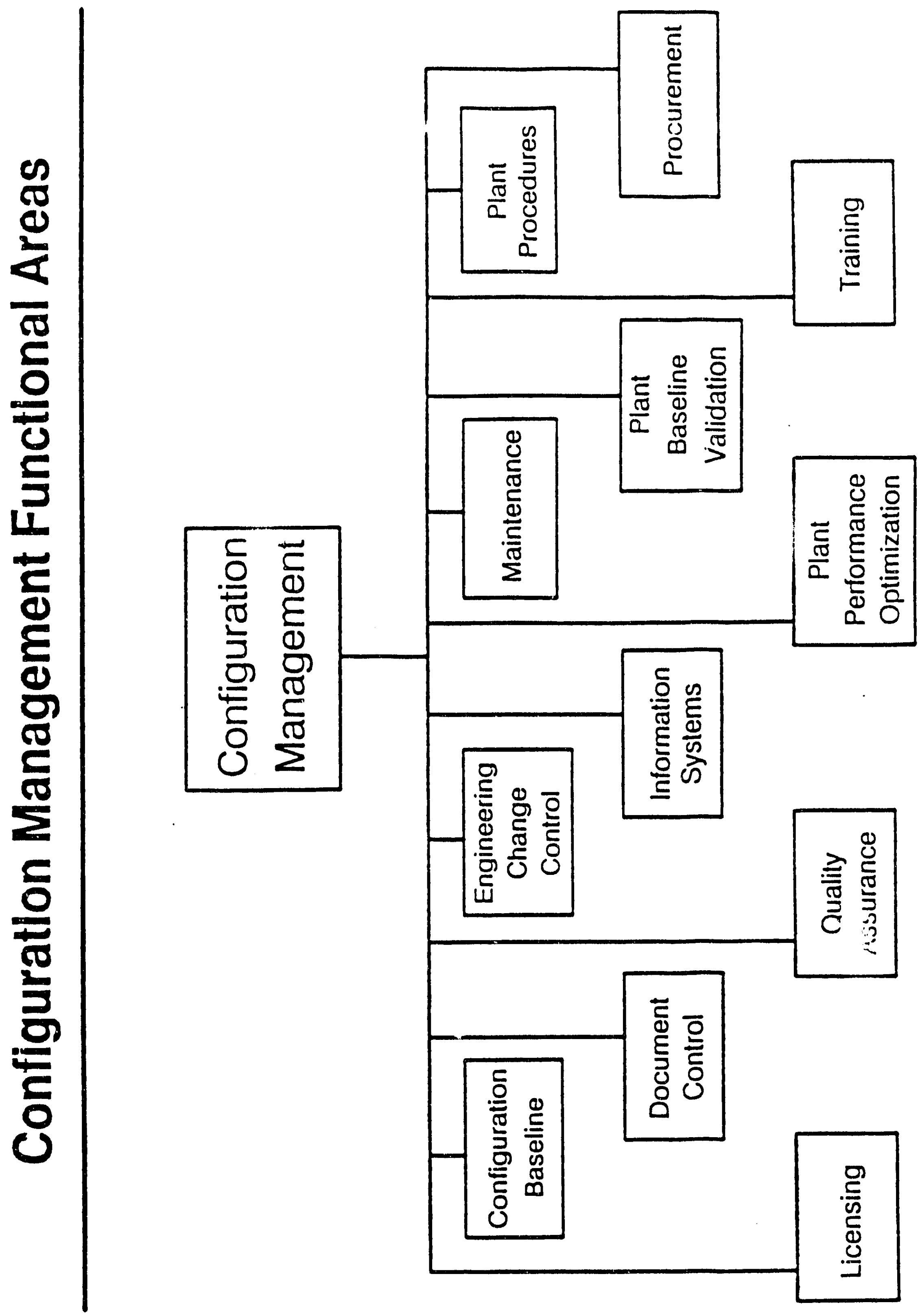

Figure 3. Configuration Management Functional Areas

organizations spread out around the facility or corporation. Therefore, by reviewing the functions that an organization performs, a determination can be made as to who needs to be interviewed to collect information about a function that supports a process. The organizational analysis is usually the first step in conducting process modeling to do the following:

1. Determine who does what function in the organization.

2. Aid in establishing the sequence of the interviews to be conducted by grouping functions that seem to support each other.

3. Determine function and process owners by name.

4. Determine how a series of functional models, developed from interviews, provides information that may aid in understanding a particular process.

Organizational structures are dynamic, that is, both the function or process definition can be continually changing. Since organizational analysis is a picture in time, the information gathered must be stored; a CASE tool may be used for this purpose. As definitions associated with processes change, a CASE tool can also capture specific definition changes over time.

Understanding how your organization processes information is important because it can appear as though there is a single process going on. However, close examination may reveal duplication in a number of process, functions that are not assigned to any organization, information that is being fractured, or information that is generated by different organizations that do not agree with each other, etc. In the case of overlap in creating information, there also may be a time delay in updating information sources that can cause sets of information to be out of date with each other, thus causing additional fracturing of information. Therefore, the size of the overlap is just as important as the determination of an overlap of information being generated. These conditions are reasons why an organizational analysis is a fundamental step in creating a strategic plan that cannot be skipped or done without proper attention to detail.

CM ENHANCEMENT PROGRAMS

The commercial nuclear power industry has spend, and continues to spent, a considerable amount of money on configuration management enhancement programs. The Nuclear Information Records Management Association (NIRMA) has written several position papers on CM. NIRMA PP14-1992 states that "Present approaches for enhancing configuration management often include costly initiatives to reconstruct, or compile, fundamental design information, i.e., the plant design basis. However, adequate processes to maintain the reconstitution basis are sometimes lacking. . . *In addition, separate initiatives are underway to manage the large volumes of information and data that have exploded over the plant life cycle with little regard for the necessity of the data, documents, being retained, or the users* *needs*." This same NIRMA paper suggests that before a large amount of money is spent on a CM enhancement program, a strategic plan to fund activities needs to be created to spend resources effectively.

For a CM information system plan, the size, complexity, and interrelationships of the CM-related information are so extensive that an information system should be established to manage the information. The CM information system should integrate information both at the facility and site levels.

PROCESS AND DATA MODELING

Graphical representation of the current state of information provides a very effective means for presenting information to both users and system developers. A business model illustrates the functions associated with a process that are performed and the organizations that perform these functions. By depicting activities and information flows, a foundation is created to visualize, define, understand, and validate the nature of a process. A data model provides the details of information to be stored, and is of primary use when the final product is the generation of computer software code for an application or the preparation of a functional specification to aid a computer software make-or-buy decision. See Figure 4 for an example of the interaction between process and data models.

Usually, a model is created after conducting an interview, referred to as business analysis. The interview consists of a facilitator asking a series of questions designed to extract required information that describes a process. The interviewer is called a facilitator to emphasize that it is the participants who provide the information. The facilitator should have some knowledge of the process of interest, but this is not as important as having a structured methodology by which the questions are asked of the process expert. The methodology is important because usually a team of facilitators is collecting information across the facility and the results of the information from all the interviewers must fit together once completed. The models are developed as defining either the current state of the process, in which case the final product is called the "as-is" snapshot model, or a collection of ideas of what the process should contain, resulting in a "what-can-be" model.

Generation of process and data models can be used to determine if the existing processes and information systems are sound and only need minor modifications or enhancements, or if reengineering is required as corrective action. The creation of business models is more than a way to view or automate your information; process analysis can be used to fundamentally reshape the way your business or organization conducts its operations.

