

Advanced Work Flow EDMS Vision 94 Fall User Forum

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Advanced Work Flow

- Over View of Work Flow
- Planning the Work Flow Process
- The Work Flow Environment
- Work Flow Systems Architecture
- Work Flow Data Representations
- A Worked Example

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Advanced Work Flow

Overview of Work Flow Systems

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Why Work Flow?

*There's no limit to how complicated things can get,
on account of one thing always leading to another.*
— E. B. White

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Why Work Flow?

Motivations for Work Flow Based EDM

- Operational Motivations
 - Repetitive Processing
 - Faster response time for information processing
 - External control over the processing of engineering documentation.
- Infrastructure Motivations
 - Client / Server based computing provides separation of data and services that assess the data.
 - Different processes make use of the same data.
 - Interaction requirements change over time.

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Why Work Flow?

Business Process Motivation (†)

- Businesses can be viewed in terms of *Functions* and *Processes*.
- The *Function* based view has been historically the one taken by upper management.
- Processes are the *naturally occurring activities* which comprise the business.
- To perform the business process, organization structured around functions must coordinate and control their activities.

† "Process Redesign: Integrating Work Flow and Information Technology," N. McGaughey, *Accounting Today*, April 19, 1993.

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Why Work Flow?

Target Applications? (†)

- Value Added Processes
 - Hand-off activities which cross boundaries of the organization.
 - These activities are usually accompanied by a control activities (both sending and receiving controls).
- Strategic Processes
 - Processes that are central to the organization's definition.
- Combining Strategic and Value Added produces the highest return.

† "A Framework for Reengineering", R. L. Manganelli, *Management Review*, June 1994.

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Why Work Flow?

Target Applications for Work Flow based EDM

- Concurrent Engineering and Shop Floor Control.
- OSHA / ISO / EPA Documentation Compliance.
- NRC Design Basis and Change Notice Processing.
- Engineering Drawing and Document Revision Control and Distribution.
- Engineering Purchasing Management.
- Maintenance Documentation Update and Distribution.

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What is Work Flow Really?

Attributes of Current Work Flow Systems

- Usually embedded in a vendor's product line
- Usually tightly coupled to the operating system environment
 - Windows and OSF/Motif
 - OS/2
- Just starting to be *unbundled* as a separate product.

Also Known As

- 4GL Language
- *The integration tool of the 90's*

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What is Work Flow Really?

Abstract Components of a Work Flow System (†)

- Flows — a component of work.
- Steps — Modular work units.
- Metadata — information about the data used by the application.
- Work Unit — application *routine*, which accomplishes a single business function.

† "Work-Flow and Legacy Systems", M. Hsu and M. Howard, *Byte*, July 1994, pp. 109-116

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What is Work Flow Really?

Physical Components of a Work Flow System

- Client Interface
 - Forms
 - Windows Dialogs
- Work Flow Engine
 - Client based with shared state information in a database.
 - Server based
- Inter-Process Communication System
 - Internal messaging provided with work flow product
 - E-Mail based messaging integrated with workflow product

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Advanced Work Flow

Planning the Work Flow Process

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Planning the Work Flow Process

When schemes are laid in advance, it is surprising how often the circumstances fit in with them.

— Sir William Osler

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Planning the Work Flow Process

Development Life Cycle

- Gather Requirements.
- Analyze the Alternatives and Synthesize the Solution.
- Design the Detailed Processes.
- Implement the Processes.
- Deploy the System.

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Planning the Work Flow Process

Target Architecture

- Absence of an architecture allows the system to become an end unto itself.
- Defining the Target Architecture becomes the essential task of the system development.
- The Target Architecture needs to be produced before any other activities take place.

The Document which describes the Target Architecture is the System Requirements Specification (SRS). (†)

† *Software Requirements: Analysis & Specification*, A. M. Davis, Prentice Hall, 1990.

