CERN Summer Student Programme 2018

Engineering Department - Mechanical and Materials Engineering - Forming & Welding

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Introduction

The beam welding team within the Forming and Welding section of CERN (EN Department, MME Group) uses a database to store their know-how of the work they perform. There are two types of machines: Laser Beam Welding and Electron Beam Welding. There are six machines that must be adjusted with some specific parameters in order to weld as desired. The parameters are stored along with information about materials, clients, experiments, operators, images, and others. This database is accessed through an application developed with Oracle Application Express (APEX) which is used to add new information.

There are some reports called Welding Procedure Specification (WPS) which are filled with the parameters used in the machines. Before this project, such reports were written manually using Microsoft Word, but it required more time than necessary, mostly because the information was already stored in the database.

In order to automate the generation of the mentioned reports a new tool was required. This tool connects directly to the database and extract the information to fulfill the template report, a Word document, programmatically. Moreover, to ensure that the essential information was added to the report, multiple changes were performed on the Oracle APEX web and its database.

Used Technology

The new application for generating reports used the following technologies:

- Visual Studio 2017 Community Edition
- AdminLTE Template for VS.
- ASP.NET MVC 5 and .NET Framework 4.5
- Entity Framework 6.2.0*
- DocX*

*Available in the NuGet Package Manager of Visual Studio.
Work Performed

During 8 weeks at CERN the work was focused on making changes in the front-end as well in the back-end of the APEX application that the section already had. This changes were required to setup correctly the database and store the necessary information in order to generate the reports with as much information as possible. While performing those changes, a tool for reports was also created. It is a new web application that allows searching for the parameters, choose one to generate and download the report. It also allows changing the template if necessary. In addition, a packaged app for backups was added to the APEX Workstation.

Front-End Changes

For each welding machine some fields were changed and others were added as required. The most important change in this machines is that it is now possible to add more than one pass of the welding process for each machine, since sometimes more than one weld pass has to be done and those passes also have to be detailed in the report.

Several custom events were added to the application. Events that change the user interface dynamically and improve the user experience regarding the fields availability and visibility, also for avoiding invalid user input. Likewise, events for real-time calculations for the laser beam welding machines were created using JavaScript code. Buttons were included for adding the extra passes of the process.

Back-End Changes

For the APEX application it was necessary to perform multiple changes in the back-end. In shared components: CATHODETYPES was updated to include a new type, HEADTYPEPERMACHINE was created to load the head types from the database according to the selected machine, OUTPUTSHAPES was also created to load the shapes of the laser machines from the database instead of using static values.
The existing queries for creating and updating the machine parameters were updated to be able to store the new information, and optimized in a way that some fields, specially the new ones for the passes, are saved only depending on the selected machine and some selected parameters. Before, all fields were saved whether it was necessary or not which stored unnecessary data to the database.

Many changes in the database structure and tables were imperative to be able to store the new data. To store the parameters of the second and third pass of the machines, new tables were created:

- **ELECTRONPASS**: To store passes of the PTR Machines.
- **BEAMSPASS, BEAMFOCUSPASS**: To store the parameter values of each new pass of the PTR Machines.
- **ELECTRONSSTPASS**: To store passes of the SST Machines.
- **BEAMSSTPASS**: To store the parameter values of each new pass of the SST Machine.
- **FL3PARAMS, QCWPARAMS, HPPARAMS**: To store the parameter values of the FIBER JK600FL3, IPG450QCW, YAG JK450HP.
- **GASPARAMS**: Depending on the selected process of the laser machines, they can use gas for cutting or welding. This table stores the parameters used for setting up the usage of the gases. This option was not available before.
- **HEADTYPES, HEADTYPESXMACHINE**: Laser machines can use different heads. The head types were static values, now they are dynamic and loaded from these tables. One head can be used by multiple machines and one machine can use multiple heads, hence the many-to-many table.
- **OUTPUTSHAPE**: This parameter of laser machines was also static, now it is loaded from the database. Also a new value “Super Pulse” was added.
- **PULSEPARAMS**: If the shape of the IPG450QCW machine is pulse or super pulse, a new box for entering the parameters of the pulse method is shown in the user interface. These parameters are then saved in this table.

In addition to the aforementioned, there was an important change in the LASERBEAMPARAMS table, many columns were never used, or only stored null values. The table structure was changed to reduce this issue, hence improving storage usage.
Report Generation Tool

The main objective of the project was to create a tool to generate the Welding Procedure Specification report automatically. For this, the ASP.NET MVC software architecture, DocX library and Entity Framework were mainly used.

DocX allows the creation and edition of word documents programmatically. To ease this task, and also the possible change of the reports templates, instead of working with the document structure, tags were added to the fields where the information should be written. Then, the software looks for this tags and takes the information from the database to substitute those tags. This is actually similar to the find and replace option available in many text editors.

Entity Framework performs the mapping between classes and database tables. It also allows the use of LINQ, which is a simpler way to write database queries for retrieving data.

Image 1. Page for searching parameters and generate reports.

Documentation

Basic documentation about the Forming & Welding section software solutions, APEX Application and Web Reports Application, was created to centralize the information about access accounts, database account, and ease APEX application and Web Reports Application maintenance.

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