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Streamlining the Target Fabrication Request at the National Ignition Facility (NIF)

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1. INTRODUCTION

National Ignition Facility (NIF) targets are complex engineering marvels in tiny packages. Creating them requires interplay among target designers, materials scientists, and precision engineers. The laser drives a target capsule inward at nearly a million miles an hour. Because the targets are subjected to extreme temperatures (greater than those in the Sun) and pressures (similar to those found in the core of Jupiter) during experiments, the targets must be designed, fabricated, and assembled with extreme precision [1].

The target production lifecycle begins with submission of a formal target request. Experimentalists and project engineers create the target feature definition based on dozens of existing and/or new parameters determined by the physics requirements and the type of shot. When the shot calls for an existing target, a previous target fabrication request can be duplicated. However, when it calls for a new type of target, a new request must be created. And in those cases, supporting documentation must be provided describing the custom parts that will be needed in the target build.

Before the commissioning of this project, experimentalists, project engineers and target fabrication team members ("users") first utilized a tool developed in Oracle Application Express (Apex). This application was developed as part of an existing tool suite called Production Optics Reporting and Tracking (PORT). The PORT-based target request tool had three major limitations: underlying data architecture precluded future automation in target order processing, data was usually duplicated, and page loading times were very slow.

Given the above limitations of the PORT-based tool, and with an estimated 500 targets needed to be produced each year, it became clear that users urgently needed a new tool. The decision was made to develop a completely new application versus modifying the existing one.

2. APPROACH

The pressing needs from the Target Fabrication organization resulted in a schedule that provided only four months of development time to the NIF Shot Data Systems (SDS) software team.

2.1 Approach

This limited development time was a key factor when selecting the technologies for this project. We decided to work with modern Web technologies that were familiar to the team and that would allow for reuse of software from other SDS tools. The main technologies used were: Node.js, Express, JavaScript, KendoUI, and Docker.

2.2 Architecture

The Target Request Tool (TRT) architecture is composed of three main pieces.

Back-end

The back-end was built using Node.js and Express. We used the Node.js-required file "package.json" for listing application dependencies and scripts for start, build, and clean.

The basic routing was done by creating an instance of Express *(var app = express())* and using the following structure: *app.http-request-method(path, handler)*. Individual pages were given their own path, i.e.: '/TRT/view-all-orders' for displaying all TR orders.

The Web server behavior and URL configurations were done with the help of a few Node.js and Express middleware modules: 'body-parser' for handling JSON, Raw, Text and URL encoded form data, and 'express.static' for serving static files such as images and third-party libraries.

The templating language we used for the view engine was Embedded JavaScript (EJS). It is very easy to use, complies with the Express view system, and allows us to have nested views. At runtime, the template engine replaces variables in a template file with actual values and transforms the template into an HTML file sent to the client [4].

The handling of data was done with routes/web services by creating a router object *(var router = express.Router())* and adding middleware and HTTP method routes in the form of: *router.get(path, [callback, ...] callback)* for pulling data, and *router.post(path, [callback, ...] callback)* for inserting data. If the response is successful, the resulting data are sent to the front-end as a JSON object. Otherwise, errors are handled and logged.

Database

Data managed by TRT are stored in an Oracle database. The schema used for the PORT-based application had to be refactored to avoid data duplication and take advantage of the current target fabrication process. Communication of the back-end with the database was done with "node-oracledb" and "orawrap." The former creates the connection to the database and the latter creates a listening pool on the provided port. When querying data, orawrap methods take an SQL command and parameter value(s) (if any) to generate the results. This is done using the *execute()* method embedded in the body of the router methods (shown above).

Front-end

The front-end was developed with a model-view-controller pattern using JavaScript, jQuery, Kendo UI, Bootstrap, HTML, and CSS. This pattern was selected to provide a clear separation between view and logic, to easily subdivide the UI into multiple sections and panels, and to provide flexibility to divide the work among developers. This section separation was made according to the type of data displayed. The result is an interactive UI with panels that appear from left to right building the sections gradually after the user's selection.

The view is mainly composed by a mix of HTML items ("div", "table" and "list"). The model is created from a set of mapping files for each of the UI sections where the HTML elements in the view are mapped to fields in the database (HTML ID to database column). The controller handles field updates, registers event handlers, loads and injects templates, and renders panels.

The most basic view (the first panel on the left is displayed) happens when a new TR is created. From there, there is a minimum amount of menu options the user must select to save the TR. This initial state is the "Draft" state, which means that the TR is still in progress and the user can close the TR and open it later to continue working before submitting it. Also, only the creator and a member of the experimental team have the required permissions to edit the TR. All permissions are handled by the UI using the role information obtained from the back-end and logic applied to each panel.