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Planning the Work Flow Process

System Requirements Specification

- Contains a complete and concise description of the entire external interface of the system, including:
 - Behavioral requirements defining what the system does.
 - Nonbehavioral requirements defining the attributes of the system as it performs its job.
- Does Not Contain
 - Project Requirements, including staffing, schedules, milestones, etc.
 - Detailed Designs or technology specifications.
 - Test and assurance plans.

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Planning the Work Flow Process

Attributes of a SRS

- Correct
- Nonambiguous
- Complete
- Verifiable
- Understandable by non-computer specialists
- Modifiable
- Traceable
- Annotated

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Planning the Work Flow Process

Designing the Work Flow Processes

- CASE Tools
 - Yourdon/DeMarco
 - Gane & Sarson
 - IDEF1X
 - Chen
- Prototyping the User Interface
 - Visual Basic
 - Power Builder
 - PC or OSF/Motif Forms Tools
- Prototyping the Data Base Model
 - Throw away tables
 - Sample SQL scripts

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Planning the Work Flow Process

Implementing the Work Flow Processes

- Client Server Paradigm
 - All data and state information regarding the work is held in the server's database.
 - Client applications:
 - retrieve the current data and state
 - alter data and / or state
 - return data and / or state to the client
- X-Terminal Paradigm
 - Workstation provides a "Window" to the work flow application, which is executing on another platform.
 - Provides some ability to bridge platforms

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Planning the Work Flow Process

Deploying the Work Flow System

- Install initiate seats in an area where the highest pay off is possible..
- ... and employ the most enthusiastic users for the initial startup.
- The design and development team, *must* continue with the system during its initial deployment.
- The System Administration staff *must* have been involved in the system design and development.
- The concept of a pilot should be avoided...the system should be deployed as *Production*.

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Work Flow System Environment

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The Work Flow System Environment

Components of Work Flow Environments

- Work Flow Language
- Work Flow Modeling Tools
- Work Flow Runtime Environments

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Work Flow Languages

Components of a Work Flow Language

- Grammar and syntax of the language.
- Runtime components which connect the language to the environment.
- Embedded functions which extend the language

Taxonomy of Work Flow Languages

- Traditional Procedural Language
- CASE Style Representation
- Forms Routing

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Taxonomy of Work Flow Languages

Traditional Procedural Languages

- *Script* based languages which have:
 - Procedures and sub-procedures
 - Local and Global storage declarations
 - Programmatic interfaces to external systems
 - Embedded run-time environments
- Development Tools
 - Editors and *compilers* which convert the language into the run-time environment
 - Debuggers which use *breakpoint* and *spy glass* like paradigms.
 - External linkage provided through operating system connection methods.

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Taxonomy of Work Flow Languages

Traditional Procedural Languages

- Major computer as well as EDM vendors offer procedural language work flow systems.
- Many have unbundled the document image management facilities from their product offerings.
- Multiple platform support is now common.

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Taxonomy of Work Flow Languages

Traditional Procedural Language Examples

- Visual Basic
 - Built-in or Custom controls provide for the display and manipulation of document images
 - Integration with E-Mail, ODBC Databases and C/C++ runtime environments
 - Operates in the MS Windows environment only
- FileNet's WorkFlo®
 - Procedural language similar to Pascal, with procedures and parameters.
 - Integrated with the Image Management System backend.
 - Operates in the MS Windows environment only.

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Taxonomy of Work Flow Languages

Other Visual Programming Languages

- *Visual Basic* and *Visual C++* (and C++'s)
- Digitalk's *SmallTalk V* and *Parts* (also IBM)
- Powersoft's *PowerBuilder*
- Metasoft's *Design/CPN*
- Novell's *Visual AppBuilder*
- Visual Solution's *VisSim*
- Prograph International's *Prograph*
- Easel's *Enfin*
- Computer Associate's *CA-Realizer*
- Magic Software's *Magic*

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Taxonomy of Work Flow Languages

CASE Style Representations

- CAD-like user interfaces which allow *drawing* of the flow of work.
- Nodes used to represent centers of work.
- Arcs used to represent the connectivity between the processing centers.
- Exit criteria from a node controlled within the processing center.
- Direct connection to data model through ODBC or other SQL interface usually provided.

