Operations Manual

Team 504: Danfoss Aftermarket Workflow Process Creation and Implementation
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Terminology

BOM: Bill of Materials
Static BOM: List of mandatory replacements for a compressor
BOM Lookup File: Excel file that contains pages: "BOM List", "Comments", and "Phantom Info"
BOM List page: BOM Lookup File page that contains a list of all compressors and their corresponding static BOM
Comments page: BOM Lookup File page that contains a list of specific changes made to replacements and component numbers
Phantom Info page: BOM Lookup File page that contains a list of every part and its corresponding component number
Planner (Material Handler): Responsible for creating BOMs
Investigations (Inspection): Department that determines which parts have failed
Manufacturing Order (MO): Contains all the work orders and bills of materials that go to a specific compressor
Component Number: Specifies a certain part
Revision: An updated part or model with the same component number (i.e. 21097C is component number 21097 revision C)

Project Overview

Danfoss is revamping their aftermarket repair program for failed compressors. Danfoss Turbocor wishes to improve the current process of replacing parts for damaged compressors returning from the field. A damaged compressor returning from the field goes through the customer service department. If the compressor is under warranty, the compressor is fixed for free. If not under warranty, the client can choose to go through a fixed price repair program, the program we are working in. The client has the option of paying a flat rate to repair the compressor or purchasing a new compressor.

The damaged compressor returns from the field and goes through investigations. Technicians in investigations determine which parts have failed and are going to be replaced. They then send a handwritten repair list of the component numbers needed to be replaced to planning. In addition, the investigations team also gives the planners a handwritten list of four main components notorious for causing problems with aftermarket inventory: IGBT, CAP, PWM, and SCR. There are also items that will get replaced for any given aftermarket repair. These components are referred to as the static BOM. Planning then creates a bill of materials of the parts that are being replaced on the compressor. This bill of materials is the sum of the static bill of materials, the

four main components, and the repair list given to the planners from investigations. A majority of the current planning process requires manual inputs from a planner who has to cross reference multiple excel files. Error arises with every manual input, so problems can occur throughout the whole aftermarket repair program. Problems include: planners can not read the handwriting of the technicians, duplicate items are placed on the BOM, wrong component numbers are placed on the BOM, component numbers that do not exist are placed on the BOM. Our goal is to help the planner by streamlining and automating this process. We are implementing a MATLAB script that produces a bill of materials of suitable replacement parts for a damaged compressor.

Component Module Description

Our system consists of a MATLAB app that requires manual inputs and various input files to produce a bill of materials for a given compressor. The input files include a BOM lookup file, a static BOM, and the list of replacement parts from investigations. The BOM lookup file is an excel file. It contains a page, "BOM List", that lists all the static BOMs for each compressor. A static BOM is a list of parts that are going to be replaced on the compressor regardless of if they are broken or not. Each compressor is associated with a specific static BOM. The BOM lookup file also contains a "Comments" page. This page lists specific changes that have been made to parts and their component numbers.
The "Phantom Info" page contains a list of all Danfoss parts and their respective component number.

Manual inputs are going to be required for this system. Ideally, we would like to have the technicians scan the replacement part's ISBN barcode to create the list of replacements. If this is not possible, the technicians will continue to handwrite the replacement part list. The planner will then manually type in the component numbers from the replacement part list.

Pseudocode/State Diagram :
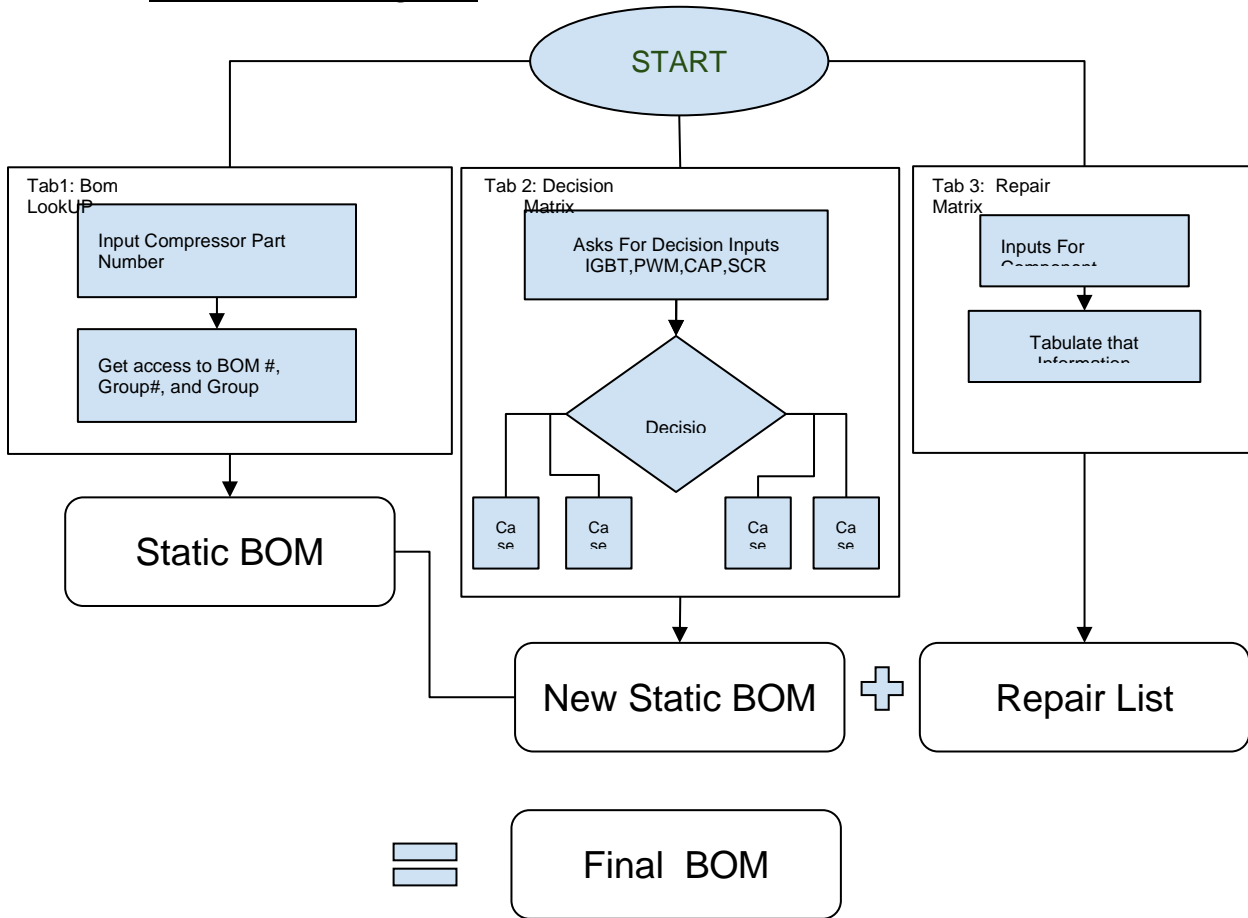
Cases:

