Engineering Management
Field Project

Configuration Change Management

By

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Spring Semester, 2012

An EMGT Field Project report submitted to the Engineering Management Program
and the Faculty of the Graduate School of The University of Kansas
in partial fulfillment of the requirements for the degree of
Masters of Science.

Acknowledgements

There are several people I would like to thank for their support and contributions to me while pursuing my advanced degree and the completion of this project:

- To my wife Heather and my children Logan and Adasyn, who continually support me in everything I do. Without each of your support none of this would have been possible, you kept me focused when I needed it.

- To Herb Tuttle for being my committee chair and providing feedback and guidance through the completion of this project. Tim Wilcoxon and Andy Elliott for serving as committee members and their insight and feedback provided during the preparation and review process.

- To the Engineering Management Department for providing instruction and guidance during my tenure in the program. It has been a terrific experience and will help me to continue to advance my career in the engineering management sector.

Executive Summary

Configuration Change Management is an integral part of the design and development process for products and processes. Many companies do not focus on the issue of change management even with the realization that change is inevitable. History has shown that if a company does not continue to innovate, whether it is products or services, it will not be able to remain successful. This philosophy is extremely important with design engineering companies. If managed correctly, change can be a significant benefit to a company.

Changes come at various stages in the lifecycle of a product. Understanding the impact at the specific stage in a product lifecycle will minimize the impact to the business. Change should be approached as a planned and managed process versus a process driven out of necessity. Configuration change management should focus to align resources and activities within an organization. Prior to a change being implemented, all stakeholders should review the proposal or request for impact assessment. This impact assessment should include an assessment of implementation feasibility, cost, resource assessment, and schedule impact, as well as a review for implementation. By analyzing this data, a business is much better positioned to make a decision that has the lowest impact to the business and the customer. In addition, prioritization and approval of the change should be a decision made by all parties within the organization.

If change is properly prepared for and anticipated, then the business will be much better positioned to react when product changes are necessary. By understanding how the change affects the business, a company is able to effectively implement the change with minimal impact to the business.

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List of Principle Symbols and Nomenclature

CA- Configuration Analyst – individual that facilitates and manages the change process and ensures product configuration is maintained and documented.

CIB- Change Implementation Board – cross functional group of employees that implement changes.

CM- Configuration Management – the overall process of controlling the product definition.

CMII- Configuration Management II – new philosophy of change management that includes status accounting and includes overall change of a business.

CN- Change Notice – the phase of the change process that involves executing the change to the documentation and implementation of the change throughout the business.

CR- Change Review – The phase of the process that involves gathering data and preparing an impact assessment for a change.

CRB- Change Review Board - cross functional group of employees that review and assess a proposed change.

CSA- Configuration Status Accounting – the discipline of tracking progress through process, recording decisions, and providing traceability.

EBOM- Engineering Bill of Materials – bill of materials as defined on the engineering documentation.

ECR- Engineering Change Request – formal request for engineering documentation to be reviewed for possible correction/update

FAA- Federal Aviation Administration – regulatory agency for the US aviation industry.

MBOM- Manufacturing Bill of Materials – bill of materials that is utilized to build product throughout the manufacturing process.

NOC- Notification of Change – documentation of proposed changes that is submitted to both customer and supplier for review and approval when applicable.

PLM- Product Lifecycle Management – the management of all associated data related to a product from concept through obsolescence.

PR- Problem Report – formal notification of a potential problem or issue with a document or process.

VCR- Vendor Change Request – procedure utilized by supplier to request change to a product or process.

Chapter 1- Introduction

No matter what type engineering segment a person is involved with, Change Management and Product Configuration becomes a very important aspect of the business and development processes. During the development process, change to product design is evolutionary and mandatory to develop a robust product. Once the lifecycle of the product moves into the production phase, a new aspect of the control of the product definition presents an issue to the engineering cycle.

Controlling configuration of products becomes more important once the product is exposed to the market. This can be anything from consumer products, such as televisions, video game consoles, or DVD players, to more controlled and regulated markets, such as medical devices, or aerospace. As these products are manufactured, changes are inevitable, but the real issue is when the change must be implemented and controlled through the manufacturing process and extends to the end user. For some industries, the effect on the end user is not as critical. For example, a change to a component that is assembled into a television is not as critical as a change to a wing spar of an airplane. There are regulatory agencies that have control measures in place to ensure the integrity of products within a specific industry. The FAA mandates strict product and process control of components and products that are to be used in the aerospace industry.

Change management evolves in a similar manner to the product. During the early phases of the product lifecycle, change management is not as critical. There are often numerous changes with little to no affect to the supply chain. Most of the parts that compose the product are only conceptual models or prototype parts used for verification. As the definition of the product is further developed and solidified, the change process starts to become more integral to the supply chain. This is when the procurement of parts and components have started and long

lead items, such as, tooling have begun. The impact of major changes become severe and need to be communicated with more involved parties. The next phase of the product lifecycle is for all parts to have been purchased, manufacturing is building parts, and product is being shipped to the customer. This is the most imperative phase for managing the change to product. During this time in the development of a product the business has the most risk and impact when a change is required. A business has parts at all levels of the manufacturing process, a simple change can greatly affect product at all levels. This can result in costly scrap charges or in tooling modification, which affects delivery schedule. The goal is for a change to be implemented in a managed and structured approach, which allows for the lowest impact to customer, manufacturing, and the customer.

Change Requirements: Minor Change/Major (Form, Fit, Function)

Product changes are essentially categorized into two classifications by the FAA FAR21.93 regulations; major and minor. A minor change is any change that has no affect on weight, balance, structural strength, reliability, operational characteristics, or other characteristics affecting the airworthiness of the product. To help provide guidance to allow for determination of the change classification, the terms form, fit, and function are often used. Form can be described as change to the shape, size and dimension of the product. Form is also associated with center of gravity and weight changes. Fit can be described as change to the interface to an assembly or in relation to other parts, including tolerance changes. Function can be described as the change in the action the part is to perform. Minor changes are essentially typographical error correction, changes to dimensional tolerances, or possible product definition clarification. These changes typically have no impact to the supply chain, in stock parts, or product delivered to the

customer. Changes that fall into the guidelines provided by FAR21.93 or that affect the form, fit or function of a part are classified as major. These can be described as a change that has an effect on the weight, size, interface to other parts, performance and/or center of gravity. This type of change requires strict control of the implementation, where there is a high risk of costly part scrap and/or impact to the customer. Often a major change is implemented due to a performance issue with the product in the field; this will require several possible dispositions of the product, for instance, retro-fit, remove and replace, or implement at later time.

Notification of Change

Changes to engineering design data have the potential to affect both the supplier and the customer. Notification of a change must be used bilaterally with both the customer and the supplier, which ensures that the change proposal will be fully evaluated for impact by the supplier and customer. The supplier has an opportunity to express concerns and provide feedback to the product prior to receiving the released engineering drawing. The customer is the end user and often holds the design authority or type certification. This essentially means that they are responsible for the performance and functionality of the product. If a change is needed, they must have visibility of the proposal to assess impact to their product and on through to their customer, i.e. Airline. An approval of change from the customer is required prior to change implementation. This approval acts as the authorization to proceed with the change.

Problem Statement

Over the past several years, Yoder Engineering Services (YES) has experienced rapid growth. In this time, there have been several mergers, acquisitions, and new facilities brought

on-line. This combined with accelerated project schedules, new employees, and a poorly defined configuration change process setup an environment that has resulted in inconsistent engineering change, poor supply chain management and lack of notification of change to both the customer and the suppliers. The volume of change being processed through the engineering department has overwhelmed the resources responsible for managing the change and its implementation. The result was a high cost of scrapped parts, numerous tool changes, wasted resources building obsolete parts, and delays in shipping product. All of these items were driving up internal and external costs for the various projects.

In addition to the inadequate process to manage change management, the active process was outdated and represented the older methodology and principles of previous business models as defined in Figure 1.

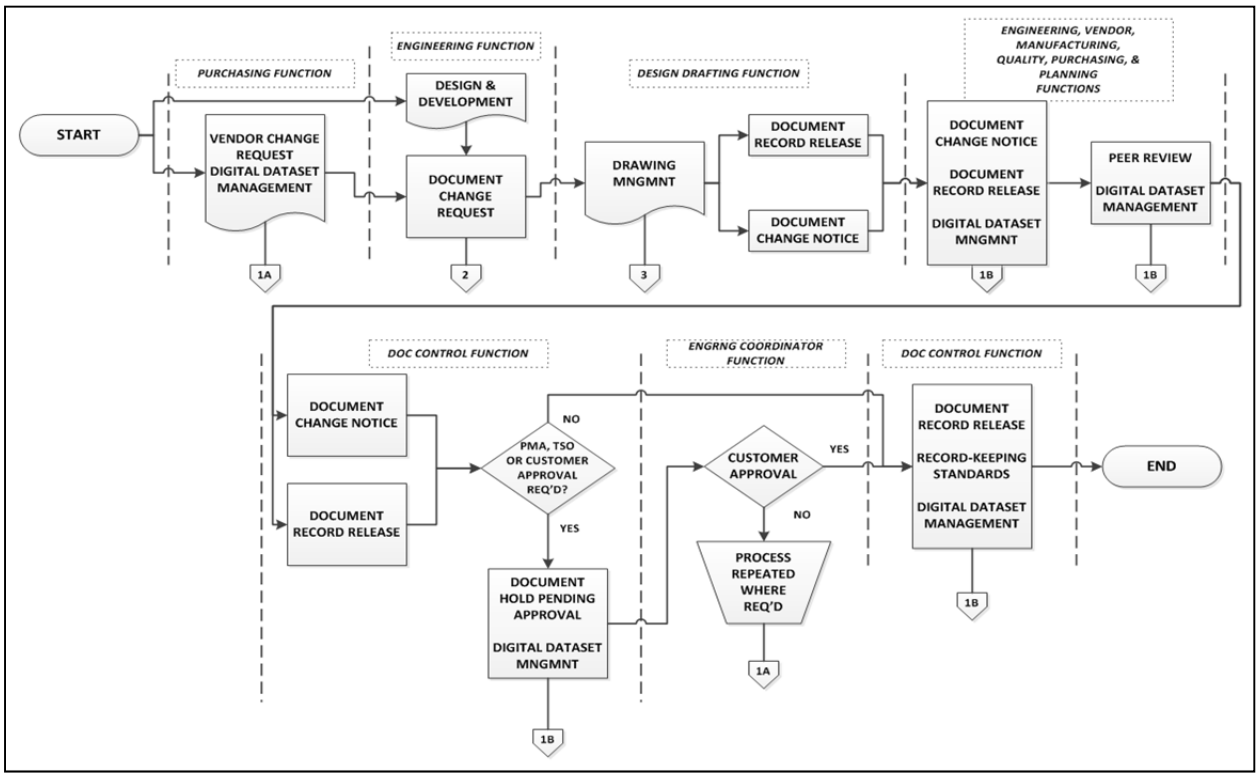

Figure 1, YES Company Current Change Process, Yoder 2011

Changes were owned by engineering and processed as engineering established priorities for the requests. These priorities were typically driven by customer requests and project schedules and there was little to no regard for the other facets of the business. Engineering would compile a change notice documentation packet that would then be reviewed by a cross-functional team consisting of engineering, quality, manufacturing, planning, and purchasing. This team would review the change and sign off on a proposed implementation of the change.

