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NIF ELECTRONIC OPERATIONS: IMPROVING PRODUCTIVITY WITH IPAD APPLICATION DEVELOPMENT

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Abstract

In an experimental facility like the National Ignition Facility (NIF), thousands of devices must be maintained during day to day operations. Teams within NIF have documented hundreds of procedures, or checklists, detailing how to perform this maintenance. These checklists have been paper based, until now. NIF Electronic Operations, NEO, is a new web and iPad application for managing and executing checklists. NEO increases efficiency of operations by reducing the overhead associated with paper based checklists, and provides analysis and integration opportunities that were previously not possible. NEO's data driven architecture allows users to manage their own checklists and provides checklist versioning, real-time input validation, detailed step timing analysis, and integration with external task tracking and content management systems. Built with mobility in mind, NEO runs on an iPad and works without the need for a network connection. When executing a checklist, users capture various readings, photos, measurements and notes which are then reviewed and assessed after its completion. NEO's design, architecture, iPad application and uses throughout the NIF will be discussed.

INTRODUCTION

In order for operations to run efficiently and be ready to fire a shot nightly, the NIF manages an average of 100 tasks per day spread among 50 diagnostics, 192 beamlines, and various facility systems all within a building the size of 3 football fields [1][3]. The work tasks to prepare NIF for a shot include removing spent hardware, installing targets, re-configuring diagnostics, exchanging large optics, aligning the equipment, and maintaining facility systems. With such a high number of tasks each day, the NIF requires an efficient method to execute tasks. The NIF Electronic Operations aims to improve task and checklist execution, eliminate paper waste, improve shot turnaround time, and provide real-time metrics of task execution.

THE NEO SOLUTION

The NIF Electronic Operations, NEO, is a unique application for managing and executing electronic checklists. Built with mobility in mind, NEO runs on an iPad with or without the need for a constant network connection. NIF has many procedures that define the steps necessary to complete a specific task, such as exchanging or installing one of the many final optics, or servicing a diagnostic. The requirements for NEO were initially developed using a prototype built within FileMaker Pro. The prototype allowed for fast development of the NEO process and identification of user requirements, which then shaped development of the final NEO application.

When executing a checklist, users capture various readings and measurements which can then be uploaded to the main database where the notes and results can be reviewed and assessed by the system owner after task completion. Prior to using an electronic checklist to track work tasks, completed paper checklists would be collected and, at best, scanned into a document repository. Extracting data from the paper checklists or scanned files was extremely inefficient. NEO has made this process electronic and provides many new features such as checklist versioning, real-time input validation, image and data capture, quick review of previous checklist transactions, searchable historical data, and detailed timing analysis of checklist executions.

Figure 1: NIF technicians performing an optic transaction utilizing NEO on the iPad.

Figure 2: NEO iPad Application home screen and list of NIF Checklists

NEO TOOLS

The NEO web application has a rich set of tools that help manage checklists and report usage. Checklists are defined in Excel and then configuration managed through a document system, where the NEO application retrieves the latest checklist version. In Excel, users define checklists in detail by identifying the text, images, and inputs along with associated validation needed to be captured during execution. For example, an author can define inputs on a step and ensure they are required, numeric, or validate they match something else within the checklist. Other validation steps include validating real-time field measurements or if the serial number of the component to be installed matches what is requested. The NEO checklist can also be configured to call a sub checklist at any location in a main checklist. This is useful when checklist steps are required at multiple locations in a procedure, or can be applied across a broad selection of tasks.

A Bluetooth barcode scanner can also be utilized while completing checklists on the iPad. Instead of manually typing barcodes into an the iPad, the barcode scanner will read the barcode and input the serial number or part number for the component being installed, significantly reducing the chance for error. In addition to defining checklists, the NEO web application allows users to view details about given checklist instances (executed checklists) and allows users to track completion in real-time. Users can browse, sort, search, and graph historical checklist instances and obtain detailed information on who, what, and when checklists and steps were completed and how long each step took to complete. NEO's reporting capability gives team leaders valuable insight into the steps of their procedures that take the longest amount of time, and gives them the necessary tools they need to evaluate the efficiency of their procedures. Additionally the data can be exported to Excel.

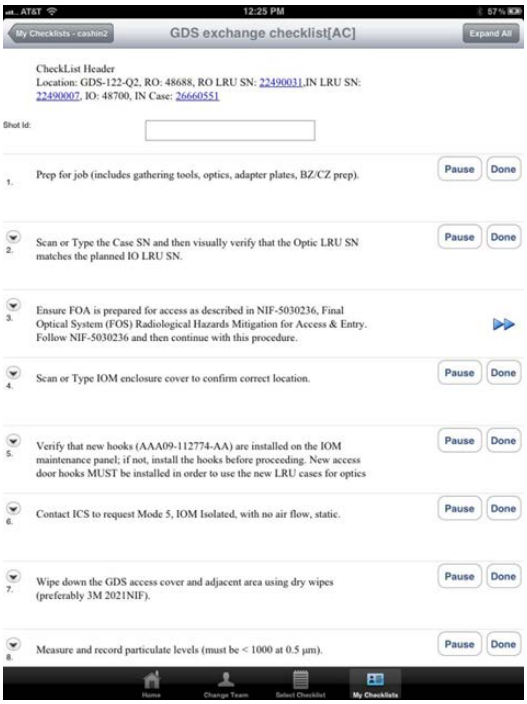

Figure 3: Example of Checklist steps on the iPad. The arrows in step 3 indicate that the step will jump to a sublist.