1) The component number was not on the static BOM but the part was good. Since that part was good, there is no action needed since the part does not need to be added to the final BOM. It does not need to be replaced if it is good.

2) The component number was not on the static BOM and the part is bad. In this case, the old component number of this same part needs to be deleted from the static BOM. The new component number which represents the correct replacement is then added to the end of the final BOM.

3) The component number is already on the static BOM but the part is good. Since the part is good the component does not need to be on the final BOM since the BOM needs to contain replacement parts. There is no need to replace something that is not broken, so this part is removed from the final BOM.

4) The component number is already on the static BOM and the part is bad. In this case no action is needed because the part is already on the static BOM and the part needs to be replaced. If no action is taken the part will be replaced correctly.

Integration

Our system uses the MATLAB app to input excel files and then make decisions. The BOM lookup file will be uploaded while using the MATLAB App. The BOM lookup file is then stored as a table in the MATLAB App. All the relevant data is stored as strings so certain characters, such as dashes and commas, are still usable within the script. The static BOM used will also be uploaded as a table. The relevant data from the static BOM is stored as strings as well. The data from these two files are then called on throughout the script.

The BOM List page is used to determine which static BOM should be used based on the corresponding compressor model. The Comments page is embedded within the script to make specific changes on imputed component numbers. For example, if the original component number for a screw was 123 and it had been recently changed to 345, the Comments page would address this issue. The Phantom Info page is used to determine if a part exists. When the user is inputting component numbers from the replacement list, the script will call on the Phantom Info data to determine if the inputted number exists.

A static BOM is downloaded from SAP, the resource planning software that Danfoss currently uses, and then uploaded to the script. The static BOM is used to add to the final BOM. When the user inputs a component number from the replacement list, the script calls on the static BOM to see if that component number is already on the static BOM. An additional component does not need to be added if the component number is already on the static BOM.

Operation

The operation of the MATLAB app is quite simple, however the steps must be implemented in a specific order for the script to run properly.