The problem with this approach is that it exposed the members of the supply chain to the change too late in the process. It did not allow for adequate communication to suppliers for major changes to the product, which is often needed tool modification. It also caused issues with product that was currently in-process in the manufacturing area.

The many combined issues that were being poorly managed in the current change process forced the management team at YES to evaluate the current condition. The result of this evaluation was to compile a project team to map the current process for benchmarking, compile issues, and redefine the process to mitigate issues with Configuration Change Management. The remainder of this paper will review published philosophies, procedures, topics associated with Configuration Change Management. It will also document the process for defining a new process, and capture best practices for defining a Configuration Change Management system for a business.

Chapter 2- Literature Review

2.0 Introduction:

Change management has become important within the industry because of the cost benefits realized by meeting customer expectations and having a process in place that ensures each stakeholder has input in the change. "The field of manufacturing is nowadays also confronted with many changes due to increasing and worldwide competition, technological advances and demanding customers" (Huang 1999). Once a change management system is put into place, clear requirements are needed to ensure clear and concise instructions.

This literature review will summarize the importance of change management in industry and the cost benefit processes that are needed to implement change management process. Sources have been researched and cited in the following literature review that describes the importance of each topic.

2.1 Why Change Management is Important

Change management is important in controlling design data and ensuring products conform to requirements set forth by customers and regulatory agencies. "Configuration management has been identified as an essential element in increasing product quality, development efficiency and enterprise profitability" (Schamp 1997). This process also confirms that products, which are revised, have controls and procedures in place to ensure activities are performed to complete the change. "It is very difficult to verify conformance and/or achieve consistency when the design, itself, is not clear or concise" (Institute 2009). A change management process, although it does not ensure design integrity, are stages to review the change and actions that are taking place in the process.

A defined change process also adds traceability. Important in internal audits, to ensure processes and procedures are met, and external audits by customers and regulatory agencies, to ensure product configuration has traceability. “Traditional CM considers identification, change control, status accounting and audits to be its major activities” (Institute 2009). Accountability for each step of the change is important to change control process.

2.2 Change Methodology CM versus CMII

To control the design definition of products, the Department of Defense, in the 1960’s, introduced traditional configuration management practices. This was due “to resolve the inability of defense contractors to build a second unit identical to the first” (Institute 2009). By not being able to accurately build an identical unit, multiple contracts spent time and resources reverse engineering the original units. “The 2nd contractor often had to reverse engineer an as-built unit in order to fix design definition from the 1st contractor” (Institute 2009).

The reason for the creation of the CM process was to maintain the design integrity through the product lifecycle. “The scope of traditional CM is limited to managing design definition and ensuring that physical items conform to the design. The emphasis is on maintaining consistency between products and their designs” (Institute 2009).

The traditional CM process is deficient when taking the entire change process into account. “Traditional CM considers identification, change control, statue accounting and audits to be its major activities” (Institute 2009). Without consideration to enterprise wide processes, “traditional CM are destined to operate in the corrective action mode and live with inflated costs” (Institute 2009). With this, CMII principles expand into areas covered by the life cycle management of a product to reduce cost and increase efficiency.

CMII principles take the traditional CM process and expand the process to include all stakeholders of the change. “CMII expands the scope of CM to include any information that could impact safety, security, quality, schedule, cost, profit or the environment” (Institute 2009).

“CMII shifts the emphasis to integrated process excellence and provides the how-to for:

1. Accommodating change;
2. Optimizing the reuse of standards and best practices;
3. Ensuring that all requirements remain clear, concise and valid;
4. Communicating 1, 2, 3 to users promptly and precisely;
5. Achieving conformance to requirements in each case.” (Institute 2009)

CMII is an enterprise wide approach to control change and configuration management, while promoting continuous improvement because the lifecycle of the product is controlled. In regards to integrating configuration management with other closely related activities, CMII Research Institute states, “Once achieved, consistent conformance and continuous improvement are by-products” (Institute 2009).

2.3 Configuration Management Tools

Implementation of a CM process is important to the lifecycle of a product. This process needs to be efficient by automating much of the process and insuring it interacts with process already in place. “Without automation, CM is a manual and time-consuming activity. The role of the CM tools is to support and automate the CM tasks and to provide help for the developers” (Kaariainen 2006). J. Estublier “divides the basic functionality of the CM tools to three main classes: repository for components, help for engineers’ usual activities and process control support.

- Component repository provides a basic functionality for storing and sharing the product related information, e.g. version management and access control.
- Engineers' support contains support for workspace, which are views to a certain set of versioned files for a particular purpose, e.g. development, bug-fixing, or testing.
- Process support provides means to support a company's predefined processes (e.g. product development process, change process, etc)" (Estublier 2000).

Leon states that the "CM tools do not solve configuration management problems, but they can be one step towards a more effective CM. Before implementing a new CM tool to processes and training needs to be put in place for the new process to be successful" (Leon 2000). Wilson also states, "Before the implementation of a CM tool can take place, analysis has to be carried out to ensure that the processes that will be mapped, and therefore controlled, are; identified, ratified, detailed and that the people who have to adhere to these processes are sufficiently educated" (Wilson 2002).

Developing the CM process takes may conversations with stakeholders of the process to determine what needs to be controlled and how to audit the system. "It becomes too easy for an organization to impose so many controls that they become difficult to understand- which makes them very difficult to follow- and therefore cause bottlenecks, reducing the productivity of all those involved" (Wilson 2002). Understanding the system already in place is important when implementing CM tools. These tools must integrate with these systems so not to cause confusion or disrupt workflows. "For complete control, the CM tool has to be able to integrate with these products to share important information about the application development process" (Wilson 2002).

2.4 Cost of Change

Cost implications are tied to poor quality and inefficiencies in change management. As Berlack stated “The roots of CM are in the defense industry environment as a discipline to resolve problems with poor product quality, parts ordering and parts not fitting, which were leading to high cost overruns” (Berlack 1992). An efficient change process increases quality and reduces cost because of high turnaround.

In a case study, Los Angeles County MTA (LACMTA) Rail Construction Project, for implementing an electronic change system, measurements were taken before and after implementation. “The net results of this study yielded the following results:

- 60% reduction in administration costs resulting in more than $10 million in savings;
- Enabled response to numerous information requests in minutes rather than days;
- Improved the processing time of change orders resulting in 90% reductions in contractor claims; and
- Changed job focus to training, analysis and management instead of data gathering.” (Technologies 2012)

This implementation of an electronic change system is an example of time and money saved by the use of an effective of change management system.

2.5 Requirements for Change Management

Projects fail because of poor planning or requirements are vague and with little detail. In a blog by Alex Gammelgard, “It’s scary to admit, but missing a poorly documented change can happen to anyone (to a varying degree of severity). It all comes down to your processes and how

tightly you're managing changes to your product with ECO/ECRs" (Gammelgard 2011). A system to process the change is essential to ensure nothing is missed. A system can by electronic, paper or a combination of the two. He also points out:

"No matter how you manage change in terms of system, I think there are some common issues that you have to deal with at one point or another.

1. Bottlenecks
2. Non-compliance (from other team members)
3. Scaling" (Gammelgard 2011).

To deal with pitfalls to implementing a change management system, a business must develop configuration, change and release management policies. "The overall configuration, change and release management policy consists of processes for managing all changes to the information systems" (Tarrani 2009). "The policy consists of three elements:

- Policy statement
- Process owners
- Related policies and procedures" (Tarrani 2009)

2.6 Summary:

Configuration management is the control of a product definition throughout the lifecycle of the product. This process was created to control product definition so the product could be made consistently. The initial inception of this process added product definition controls, but acted as a corrective action tool and did not promote continuous improvement.

The traditional process of Configuration Management, CM, has been improved upon to add enterprise wide processes to configuration control, called CMII. By adding other processes

that integrate into the control of product definition, CMII promotes continuous improvement of the product and its related processes. CMII ideology is management of product configuration and related activities but can be laboring if controlled by a manual process.

The training of processes and procedures are very important in automating and integrating a CM process. Automated tools for configuration management are important to controlling cost and efficiency to the process. With this in mind, a new automated system must integrate with processes and procedures of related activities to not cause bottlenecks and breakdowns in the system. Also, you must keep in mind that processes must not become too complex or too undefined, such that there would be deviations from the change management structure, which reduces control of the product definition.

Chapter 3- Procedure and Methodology

The numerous issues that were endured during the change cycle for company YES forced management to implement a project team tasked with developing a Configuration Change Management process, which will address the need of the business unit. The team was compiled of cross-functional roles that were both directly and indirectly involved with the change process. Members include engineering, document control, operation excellence, and supply chain. These members are also representing each of the three YES locations. A project charter was developed to focus on the main issues that the change process needed to develop, yet align with the philosophy and practices of the CM II methodology. Guidelines and deliverables were developed to guide the team to address the main issues.

Project Deliverables:

- The Change Management Procedure; released and all associates trained
- Process to utilize 3 primary stages: Problem Review, Change Request, and Change Notification (reference Figure 2)
- Process to utilize a cross-functional Change Board and Change Implementation Board
- Implementation Reviews to have action items and resources assigned with completion dates.
- Required inputs and outputs from each phase of the process
- Configuration Plan outlining guidelines and processes for controlling configuration of product
- Notification of Change process with standard form and applicable data fields
- Metrics for measuring the process

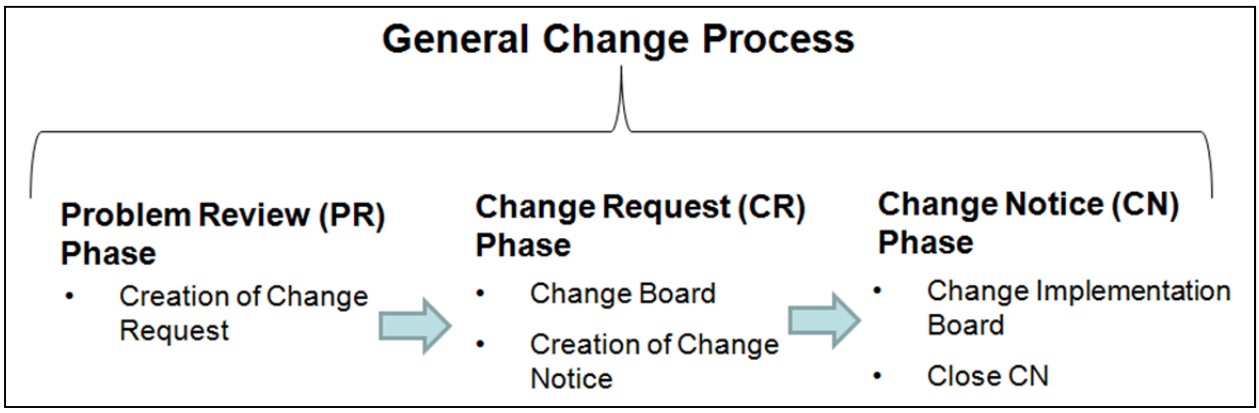

Figure 2. YES Project Scope Process Outline, Yoder 2011

Core Team Action Items:

- A Core Team will be assembled with representatives from each of the YES sites.
- Core Team will be responsible for identifying stakeholders of process.
- Identify inputs and outputs from each of 3 process stages.
- Identify project timeline.
- Attend weekly meeting.
- Review and make determination on "scope creep" issues.
- Responsible for leading Site Project Teams.
- Solicit/Verify all precursor processes and requirements for all YES customers.

