

Analysis of E-Change Software Impact: Current Application in the Documentation Process

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Abstract — *The CAD/PAD Systems Engineering Department utilizes the E-Change software system in the process of routing/approving engineering change proposals (ECPs). Before the E-Change system, the Department used to process the ECPs manually which constituted a huge amount of transactions via paperwork. Therefore, to reduce the amount of paper used, streamline and automate the routing/approving process of engineering change proposals (ECPs) in the Department, the E-Change system was implemented on 04/09/2014. This Project studied the routing/approving process for the E-Change system during the period of 04/09/2014 to 04/01/2015 and compared it with the Manual method from 01/15/2014 to 03/09/2014. It was found that for the Manual method, the average routing/approving time for each ECP was approximately 60 days and for the E-Change System is currently 10 days. This demonstrates that the E-Change System is faster than the old paper-intensive process (Manual Method), as well as, featuring superior capabilities traceability-wise.*

Key Terms — *Systems Engineering, Data Management, Engineering Change Proposal, CAD/PAD Department*

INTRODUCTION

The nature of militarized air warfare is a delicate one and proper performance of the aircraft support system is essential to the survivability of the aircrew. A simple and often taken for granted feature of today's aircraft is the ejection device; without it, there is no means of escape and survival for the pilots whose life can literally depend on its functions.

The Naval Surface Warfare Center (NSWC), Indian Head Explosive Ordnance Disposal Technology Division (IHEODTD), is one of ten Naval Sea Systems Command Warfare Center Divisions and is the largest Department of Defense full-spectrum energetics facility. The Cartridge Actuated Device (CAD)/ Propellant Actuated Device (PAD) Systems Engineering Department and its branches are technical departments inside the NSWC IHEODTD that focus on: assuming the responsibility as lead service for the escape system in the operational readiness of aircrafts, employing the joint effort of these organizations for the sustainment phase of the life cycle, and using the best practices available for responding to customer needs [1].

The CAD/PAD Systems Engineering Department utilizes customized software to facilitate the data management processes. The E-Change software system is one of these crucial tools designed to aid users in the documentation process.

This Project aims to determine the impact of the E-Change system in the documentation process in the systems engineering department measured from September 2014 to January 2015 and to analyze the software applications in the current approval/routing process of Engineering Change Proposals (ECP) in comparison to the manual method. As a result, possible areas of improvement in the E-Change System will be identified.

BACKGROUND

The systems engineering department of the organization uses the Defense Acquisition Guidebook and the Military Handbook MIL-

HDBK-61A for guidance on policy and best practices. As defined in the Defense Acquisition Guidebook, "Systems engineering (SE) is a methodical and disciplined approach for the specification, design, development, realization, technical management, operations, and retirement of a system" [2]. In this case, the system refers to military aircraft, ground vehicles, among others. The organization's systems engineering department focuses in executing energetic projects across the system life cycle (cradle to grave concept).

The CAD/PAD In-Service Engineering Branch provides engineering support of Cartridge Actuated Devices (CADs) and Propellant Actuated Devices (PADs) during the procurement phase and in-service support once released for service use to the Army, Air Force, Navy, FMS and private party costumers. The Engineering Branch reviews and approves Engineering Change Proposals, and requests for waivers and deviations to documentation requirements. It also provides test assistance and verification during various types of acceptance tests and manages investigations of failed production lots. In addition, it provides engineering support as required on product improvement, maintenance engineering, and quality evaluation programs [3]. For this reason, the team responsible for the Cartridge Actuated Devices/Propellant Actuated Devices (CAD/PAD) operations is composed of thousands of engineers supporting a government-exclusive military line of production [4].

CADs/PADs are used even beyond aircraft ejection seats, implemented as well inside weapons release mechanisms and fire suppression systems. The malfunction or lack of maintenance towards these devices can result in the fatal grounding of an aircraft due to their explosive chemical composition; thus, hundreds of bases across the United States are responsible for replacing old CAD/PADs with new ones, and then demilitarizing the now outdated cartridges.

The task of documenting thousands of these transactions via paperwork has proven to be an arduous one. In order to streamline the process of

submitting, verifying, and tracking stored data on these devices, a new method was needed. To put matters into perspective, the old system required the 780 Navy maintenance locations around the world to send a diskette every month to the Navy CAP/PAD Program at Indian Head in order to input or even receive data because of the method's centralized infrastructure [4].