1) First be sure that the most up to date version of the BOM Lookup file has been uploaded to the file directory in which the app is contained. The script will preload this excel file into its workspace in order to create several key variables used in the logic of the code.
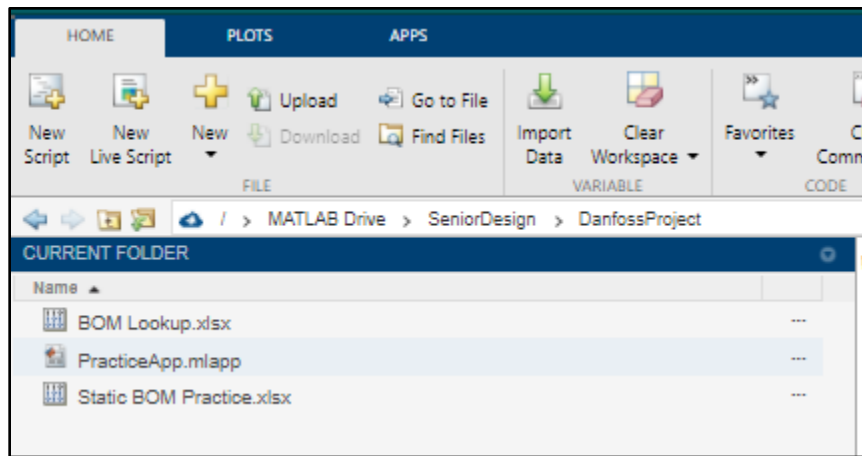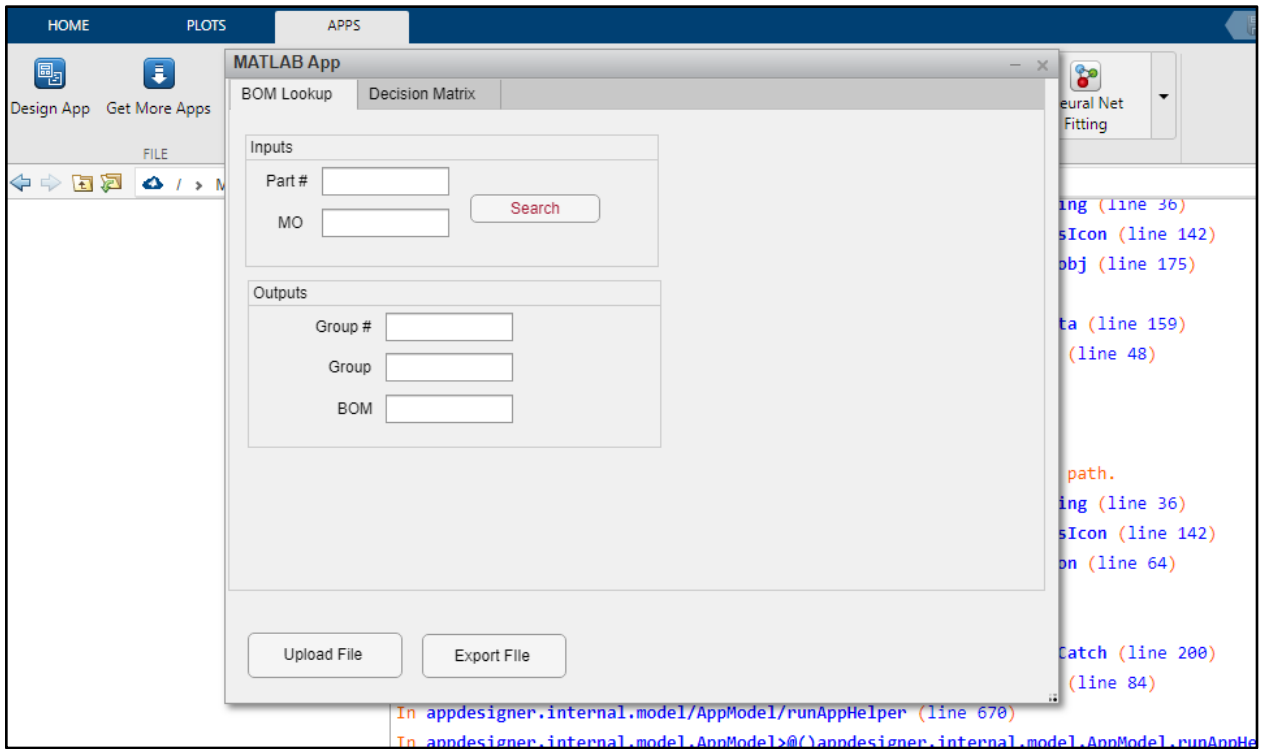
2) Within the MATLAB App designer interface, open up the file called PracticeApp.mlapp. The app will pull up with the GUI seen below. Click the run button to start the app.
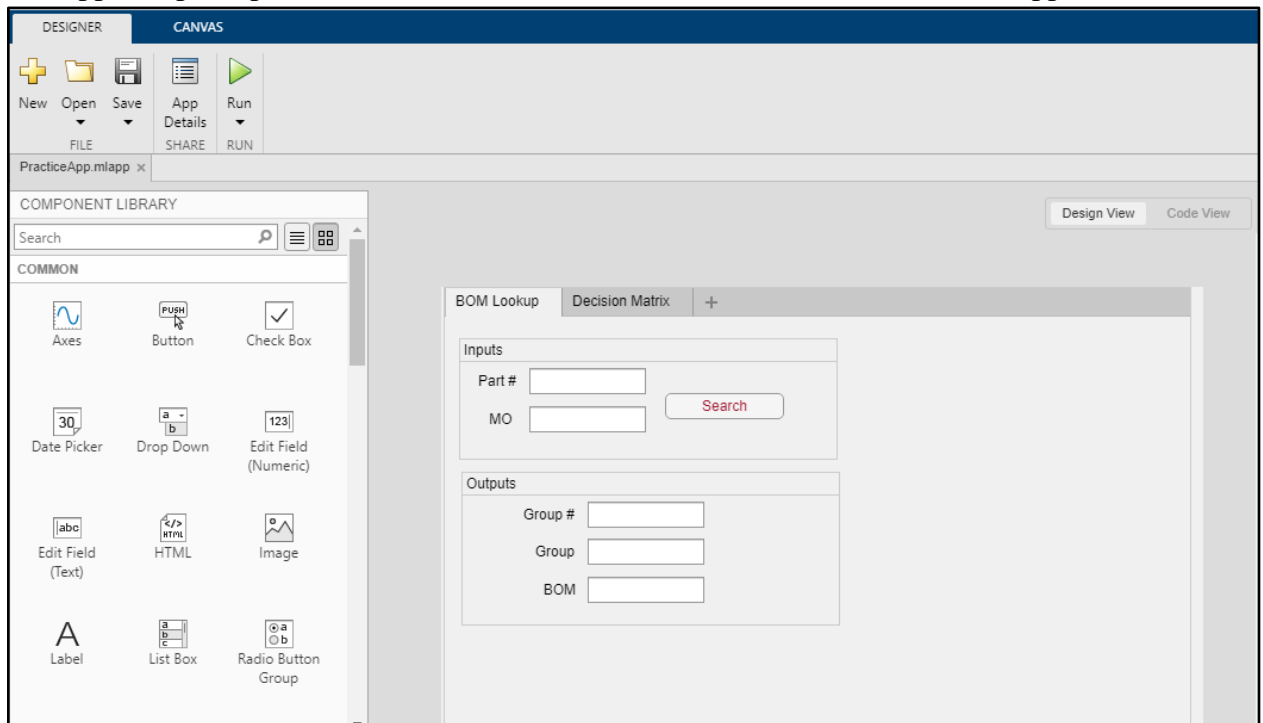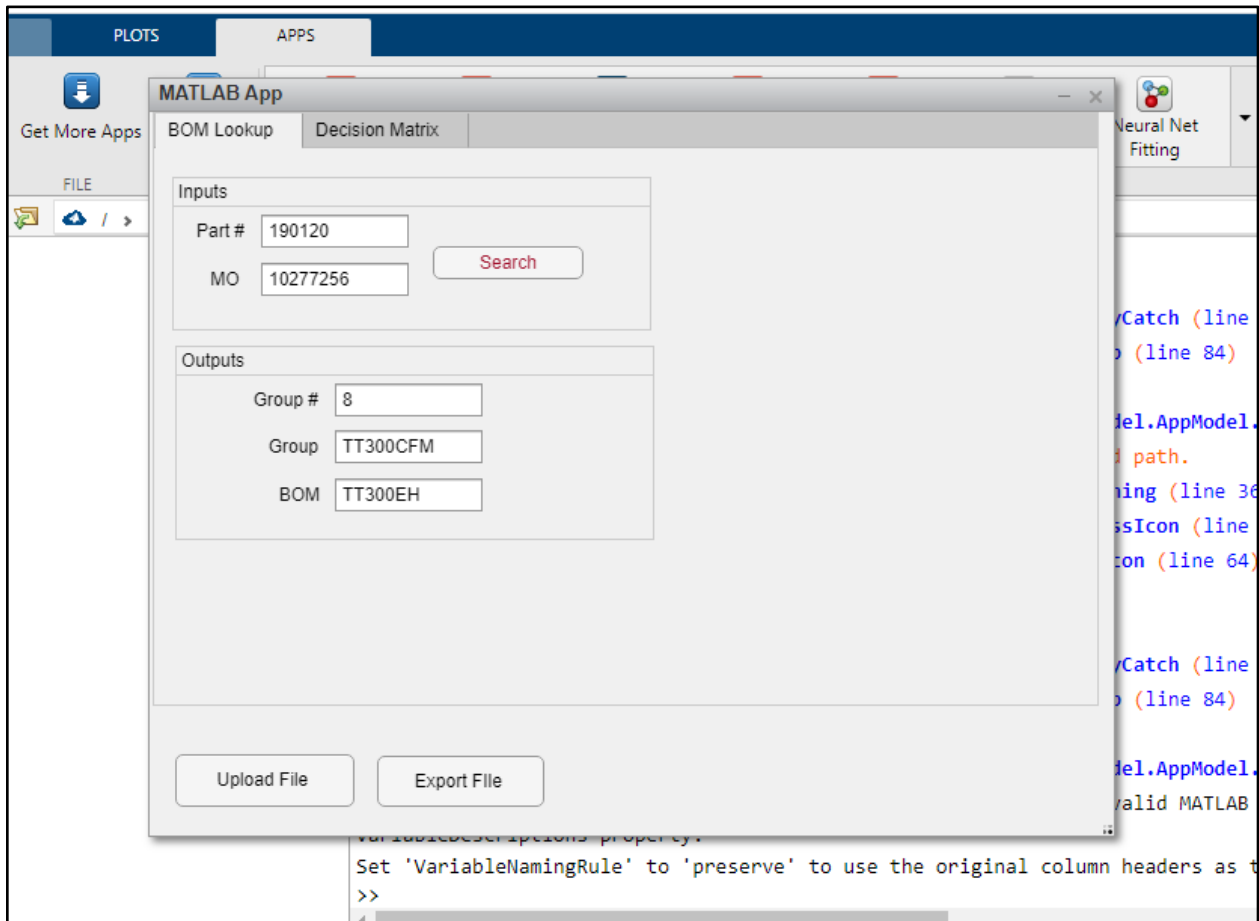