One of the guidelines provided to the team was a high level overview of the future change process. This guide was aligned with several other business units in the corporation. Previous meetings generated the basic guidelines and phases for the new process. This included change classifications and provided some detail as to what roles are involved in which stages of the process (reference Figure 3). The next step was to start collecting the requirements for the change process from each of the respective departments. To complete this, a questionnaire was

developed to uncover needed inputs for accurately assessing change requests. The questions also generated discussion within the group to uncover gaps within the current process. The team used the high level overview to start developing a more specific workflow with more detailed steps to address the needs identified with the questionnaire. The other major deliverable was to develop clear requirements and a stage gate approach to moving packages to the next process step. To achieve this, the team needed to define the needs of each stakeholder and the type of data that they required to evaluate the impact of the change.

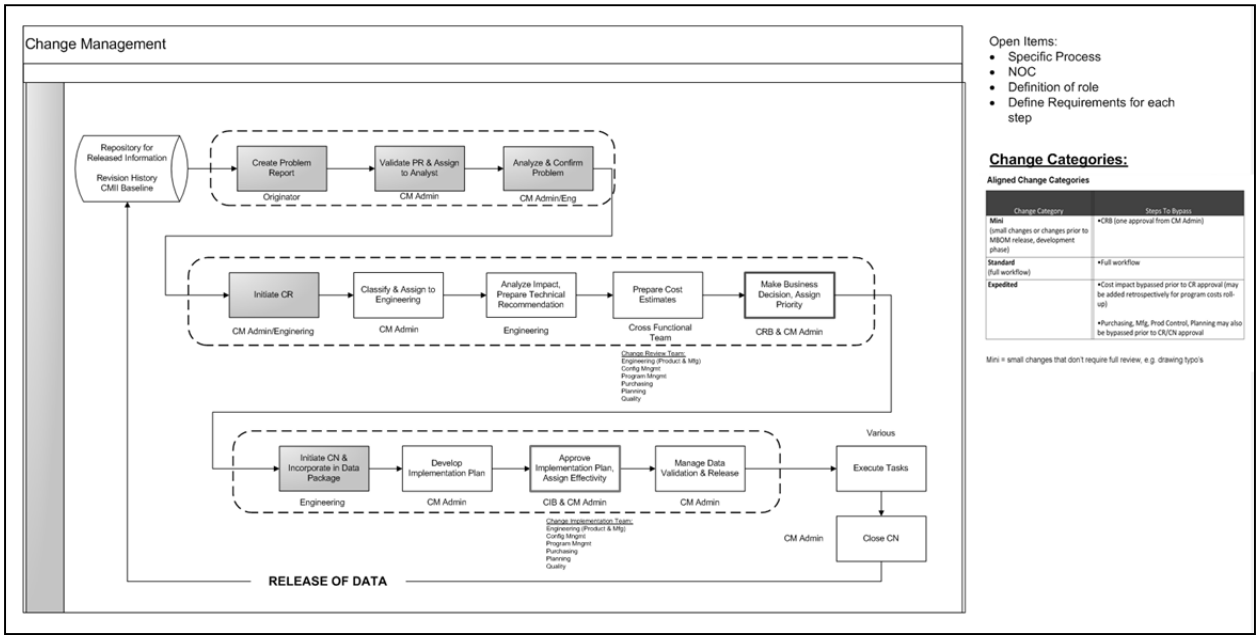

Figure 3. YES General Process Map, Yoder 2011

The first phase of the project was to collect data for the current process and the "pain points" that the process subjected on the different departments. The focus was to highlight the things that worked and more importantly the things that did not work with the current processes. The data was collected from all the departments that were affected or involved with the change process. Representatives from each department were pulled together and collectively answered the questionnaire that was created to extract requirements from each department (reference Appendix – Questionnaire). The results from each sites questionnaire were then compiled and

rationalized to drive the functional requirements for the new process (reference Figure 4). These requirements were then developed into specific data inputs and outputs needed for the different departments needed by the different departments to execute and evaluate a change (reference Figure 4).

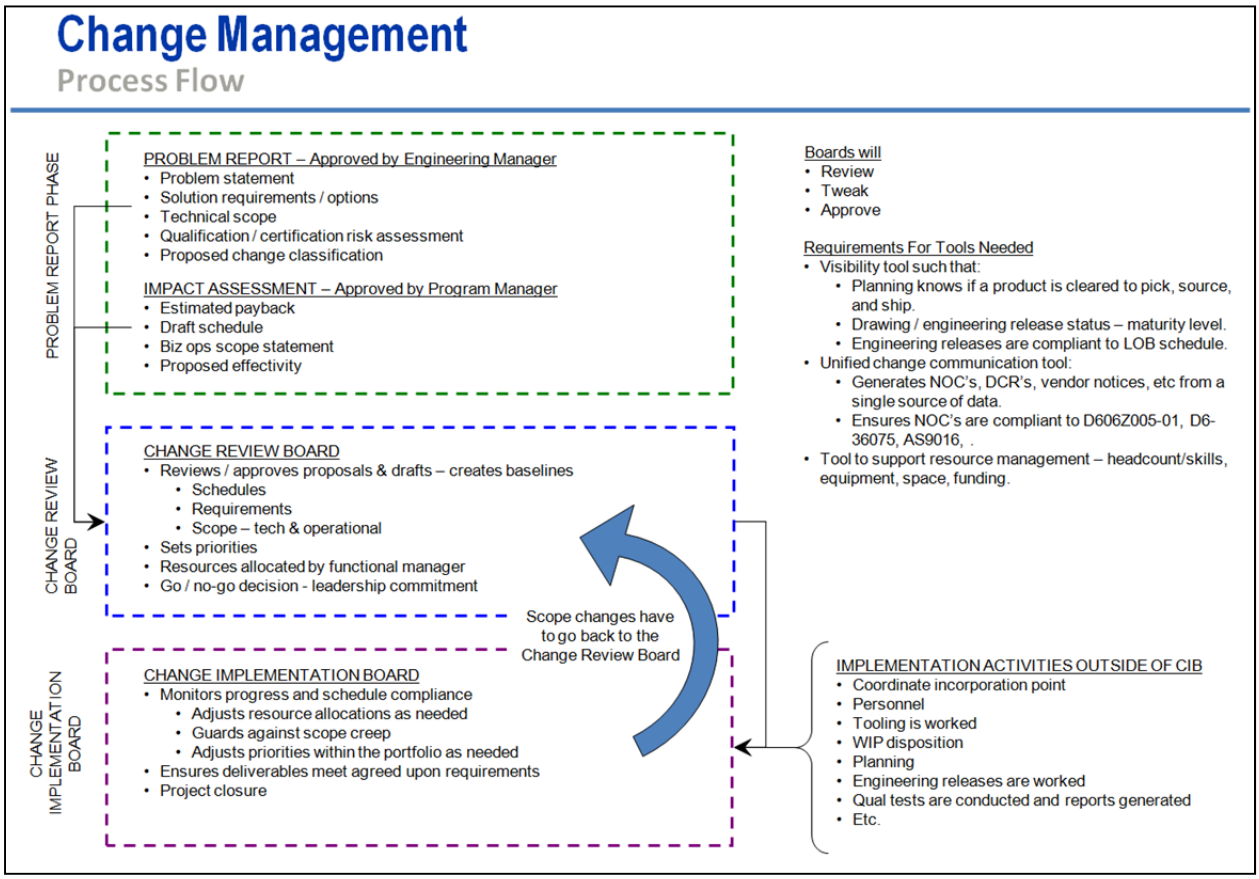

Figure 4. Rationalized Process Flow with Requirements, Yoder 2011

Based upon the questionnaire meetings, a group was established for the purpose of reviewing the requested changes. This team was considered to be the stakeholders of the change request and labeled as the Change Review Board (CRB). The role and function of the CRB is to assess requested changes for impact to the business and to develop an implementation plan for the proposed change. A decision is made based upon information presented at a CRB meeting. The information provided from each department is focused on the effects of the change on that

department, it also captures the data required to make a decision. The next phase of the process was to act upon the post approval or acceptance of the Change Request. This phase was identified as the Change Notice (CN) and it includes data collected from the CRB and is needed for the notification of change to the customer and/or supply chain. This type of data would include items such as schedule impact, cost, specification changes, technical proposal and proposed implementation date. This information would then be conveyed to the customer for review and approval. Once an approval is received from the customer, the actual implementation of the change would be initiated. This execution stage will utilize the decisions of the CRB and any information received from the customer to implement the technical proposal and act upon the proposed impact assessment. The last step within the CN phase is the Change Implementation Board (CIB). This group is responsible for reviewing the change proposal from the CRB and then defining an implementation plan for the change. An issue that will need to be addressed is that there is no way to guarantee the approval timeframe from the customer; which poses the issue of not having valid information from the CRB. Existing stock and ordered parts may have changed, thus changing the impact assessment created during the CRB. The CIB will need to review the change proposal from the CRB to determine if the data is still valid and applicable. If the data is found to be out of date or not accurate for the current business state, this review will allow changes. The final phase of the process will be to take action items from the CIB meeting and assign resources to implement the change. This will include releasing the engineering data package, updating MRP, executing rework and material disposition. This final stage will provide a closed loop process that will ensure that the change is fully implemented and all impacts to the business and customer were mitigated

The final point for the project team to address is the need for status accounting. This is needed to provide clear and concise snapshot of where the change is in the process and what actions were assigned at the different stages in the process. This reporting or tracking system will allow for accurate assessment of the progress of a change. Traceability throughout the entire process is also an important factor that is addressed through the status accounting. Typically, the status accounting system will provide the data required to generate the required metrics to track performance of the change process. The below figure shows a diagram from the MIL-HDBK-61A: Configuration Status Accounting outlines the typical Configuration Status Accounting process (reference Figure 5). (Department of Defense 1997)