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Taxonomy of Work Flow Languages

Case Style Tools

- Most tools used by systems development organizations in conjunction with data base CASE tools.
- Applied in environments where *role* stratification takes place.
 - Corporate data modeling
 - Verification of models against corporate guidelines
 - Implementation of data and process model
- Development cycle includes review and confirmation of design to avoid negative impact to overall strategy.

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Taxonomy of Work Flow Languages

Forms Routing Work Flow Languages

- Rules based transition from one state to another.
- Design and development usually provided by *filling in forms* which define the state transitions.
- Some vendors provide front ends which provide *graphical* definition of the tables and their rules.

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Taxonomy of Work Flow Languages

Folder Routing

- Folders usually contain
 - Forms
 - Documents, both images and CAD renderings
 - Possibly data record references
- Folders model how some approval processes take place in the plant or shop floor.
- Folders have some limitations:
 - Cross references can become cumbersome
 - Structural references within the folder do not always model the physical plant organization — not every situation is hierarchical.

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Taxonomy of Work Flow Languages

Forms Routing Work Flow Examples

- FormTek's TDM Workflow
 - Routes folders of work among the distribution list
 - Forms used to capture state information and alter the routing of the work package.
 - Makes use of the underlying SQL database manager for storage and communication of forms contents
 - An E-Mail paradigm is built into some of the Formtek workstation applications
 - At each step in the process the *Task* be routed can interact with the work station user through a tailored form.

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Taxonomy of Work Flow Languages

E-Mail Work Routing

- A very straight forward method of adding *Work Flow* capabilities in a work station application.
- Similar in structure to forms based systems, without the complexities of the vendors runtime package.
- *Packages* of work are routed among the group of users contained in the E-Mail's distribution list.
- The state of the package can be captured using forms and a database server.
- X.400 connectivity allows *cross platform* execution.

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Advanced Work Flow

Work Flow Systems Architecture

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Work Flow Systems Architecture

Basic Work Flow Building Blocks (†)

- Target Architecture
- Process Modeling
- Data Modeling
- External System Integration

† *Information Systems Architecture: Development in the 90's*, W. H. Inmon and J. H. Caplan, John Wiley & Sons, 1992.

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Work Flow System Architecture

In nearly every software project which fails to meet performance and cost goals, requirements inadequacies play a major role in project failure. (†)

Development of the requirements specification "in many cases seems trivial, but it is probably the part of the process which leads to more failures than any other." (§)

† "Software Requirements Engineering Methodology (Development)," RADC-TR-79-168 (DDC-AD-A073132)

§ "Construction of Software, Problem and Practices," *Practical Strategies for Developing Large System Software*, E. Horowitz, Addison-Wesley, 1975.

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Work Flow System Architecture

Objectives of the System Requirements for:

Analysts

- > Functional Definition
- > Complete
- > Frozen
- > Definition produced within allotted time
- > Resulting system delivered within project schedule and budget
- > Good System

Users

- > Qualitative definition
- > Interpretation to be expected.
- > Flexible definition
- > Definition an on going process
- > Favorable impact of system on departmental budgets
- > System will work

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Work Flow System Architecture

Taxonomy of Work Flow Processes (†)

- > Data Maintenance
 - Retrieve, Display, Insert, Alter and Delete records from a database.
- > List Generators
 - List data, images, documents on the display or printer
- > Transformation Programs
 - Copy data from one record set to another and transform this data in some form.

† *Myths and Methods: A Guide to Software Productivity*, D. T. Fisher, Prentice Hall, 1991.

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Work Flow Systems Architecture

The Ten Basic Types of WF Transactions

- > Retrieve a Record From the Database.
- > Move Forward to a Record in the Database.
- > Move Backward to a Record in the Database.
- > Insert a New Record in the Database.
- > Alter the Contents of a Record in the Database.
- > Delete a Record From the Database.
- > Prepare a Screen for Displaying Information.
- > Present Help to the User.
- > View a Table Extracted From the Database.
- > Properly Terminate the Processing Session.