KNOWLEDGE ACQUISITION

Knowledge acquisition can be used to capture and retrieve an otherwise intangible asset—an expert's knowledge. Correctly done, knowledge acquisition can collect information and allow it to be shared throughout the organization despite organizational conflicts. Since

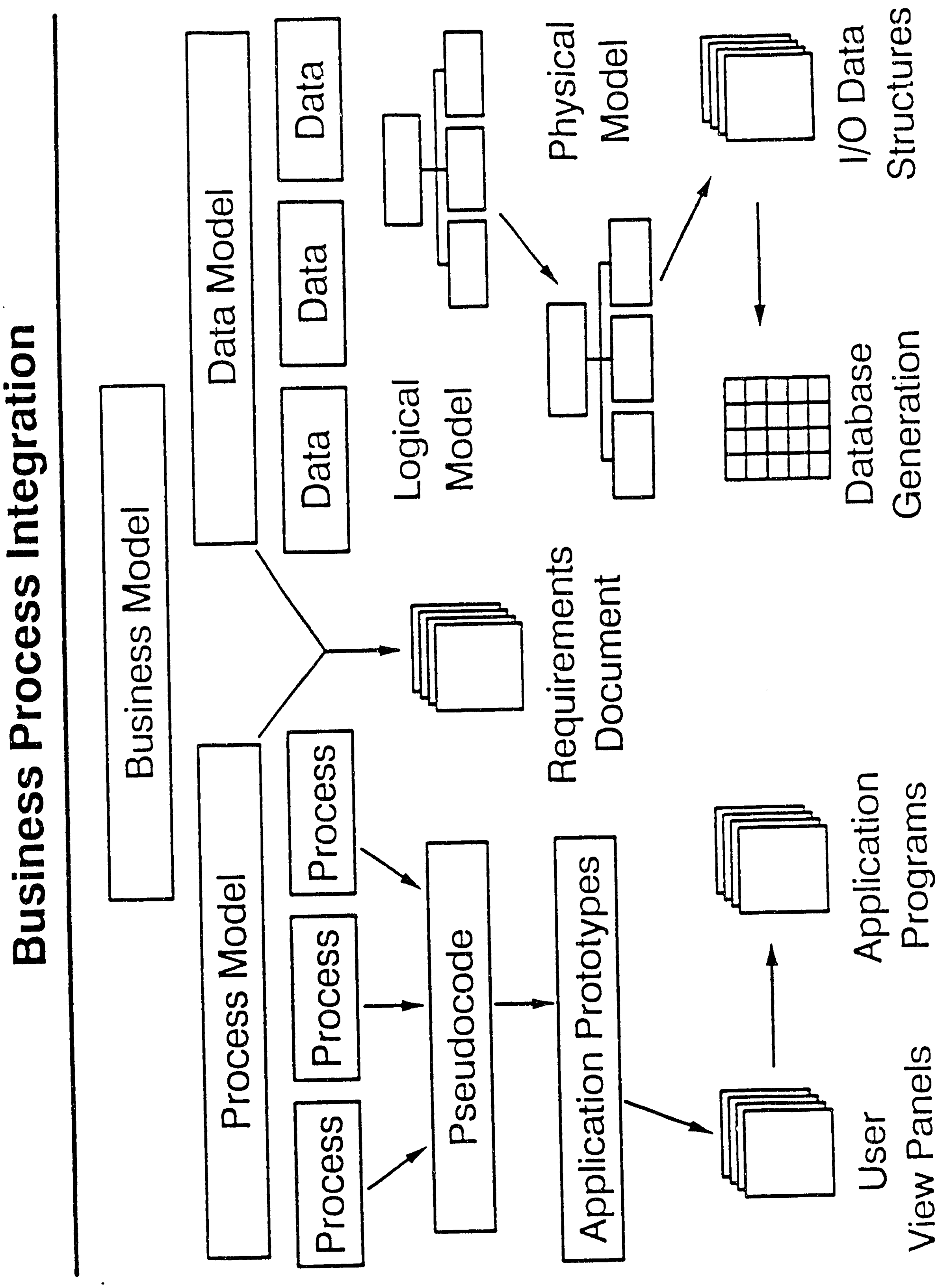

Figure 4. Business Process Integration

persons who actually perform a process know exactly what they do, they rarely examine it. Therefore, asking people to define how they perform a process poses a challenge they normally do not deal with. Thus, to interview experts and understand what they do requires a group of people to work together to build an explicit model of the expert's implicit domain (knowledge). Also, within large organizations, no individual or group controls a complete high level process because it is so complex. Collecting information about a complete process will require interviewing multiple experts who have different perspectives. Keeping these constraints in mind, it is no wonder that knowledge acquisition is considered an art and not a science. Collecting the information requires proficiency to question skillfully, listen carefully, and resolve turf issues without alienating any of the experts in the interview. Also, some experts can resent the replication of their knowledge because the result of this process can be perceived to equate with a loss of status, potential loss of job security, and transferring their knowledge gained over many years. Process and data modeling is one way to collect this information, thus converting the experts' knowledge into an easily understood format.

METHODOLOGY

The list of tasks required to collect information about the processes conducted at a facility or site constitutes a methodology. A methodology must contain a set of specific sequential steps that are followed and completed. At the end of each step, at least one deliverable is generated. The methodology associated with a CASE tool can provide the structure and discipline needed to conduct a series of interviews which are all related. Standardization is critical because the methodology must ensure that, if followed properly, each step will always produce the same type of deliverable. This creates an environment under which trained individuals can follow the required steps and consistently achieve similar results; this is probably the most important characteristic of a methodology.

A statement of purpose (what to do), objectives, techniques employed to achieve the objectives, and integration of deliverables are important properties as well. The methodology must address the following:

1. Identify the current processes conducted by each organization, company, or site.

2. Determine the information needs of the company (or site), particularly those that span across organizations.

3. Determine who the responsible individuals are that perform key functions within each organization.

4. Understand the primary roles of individuals and determine where they receive the information, what information is used by whom, what new information is generated. and what is done with the newly generated information.

5. Determine the current, near-term, and long-range plans for the persons being interviewed.

The information may be gathered using different approaches, particularly when using CASE tools that employ varying methodologies where the information is typically consolidated into models and narrative. Two CASE proprietary software products, including their methodologies, are described in a subsequent section. The emphasis of this paper is to describe the processes associated with collecting information to support the development of a strategic CM plan, including information strategic planning. Detailed discussion of subsequent steps to create a functional specification to purchase or develop a software application is beyond the scope of this paper.

Information models that support the development of a strategic CM plan can be built using a myriad of techniques, most of which use automated tools. These modeling tools may be used to perform decision-making analysis without ever having to generate a software application. What follows is an explanation of the steps used to develop an information system (IS), particularly when using a CASE tool. The knowledge associated with creating an IS is important to CM because the IS designer must understand the processes conducted at the facility or site and how these processes exchange information. Therefore, the techniques required to understand the processes by an IS designer can be used to generate a CM plan.