3. RESULTS AND CONTRIBUTIONS

The resulting application is a website application that runs in Chrome and Firefox web browsers.

The full UI view is composed of the following sections: Shot Pairing, Shot Planner Data, Target Menu, and Target Status (see Fig. 1).

We have developed a software tool that supports a more streamlined target fabrication process. The tool provides faster loading time, great user interaction, and data integration. The use of modern technologies allowed the software team to meet the overall project goals primarily within the development time allocated.

3.1 Current Status and Future Work

TRT is currently used by more than 50 users on a regular basis. Older TRs have been ported and are accessible through TRT. It is hosted in the internal NIF site together with other applications. It is actively maintained and supported by the SDS team. Since its first release, a few additions have been made, such as automatic generation of TRs when a new experiment is created and automatic logging of user actions that affect the state of the TR.

Some work will be needed to modify the current back-end code that uses orawrap. At the time of writing, the orawrap library is no longer being maintained. It has been added to the core Oracle database driver (node-oracledb).

4. ACKNOWLEDGEMENT

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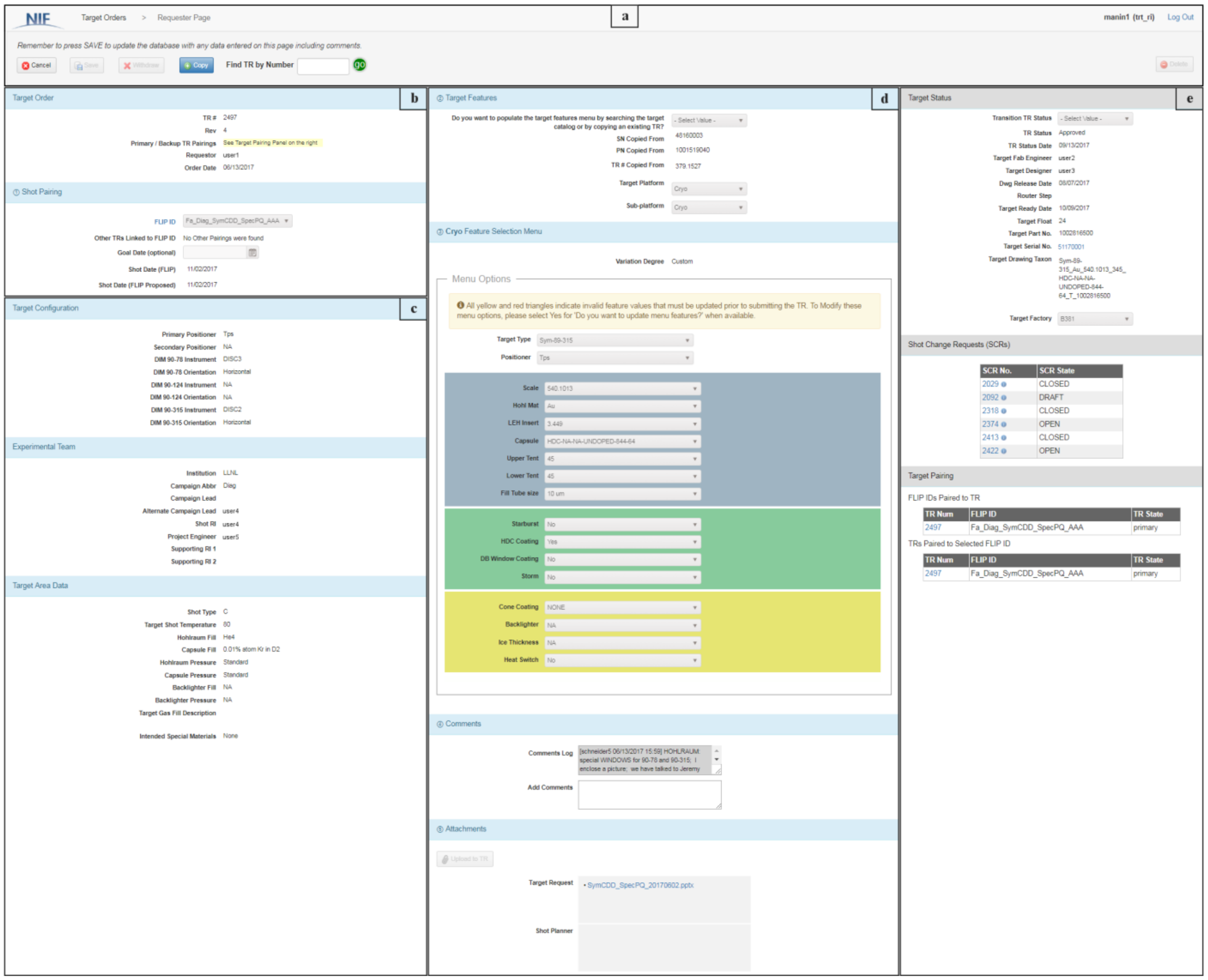
5. REFERENCES

