Revisions, Versions, and Approvals
in Process Manufacturing

Managing content in a process manufacturing environment, where inspections and testing and plant turnaround maintenance are a common practice, requires an understanding of concurrent change management and the important distinction between revisions, versions, and role-based approval workflows.

In process manufacturing, many documents go through what is called an evergreen change process. This means that documents are constantly being updated and there needs to be some distinction made between what represents a master document that is in an as-built or as-designed stage and what is considered to be work in progress. The as-built or as-designed documents represent the most up-to-date content and is used to operate and maintain the plant or facility. However, all the while, there could be multiple iterations going through a workflow that represent the future state.

The figure below depicts how this might look in a flat file system using a file naming hierarchy.

In this simple example, a master document for the generator room has a file naming convention which includes a semi-static revision number followed by a version number and the state the version was in a four-stage workflow process. Notice that the highlighted documents have incremented revision numbers to indicate that there are updates taking place and each version shows what status the document is presently in.

The main takeaway from this example is that document revisions represent a body of work that contains multiple versions and that each version also represents a stage in a workflow. It should be noted that multiple versions are likely to occur at every stage. For example, in the draft stage there could be several iterations composed by one or more individuals before the documents reaches the "issue for construction" phase. It's also likely the stages will vary; there could be more stages needed, or the naming convention used for each stage is completely different. The key point is that the end state for a single revision is usually the beginning state of the next revision.

Maintaining such a document structure in a folder requires a great deal of discipline. This simple example clearly shows how the complexity of properly maintaining both the revision and version can grow exponentially. It becomes even more confusing when expanded to include a PDF for each file so users can access this content from the field. You can image that in large set of documents this process becomes nearly unmaintainable but, nonetheless, there are companies that have done this.
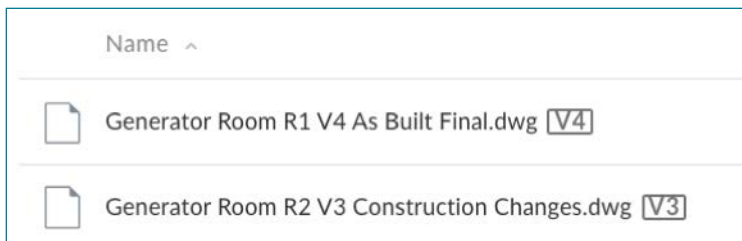
MAINTAINING FILE RELATIONSHIPS

Using file naming conventions may solve how to manually distinguish revisions and versions. It also allows users to discern what the current approved document is versus what is considered a past or present work in progress. However, this naming convention causes real chaos when other files use the filename as reference. For CAD users, this is a very common practice. A CAD file that represents a generator room could actually be a conglomeration of CAD files that reference each other as they are opened. For example, one room could contain external reference files (commonly known as Xrefs) that are separated based on the engineering discipline. This way, electrical engineers can work on the wiring diagrams, while piping engineers work on water and material flow, and civil engineers can be designing the walls and floor structure. In addition to engineering drawing files, there also embedded relationships found in Office files such as Word and Excel where it common to have OLE links or embedded files.

2

Knowing that these applications search for reference files by first checking for the filename in the absolute path (eg C:\documents\files\FileName) and if not found, looking in the relative directory—meaning relative to where the file that includes the reference link is open—is helpful. However, if the files are renamed as the previous figure depicts, all the reference links would need to be updated to match the new filename. This again adds to the complexity of maintaining revision and versions and yet, many companies still maintain this structure using strong discipline in file naming and folder structuring.

LEVERAGING ENTERPRISE CONTENT MANAGEMENT SOFTWARE TO MAINTAIN REVISIONS AND VERSIONS

Almost every document management system has the ability to manage file versions. For many, the process of creating a version has commonly been referred to as check-in and check-out. In short, these options begin when a file is added and the content creator or another user makes an update. In almost all cases, ECM adds a permissions layer to validate if the user has the rights to check out the file. When a file is checked out it is usually locked, preventing others from editing the file while the initial user makes changes.

What's nice about an ECM environment versus a file system is that versions are stacked and metadata can be added to address keeping the file name intact. The figure below depicts how this versioning might look in a ECM system.

Notice in this ECM example, a master document for the generator room has a similar file naming convention but the number of files are condensed. What the user is shown is the last version of the revision with an indicator of the number of revisions behind the version.

If the user wanted to see the version history for any particular revision, they could drill down by selecting the particular revision. Newer cloud-based technologies have simplified how content is synced between an ECM repository and the applications that are used to edit and update the content, even to the point where some applications allow simultaneous edits. However, there are still challenges associated with maintaining compound document relationships and managing the access control and approval processes. Automating the process of starting a new revision or synchronizing new files that are part of the update process remains a challenge.