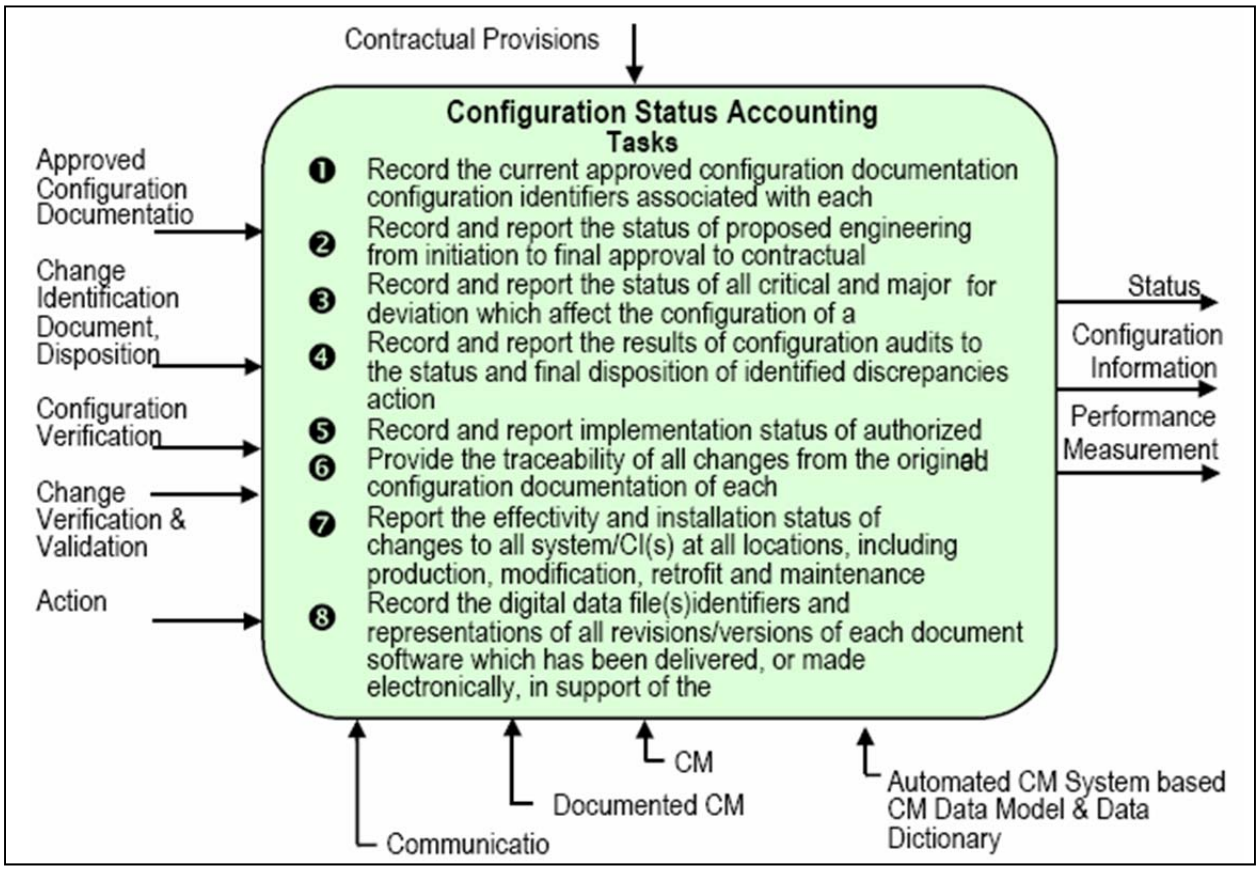

Figure 5. Configuration Status Accounting (CSA)

Chapter 4- Results

Configuration Management Process

A successful configuration management plan must control production configuration and definition, while managing change through the lifecycle of the product. As mentioned previously, the first phase is the Problem Report, which is able to be initiated by anyone within the business unit. These requests may come from a variety of sources, for example, customer, sales and marketing, manufacturing, etc. In addition, the supplier may request a change via the Vendor Change Request procedure. This type of request would be converted into a PR and the request would flow through the Configuration Change Management process. The PR will require a minimum amount of information for the request to be submitted to the CA, defined below.

- Date of PR creation,
- Part Number or Document Number,
- Logical short description of change,
- Project or Product Family,
- Initiated by who: customer / supplier / in-house,
- Red-line drawing (existing/attached) optional,
- Form/Fit/Function considered optional,

This information will then be sent to a Configuration Analyst to check that the above information is accurate and all required fields are populated. The CA would then review the request for validity, which would be a review for non-technical type changes, for example, typos and note changes to drawings. If the change request is outside the defined set of requirements for the CA to review, then the PR is forwarded to a technical analyst, for review and validation. Once

determined to be a valid change by the technical analyst, the PR is then converted to a Change Request by the CA.

The CA would then start the Change Request phase and send out the data package prior to the CRB meeting to the defined members (reference Figure 6 CRB Members). The data package would need to be sent out 48 hrs prior to CRB, ensuring the respective members will have sufficient time to acquire all data needed for the CRB decision. If a member is unable to gather all data, then this will need to be communicated to the CA for rescheduling of the CRB.

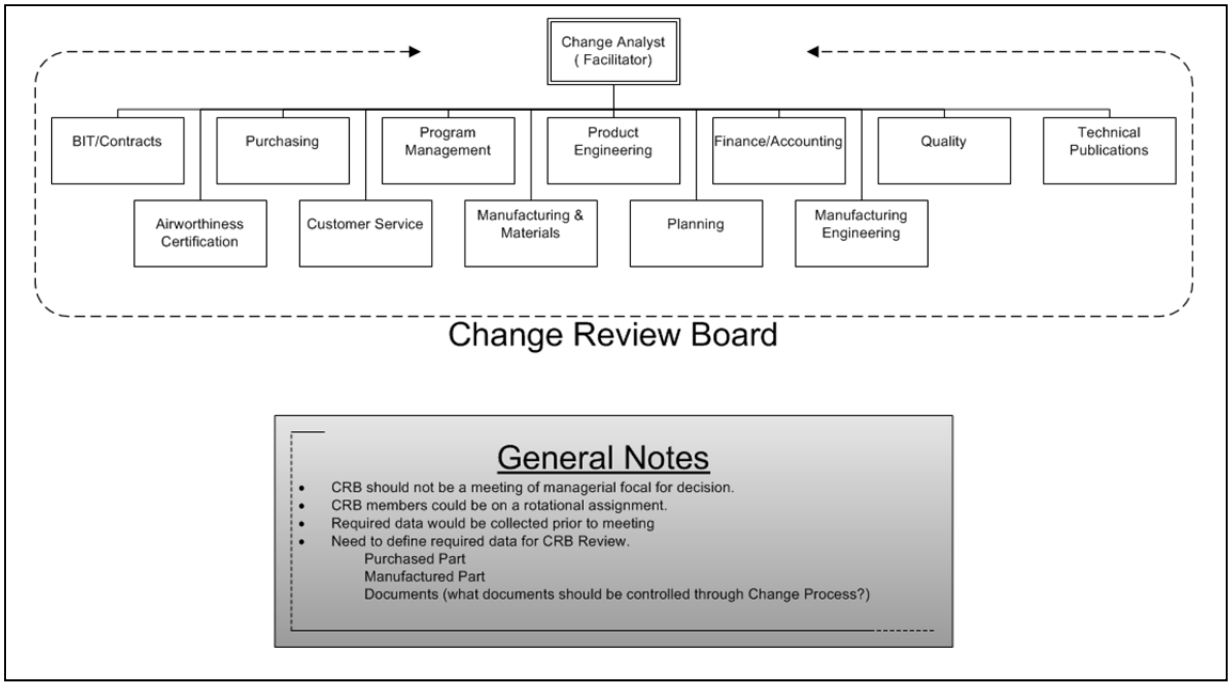

Figure 6. CRB Members, Yoder 2011

The CA will coordinate and facilitate the CRB, which will include, capturing minutes, decisions, and action items. The Configuration Analyst will function as the CRB chair but may delegate that responsibility to another member of the Configuration Management group or CRB team. The CRB will meet on a frequency dictated by the needs of the business or by the CRB chair. The chair will facilitate the meeting, ensure all participants are in attendance, all required data is provided prior to the meeting, and record decisions and action items of the meeting. The

CRB chair will resolve all conflicts that cannot be resolved between approving groups. This means that the CRB chair will take the action to escalate the issue to the respective management team for a decision. The chair also has the responsibility to report decisions and status of the change process to the management team.

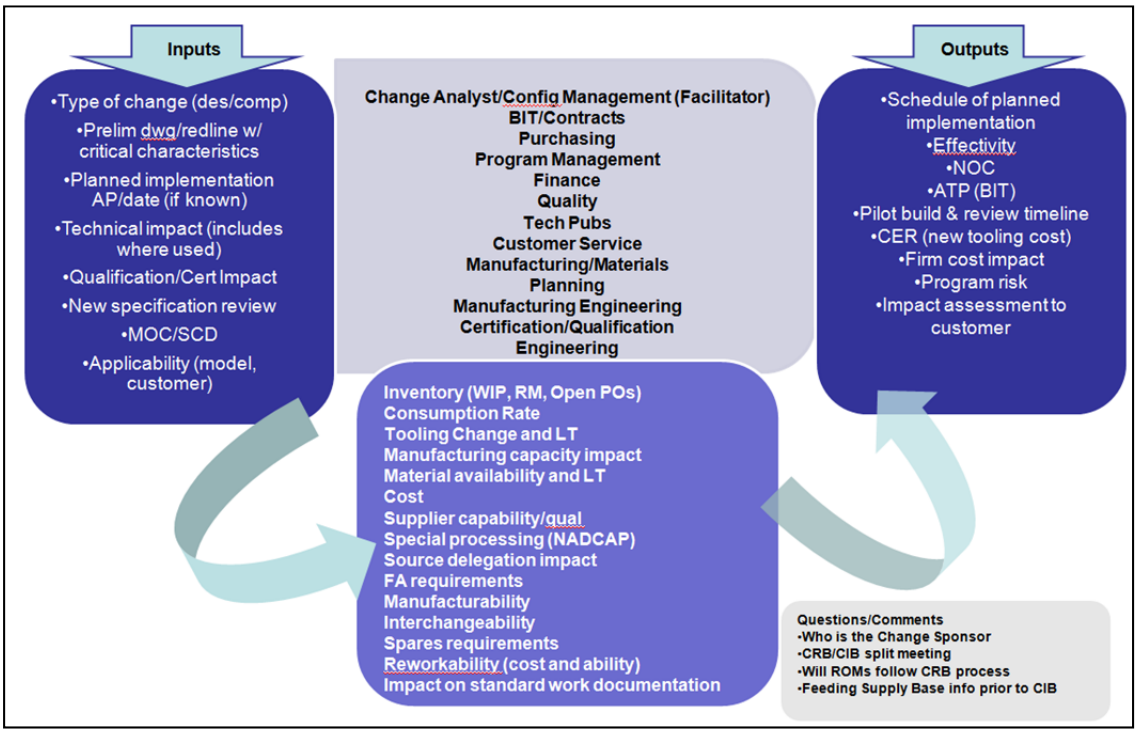

Figure 7. CRB Requirements, Yoder 2012

The required outputs of the CRB should be, at a minimum, all required information to populate the notification of change, which will be submitted to the customer and/or supplier (reference Figure 7). This information is outlined in the AS9016 and will be compared against the other customer requirements to get an all inclusive list of required data (reference Appendix Notification of Change).