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Work Flow Systems Architecture

Additional Complexities in Work Flow

- > Branching Decisions Based on the Contents of a Database Record.
- > Routing of Information Given the Contents of a List.
- > Termination and Restoration of the Database Given an External Event of Database Condition.
- > Editing the Contents of a Database Record Given Specific Rules.
- > Verification of the Contents of a Database Record Given Specific Rules.

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Work Flow Systems Architecture

Process Modeling

- > Results in the specification of the functions that need to be accomplished by the work flow implementation.
- > Types of process modeling:
 - Transactions processes
 - Iterative processes
 - Batch processes

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Work Flow Systems Architecture

Process Modeling

- > Scope of Integration
- > Functional Decomposition
- > Context Diagram
- > Basic Process Model
- > Data Flow Diagram
 - State Transition Diagram
 - Programming Specification
 - Pseudo Code

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Work Flow Systems Architecture

Transaction Processing

- Each transaction represents a *self contained lump of work*.
- Each transaction can be completed in a small number of self contained steps.
- Each transaction can be suspended or terminated without effecting the integrity of the database.

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Work Flow Systems Architecture

Iterative Processing

- Each step in the work flow is repeated until the *job* is complete.
- Iterative work is usually repetitive in nature and performed in a *heads down* manner.

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Work Flow Systems Architecture

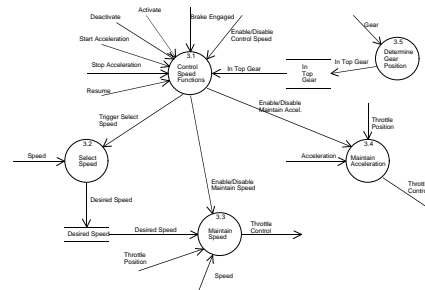
Batch Processing

- Transaction or Iterative processing with the results of the work flow *postponed* under a later time.
- Requires some form of *check point* processing to maintain the integrity of the database if the batch does not complete properly.
- May require large amounts of storage in order to *roll back* the batch during failure recovery.

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Work Flow System Architecture

Process Diagram



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Work Flow Systems Architecture

Data Modeling (†)

- Database Requirements Specification
- Logical Design
 - ER Modeling
 - View Integration
 - ER Transformation
 - Normalization
- Usage Refinement
- Data Distribution
- Local Schema and Physical Design

† *Database Modeling and Design*, T. J. Teorey, Morgan Kaufmann, 1990.

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Work Flow Systems Architecture

Data Model Components

- Entities — are the principal data objects which information is to be collected
- Relationships — represent *real world* associations among one or more entities.
- Attributes — are characteristics of entities or relationships that provide descriptive detail about them.
 - Identifiers — uniquely determines an instance of an entity. (Key)
 - Descriptors — specifies a non unique characteristic of a particular entity instance (Non Key).

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Work Flow Data Representations

Data and Its Stored Representation

- Data Base Tables and Records
- Variables and Constants
- External Inputs
- Objects

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Work Flow Data Representations

Data Base Tables and Records

- The Data Modeling process is capable of *directly* producing database tables.
- Tables and their contents then represent the model, using the relationship rules defined in the database.
- Database procedure language can be used to enforce the relationship rules.
- The key to success in defining the database relationships is *Normalization*

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Work Flow Data Representations

Normalizing the Database

- Eliminate Repeating Groups
 - Build a separate table for each set of related attributes.
 - Give each table a primary key
- Eliminate Redundant Data
 - If an attribute depends on only part of a multivalued key, remove it to a separate table
- Eliminate Columns not Dependent on a Key
 - If attributes do not contribute to a description of the key, remove them to a separate table.
- Isolate Independent Multiple Relationships
 - No table may contain two or more 1-to-*n* or *n*-to-*m* relationships that are not directly related.

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Work Flow Data Representations

Variables, Constants and External Inputs

- In the Client / Server paradigm, variables and constants may only be used to maintain local state information during the execution of the work flow application.
- To do otherwise connects the client with the server in a manner that prohibits the movement of the *work package* between workstations.
- External inputs should always be gathered through a *transaction* interaction, using a form — then action taken on these inputs at the conclusion of the form's processing.