3) The GUI interface will appear as an icon where you can type in the Part # for the compressor and the Manufacturing Order number for the repair. After entering this info
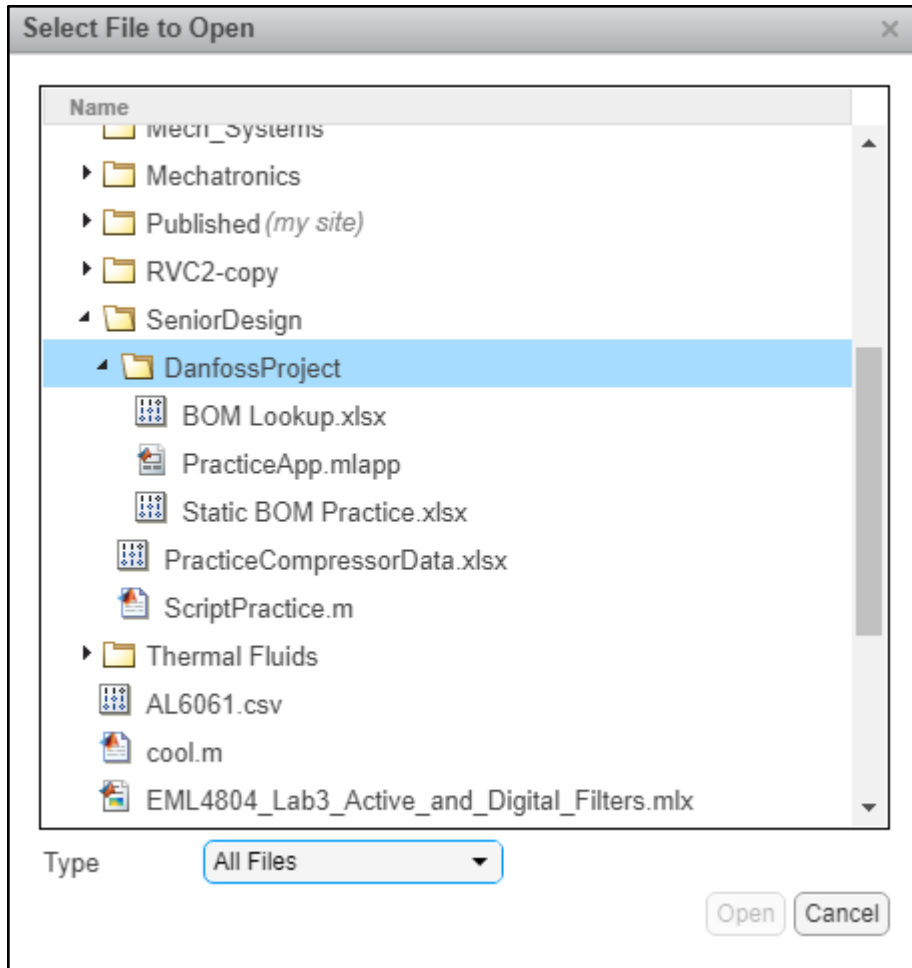
click search.

4) After this info is typed in, the Group #, Group, and BOM fields will populate as seen in the next image.

5) Now the user knows the correct Static BOM to use, "TT300EH." This static BOM will need to be downloaded from SAP or whatever ERP program Danfoss is working with in the future in order to begin the next steps of the process.