To change the product definition for the design data originally used in the certification, the change must be submitted to customers for approval prior to implementation. This procedure also includes the notification to suppliers for those purchased items that are affected by the

change. This allows for suppliers to take action to implement the change to reduce the impact of the change on delivery schedule.

After the CR package is approved by the CRB, the change package will enter into the last phase called the Change Notice. During this phase, the notification of change package is submitted to the customer for approval. The actual execution of the change will also be completed during this phase. Depending on the impact assessment, the business may determine that they will start the execution of the change in parallel with the customer review and approval of the notification of change. This method helps to expedite the change for shortening of the implementation. The change execution can also be completed after receiving the approval from the customer. Only changes documented on the notification of change, which is reviewed and approved by the CRB, should be implemented in the change. The change to the documentation should not vary from the changes that were presented to the customer and the approved by the CRB. If there are additional changes to be incorporated, the change package is then rejected back to the beginning of the CR stage or incorporated into a PR/CR package for evaluation later evaluation by the CRB team. The final step of the CN process is to bring the completed change package to another cross-functional review board called the Change Implementation Board (CIB). This team will be comprised of the same members from the CRB. The proposed implementation, impact assessment and stock disposition will be reviewed and then formalized into a finalized implementation plan. This plan will have formalized action items and assigned resources to complete the change process. The action items will be monitored and closed by the CA, providing the “closed loop” process needed for complete and accurate Configuration Change Management.

Change Classifications and Process Status

Standard changes that require a modification to the product definition does not always follow the same process. There are times where a change request will require a fast track process. This process is where a customer or supplier requires a change to a product definition in a timeframe shorter than the normal process. The process must be able to adapt to different change categories. These categories are Mini, Standard and Expedited:

- Mini- small changes or changes prior to MBOM release, development phase;
- Standard- full work flow, follows each step in change process;
- Expedited- fast track process that requires immediate revision change.

Along with the change classification, each stage of the process also will have a status applied for visibility and tracking purposes. This will allow the CA to report the stage and status of each change package. The statuses will be the same for each step and will reset when moved to the next stage. These statuses will be In-Process, Approved, Rejected, or On-Hold.

- In-Process – Work is being completed or investigated
- Approved – All applicable information is present and acceptable
- Rejected – Change or information is not acceptable to the business
- On-Hold – Request is valid but not a priority or not immediately required, can be implemented at future date

The next steps are to complete several pilot runs and to capture any additional information required by each step in the process. Explicit documentation (user's guide/work instruction) will be required for the different steps in each phase. This will help to ensure that the process is robust and consistent for each change.

Chapter 5- Suggestions for Additional Work

The development of this project elaborated on many areas that can be researched and developed further. This change process was developed and implemented to control the definition of a product during its life cycle. A critical aspect to the change process will be how to keep effective metrics on cost, effectiveness and time through each stage of the PR, CR and CN process. A possible next phase would be to develop an electronic workflow process to allow a paperless process. In addition, this process can be expanded to control the digital models, known as 3D digital datasets.

Metrics

The metrics taken from the engineering change process can be used to measure how long it takes a change to move from each stage. This data can be used to identify bottlenecks in the process and other problem issues. Metrics can also be used to track changes to products for design improvement activities and lessons learned for new product development. Best practices can be compiled on how other companies track changes throughout the process and what metrics are used to ensure an efficient process.

Electronic Workflow

An electronic process makes it easier to track metrics and to maintain an efficient change process. Modern electronic change management processes and the different systems that are available should be researched and evaluated for the best fit into the business. These case studies can also be used in the development of an electronic change management process with electronic notifications and reporting.

3D Dataset Control

Controlling the design definition of a product is the basis for the development of the change management process. Model based definition, also known as digital product definition, is another area for research. 3D digital datasets are being used more to control design definition of a product without the need of 2D engineering drawings. There is increased importance on developing processes and putting controls in place to ensure the integrity of digital product data. Case study research can also be conducted on how companies control digital data used in production.

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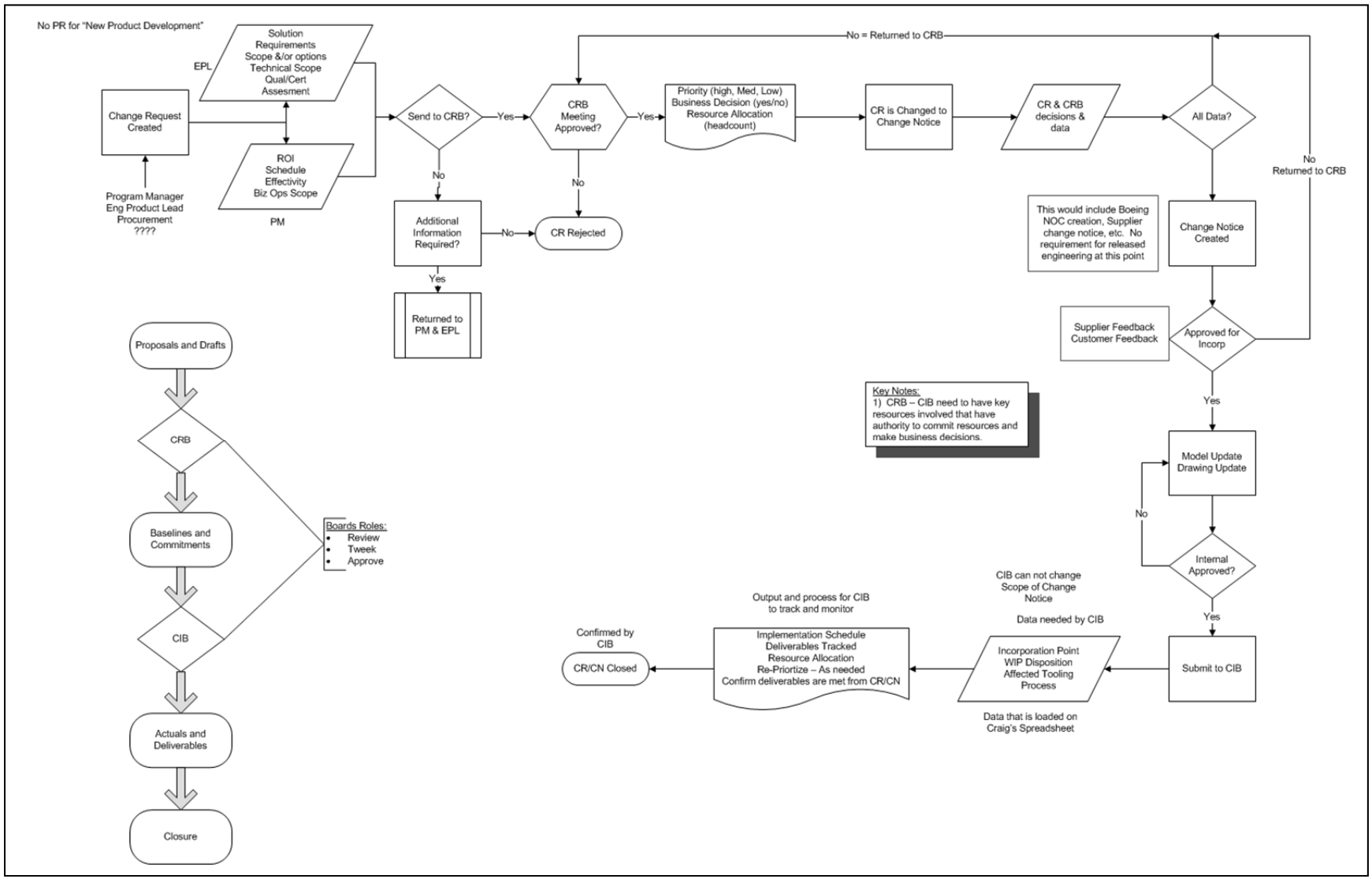
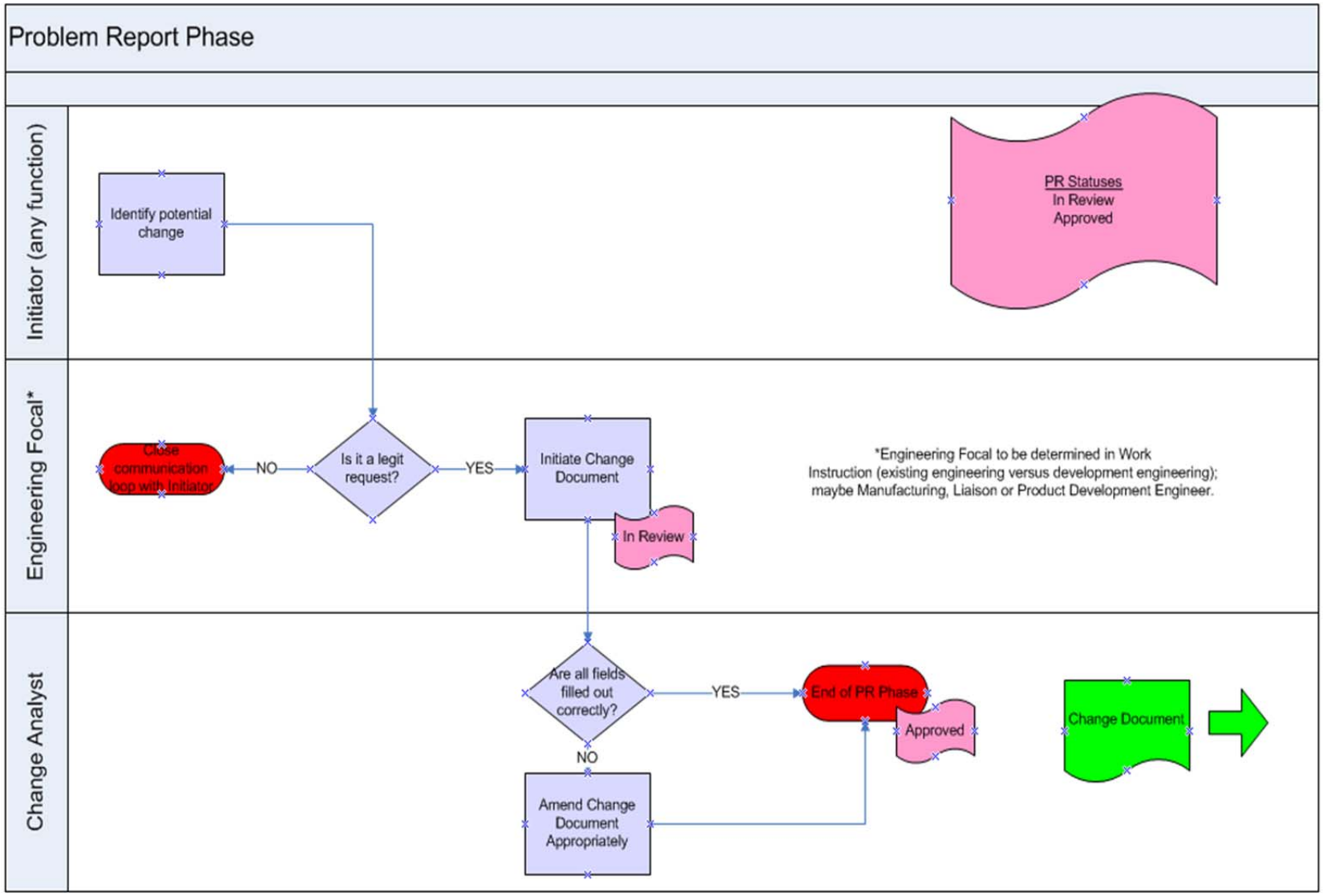
Appendices