CURRENT INFORMATION SYSTEM STATUS

Computers were introduced into most DOE facilities to solve unique applications for end users. Computerization sprung up in a parallel form with end users automating at their own speed, with a unique view of information needs. Their emphasis was to expedite existing manually conducted tasks. This application-driven concept of computerization helped individual applications to be done more efficiently. However, since each application was computerized separately, the overall process was not computerized from beginning to end. Many of the information systems in place today were built over a period of time on multiple computer platforms and have disparate file and database structures. This situation has led to minimal sharing and much duplication of data. NIRMA has given an example of multiple, isolated applications developed from the commercial nuclear utility industry, as presented in Figure 5. This application-based process was used by nearly every enterprise and vertical market in the United States. This resulted because of the rapid way computers were introduced into the market place with the advancement of technology. The overlap and duplication of organizations in some cases was incorporated into the computerization process. Thus, the computerization that was supposed to increase the efficiency of organizations has ended up, in some cases, reducing the efficiency of the organizations. This challenge was worsened by the rapid introduction of personal computer (PC)-based application software packages that did not communicate with each other. Now, sites and corporations are beginning to treat information as an asset, such as land, labor, and capital. In the current business environment, managing information flow is as important to the success of the organization as managing product flow. For information systems to be optimized, these divergent systems must come together to form a cohesive integrated whole. During the last

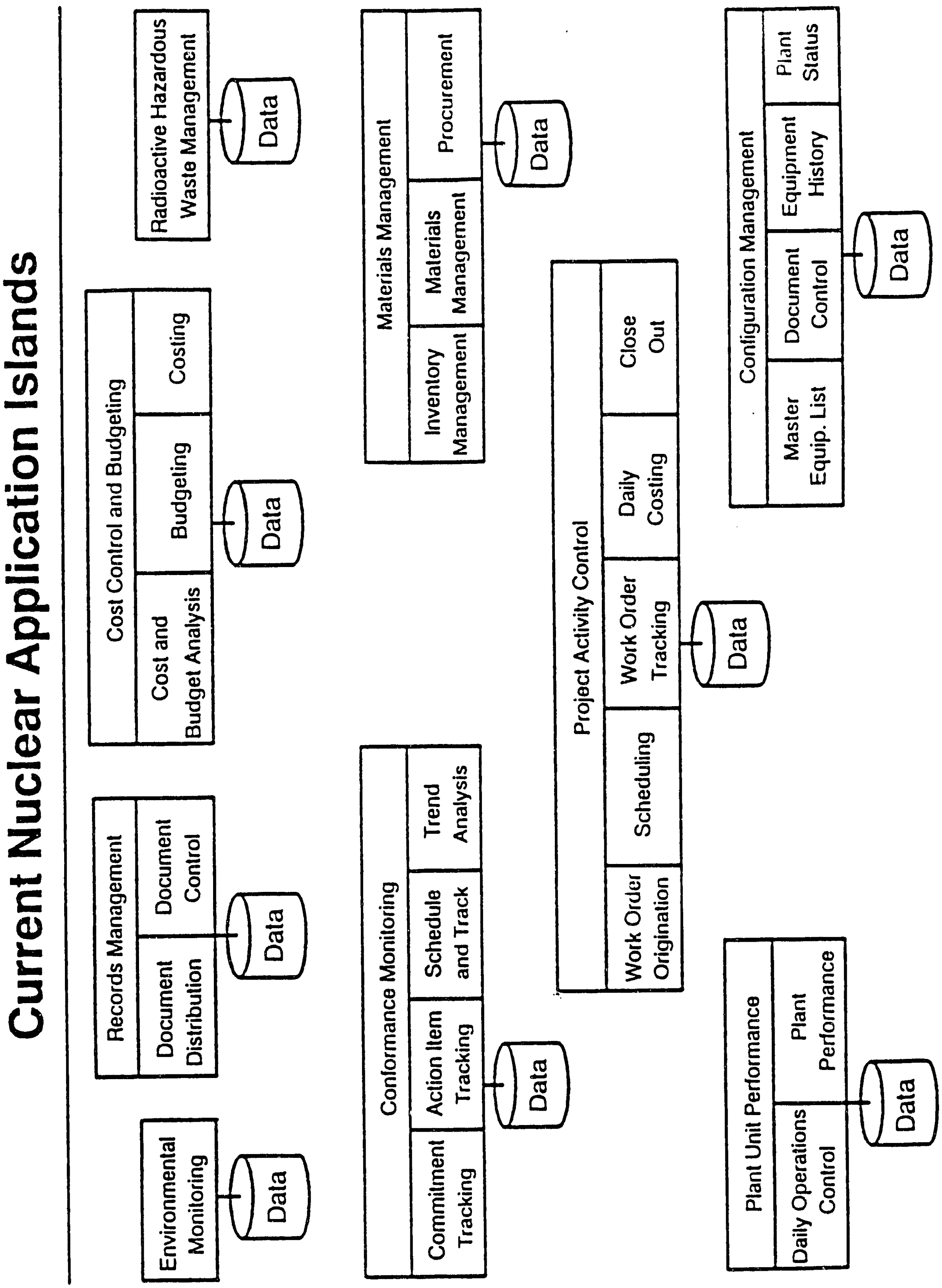

Figure 5. Current Nuclear Application Islands

10 to 15 years, there has been a great deal written about structured analysis and structured approaches to develop information systems. IBM, among others, was one of the early proponents of these structured approaches, and they developed their own proprietary methods for structured systems development. (We will discuss two vendor's methodologies later on in this paper). Therefore, a top-down approach to systems planning must be established to complement a bottom-up implementation strategy.

Process analysis is conducted by the creation of process models (activity, data, and interaction models) of areas that are of interest to the facility (engineering, operations, construction) to determine the way an organization, functional area, or facility performs functions, such as change control. Diagrammatical and narrative information can be captured and used to define the current state of the information associated with that function.

PROPOSED CM INFORMATION SYSTEMS

The principles of CM should be used to understand all the processes and integrate the information associated with these processes. Organizational analysis, supported by process and data models, assists the CM planners to gain a better understanding of what information is required to support the processes and information needs of CM. Correctly done, a CM program should strive to attain fully integrated applications. DOE-ID's facilities have to define all the various functions that support their applications, and this should be an integral part of their strategic plan. In private industry, electric utilities have already gone through that process successfully. Figure 6 (extracted from NIRMA PP03-1992) illustrates an example of a fully integrated information system.

An IS can be developed in a number of different ways. Traditional life cycles (also called system life cycles or system development life cycles) include planning, analysis, design, programming, testing, implementation, operation, and maintenance. In the past, a structured change-control mechanism for system modifications and enhancements has been lacking. This condition provides for weak version control, system interface constraints, and a decaying architecture.

Recent methodologies have become more structured and productive. They follow standard engineering principles and processes such as analysis, initial design, advanced design, etc. Typically, the deliverable of an integrated engineering process is a service or specifications to manufacture some product. As mentioned earlier, a methodology that has specific steps, standardized deliverables generated during each step, and can create the same end product consistently is in higher demand. Information engineering (IE) is probably one of the most widespread methodologies primarily for two reasons; first, it includes techniques for performing strategic information planning, analysis, design, and system construction; and second, there are several mature and proven CASE tools that support it. Among these tools, the information engineering facility (IEF), developed and marketed by Texas Instruments, ranks among the top three highest in the CASE marketplace.