The automatic Virtual Fleet Support (VFS) system is web-based and can manage data from any member of the global maintenance and support teams [4]. The program connects individuals to ensure fluidity in the operations process, improving the effectiveness of those from ordnance logistics to supply systems or aircraft maintainers to the fleet support team. The vast categories of data that it compiles together with factual fidelity actually complete work for maintainers. The program is fitted to the workplace, and to successful results.

A new tool that's part of the VFS system is the E-Change software located under the engineering configuration management module which is tied to the Data management office and is used daily by the engineering group since it first launched the 4th of September 2014. This software helps engineers to generate, route, and approve engineering change proposals (ECPs) on a daily basis. Military Handbook MIL-HDBK-61A defines an engineering change proposal as "the documentation by which a proposed engineering change is described, justified, and submitted to (a) the current document change authority for approval or disapproval of the design change in the documentation and (b) to the procuring activity for approval or disapproval of implementing the design change in units to be delivered or retrofit into assets already delivered" [5].

In the past, the Manual method for processing engineering change proposals (ECPs) consisted in writing the ECPs on a piece of paper and then handing each ECP for approval to the first approving official. After it had been reviewed by the first approving official, it continued through the approval chain to be handed to the second approving official, and so forth. The step-by-step

process used by the Department for routing/approving engineering change proposals (ECPs) is presented in Figure 1.

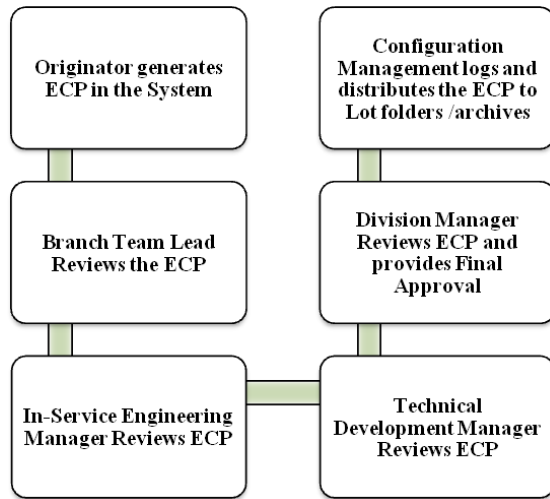


Figure 1

ECP Routing/Approving Process for Manual Method & E-Change Method

This process requires the signatures of five approving officials per each ECP being routed, in which case paper copies would get lost in the process with no way to track the whereabouts of any ECP in the approval/routing process. Consequently, program deadlines and item deliveries were affected which triggered a change in the requesting and processing of ECPs in the Department.

Recently, the department has deviated from the Manual method and moved forward with the E-Change system. This system has been introduced as a new tool to assist the engineers in the process of routing/approving ECPs electronically and was implemented as a green approach to reduce the amount of paper used in the systems engineering department.

METHODOLOGY

The first step is the data collection phase which consists of researching existing data of past (log folders) and current (E-Change database) Engineering Change Proposals (ECP) for their respective time stamps between initial submission and final approval. Then, the ECP data recorded for

the four months before (May 2014 – September 2014) and after (September 2014 – January 2015) E-Change implementation is to be organized, compared, and analyzed. Workplace disclosure policy affects the type of information that can be disclosed. Specifics on ECP contents should not be disclosed. In addition, ECPs should not be referred to by their original log identifiers and instead will be assigned an alpha-numeric code.

Findings for both routing/approval methods will be compared to each other. Average processing time will be calculated for each Engineering Change Proposals (ECP) method. This aims to determine the impact of E-Change in the ECP process and provide recommendations for improvement while also taking into account the user standpoint.

RESULTS AND FINDINGS

The Engineering Change Proposal (ECP) data recorded for the Manual Method during the timeframe of 01 May 2014 – 03 September 2014 is presented in Table 1. Based on the ECP data collected for the Manual method, the average routing/approving time for each ECP is approximately 60 days. A trend can be seen in the first seven ECPs recorded, as they all have very long processing times in comparison with the other ECPs listed in Table 1. For these cases, three of the seven engineers that originated the ECPs were tracked down to determine the reason behind the delay. The engineers explained that when a paper copy is submitted for the first time, the printed document contains its creation date. If the document is somehow lost between approving officials, the document is then printed once more, but now has the original creation dates without referencing its revisions. The transaction reverts back to step one and, as a result, the process appears to be longer than it is (to the extent that it seems to prolong indefinitely). The other four engineers could not be reached for comment because they are no longer working for the organization; nonetheless, it is likely they

encountered the same issue as the engineers that were interviewed.