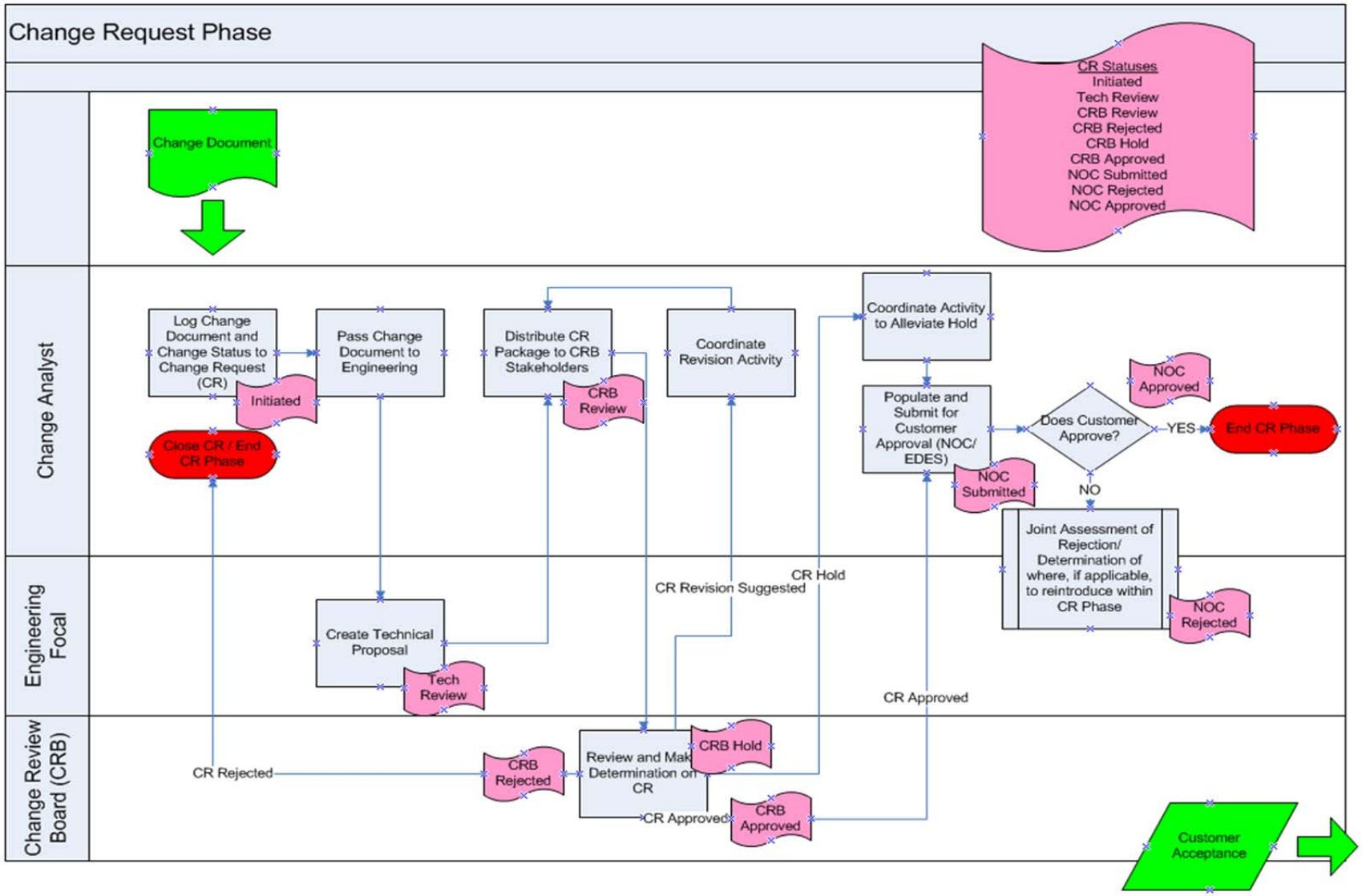
A. Initial Concept Workflow



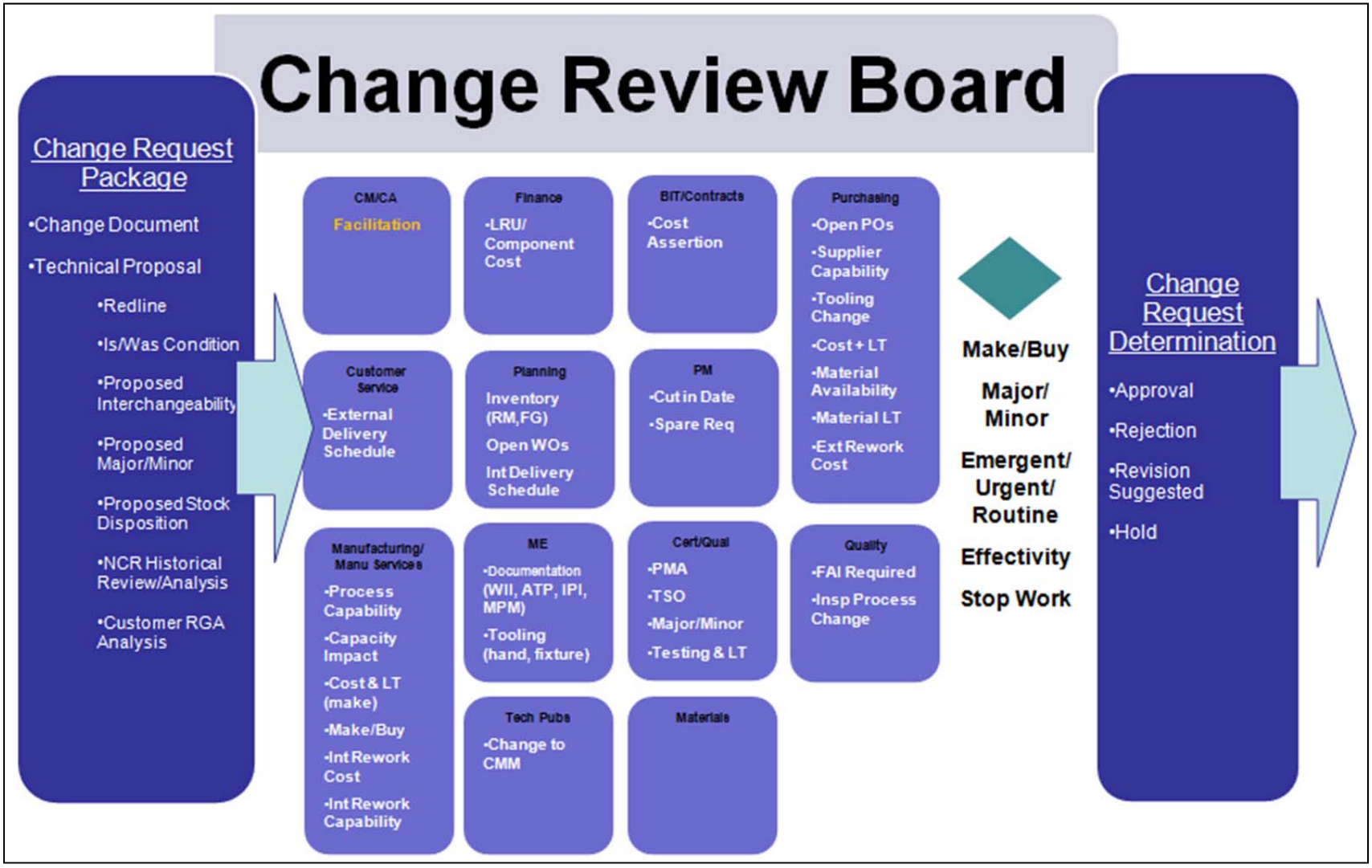
B. Problem Report Workflow



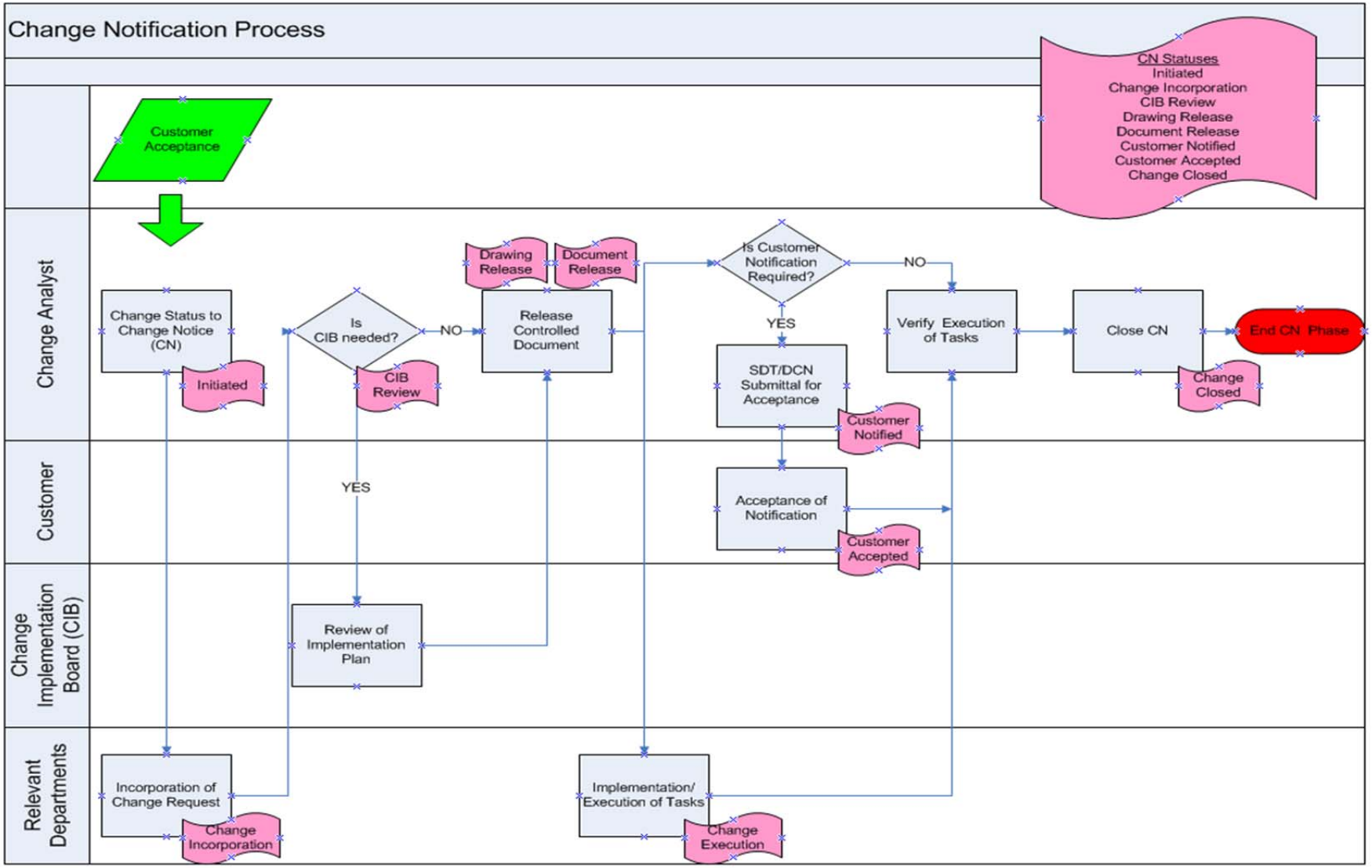
C. Change Request Workflow



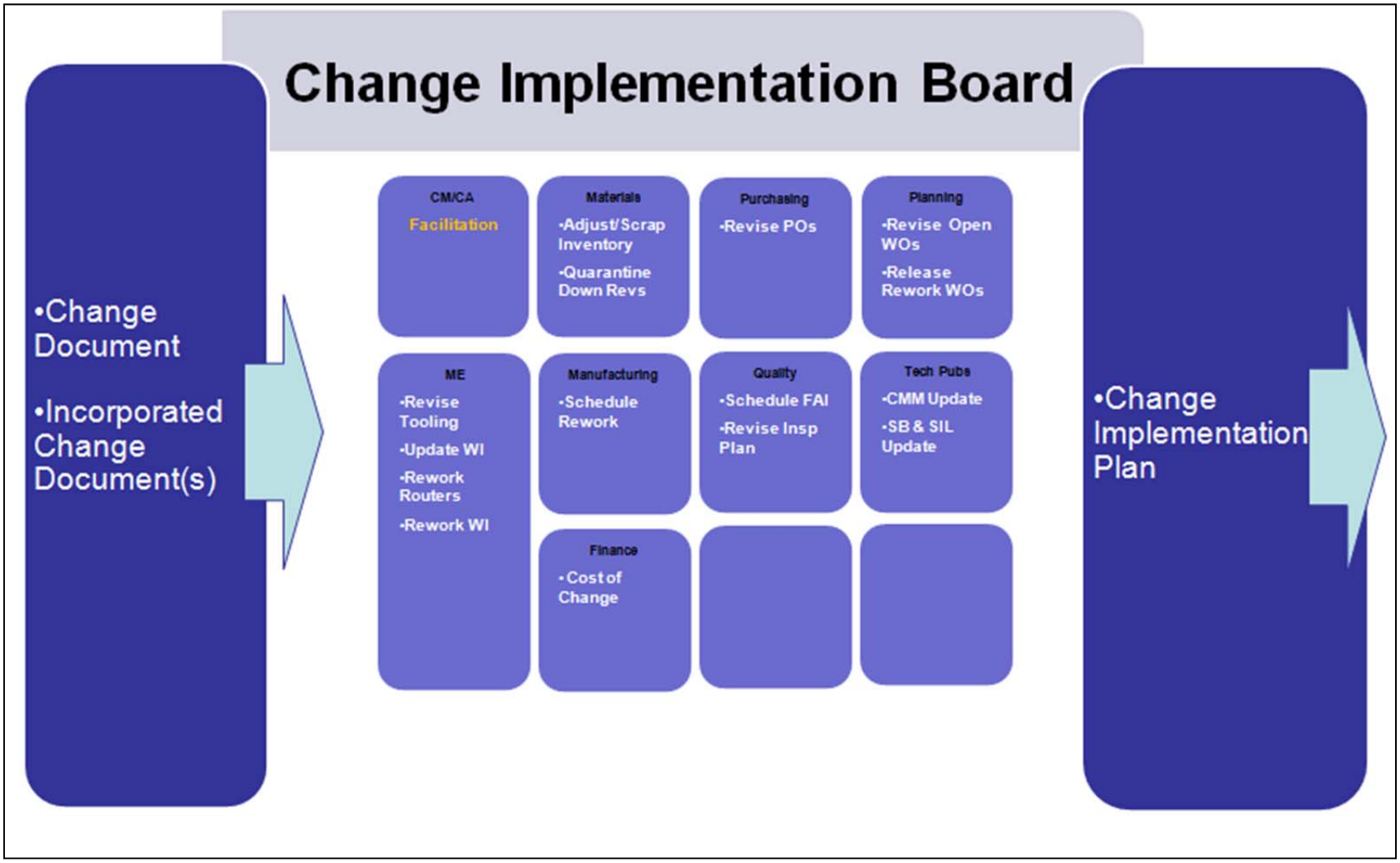
D. Change Review Board Members



E. Change Notice Workflow



F. Change Implementation Board Members



G. Change Process Questionnaire

Change Mangement Questionaire				
#	Process	Question	Response	Observations/Opportunities
1	Change Mgt	What are your triggers to initiate a Change request?	Customer Suppliers Manufacturing MRB	All internal Customers Requests Would typically be recorded through Customer Support Reps (existing product), Program Managers(new Programs), Customer Service??
2	Change Mgt	Who Initiates? What are mandatory data requirements?	Any internal employee can initiate a chage request Data Requirements: defined in WI-DCR None. Text description can be filled out at this stage but is often left blank	Need to define set of mandatory data that would be needed prior to Focal r iew
3	Change Mgt	Who Owns the Change?	: Engineering, Initiator, Mfg Eng, Prog Manager : Initiator is owner of change,	Config Manager/Analyst
4	Change Mgt	Who Approves? What is your escalation process? Who are your external approvers?	/ : No formal approval Escalation process is walk around and manually follow up No external approval for Change Request : Product Line Manager (DCR-CB provided buy-in steps 02 through 06) Escalation process is walk around and manually follow up No external approval for Change Request	CRB (does this need product line manager?) Customer Approval (prior to implementation) Supplier acceptance Need escalation process
5	Change Mgt	What are your Notification requirements?	: No documented Notification + DCN process during Change Request phase. NOC Process comes after Peer R iew and engineering activity has been completed PMA/TSO reported quarterly : Follow up	Notification of Change required prior to engineering activity
6	Change Mgt	How many changes per month?	: avg 130 : avg 100 DCRs and 750 Doc Control PN changes/processing : avg 25-30 DCRs	Metrics required
7	Change Mgt	Do you have a separate Change Request and Change Order/Notice?	: Single process that is adjusted to suit / : DCR which rolls into DCN and DRR processes	
8	Change Mgt	Do you have a fast track change process?	/ : walk around : ability to cut out approvals/sign offs to "fast track"	Note to maintain/inc de Engineering Manager/Chief Engineer signature
9	Change Mgt	What are your Item lifecycle phases?	: : Isolate concept phase from standard DCR process / : None	Item lifecycles: Concept/Design, Pre-release (long lead-items), release (production), obsolete Chage Process needs to have dual path for New product versus Existing
10	Change Mgt	What are your change types?	: Major/Minor	Mini Standard Expedited
11	Change Mgt	What are your Change Statuses? What are your pre-defined mandatory data for each status?	/ : Pre-release (prior to Doc Control release) Release :Preparation Phase DCR-CB DCR Processing Preparatation DCR-Processing	:DCR (translation version) :
12	Change Mgt	Is your Change management electronic? Are sign-offs done electronically?	: Baan (Drawings electronicsignature with no r iew, designer adds in CAD file) : Electronic signatures done through TC workflow : Wet signature on drawing	Electronic digital process required
13	Change Mgt	What is your average change cycle/target time? Release/Incoporation/Disposition	: (As it pertains to DCR) apprx 10 weeks thru Preparation, DCR-CB and DCR Processing : Standard 2 wks (avg 6 wks not inc ding customer approval) : 3 days???	PR -> 3 day CR -> 1 week NOC -> 30 days CN -> 1 week CI (assigned task; Closed Loop) -> 2 days
14	Change Mgt	Is your change process open/closed?	OPEN	Needs Change Implementation to ensure Disposition, Effectivity, Cost Roll is completed