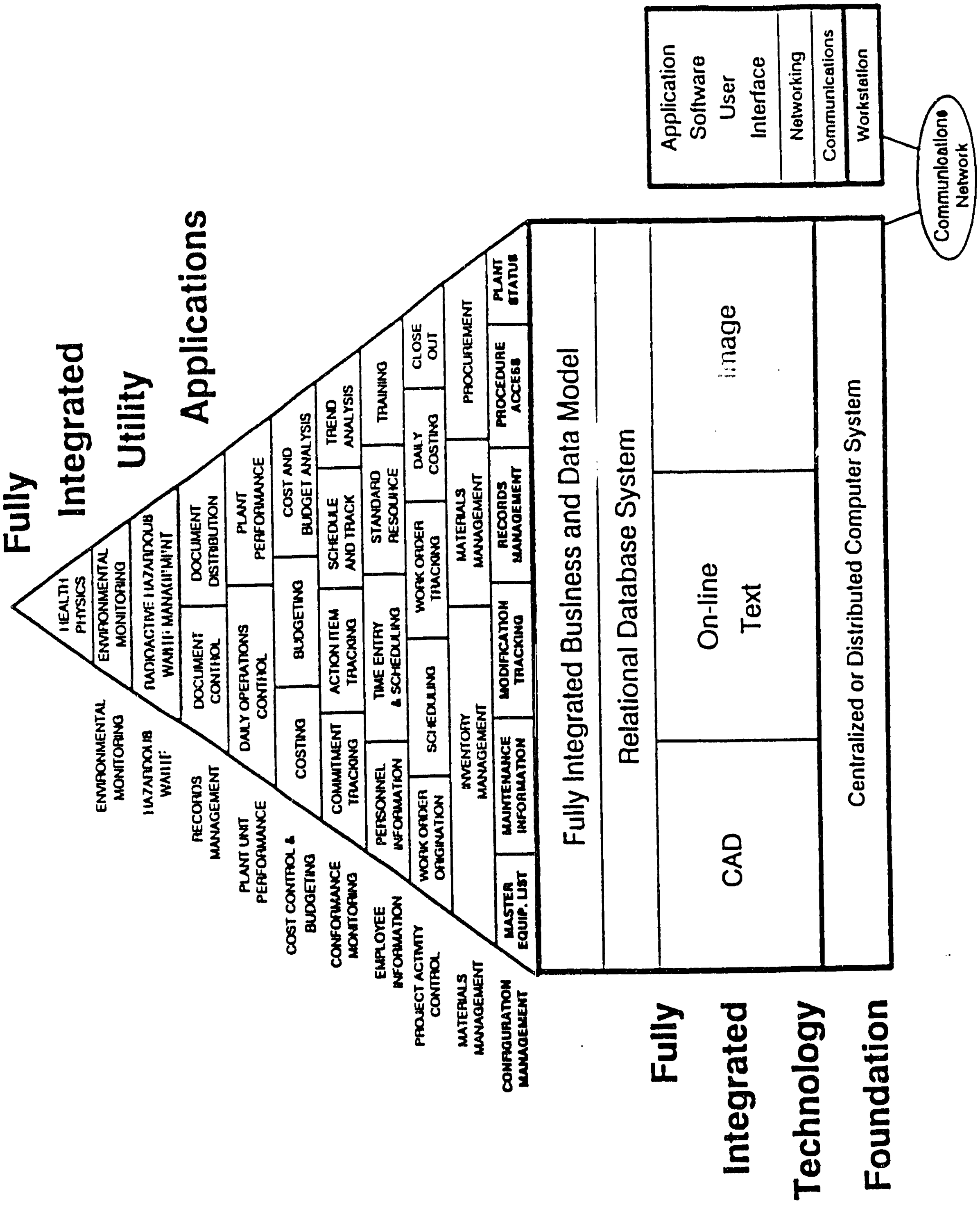

Figure 6. Fully Integrated Applications

A system development life cycle for developing an automated information system consists of five fundamental steps; although some CASE tools support seven stages, the last two being transition and production:

1. A feasibility study is usually conducted to assess, at a very high level, whether there is a strong justification to proceed with the implementation of an IS project. This step loosely equates to IE's first stage, information strategy planning (ISP). ISP addresses the entire enterprise's (company's) needs at a functional level. Examples are engineering, management & operations, waste management, etc.

2. The second step under a traditional system life-cycle methodology is analysis, which addresses the conceptual functional requirements for the identification of an IS. A major challenge with this approach is that multiple information systems can possibly be developed for different subject areas independent of each other. This fragmented environment is conducive to data duplication, poor data integrity, and massive changes when new requirements impact two or more of these systems.

3. The third step involves design, which is quite similar to any engineering process. In IE, this stage is called business system design (BSD), which further refines a subset of the business area models generated during business area analysis (BAA). This subset is called a business system, which is a compilation of elementary processes that define 'what' is required to support business activities, and procedures, which are detailed definitions of 'how' the elementary processes are performed.

4. In a traditional systems life cycle, the database definition, optimization (for faster system response time, improved performance throughput, etc.), and other subtle details are often commingled during the programming phase. In IE, this stage is called technical design, and it is important for the proper preparation of the technical environment.

5. Programming is the phase when code and logic are written, compiled, and tested to ensure that the system fulfills the functional requirements set forth during the analysis and design phases. In IE, this stage is called construction, where the source code (programming instruction rows usually called lines of code), source code compilation (where the lines of code are converted into machine language), and testing are performed.

CASE TOOLS

CASE tools have a unique set of rules and an underlying methodology. The high-end CASE tools support three fundamental model types:

Processes — This model assesses what activities are conducted by the organization (company, site, etc.). Activity hierarchy, activity dependency, and data flow diagrams are some of the leading diagramming techniques.

Data — This model assesses what data is stored and used by the organization (company, site, etc.). Entities (things of interest to the enterprise about which data is stored such as people, organizations, etc.) are defined, and their relationships are established. One diagramming technique associated with this approach is the entity relationship diagram (ERD). A key advantage to modeling data correctly is that, even though dynamic changes can occur to processes over time, the data structures remain relatively unchanged.

Interaction — This model assesses what processes use what data. It is a fundamental quality-assurance step, identifying processes that do not use any data or data that is stored but never used by any process. In either situation, an error has been made and is flagged before additional mistakes are made.

INFORMATION ENGINEERING FACILITY (IEF)

IEF comprises the following seven stages:

- Information strategy planning (ISP)
- Business area analysis (BAA)
- Business system design (BSD)
- Technical design (TD)
- Construction
- Transition
- Production.

BAA is the stage that defines an area of the enterprise (business) to be analyzed. This is achieved by performing three major tasks. First is activity analysis, which includes functional decomposition and process dependencies. The deliverables are activity hierarchy and activity dependency diagrams. Second is data analysis, where the business entities, attributes, relationships, cardinalities, etc., are identified. The deliverable is a data model, commonly referred to as an ERD. The third task is an interaction analysis between process and data such as what processes require what kind of data to be generated, managed, and stored. During BAA, interaction analysis is probably the most rigorous facet. A matrix is developed containing business processes along one axis and data elements along the other. For each matrix intersection (cell), the analyst and the user confirm whether a process creates, reads, updates, or deletes data (also known as a CRUD matrix). If any of the cells in the matrix appear blank, that portion of the analysis is probably flawed and must be examined further.

Another IS methodology that is useful to strategic planning collects and provides information to the IS designer and application user by a technique called cybernetics business modeling. This technique is discussed in the following section.