Table 1
ECP Data for Manual Method

Log Identifier	Start Time	Finish Time	Total Time (Days)
ECPOM-01	6/11/2013	5/25/2014	348
ECPOM-02	10/18/2013	5/15/2014	209
ECPOM-03	10/31/2013	5/30/2014	211
ECPOM-04	11/14/2013	5/23/2014	190
ECPOM-05	11/19/2013	6/24/2014	217
ECPOM-06	11/20/2013	8/10/2014	263
ECPOM-07	12/18/2013	8/20/2014	245
ECPOM-08	4/23/2014	5/7/2014	14
ECPOM-09	5/1/2014	5/7/2014	6
ECPOM-10	5/6/2014	5/28/2014	22
ECPOM-11	5/8/2014	5/9/2014	1
ECPOM-12	5/16/2014	5/17/2014	1
ECPOM-13	5/16/2014	5/17/2014	1
ECPOM-14	5/22/2014	6/10/2014	19
ECPOM-15	6/4/2014	6/10/2014	6
ECPOM-16	6/4/2014	6/17/2014	13
ECPOM-17	6/4/2014	7/3/2014	29
ECPOM-18	7/12/2014	7/16/2014	34
ECPOM-19	6/12/2014	7/9/2014	27
ECPOM-20	6/25/2014	6/26/2014	1
ECPOM-21	7/7/2014	7/8/2014	1
ECPOM-22	7/14/2014	7/17/2014	3
ECPOM-23	7/16/2014	7/18/2014	2
ECPOM-24	7/16/2014	7/19/2014	3
ECPOM-25	7/21/2014	8/6/2014	16
ECPOM-26	8/13/2014	8/21/2014	8
ECPOM-27	8/14/2014	9/1/2014	18
ECPOM-28	8/19/2014	9/2/2014	14
ECPOM-29	8/19/2014	9/2/2014	14
ECPOM-30	8/19/2014	9/3/2014	15
ECPOM-31	8/28/2014	9/3/2014	6
ECPOM-32	8/28/2014	9/3/2014	6
ECPOM-33	8/29/2014	9/24/2014	26
	Average Time		60.27272727

*Workplace disclosure policy affects the type of information that can be disclosed.

The Engineering Change Proposal (ECP) data recorded for the E-Change System during the timeframe of 04 September 2014 - 04 January 2015 is presented in Table 2. Based on the ECP data collected for the E-Change System, the average routing/approving time for each ECP is approximately 10 days. The last four ECPs have long processing times in comparison with the other ECPs presented on Table 2 with the longest time being 44 days. One characteristic that they have in

common is that the ECPs were originated during the month of December and were finalized in the beginning of January 2015. It is likely that during this timeframe, employees were out of the office because of the holidays and this could account for the extended processing times.