UNDERSTANDING GROUPS, ROLES, STAGES, AND REVISION SYNCHRONIZATION

Role-based workflows segregate the assignment of a task—like edit, view, review, and approve—to a role rather than to a user or group. Stages also affect the assignment of tasks because at different stages, the roles of a user or group will change. To illustrate this point, think about how roles and stages affect engineering content. Here, the role of editing, reviewing, and approving content falls to the discipline for which the engineer is certified. For example, only certified electrical engineers should be allowed to update electrical drawings. For quality and safety purposes, the best practice is to have a peer who is also certified in that discipline review that work. In many cases, these duties become role based because the edits and updates

usually fall to the person who is available and not necessarily assigned to a specific individual, but assigned by credentials. Stages make a difference in roles because, in the draft stage, the role of the engineer is to edit the document while during a review stage or an issued for construction stage the role of the engineer changes to a view and markup. This is to ensure that no last minute changes slip by.

Where this role- and stage-based model becomes very interesting is when you consider that in an evergreen process there is typically multiple, simultaneous versioning and revisioning happening on the same content and a large volume of that content has interrelationships. For example, within a plant there could be more than one project going on in the same area where they are putting in a new piece of equipment. This equipment impacts multiple engineering disciplines and each play different roles. The mechanical engineer is editing the mechanical drawings and procedures while the civil, piping, and electrical engineers are reviewing or updating the design to ensure they can support the loads. If two or more projects happen simultaneously, these engineers need to not only be aware of the current as built documents and drawing, they also have to be aware of what stage the other projects are in because of likely impact.

Example of groups roles, stages, and actions

Using the example above, the diagram below depicts a what a role-based workflow might look like in process manufacturing.

In an evergreen change-control process, the workflow stages are typically circular and repetitive. While simplistic looking, the complexity is derived by:
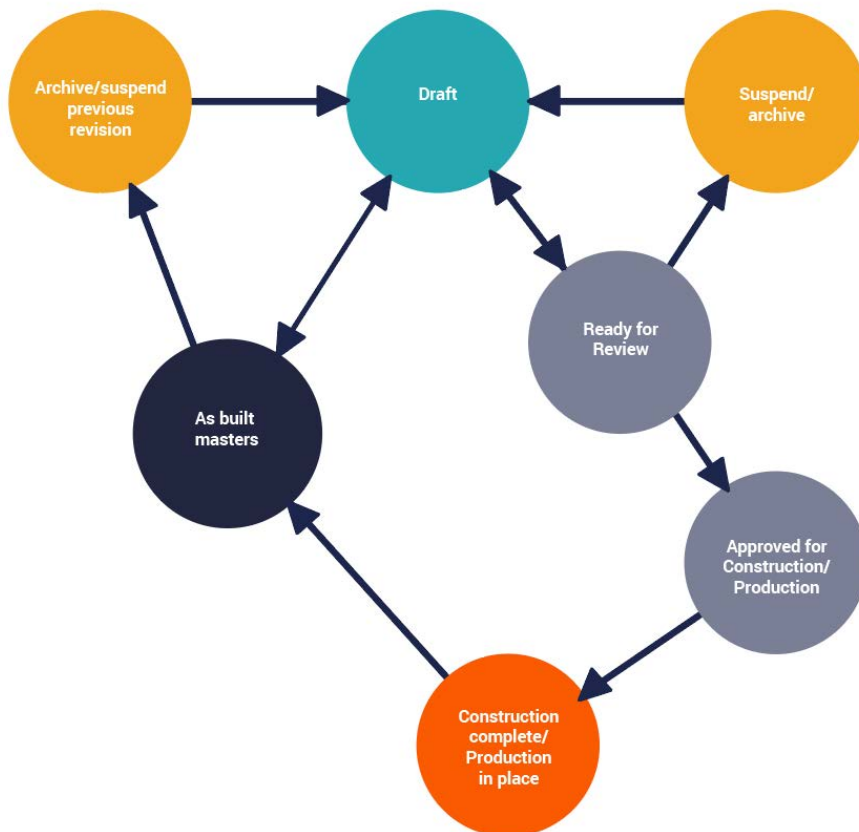
- Users and groups having default access permissions/
  - Editing and viewing rights are based on discipline. For example, electrical engineers can edit electrical documents and drawings but only view the other disciplines content (Civil, mechanical, piping documents).
- Roles and actions change permissions based on each stage.
  - In the draft stage, engineering groups have editing rights to content based on discipline.
  - In review stages, the engineering groups lose edit rights so no last minute changes sneak by. If a change is surfaced in the review stage the content can be sent back to draft stage where edit rights are restored.
- Because of the interrelationships between content and projects, should more than one project affect the same area, notifications and collaboration are critical as content advances to the next stage.