METAVISION

Applied Axiomatic Inc. developed and markets a CASE tool call Metavision. It comprises three stages (as illustrated in Figure 7): cybernetics (integrated) business modeling, software engineering, and software generation. Cybernetics (integrated) business modeling has three steps: model the business, analyze the business, and propose solutions to business problems. Software engineering has four steps: create a detailed data model, design screen and reports, design program logic, and prototype the system. Software generation has two steps: select a target language and platform, and generate the code. All of these stages are interrelated and integrated so that information can flow both ways between the various stages.
Cybernetic business analysis uses an activity modeling technique known as IDEF0. Originally developed by the U.S. Air Force, it is currently used by many corporations and government agencies, including DOE facilities. In a pictorial diagram, an activity is represented by a rectangular box that is labeled using an active verb or verb phrase. Any complex activity can be decomposed (broken down) into more detailed activities. The purpose is to stop the decomposition once an activity is clearly defined, understood, and, if broken down further, would not provide any value-added information as shown in Figure 8 (similar to a functional primitive used in data flow diagrams). Each activity has four roles: process, data, control, and support as illustrated in Figure 9. Processes consume and produce data. Data is created by a process. Control includes the policies, procedures, and quality indicators for the business. Finally, support defines who does the business and what tools they used.

Software engineering uses a data modeling technique known as IDEF1X, which was developed by DACOM for the U.S. Air Force as part of the Integrated Computer Aided Manufacturing (CAM) program, and it is commonly used in the private and public sectors. It is composed of a set of diagrams representing entities, attributes, and their relationship to one another. These form a fully attributed data model, which is subsequently used to build the actual physical structure of the application using a relational database, or is some rare cases, simple files. Software engineering also defines screen designs and associated reports and design program logic. A prototype can be used to create screen design and reports that are presented to the users to verify that their functional requirements are met.

Software generation involves selecting the target programming language and the platform in which the system will operate. Based upon the three stages and their corresponding steps, the code will be generated automatically through a process called connected development (refer to Figure 7).