[1] NIF Target Fabrication, https://lasers.llnl.gov/about/how-nif-works/seven-wonders/target-fabrication

[2] Node.js Wiki, https://en.wikipedia.org/wiki/Node.js

[3] Express Wiki, https://en.wikipedia.org/wiki/Express.js

[4] Express template guide, http://expressjs.com/en/guide/using-template-engines.html



Remember to press SAVE to update the database with any data entered on this page including comments.

Target Order

TR #	2497
Rev	4
Primary / Backup TR Pairings	See Target Pairing Panel on the right
Requestor	user1
Order Date	06/13/2017

① Shot Pairing

FLIP ID	Fa_Diag_SymCDD_SpecPQ_AAA
Other TRs Linked to FLIP ID	No Other Pairings were found
Goal Date (optional)	
Shot Date (FLIP)	11/02/2017
Shot Date (FLIP Proposed)	11/02/2017

Target Configuration

Primary Positioner	Tps
Secondary Positioner	NA
DIM 90-78 Instrument	DISC3
DIM 90-78 Orientation	Horizontal
DIM 90-124 Instrument	NA
DIM 90-124 Orientation	NA
DIM 90-315 Instrument	DISC2
DIM 90-315 Orientation	Horizontal

Experimental Team

Institution	LLNL
Campaign Abbr	Diag
Campaign Lead	
Alternate Campaign Lead	user4
Shot RI	user4
Project Engineer	user5
Supporting RI 1	
Supporting RI 2	

Target Area Data

Shot Type	C
Target Shot Temperature	80
Hohlraum Fill	He4
Capsule Fill	0.01% atom Kr in D2
Hohlraum Pressure	Standard
Capsule Pressure	Standard
Backlighter Fill	NA
Backlighter Pressure	NA
Target Gas Fill Description	
Intended Special Materials	None

② Target Features

Do you want to populate the target features menu by searching the target catalog or by copying an existing TR?	- Select Value -
SN Copied From	48160003
PN Copied From	1001519040
TR # Copied From	379.1527
Target Platform	Cryo
Sub-platform	Cryo

③ Cryo Feature Selection Menu

Variation Degree	Custom

Menu Options

All yellow and red triangles indicate invalid feature values that must be updated prior to submitting the TR. To Modify these menu options, please select Yes for 'Do you want to update menu features?' when available.

Target Type	Sym-89-315
Positioner	Tps
Scale	540.1013
Hohl Mat	Au
LEH Insert	3.449
Capsule	HDC-NA-NA-UNDOPED-844-64
Upper Tent	45
Lower Tent	45
Fill Tube size	10 um
Starburst	No
HDC Coating	Yes
DB Window Coating	No
Storm	No
Cone Coating	NONE
Backlighter	NA
Ice Thickness	NA
Heat Switch	No

④ Comments

Comments Log	[schneider5 06/13/2017 15:59] HOHLRAUM: special WINDOWS for 90-78 and 90-315; I enclose a picture; we have talked to Jeremy
Add Comments	

⑤ Attachments

Target Request	• SymCDD_SpecPQ_20170602.pptx
Shot Planner	

Target Status

Transition TR Status	- Select Value -
TR Status	Approved
TR Status Date	09/13/2017
Target Fab Engineer	user2
Target Designer	user3
Dwg Release Date	08/07/2017
Router Step	
Target Ready Date	10/09/2017
Target Float	24
Target Part No.	1002816500
Target Serial No.	51170001
Target Drawing Taxon	Sym-89-315_Au_540.1013_345_HDC-NA-NA-UNDOPED-844-64_T_1002816500
Target Factory	B381

Shot Change Requests (SCRs)

SCR No.	SCR State
2029	CLOSED
2092	DRAFT
2318	CLOSED
2374	OPEN
2413	CLOSED
2422	OPEN

Target Pairing

FLIP IDs Paired to TR

TR Num	FLIP ID	TR State
2497	Fa_Diag_SymCDD_SpecPQ_AAA	primary

TRs Paired to Selected FLIP ID

TR Num	FLIP ID	TR State
2497	Fa_Diag_SymCDD_SpecPQ_AAA	primary

Figure 1: An approved TR is shown. (a)Top menu with navigation links, user information and log-out button, TR search field, and action buttons. The main sections are: (b)Shot Pairing, (c)Shot Planner Data, (d)Target Menu, and (e)Target Status.