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Work Flow Data Representations

Objects

- Brief History of "Object Oriented" Techniques
 - Object oriented concepts came in significant use in the early 1070's with the release of the programming language SmallTalk
 - Object oriented databases become commercial products in the mid 1980's
 - In the late 1980's object oriented analysis and requirements specification techniques entered the market.
- What does an "Object" mean?
 - It depends on who you ask!

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Object Oriented Work Flow

"When I use a word ... it means just what I choose it to mean — neither more or less."

— Humpty Dumpty to Alice

"The question is ... whether you can make words mean so many different things."

— Alice to Humpty Dumpty

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Work Flow Data Representations

What Does the word Object Mean?

- Programming Language definitions
- Software Engineering definitions
- Data Modeling definitions

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Work Flow Data Representations

What is an Object? (†)

- An *object* is anything, real or abstract, about which information, along with the operations to manipulate the information, is stored.
- An *object type* is a category of an object
- An *object* is an instance of an object type
- An *operation* describes the rules to manipulate the data of an object.
- A *method* specifies the way in which operations are encoded in software.

† *Principals of Objected Oriented Analysis & Design*, James Martin, Prentice-Hall, 1993.

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Advanced Work Flow

A Worked Example

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A Worked Example

Management of Change Application

- System Requirements
- System Design
- Implementation Strategy
- Deployment

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Management of Change

System Requirements

- Recognize a request for a change
 - Capture the action that requires a change.
 - capture an already implemented emergency fix that must be made permanent.
- Classify Change
 - Initiate an electronic Change Request Form.
 - Answer all questions on the form.
- Evaluate the Consequences of the Change.
 - Consult the reviewers.
 - Allocate resources for the change.
 - Plan the implementation of the change.

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Management of Change

System Requirements, continued...

- Authorize and Approve Change
 - Obtain authorization to proceed.
 - *Approvers may require more input.*
- Execute the Change
 - Schedule the Change.
 - Implement the Change.
 - Perform pre-startup safety review.
 - Changed evaluated.
 - *If Temporary, then MOC process is begun a second time to undo the change.*

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Management of Change

System Requirements, continued ...

- Close out the Change Request
 - Review the effectiveness of the change.
 - Update the relevant documentation.
 - *Sign Off* the Change Request Form.

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Management of Change

Design Specification (Very High Level)

- User Interface written in Visual Basic.
 - Embedded SQL calls made by a single VB module.
 - All updates provided through a stored SQL procedure executed on the DB server.
 - Representation of the documents to be managed provided by a workstation relational data base, extracted from the servers representation.
- Documents stored in an EDM system, accessed through SQL calls.

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Management of Change

Design Specification (Very High Level)

- Routing for Approval Performed using X.400 Mail.
 - Using OLE interface, arriving messages are presented to the user (after logging on).
 - *Folders* containing the various documents to be routed for approval — in addition to the Change Request Form — are bound together into a single package.
 - Approval takes place through the Change Request Form.
 - Single or multiple approvers.
 - Override approval allowed by specific users.
 - *Time out* signaling for approval list members.

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Management of Change

Design Specification (Very High Level) ...

- Database Updates
 - All interaction with the database takes place through the Change Request Form and the controlling Visual Basic modules.
 - Changes in the state of the Change Request Form initiated by the user.
 - Rules for the various state changes are maintained in the database, along with the routing lists, security, change classification and all other information associated with the Change Request.
 - All updates performed using stored SQL scripts, allowing for final validation prior to committal.

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Management of Change

Design Specification (Very High Level)

- Work Flow Modules needed for the basic system:
 - Change Request (CR) forms capture.
 - Routing Mailing List selection and alteration.
 - Change Status of the CR:
 - Approve
 - Reject
 - Re-route
 - Close
 - Suspend
 - Revert to original status all documents and information.
 - Select documents attached to the CR for viewing.
 - Markup documents associated with the CR.