Coordinating User and Group Permissions

A fundamental principle of evergreen change control is that users are assigned to groups and groups are given default permissions. For example, by default anyone assigned to group can have one or more of the following default privileges: view, add, update, delete, print, modify metadata, and change stages. Below are some examples of groups:

- Engineering Groups
  - Piping Engineers
  - Electrical Engineers
  - Civil Engineers
  - Mechanical Engineers
- Construction Foreman
- Maintenance and Construction Workers
- Engineering Office Supervisors
- Records Managers

Roles and Actions Based on Evergreen Process Stages

Assigning Roles

In an evergreen change-control process, the groups play different roles at each stage and therefore their default rights change. Typically, these roles can be generalized and assigned various actions. Below is an example of some generalized roles:

- Content Producers: Add, update, view/markup, print, modify metadata
- Content Consumers: View/markup and print content
- Content Reviewers/Approvers: View/markup, print, and change stage
- Content Revisors: View/markup, print content, and revise existing content
- Content Administrators: View/markup, print, modify metadata, delete

Performing Actions

As content moves from one stage to another, there are a number of actions that could be assigned based on the stage. Here's a list sample of actions that might take place at a particular process stage:

- Document Uniqueness Check (confirm that there is no duplication in the system by comparing metadata)
- Document Numbering (assigned based on sequencing, field concatenations, or data lookups)
- Update Access Control List (assign new user/group permissions)
- Send Notifications (use E-Mail or SMS to notify users or groups of document status)
- Add/Remove from Folders
- Print/Plot Content
- Render Content
- Update Metadata Fields
- Increment Revision Number
- Suspend Workflow
- Assign to New Stage

Orchestrating Groups, Roles, and Actions Based on Stages

Going back to the simple evergreen change-control diagram and applying the roles and actions to each of the stages, the remaining section describes how groups, roles, and actions are orchestrated to manage an effective change control process.

Draft Stage

In the draft stage, each engineering group would be considered to have a content producer role allowing them to add their own content using the default permission sets. Other groups would have either have no access at all or be assigned to content consumer role.

Actions that the system might take at this stage would include conducting a document uniqueness check to ensure the content was not already added; applying a document or drawing number based on the metadata that was assigned; adding the content to a project folder (also based on the metadata and setting the revision number (using a revision schema like 1A, 01A or 1-1 ect). The secondary number is for cases where one or more projects are using the same content, the revision numbers would increment the second value (e.g., next revision would be 1B and then 1C).

Ready for Review Stage

In the ready for review stage, each engineering group as well as the maintenance and construction foremen and workers would be assigned role of content consumer and the engineering supervisors would be added to the reviewer-approver role. As a reviewer-approver they would have the right to return the content back to the draft stage, suspend the content in cases where the project is put on hold, or move to the approved for construction stage. If approved for construction, the process would be to notify owners of other revisions if there's a status change so they can review the approved for construction content and determine its impact.

Actions that the system might take at this stage would include applying a stamp on the document or drawing number indicating it's in the ready for review stage.

Approved for Construction Stage

Here, each engineering office supervisors' role would change to a content consumer role in the engineering group. The maintenance and construction workers would also continue to have that content consumer role but the construction supervisors would now have a content approver role.

Actions that the system might take at this stage would include applying a stamp on the document or drawing indicating it's in the approved for construction stage. All content consumers are likely to need a non-editable PDF version. Groups like maintenance and construction workers could access that content remotely using any portable device. Users would also have the ability to print/plot the content in cases where a hard copy is needed in the field.

Construction Complete

In the construction complete stage, the roles of the construction foreman and the engineering office supervisors are switched, while the other groups and their roles remain the same as they were in the approved for construction stage.

The engineering office supervisors now have the content reviewers/approvers role as their job is to ensure the content accurately represents the completed construction. Aside from a role change, the important distinction between issued for construction and construction complete stages should be noted. This is to address the occasions where changes are made in the field and the content then needs to be updated to reflect the actual completed design. This is commonly referred to as updating the as built or as designed content. If no changes are needed, the content is moved to a final as built stage to signify the content is now a document of record and it now represents the design and can be used as the bases for the next revision .

Actions that the system might take at this stage would include applying a stamp on the document or drawing indicating it's in the construction complete stage. In cases where an update is needed, there might be an extra

step where content producers are temporarily assigned edit rights again to update the content based on as built design changes. While not depicted as a stage, it can easily be added into the workstream.

As Built

This stage is where content is considered a document of record. It can confidently be used for field maintenance and it is also the starting point for new revisions. In this stage, all engineering groups would have a reviser role so they can initiate a new drafting process. The construction foreman, maintenance and construction workers, and engineering office supervisors would all have a content consumer role and now the records managers are given a content administrators so they can apply records and retention rules and manage disposition.

Actions that the system might take at this stage would include applying a stamp on the document or drawing indicating it's in the document or drawing represents the as-built or as-designed stage. Previous revisions get archived so all groups and roles, other than content administrators, lose access or, at minimum, know previous revisions do not represent the current as-built stage. If multiple revisions of multiple projects are allowed and underway, the process would be to notify owners of these other revisions that there's a new as-built drawing and they need to synchronize their design changes against this new revision.

LEVERAGING THE RIGHT CONTENT MANAGEMENT AND COLLABORATION TOOL TO DO THE JOB

While this white paper attempts to illustrate some of the intricacies of revisions, versions, and approvals in process manufacturing, anyone familiar with these environments will attest that there's a myriad of details not accounted for. The purpose of this document is to open a discussion and to seek the opportunity to demonstrate how content management software can be implemented by Zia Consulting and used to facilitate this type of change control process. Whether you're the owner-operator of a plant or the engineering procurement and construction company, Zia can play a very strategic role in ensuring companies have accurate documentation and that the changes made during the construction phase of the plant are recorded and updated as they happen.

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