6) Select the upload file button and choose this file you just downloaded from SAP and upload. Remember under type to select "All Files," otherwise you will not be able to see your excel file within the folder. It is also best practice to save your downloaded static BOM file in the same folder as the working directory of the MATLAB App itself.
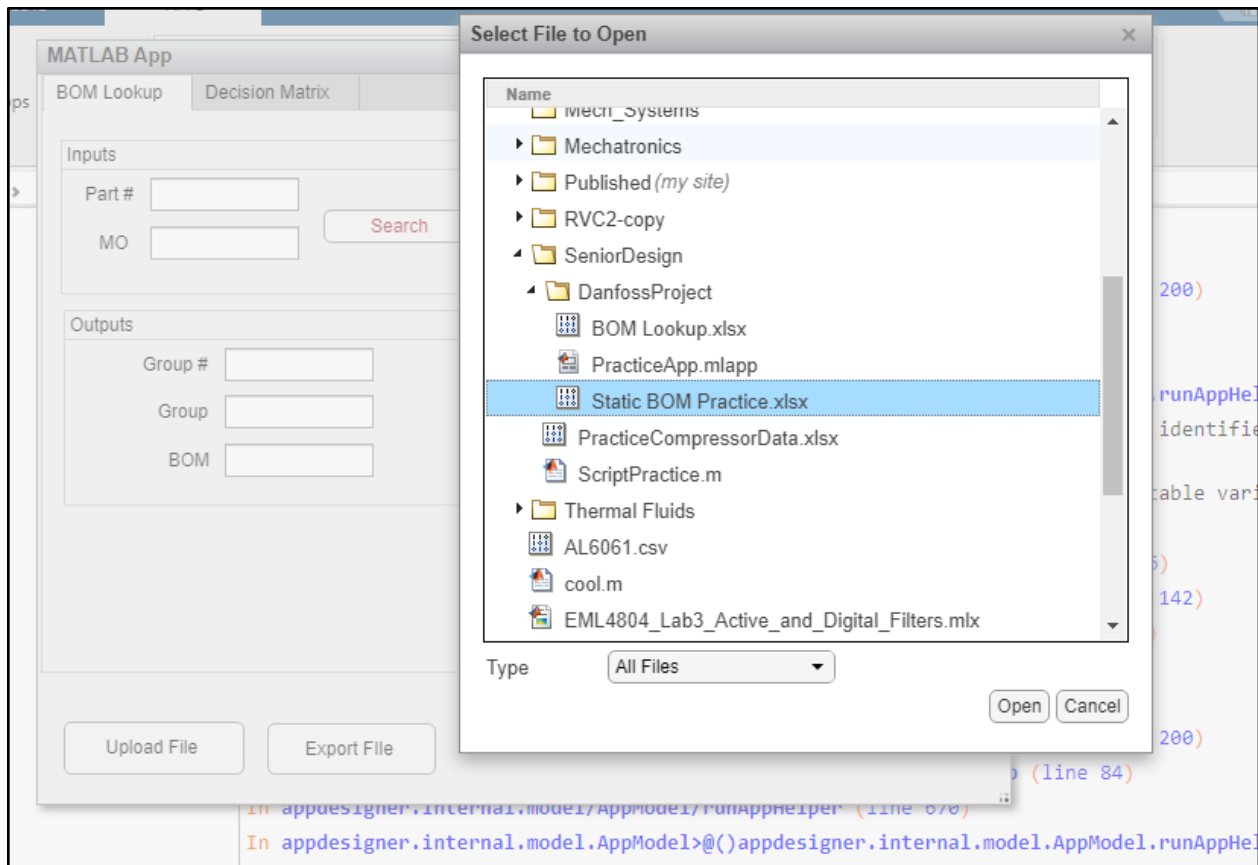
7) After this file has been uploaded we can now move on to the second panel of the app. This panel has been named the decision matrix, as this panel handles the four main components and the logic surrounding them. At this stage, enter the four main components given to planning from investigations. Also select whether the part provided was good or bad.
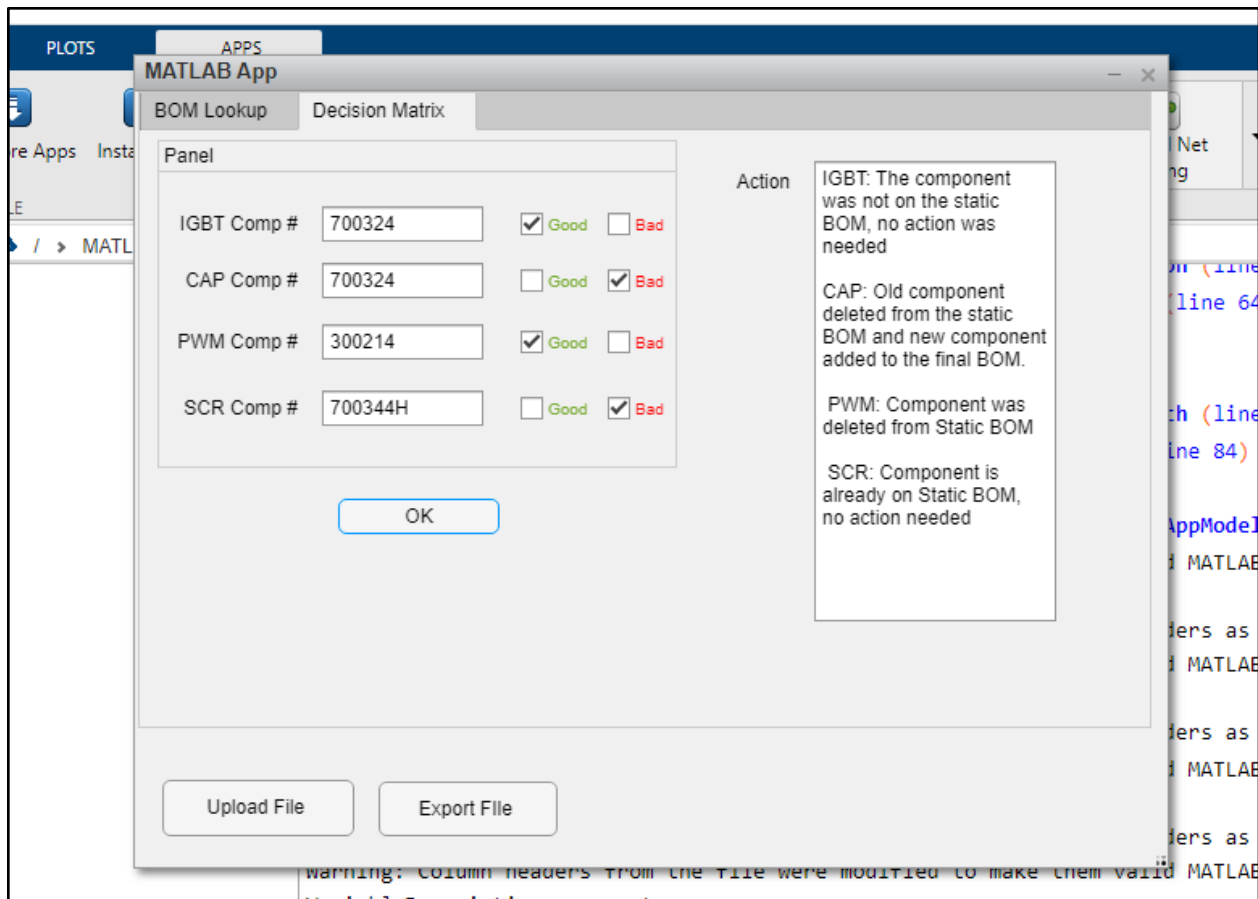
Above outlines the four possible outcomes of actions needed based on the inputs. These four possible outcomes are also explained in the control diagram in the section entitled pseudocode/state diagram.