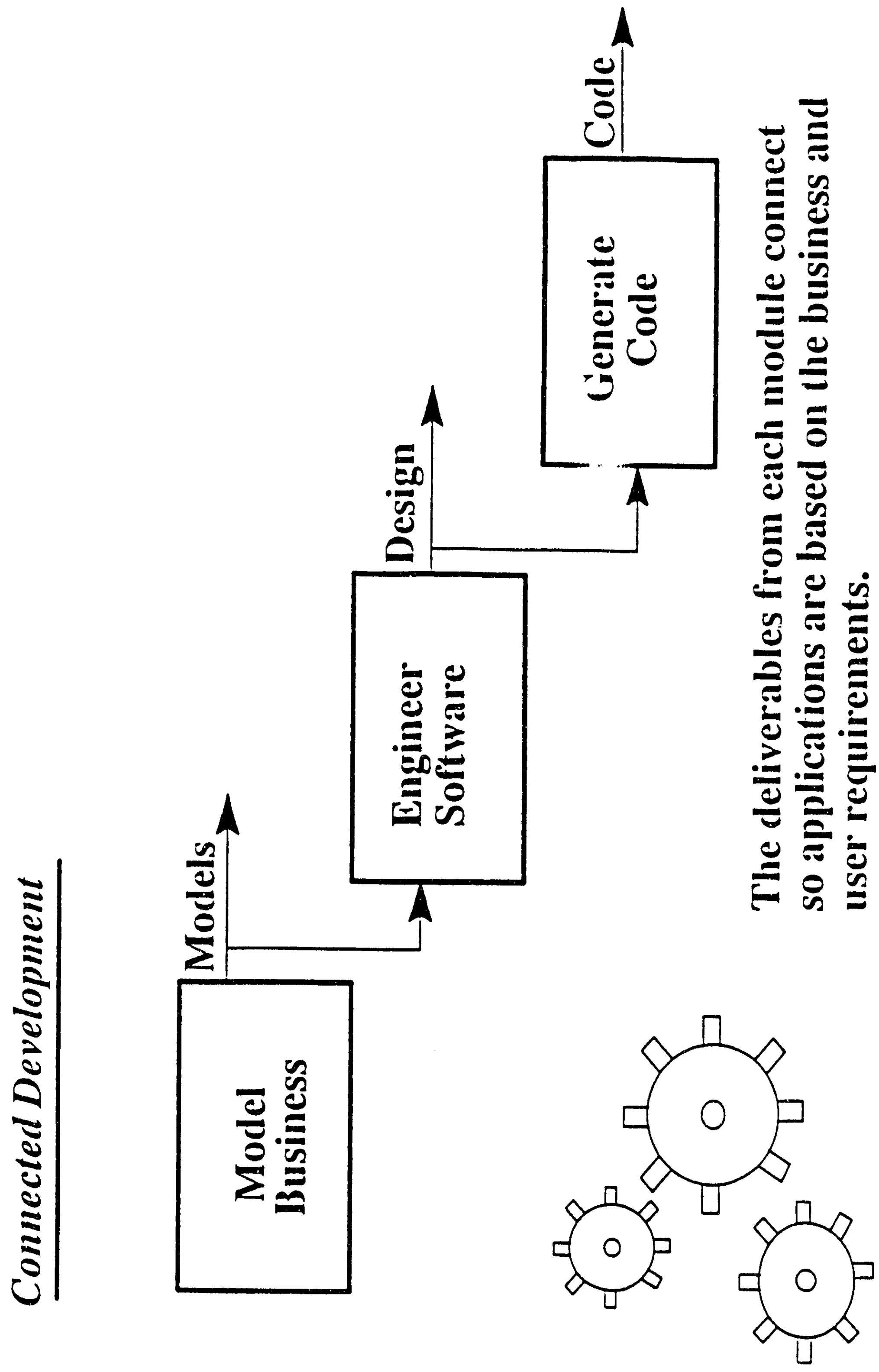

Figure 7. Three Stages of Connected Software Development

PROCESS HIERARCHY BREAKDOWN

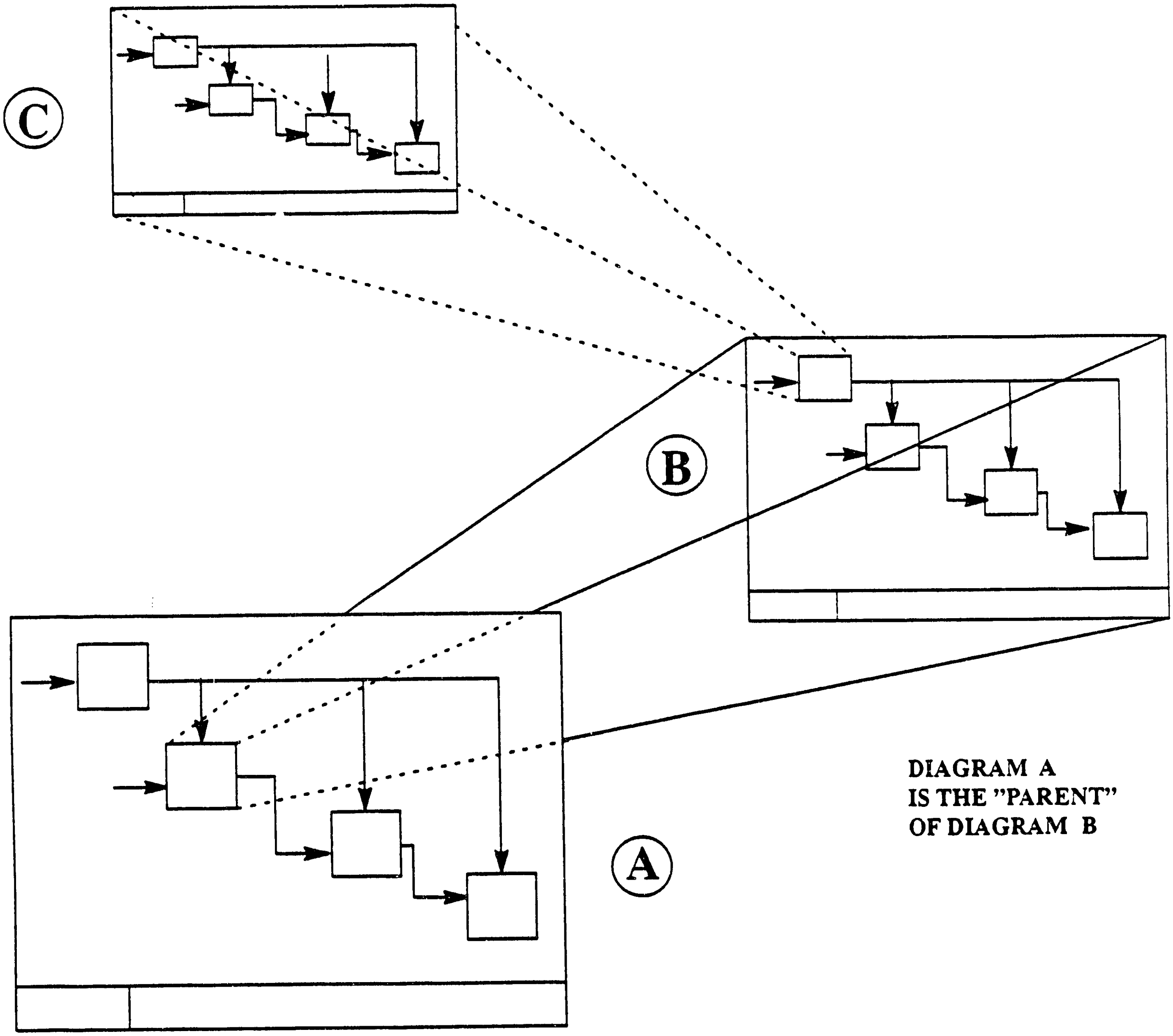

Figure 8. Process Hierarchy Breakdown

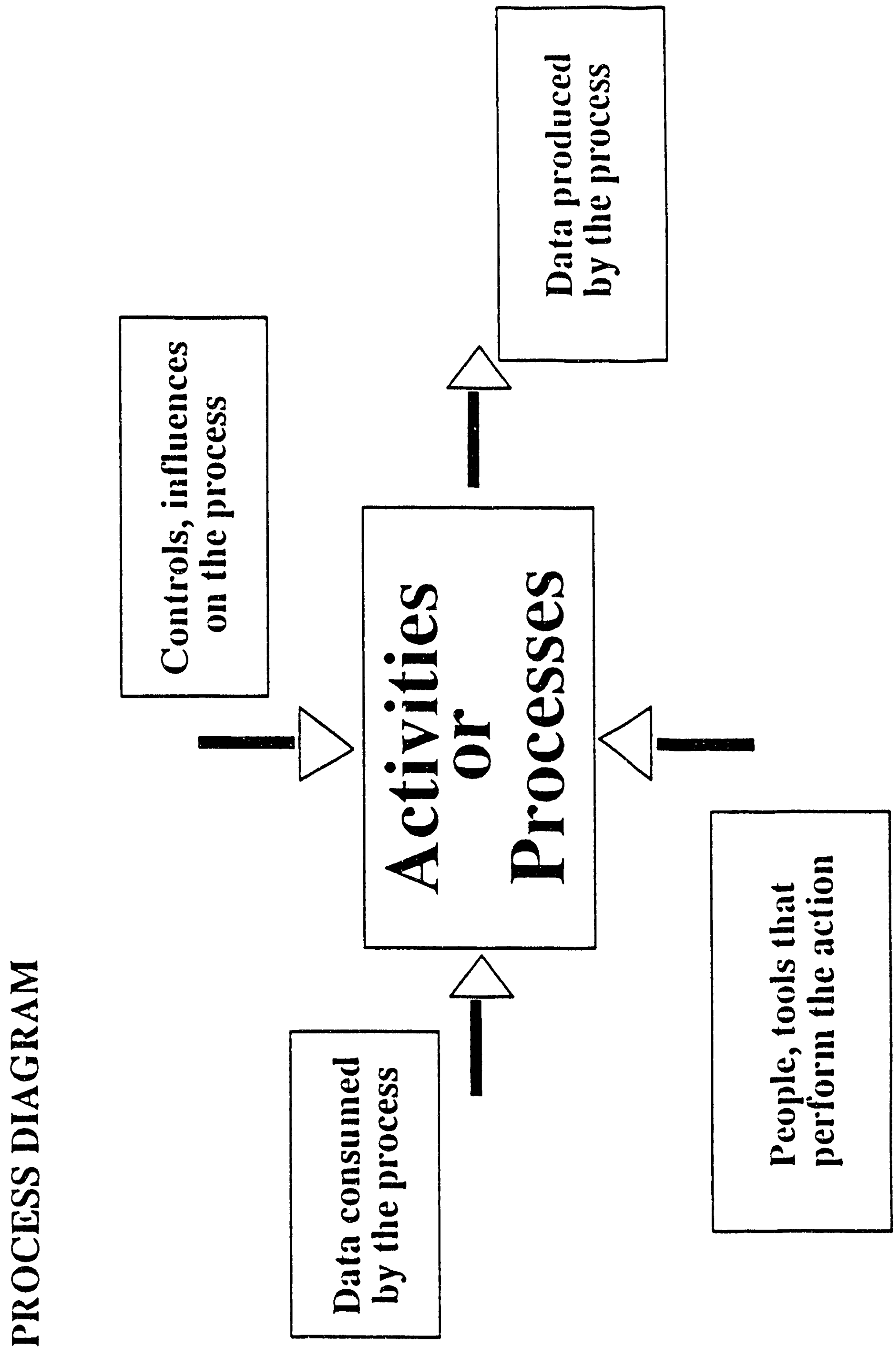

Figure 9. Four Roles of Activity or Process Analysis

CASE TO SUPPORT CM STRATEGIC PLAN

Information gathering is the most important process to ascertain the current environment's information needs. The analyst team must interview the users so they can explain what they want, without telling them what they need. Analysts, by nature, display a tendency to formulate a solution for the user, and the user in turn usually concurs with it despite the fact that what the user understood differs from what the analyst proposed. This challenge is discovered further in the process and may represent serious cost and schedule problems. A method used to gather requirements is called joint application development (JAD) and has become quite popular. Its main benefits are that it accelerates the deve'opment process, increases productivity by using more resources in a shorter period of time, reflects business needs from the user's perspective, and increases total organizational commitment. In order to achieve the latter, an executive sponsor, typically a senior manager or even a chief executive officer, must communicate to his or her peers and subordinates that the forthcoming JAD sessions carry a high priority, and that all requested parties attend, confer, and create a management guide that contains the functional requirements to meet the information needs of the company or organization. The JAD participants must be knowledgeable in their respective areas, cooperative, available, and most importantly, empowered to make decisions during the session without resorting to obtain management approval. A facilitator mediates any differences of opinion and enforces the JAD session rules (discussion on JAD rules is beyond the scope of this paper).