15	Change Mgt	How many type of Items are Change controlled?	Engineering documentation that is associated to the product configuration. / : All released/r ision controlled documents utilize DCR system : Documents not associated/consumed in a product build are not involved in the Change Process.	Need to eliminate entry into JDE as config mngmt tool. Only items consumed in MBOM are entered into ERP system
16	Change Mgt	What are the categories of Changes? Mini, Major… How do they differ?	See Question 10	
17	Change Mgt	Explain your Control Board process? How often do they meet?	: As needed Peer R iew consists of Engineering, Mfg Eng, Quality, Purchasing, Planning : MPL, Procurement, Mfg Tech, Prod Planning, Incoming Inspection, Sales VTR, Prod Support, Final Approval Product Line Manager	Target is to have CRB and CIB for final approval of CR and CN Finance Quality Program Management Purchasing Planning Customer Service Materials Mfg Eng Prod Eng Tech Pubs BIT
18	Change Mgt	What are various metrics your track about your Changes?	: DCR Report : No active or current report : lain provide	Need defined metrics for various stages of the change process, inc de KPIs
19	Change Mgt	What are reason/cause codes you capture changes against?	/ : N/A	
20	Change Mgt	What are the various change cut-in effectivity methods you follow?	/ : Manual entry into JDE, current process release is immediate effectivity :	
21	Change Mgt	Explain your Dispositioning process? Is it closed-loop with the Change?	: Dispostion is defined by Peer R iew and/or Engineering	
22	Change Mgt	Does your present change process cover part obsolesence? Stop work? Stop ship?	: WI-Product Obsolescence : No. verbal catches and final inspection stops	
23	Change Mgt	Do you have a separate change process for mBOM changes?	: No defined mBOM change process. Requested via email or phone	Would need some type of formal request process that is documented. Baan capture changes for a part BOM and a drawing.
24	Change Mgt	Do you have a bulk change process?	: No	
25	Change Mgt	Are there procedures and policies defined for the process?	/ : QP7.3, WI-DCR, WI-Document Change Notice	
26	Change Mgt	What are the bottlenecks in the process and how would you solve them?	: Engineering resources to support change activities	
27	Change Mgt	What do you think is the downstream impact of the bottle neck?		
28	Change Mgt	What process features are required at the specified primary site? (i.e. closed loop)	: Closed Loop process, visibility of change to other functions	
29	Change Mgt	Are there inputs / activities from which departments?	: All departments have inputs on change process. Currently not all departments partcipate in the change process	
30	Change Mgt	Have people been trained on the process?	/ : yes. Would need update training for new employees	
31	Change Mgt	Is the process followed, and if not, what d iations are common?	/ : Many d iations	
32	Change Mgt	Are there well-defined policies for the process? (i.e. exception reporting, validation)		
33	Change Mgt	What policies exist that are related to this process or impact this process?		
34	Change Mgt	Which systems / tools are used during this process?	Lotus Notes database,Teamcenter and JDE : Baan	
35	Change Mgt	Does the existing system support the functionality required?	/ :not good effectivity of change, not good process for go/no go decision for change	
36	Change Mgt	Are there other applications in use to enable elements of functionality for this process?		
37	Change Mgt	Are there systems interfaces to automate the requisition of upstream interfaces?		
38	Change Mgt	Has poorly formatted or incorrect data been a problem at the sites?		
39	Change Mgt	What is the magnitude of the efficiency benefit in automating the features of this process?		
40	Change Mgt	What up-stream and down-stream capabilities will this process enable?	/ : Cost impact of change, stock disposition, execution of disposition and visibility of the change	
41	Change Mgt	How will this standardization reduce waste or improve cycle time?		
		Other		