Table 2
ECP Data for E-Change System

Log Identifier	Start Time	Finish Time	Total Time (Days)
ECPEC-01	9/4/2014	9/29/2014	25
ECPEC-02	9/4/2014	9/30/2014	26
ECPEC-03	9/4/2014	9/8/2014	4
ECPEC-04	9/9/2014	9/10/2014	1
ECPEC-05	9/9/2014	9/11/2014	2
ECPEC-06	9/10/2014	9/18/2014	8
ECPEC-07	9/10/2014	9/30/2014	20
ECPEC-08	9/10/2014	10/1/2014	21
ECPEC-09	9/10/2014	10/1/2014	21
ECPEC-10	9/12/2014	10/1/2014	19
ECPEC-11	9/12/2014	10/1/2014	19
ECPEC-12	9/26/2014	9/28/2014	2
ECPEC-13	9/26/2014	10/6/2014	10
ECPEC-14	9/26/2014	10/6/2014	10
ECPEC-15	9/26/2014	10/6/2014	10
ECPEC-16	10/2/2014	10/6/2014	4
ECPEC-17	10/2/2014	10/6/2014	4
ECPEC-18	10/2/2014	10/14/2014	12
ECPEC-19	10/9/2014	10/14/2014	5
ECPEC-20	10/15/2014	10/16/2014	1
ECPEC-21	10/21/2014	10/23/2014	2
ECPEC-22	10/22/2014	10/28/2014	6
ECPEC-23	10/23/2014	10/28/2014	5
ECPEC-24	10/24/2014	10/28/2014	4
ECPEC-25	10/24/2014	10/28/2014	4
ECPEC-26	10/24/2014	10/28/2014	4
ECPEC-27	10/29/2014	10/30/2014	1
ECPEC-28	10/29/2014	10/30/2014	1
ECPEC-29	10/29/2014	10/30/2014	1
ECPEC-30	11/10/2014	11/13/2014	3
ECPEC-31	11/12/2014	11/14/2014	2
ECPEC-32	11/18/2014	11/19/2014	1
ECPEC-33	11/25/2014	12/3/2014	8
ECPEC-34	12/2/2014	1/15/2015	44
ECPEC-35	12/4/2014	1/5/2015	32
ECPEC-36	12/8/2014	1/6/2015	29
ECPEC-37	12/12/2014	1/8/2015	27
	Average Time		10.75675676

* Workplace disclosure policy affects the type of information that can be disclosed.

One great feature of the E-Change system is the auto-generated email notifications which are sent for each ECP to all users involved in the

routing/approving process. This notifies officials when an approval request is waiting for their action. Also, the system provides the approving officials the capability to add comments or issues electronically to each ECP that is being processed. This allows the originators of the ECP to address the issues or concerns submitted by the officials before final approval.

In terms of minimum processing time, the routing/approving process for the E-Change system takes approximately 10 days in comparison with the Manual Method which takes around 60 days. This is a significant difference in processing times between both methods, which demonstrates that the E-Change system is faster. Furthermore, traceability-wise the E-Change system has proven to be superior than the Manual Method because now the comments, issues, and changes of each ECP can be tracked to the users who originated it. Moreover, the Manual Method was paper intensive and required the completed ECPs to be stored in file cabinets which occupied a lot of space and had to be re-located to a different building. However, by implementing the E-Change System there's no need for storage since it's all done electronically and the Department has experienced a drastic reduction in the utilization of paper. This has helped the Department increase its productivity and save time and money.

RECOMMENDATIONS

As with any new system, there is always room for improvement and the E-Change System is no exception. From a user standpoint, only minor issues have been encountered. For example, when an approving official is not available for an extended period of time the Originator of the ECP has to contact the back-up approver, but if this individual is not available, then the configuration manager needs to be contacted. This issue can be easily fixed by modifying the system to include the names for the back-up approvers for each step of the process and sending auto-generated email

notifications to make them aware of their role in the ECP approval process.

Another feature, besides processing ECPs, that needs to be added to the E-Change System is the capability to process other documentation like waivers and deviations. Processing these documents, as well as ECPs, are part of the Project Engineers' daily tasks in the Systems Engineering Department. However, currently these documents are being processed manually using paper copies and following the same routing/approving process depicted in Figure 1. The risk of paperwork getting lost in the routing/approval process is unacceptable; as it can affect mission performance, and have a negative impact in the Department's support to the warfighter. Therefore, adding the feature to process waivers and deviations to the E-Change system is essential in order to streamline the routing/approving process for these documents.

CONCLUSION

The CAD/PAD Department plays a crucial role in the military industry of today. The In-Service Engineering Branch specifically provides in-service support for aircrew escape propulsion systems, serving warfighters around the world. The E-Change System is one of the crucial tools that the department uses to streamline and automate the routing/approving process of engineering change proposals (ECPs). This new system has an average processing time of 10 days for each ECP which is a major improvement from the old paper-intensive process that took around 60 days. The addition of this system saves time and money while increasing the Department's productivity. Furthermore, the E-Change System has room for improvement (as does any new system). The recommendation to incorporate the capability to process waivers and deviations is currently being considered for implementation in the near future. The E-Change System is nonetheless the lead data management tool used in the CAD/PAD Department and, with the appropriate improvements, it has a promising future ahead.

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