The major deliverable from the JAD process is a set of functional requirements that have complete consensus and concurrence from the candidate users of the information system. The functional requirements are consolidated into a functional requirements document (FRD). However, it is certain that some requirements will need to be further refined, combined, or modified. This is when a diagrammatical representation of the functional requirements must be constructed to communicate with the users, since it is easier for them to assess a picture than thousands of words.

These diagrams are usually referred to as business models, usually referred to as process and data. The formulation of the models is a tedious and iterative process since additional information is being obtained from the user at different points in time. To maintain the models manually (i.e., make changes) can seriously jeopardize major project milestones. Thus, there is a need for an automated tool that not only allows for an easy means of recording the changes but also provides consistency checks to ensure that changes made in certain models automatically update associated models that are not apparently visible at the time of the change.

CASE TOOLS USED TO CREATE AND MANAGE MODELS

The current IS environment, also known as the 'what is', must be defined to establish an information baseline. This is done by conducting the following tasks:

1. Establish the context and definition of CM.

2. Establish the content and connectivity of existing ISs.

3. Establish a company vision for information management relative to CM.

Assess the connectivity of existing ISs

Most companies are burdened with fragmented ISs that were myopically built for the needs of one subject area (e.g., payroll within finance) without taking into account another subject area. This has lead to data redundancy, data corruption (loss of data integrity), and concurrency problems, e.g., two ISs have a duplicate attribute, such as DOE Order, the value is obtained externally and entered by two different persons into the two ISs. One IS fails to be updated on a certain month, yet both ISs generate the same report for two different sources but with different values. This represents a concurrency problem.

A subset of the definition process is to interact with the users to verify and validate the 'what is'. Models, which are usually comprised of narrative and illustrations, are created and gradually refined until they are concurred and approved by the user. These models must not only be accurate, but must allow easy visualization. The management and maintenance of these models is tedious, paying attention to substantial detail. At this point, the use of a CASE tool becomes critical because it provides a higher level of accuracy and is less labor-intensive for not only the drawings but also the referential integrity of the model's information. Once again, it is important to note that model management can be performed with a CASE tool that does not have the capability to generate code (upper CASE), although an I-CASE tool is preferable.

Data Model Example

The following example illustrates some basic data modeling concepts (see Figure 10). Suppose that we want to gather, manage, and store data germane to a nuclear plant environment; one entity could be FACILITY, another could be EMPLOYEE, and a third could be PROCEDURE. It becomes apparent that a unique method of identifying each occurrence of the three entities is necessary. One FACILITY instance (the value of an occurrence of the entity, such as Advanced Test Reactor) would most likely have a name, a number, or some other combination to differentiate it from another FACILITY. The same is true for the entity EMPLOYEE, where last name is not sufficient to uniquely distinguish an instance of this entity; thus. we might use a BADGE_NUMBER to identify an EMPLOYEE. The same is true for a given PROCEDURE; it may have a unique identifier such as PROCEDURE_NUMBER and may also contain an AUTHOR, an ISSUE_DATE, etc. PROCEDURE_NUMBER, AUTHOR, and ISSUE_DATE are called attributes, which are

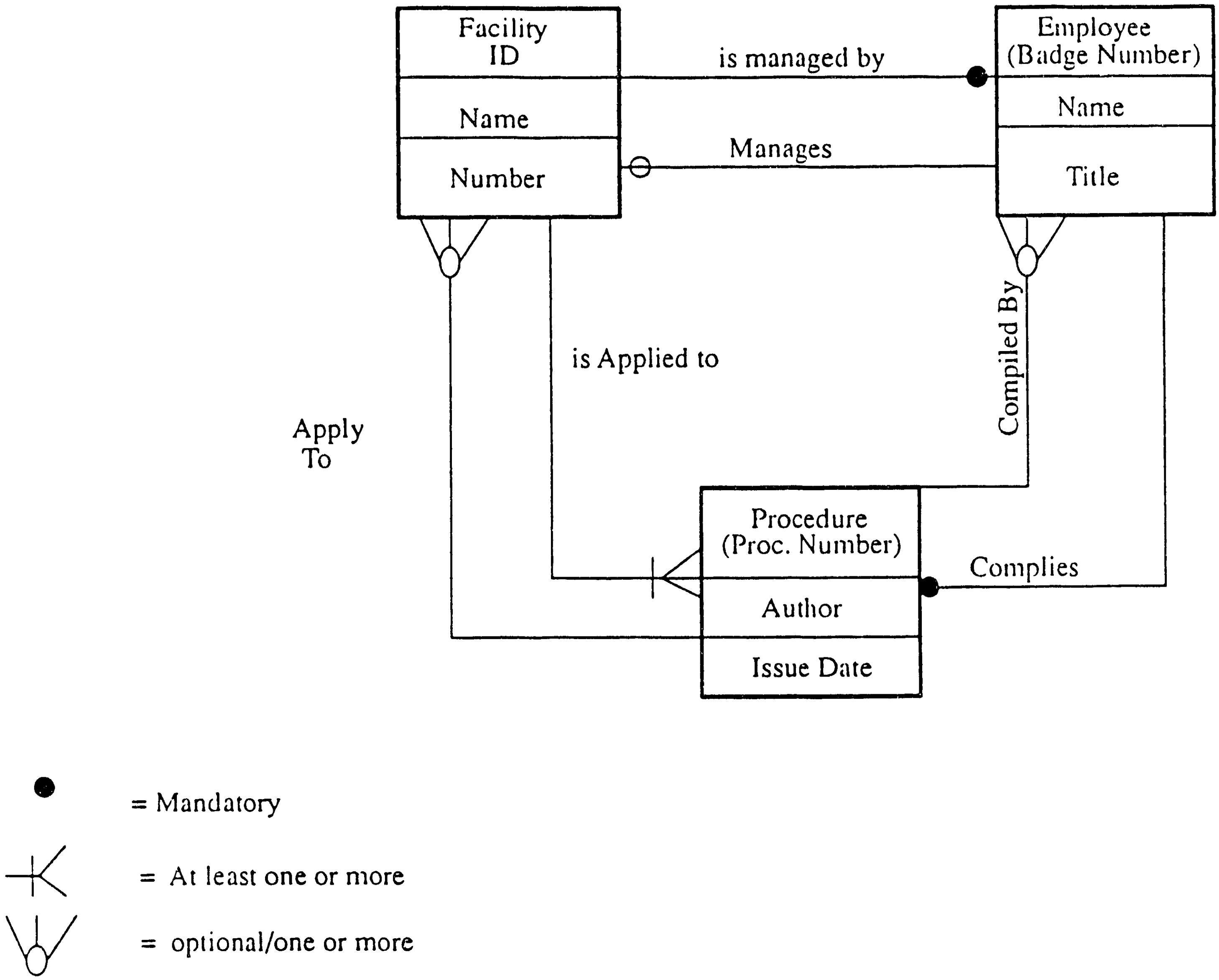

Figure 10. Data Model Example

facts about an entity. A FACILITY must be MANAGED by at least one EMPLOYEE and that EMPLOYEE must COMPLY with at least one PROCEDURE to safely run the FACILITY. A FACILITY has many PROCEDURES APPLIED to it, and a PROCEDURE MAY APPLY to a FACILITY. MANAGED, COMPLIED, APPLIED to and MAY APPLY to are relationships between entities. (Further discussion about cardinality, optionality, and association is beyond the scope of this paper.) Finally, we have business rules that may not be explicitly stated in the relationships. For example, a PROCEDURE creates an ACTION for an EMPLOYEE, and for some reason the ACTION is reassigned to a different EMPLOYEE and CLOSED only after it is completed and approved. The business rule would state that the EMPLOYEE who was first assigned the ACTION, may not CLOSE it if it has been reassigned to another EMPLOYEE who then is responsible to CLOSE the ACTION.