5) The component number was not on the static BOM but the part was good. Since that part was good, there is no action needed since the part does not need to be added to the final BOM. It does not need to be replaced if it is good.

6) The component number was not on the static BOM and the part is bad. In this case, the old component number of this same part needs to be deleted from the static BOM. The new component number which represents the correct replacement is then added to the end of the final BOM.

7) The component number is already on the static BOM but the part is good. Since the part is good the component does not need to be on the final BOM since the BOM needs to contain replacement parts. There is no need to replace something that is not broken, so this part is removed from the final BOM.

8) The component number is already on the static BOM and the part is bad. In this case no action is needed because the part is already on the static BOM and the part needs to be replaced. If no action is taken the part will be replaced correctly.

8) Another scenario to consider is if you chose to enter bad inputs. Those two scenarios are depicted below. The first is if you chose to check the good and the bad checkbox at the same time. The second is if you enter an invalid part number. More details on how to troubleshoot these errors are given in the troubleshooting section of the document.
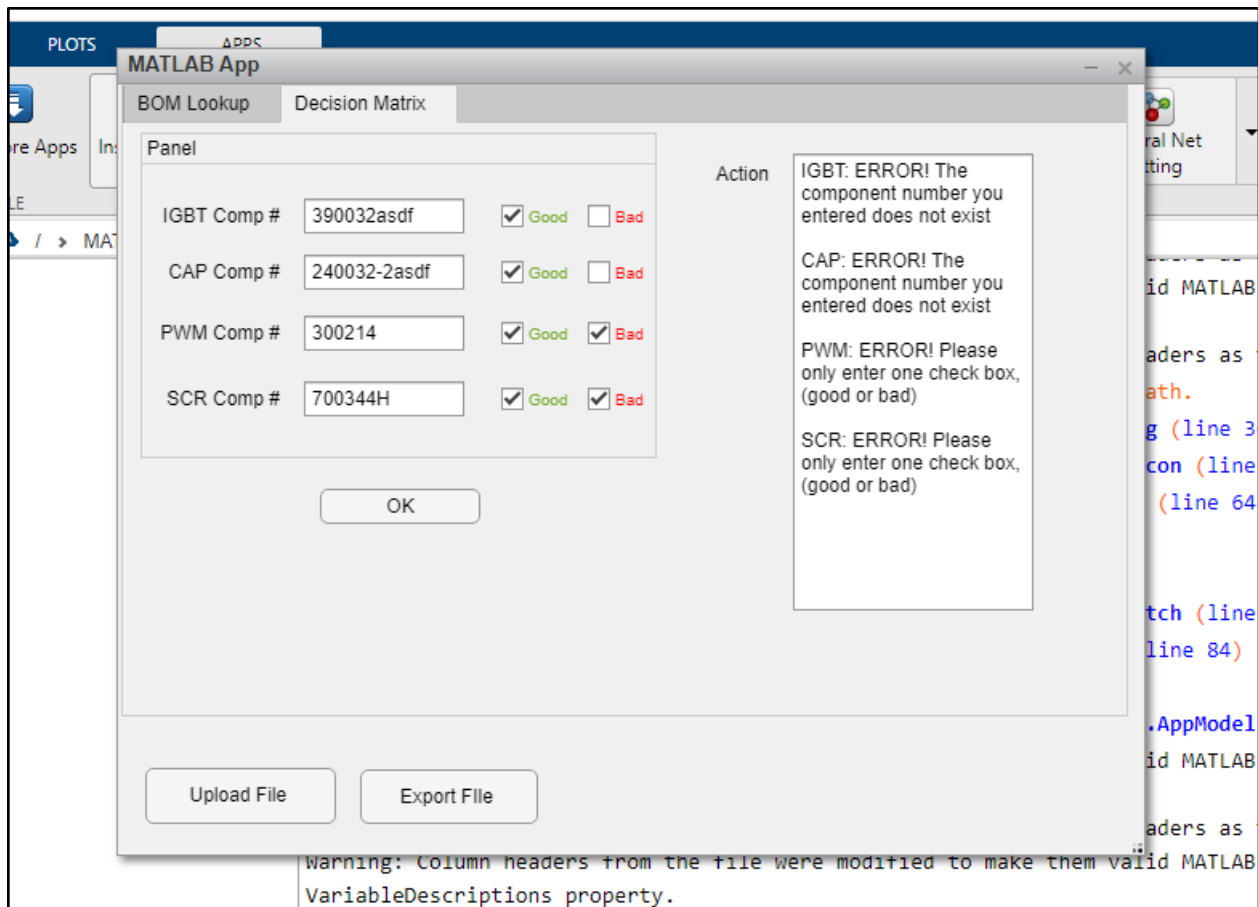
9) After these four main components are entered into the interface, the script will perform the action prescribed in the action textbox. The next step in this stage is to upload the repair list. This is done by selecting the upload button on the decision matrix panel as seen below.
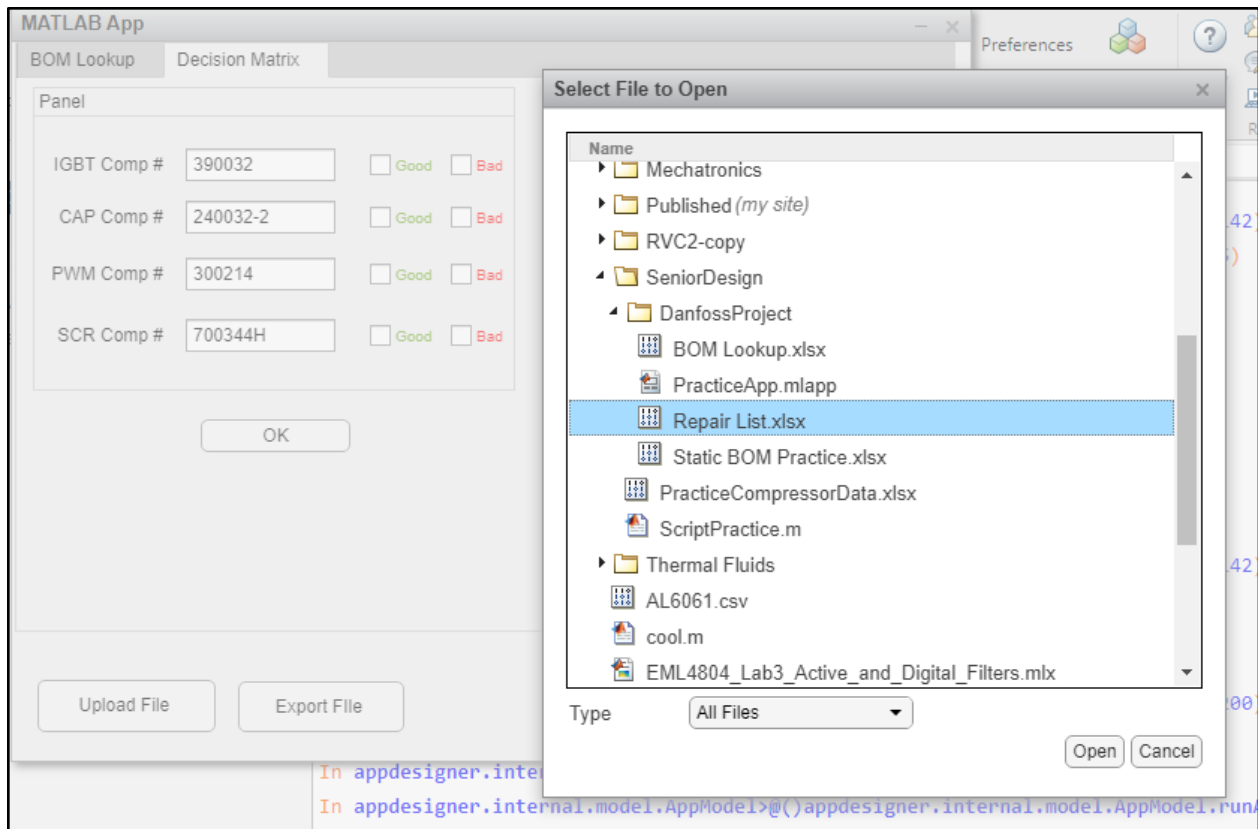
This repair list contains the additional components that are given to the planners from investigations and are in the format (part number, quantity). The script will add these components to the final BOM.