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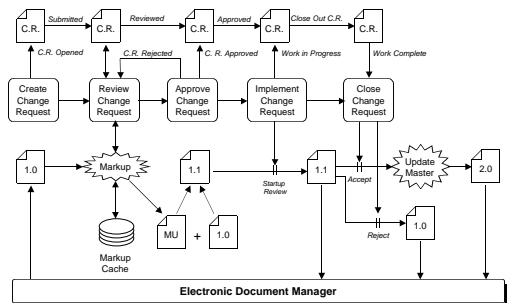
Management of Change

Design Specification (Very High Level)

ID	Task Name	Duration	1	2	3	4	5	6	7	8	9	
1	Design Modules	4w	█									
2	Begin Coding	2w		█								
3	Initial Prototype Integration	1w			█							
4	Database Modeling	2w			█	█						
5	Build Initial Database Tables	1w				█						
6	Test Database Access	1w					█					
7	Final Coding and Test	5w						█				
8	Test Prototype with Users	1w						█				
9	Construct Routing Infrastructure	1w						█				
10	Construct Actual Database	1w							█			
11	Final System Test	2w								█	█	
12	First Use	0d									█	
13												
14												

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Management of Change



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Advanced Work Flow

Evaluating Work Flow Systems

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Evaluating Systems

Requirements Stated in Worked Example

- Access to SQL database
- Forms based data capture
- Branching and iteration based on current *state* of the form.
- Routing of both the Form and the associated document images.
- Suspense and time out notification of the routed Change Request.
- Integrity of the Database maintained throughout the process.

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Evaluating Work Flow Systems

Questions to Ask of the Vendor

- Can the work flow be suspended and re-routed at a later time?
- Can embedded SQL scripts be executed as a result of an input from a user?
- Can arbitrary document management applications (viewing, markup, editing) be *launched* as a result of a specific state maintained in the Form or in the external database?
- Can *Batch* type processes be implemented, using iteration, local variables and external storage.

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Evaluating Work Flow Systems

Questions to Ask, continued ...

- Are there graphical design tools available, which can be used to *design* the specific work flows, prior to implementation.
- Do these design tools support a known methodology?
- Do they provide a connection to the data dictionary produced by the Data Modeling Tool?
- Does the run-time environment operate in a Client/Server environment or does it require an X-Terminal environment?

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Evaluating Work Flow Systems

Questions to Ask, continued...

- How can the work flow system be directly connected to an external database?
- Can LU 6.2 / APPC connections be made through the development tools?
- Are 3270, 5250 and VT emulations provided for the integration of external systems?
- Are there run-time tools for monitoring the execution of the work flow routines?

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Evaluating Work Flow Systems

Questions to Ask, continued ...

- Can third party applications, like AutoCAD be launched using the work flow tools?
- Can E-Mail systems be integrated with the work flow environment? Does this integration support X.400, cc:Mail, Microsoft Mail, Oracle Office?
- Can the work flow system support the acknowledgment of a mail message as well as receiving and sending mail messages — does the system support access to the Mail system's API.

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Advanced Work Flow

Open Questions

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Open Questions

Human Factors of Work Flow (†) (§)

- Cognitive Psychology
 - Perception
 - Attention
 - Information processing
 - Memory and Learning
 - Sociological and Organizational factors
- Systems Analysis
 - Usability
 - Error Rates
 - User Satisfaction
 - Retention of Interface Functionality

† *Developing User Interfaces*, D. Hix and H. R. Hartson, Wiley, 1993
§ *A Guide to Usability*, J. Preece (editor), Addison-Wesley, 1993.

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Open Questions

Motivation for User Interface Design Analysis

- Use of EDM System for OSHA/ISO/NRC compliance.
 - Safety
 - Compliance maintainability
 - Productivity.
- Interaction with Other Systems
 - CAD document modification of *as built*s
 - WP modification of SOP's, Instructions, MSDS's
 - Maintenance System Interaction
 - Contractor Safety Interaction

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