Process Model Example

The following example illustrates how a process model can be used to understand the way a process is conducted at a facility. Figure 11 contains a model with four process blocks labeled Collect Data for Master Equipment List (MEL), Walk-Down Systems Components, Develop Drawing Missing Data (DMD), and Label Equipment. These process blocks are similar to any level of the organization under investigation such as shown in Diagram A of Figure 8). The information gathering for the organization may go up or down the organization chart in the form of a process hierarchy breakdown, as shown in Figure 8 (with Diagram B at the center of the three organizations under investigation). The nomenclature associated with the information attached to any process block is described in Figure 9. Note that the process block has information provided to it by four arrows (which are labeled) that have a four-dimensional appearance and provide information to all four faces of the process block. The first process block in Figure 11 (labeled Collect Data for MEL) has information provided to it (labeled Request for MEL Data) and existing system data (which is provided from the Operations Engineering (OE) Database). The Control of the process is the OE procedure. The Organization (people) who supports the process is the OE. The data produced by the process is labeled System Walk-Down. The four types of information associated with a process have now been described for one process block in Figure 11. The remaining information for the three process blocks appearing in Figure 11 is provided in the same format as the first block. By reviewing Figure 11, it is apparent that the process to update the MEL has been described for that facility and has been illustrated on the model.

By reviewing the MEL model, additional items can be discovered that appear to be missing prior to this step. If the information consumed or produced by a particular process is not described, a model could identify important information that should be collected but is not currently being done. Therefore, corrective actions could be required immediately to collect the required information to be used in the future. If the organization has issued a procedure to control a process that has not been identified on the model, the persons organizally interviewed to create the model should be interviewed again to assess if this omission was an oversight, or if a procedure is not being followed to control a process. If a database should be used to support the process, but is not shown on the model, this could be an indication that the organization is unaware of the database, or is not using it for some reason. If

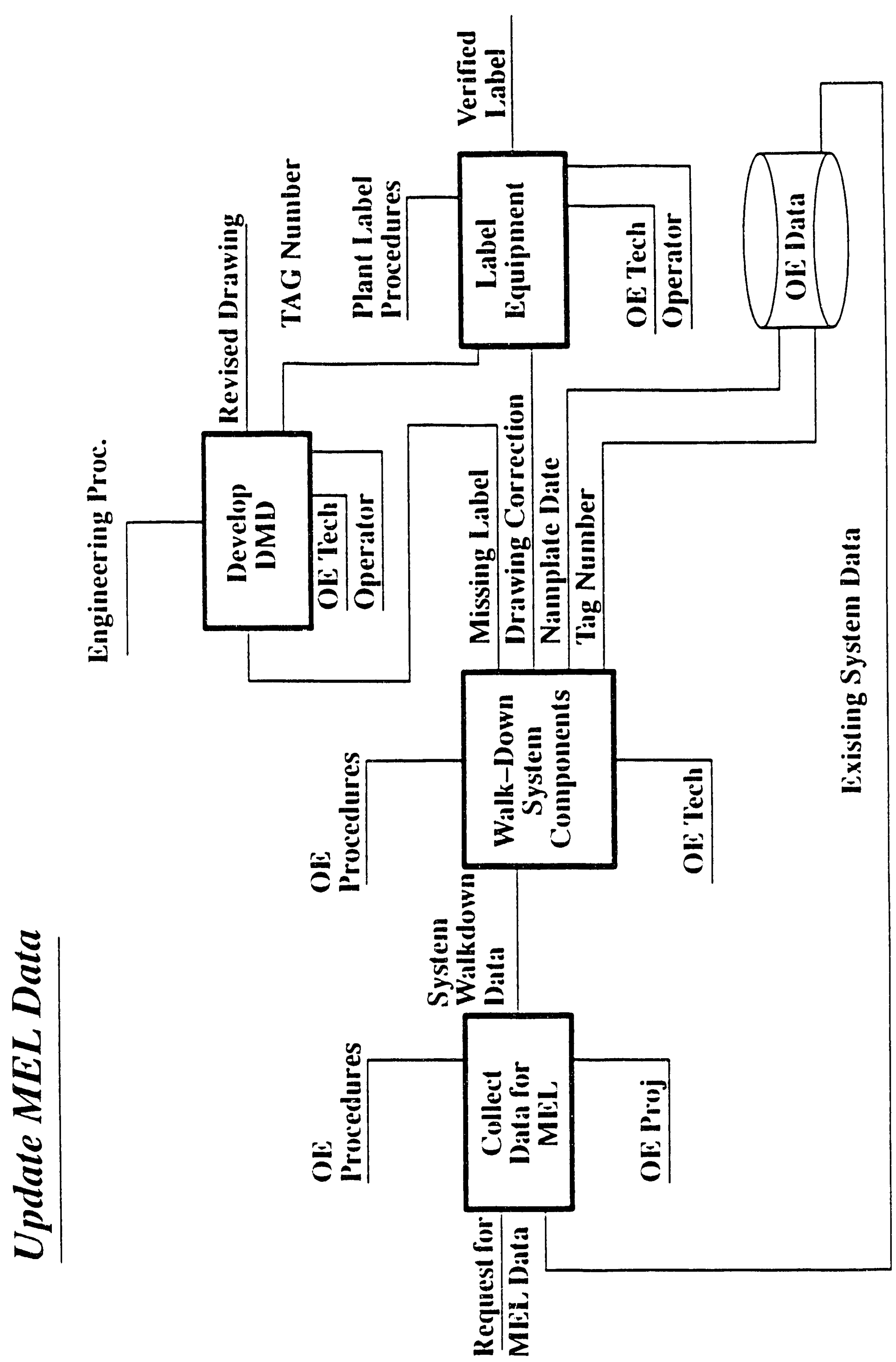

Figure 11. Process Model Example

multiple databases are being used by the process, analysis should be conducted to determine if they should be consolidated into a central repository or single database.

CONCLUSION

To implement configuration management at a facility, management needs a strategic plan that includes a structured approach and methodology to define the processes. The strategic plan will most probably conclude that a process analysis, supported by a CASE tool selection, is one of the first steps. This methodology must be capable of supporting process analysis and CM throughout the life cycle of the facility. The CASE tool that helps define the problem can be used to gather information necessary for the solution as a parallel activity.

REFERENCES

Nuclear Information Records Management Association (NIRMA), Position Paper for Configuration Management Information Systems, paper number PP14-1992.

Nuclear Information Records Management Association (NIRMA), Position Paper for Implementing a Configuration Management Enhancement Program for a Nuclear Facility, paper number PP03-1992.

P. R. Smith and R. F. Cook, Design Basis Reconstitution and Configuration Management of Nuclear Power Plants, *Nuclear Engineering and Design*, 1990.

P. R. Smith and R. F. Cook, Configuration Management-Are You Operating the Plant You Licensed?, *Nuclear Plant Journal*, 1991.

R. L. Cowley, Configuration Management "What is" Versus "What Should Be," Nuclear Information Records Management Association (NIRMA), 1989.

H. R. Sager, R. L. Cowley, Retrofiting Configuration Management, Paper presented at American Nuclear Society 15th biennial Reactor Operations Topical Meeting on Reactor Operating Experience, August 11-14, 1991, Seattle, WA

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