10) The final step that must be performed is the data must be exported to an excel file so the planner can review the final results to ensure their accuracy. The app is only as accurate as the inputs that are put into it. It is best practice to ensure that the inputs at each stage of the process are both correct and up to date.
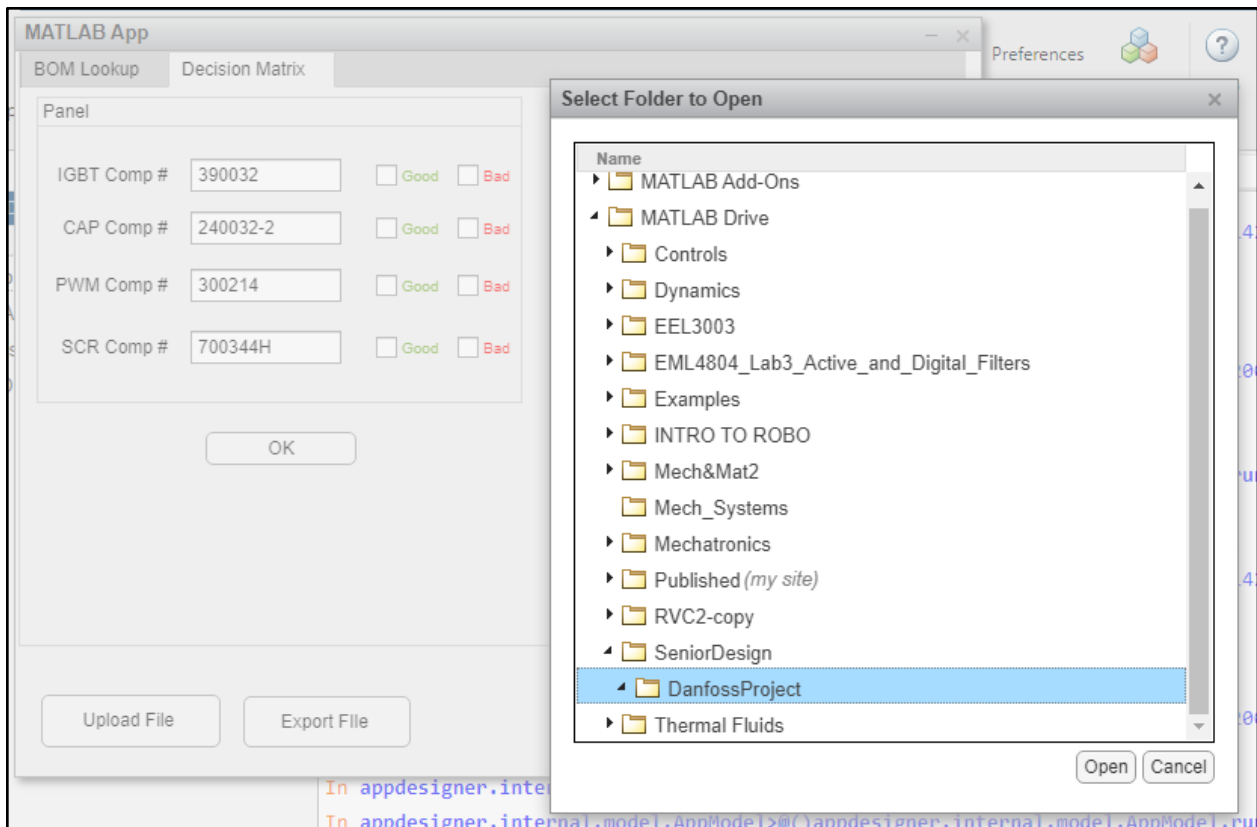
Below is a sample image of the final result that will be seen by the planners upon completion of step 10. These results can be compared to previous repairs and validated to ensure that this process encapsulates all of the necessary information into the aftermarket repair process.