H. Notification of Change Form

NOTIFICATION OF CHANGE

NOC NO:
Sheet 1 of 3

	Revised No	Date:	By:
Affected Requirement(s):			
Category Type: / Submittal Date:			
Completed By: / NOC Focal: / Program Mgt:			

Proposed Effectivity (ODD):	**Change Type:**		
	MAJOR Design Change	☐ Yes	☐ No
	MINOR Design Change	☐ Yes	☐ No

Reason For Change:

Description of Change/Evidence of Substantiation:

	NOTIFICATION OF CHANGE	NOC NO: Sheet 2 of 3

Affected Documents List

Document Number	Latest Approved Revision	Proposed Document Number	Proposed Document Revision

	NOTIFICATION OF CHANGE	NOC NO: Sheet 3 of 3

Previously Qualified Parts

Part Number

I. Change Document

CHANGE MANAGEMENT PROCESS FLOW AND ASSOCIATED FORMS

A) PROBLEM REPORT PHASE:

STEP 1: Identify Problem (Owner = Anyone)

1. **Describe issue to the assigned engineering focal (manufacturing engineer) for the area.**

STEP 2: Assess Problem for Legitimacy (Owner = Focal Engineer)

1. **Yes = Create a problem report for issue**
2. **No = Close communication loop with initiator**
3. **Send problem report to CM Analyst**

PROBLEM REPORT

INITIATOR	DOCUMENT NUMBER:	Revision	INITIATOR:	
			ORIGINATION DATE: / /	
			APPROVED BY:	
	One (1) Document Number per RFA. If other documents are affected, state in Reason section.			
	CHANGE ACTION: (Describe change needed. Attach sketch or marked print as necessary)			
	REASON: (State why the action is requested)		Sub Notice #:	
			NCR #:	
	DRIVER: (Circle one) Customer Quality Procurement Mfg. Safety Other			
	PRIORITY: (Please explain importance of action and urgency. Include critical dates, if applicable)			

STEP 3: Review Problem Report for Accuracy (Owner = CM Analyst)

1. **Ensure all fields are filled out correctly**
2. **Amend PR appropriately**

CM	**PROBLEM REPORT APPROVAL – BY CHANGE MANAGEMENT ANALYST**

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	APPROVAL: **YES**_____ **NO**_____

B) CHANGE REQUEST PHASE:

STEP 4: Log the Problem Report & Move to 'Change Request Status' in the System (Owner = CM Analyst)

STEP 5: Submit Change Request to Engineering Group for Assignment of Technical Proposal (Owner= CM Analyst)

STEP 6: Create Technical Proposal (Owner = Focal Engineering)

	TECHNICAL ENGINEERING PROPOSAL – BY ENGINEERING
ENGINEERING	**a) Problem Report / Change Request Reviewed:** **b) Redline Document Attached:** **c) IS / WAS Condition:** **d) Where Used:** **e) Proposed Disposition of Stock:**

STEP 7: Distribute CR Package to CRB Stakeholders (Owner = CM Analyst)

STEP 8: CRB Stakeholders Submit Required Information for CRB Meeting (Owner= CRB Stakeholder)

	CRB STAKEHOLDER IMPACT ASSESSMENT – BY CRB STAKEHOLDERS
CRB STAKEHOLDERS	**a) Customer Service:** - *External Delivery Schedule* _____ **b) Finance:** - *LRM and Component Cost* _____ **c) BIT / Contracts:** - *Cost Assertion* _____ **d) Purchasing:** - *Open PO's* _____

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- *Supplier Capability (Y/N) _____*
- *Tooling Change Cost and Lead Time _____*
- *Material Available (Y/N) _____*
- *Material Lead Time _____*
- *Rework Cost (External) _____*

e) Planning:
- *Stock on Hand _____*
- *WIP (Open WO's) _____*
- *Finished Goods _____*
- *Internal / Delivery Schedule _____*

f) Manufacturing Engineering:
- *Documentation (WI, ATP, IPI) _____*
- *Tooling Change or Addition _____*

g) Manufacturing Operations / Services:
- *Process Capable (Y/N) _____*
- *Capacity Impact _____*
- *Cost, Lead Time for Make/Buy Part _____*
- *Rework Cost (Internal) _____*
- *Internal Rework Capability _____*

h) Program Management:
- *Cut In Date _____*

i) Qualification Certification:
- *PMA (Y/N) _____*
- *TSO (Y/N) _____*
- *Major or Minor Change _____*
- *Testing Lead Time _____*

j) Quality:
- *FAI (Y/N), Lead Time _____*
- *Change to Inspection Process _____*
- *Change to CMM's (Y/N) _____*

STEP 9: CRB Meeting to Accept / Reject Change Request (Owner = CRB)

1. **Accept = CM submits for NOC approval**
2. **Reject = CM communicates status to initiator**
3. **Revision Suggested = CM coordinates required revision work back through CRB stakeholders**

CRB	CRB APPROVAL OF CHANGE REQUEST – BY CRB TEAM
	APPROVAL: YES_____ NO_____ REVISE_____
	PRIORITY: _____
	SET EFECTIVITY DATE: _____
	MAJOR or MINOR CHANGE: _____

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	MAKE OR BUY: _____ **STOP WORK ORDER: YES_____ NO_____**

STEP 10: Submit for NOC / EDES Approval Status (Owner = CM Analyst)

NOC: See Notification of Change Form

STEP 11: Receive NOC Approval Status from Customer (Owner = CM Analyst)

1. **NOC Approved = Move to CN Phase**
2. **NOC Rejected = CM takes request back to engineering for review.**
   a. ***May require the issue to run back through CRB process for CRB approval.***

CM ANALYST	**NOC APPROVAL – BY CHANGE MANGEMENT ANALYST**
	NOC APPROVED: YES_____ NO_____

C) CHANGE NOTICE PHASE:

STEP 12: Update Change Request Status to 'Change Notice Status' (Owner = CM Analyst)

STEP 14: Submit for Engineering Design/Drawing Work (Owner = CM Analyst)

STEP 15: Design Engineering Workflow (Owner = Design Engineering)

Insert Engineering Design Workflow Process Steps/Form Here

STEP 13: Incorporation of Change Request (Owner = Relevant Departments)

STEP 14: CIB Meeting Optional (if Needed) for Significant Change Requiring Management Approval (Owner = CIB)

1. ***If CIB is not needed, then advance to step 14 below.***

C I	**CIB VALIDATION – BY CIB STAKEHOLDERS**

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	a) Materials Logistics: - *Adjust Scrap / Inventory* _____ - *Quarantine In-Transit Inventory* _____ - *Purge Old Revs' Out of Production* _____ **b) Finance:** - *Capture CM Costs)* _____ **c) Materials Purchasing:** - *Revise PO's* _____ **d) Planning:** - *Revise Rev's on WO's* _____ - *Rework WO's* _____ - *WIP Adjusted* _____ **e) Manufacturing Engineering:** - *Update Documentation (WI, ATP, IPI)* _____ - *Revise Tooling* _____ **f) Manufacturing Operations / Services:** - *Schedule Rework* _____ **g) Quality:** - *Schedule FAI* _____ **h) Tech Pubs:** - *CMM Update* _____ - *SB and SIL Update* _____ **i) Change Management Analyst:** - *Document Open Action Items* _____

STEP 15: CIB Meeting to Accept / Reject (Owner = CRB)

1. **Accept = CM submits for Drawing Release**
2. **Reject = CM closes CR**
3. **Revision Suggested = CM coordinates required revision work back through CRB stakeholders**

CIB	**CIB APPROVAL OF CHANGE REQUEST – BY CIB** **APPROVAL: YES_____ NO_____ REVISE_____** **MODIFY EFECTIVITY DATE: _____**

STEP 16: Release a New Controlled Drawing Document (Owner = Doc Control)

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DOC CONTROL	DRAWING RELEASE – BY DOC CONTROL
	RELEASE OF DRAWINGS: YES_____ NO_____ **SUBMIT FOR CUSTOMER NOTIFICION (EVERETT): YES_____ NO_____**

STEP 17: Execute Tasks to Implement Change Notice (Owner = Functional Department Stakeholders)

CIB STAKEHOLDERS	CIB EXECUTE TASKS – BY CIB STAKEHOLDERS
	j) Materials Logistics: - *Adjust Scrap / Inventory* _____ - *Quarantine In-Transit Inventory*_____ - *Purge Old Revs' Out of Production*_____ **k) Finance:** - *Capture CM Costs)*_____ **l) Materials Purchasing:** - *Revise PO's*_____ **m) Planning:** - *Revise Rev's on WO's*_____ - *Rework WO's*_____ - *WIP Adjusted*_____ **n) Manufacturing Engineering:** - *Update Documentation (WI, ATP, IPI)*_____ - *Revise Tooling*_____ **o) Manufacturing Operations / Services:** - *Schedule Rework*_____ **p) Quality:** - *Schedule FAI*_____ **q) Tech Pubs:** - *CMM Update*_____ - *SB and SIL Update*_____ **r) Change Management Analyst:** - *Document Open Action Items*_____

STEP 18: Verification That All Implementation Steps Have Been Completed (Owner = CM Analyst)

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CM ANALYST	CIB TASK COMPLETION TRACKER – BY CM ANALYST
	ALL CIB TASKS COMPLETED: YES_____ NO_____ COMMENTS:

STEP 19: Close Change Notice (Owner = CM Analyst)

CM ANALYST	CHANGE NOTICE CLOSURE – BY CM ANALYST
	CN CLOSED: YES_____ NO_____

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