CHECKLIST EXECUTION

Checklist execution is done via the NEO iPad application (see fig. 2,3) or the NEO web application on a PC connected to the network. The NEO iPad application is a native application written in Objective C. It works in a disconnected mode, so it can be used where wireless coverage is not reliable. Once a checklist is defined with the Excel template and approved through the document management system, it can be used on the iPad or web application. Operators select the work they need to perform and then execute their checklists accordingly. Through a task tracking interface available in NEO, the user can select a planned task and NEO will provide the appropriate checklist for the user, along with the associated task ID, task type, part information, and work orders. This information is utilized to validate information at selected places within the checklist. A checklist in progress can also be transferred between any device, allowing users to start a checklist at a workstation PC, and finish the checklist on an iPad in the field or vice versa. This feature also allows checklists to be transferred from one user to a different user to complete the task.

Once a checklist is completed, the NEO application on the iPad is synced with the server, where the completed checklist is added to the database repository and is then also viewable within the NEO web application. NEO automatically closes the task and associated work orders and updates the part repository with serial numbers for the components that were removed or installed. This significantly reduces overhead and error by eliminating many of the steps that used to be performed by hand, saving as much as 30 minutes per task.

TECHNOLOGIES USED

The NEO system consists of two primary applications. The web application manages checklists, provides access to checklist execution data, and can act as a client for executing checklists. The iPad application allows for execution of a checklist in the field but does not have any administrative functions of the web application. The technologies backing these applications are discussed below.

iPad

The iPad application is a native iOS application built with Objective C. When planning NEO development there were several development platforms to choose from for building the iPad client. The top contenders being a web based jQuery mobile application, the phone-gap framework (aka Cordova [4]), and a native IOS app. The main reasons for choosing a native application were 1) Support for picture taking was desired and it was questionable what level of camera support we could get in the other frameworks. 2) Operating in disconnected mode was a strong requirement, and the amount of offline storage provided by the other frameworks was determined to not be adequate and would present technical challenges. 3) The NEO team wanted to provide the best user experience possible. Based on a sampling of apps created in the other frameworks the team found that native applications were generally more responsive. Furthermore, since only the iPad was being targeted, the write once, run anywhere features of phone gap were not needed.

Web Application

The web application front end is written in jQuery [5], and is backed by java based Jersey RESTful web services[6]. RESTful services communicate with an Oracle database which stores our checklist data model. Users define new checklists by modifying an excel template which is accessible through the NEO website. This template contains the checklist name and configurations for all steps within the checklist. The template is converted to the NEO data model once it is uploaded back to the NEO web application. Users can also upload the checklist to a content management system (ECMS) and have NEO automatically add the document to its data store and make it available as a checklist. This allows the document to be managed by a true content management system while being kept in sync automatically with NEO. Once a document is content managed, it is not modifiable from within NEO. Figure 4 shows this workflow.

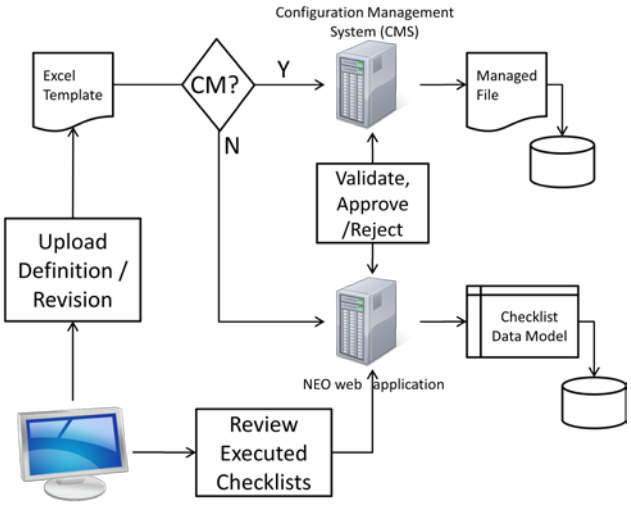

Figure 4: Overview of NEO checklist publishing. A checklist originates as an excel template and is uploaded directly to NEO or indirectly through a CM system.

USER FEEDBACK

User feedback has been very positive since NEO's initial production release in early August 2012. To date it has guided users through more than 2090 procedures and tracked more than 3400 hours of work [1]. Upcoming capabilities for NEO include the ability to redline checklists in the field, send notifications to system owners upon checklist completion, and fully integrate metrics reporting for all aspects of the facility. Other groups outside of the NIF have also expressed interest in using a

tool like NEO, which has encouraged the NEO team to develop a plan of action for making the software deployable to other organizations. This would require removing NIF specific portions of the software and making these features more pluggable and generic.

CONCLUSION

The implementation of electronic checklists has increased efficiency by approximately 30 min per task or 50 task hours per day. NEO eliminates time spent searching for procedures, printing paperwork and completing transaction orders. Operational reliability is increased by ensuring the technicians have the most up to date checklist readily available. Operator error is reduced through part verification and automatic parts inventory updates, eliminating errors in transcribing information or installing the incorrect part. Reducing overall time and eliminating errors thus reduces the shot turnaround time. In the NIF facility, technicians perform operations in cleanrooms ranging from class 100 to 10000, so the use of the iPad reduces airborne particulates caused by paper. There is an added savings by eliminating the need for costly cleanroom paper waste and reducing the environmental impact. The Continual use of NEO will further improve the efficiency of NIF operations.

REFERENCES

[1] Metrics reported through the NEO application

[2] Metrics reporting through the NIF Production Operations Reports Tracking application

[3] Information obtained from https://lasers.llnl.gov/about/nif/about.php

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[5] http://jquery.com/

[6] https://jersey.java.net/

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