Item	Component	Description	LT	Reqmt Qty		UM	IC	S..	SLoc	Plnt	Op...	Batch	Proc. Category
0000	197126	TTS350FGS1S030X0XXS331			1	PC	L		DT20	1351	0010		Reservation for Order
0010	100329	KIT - O-RINGS (PORTS CONNECTION)			1	PC	L		DT20	1351	0010		Reservation for Order
0020	187229	SWV 4-1-0 TT350-G-1-ST-F SCG				PC	L		DT20	1351	0010		Reservation for Order
0030	720250	HOUSING - MAIN TT350H				PC	L		DT20	1351	0010		Reservation for Order
0040	200084	SHAFT KIT ASSY - S1.23 +5% S1.2 -10...			0	PC	L		DT20	1351	0010		Reservation for Order
0050	290005-1	IGV HOUSING ASSEMBLY - S1.23 +5%				PC	L		DT20	1351	0010		Reservation for Order
0060	200238	BEARING ASSEMBLY -FRONT TWIN -174 ...				PC	L		DT20	1351	0010		Reservation for Order
0070	200193	MODULE SOFTSTART ASSEMBLY			1	PC	L		DT20	1351	0010		Reservation for Order
0080	200237	BEARING ASSEMBLY-BACK-174OD, 22.5LG			1	PC	L		DT20	1351	0010		Reservation for Order
0090	200125	MODULE BACKPLANE ASSEMBLY - Main A...				PC	L		DT20	1351	0010		Reservation for Order
0100	300214	MODULE BEARING PWM ASSEMBLY				PC	L		DT20	1351	0010		Reservation for Order
0110	783011	HOUSING. LABYRINTH SEAL PLATE TT-3...				PC	L		DT20	1351	0010		Reservation for Order
0120	702020	HOUSING DIFFUSER - 1st STAGE MC S1.2..			1	PC	L		DT20	1351	0010		Reservation for Order
0130	702027	HOUSING 2nd STAGE DIFFUSER AND VO...			1	PC	L		DT20	1351	0010		Reservation for Order
0140	300046	MODULE BEARING MOTOR COMPRESSOR...			1	PC	L		DT20	1351	0010		Reservation for Order
0150	300047	MODULE SERIAL DRIVERS - Main Assy			1	PC	L		DT20	1351	0010		Reservation for Order
0160	310003	SHAFT ASSY - TURNING - 135LG 2*11-2...			1	PC	L		DT20	1351	0010		Reservation for Order
0170	333008-6	MOTOR WINDING ASSEMBLY: 135LG - 8...				PC	L		DT20	1351	0010		Reservation for Order
0190	300287	ASSEMBLY - DC/DC CONVERTER			1	PC	L		DT20	1351	0010		Reservation for Order
0200	390032	IGBT ASSEMBLY - SEMIKRON SKiiP613GD...				PC	L		DT20	1351	0010		Reservation for Order
0210	701712-2	VALVE - ORIFICE SOLENOID - 2.0				PC	L		DT20	1351	0010		Reservation for Order
0220	701712-25	VALVE - ORIFICE SOLENOID - 2.5 TT500...				PC	L		DT20	1351	0010		Reservation for Order
0230	710028	HOUSING_END CAP			1	PC	L		DT20	1351	0010		Reservation for Order
0240	750206-2	BRACKET-MAINS INPUT 2"				PC	L		DT20	1351	0010		Reservation for Order
0250	880188-1	COVERS - KIT - BLACK EN/FR			1	PC	L		DT20	1351	0010		Reservation for Order
0260	792017	SPACER 1st STAGE IMPELLER S1.69			1	PC	L		DT20	1351	0010		Reservation for Order
0270	795017	SPACER 1st STAGE IMPELLER 90 TON HE..			1	PC	L		DT20	1351	0010		Reservation for Order
0280	790306	SPACER SLEEVE 2nd STAGE IMPELLER 1...			1	PC	L		DT20	1351	0010		Reservation for Order
0290	201132	CABLE HARNESS COMPRESSOR DC SUPPL..			1	PC	L		DT20	1351	0010		Reservation for Order

Troubleshooting

When operating the app if an issue is encountered,be sure to double check the inputs are correct. Also make sure to not skip any step described in the operation section. Correct inputs include the import file (make sure the file is an excel file), manual strings put into the text input section, and associated checkboxes. If trouble still persists, more solutions can be found by going into the code section of the app and look up the built-in flags set up for said error. Most error cases can be due to wrong number inputs, so make sure to follow the static BOM format or match the imported file string formats. Other errors may happen if two functions are called at the same time, an example being checking the good and bad boxes for part assessment as seen in step 8 of the operation section. Make sure to do one at time, if the code malfunctions a flag should pop up for the user to check the incode error message solution.

What to do if the error message pops up:
- If two boxes are checked at the same time a message will pop up in the action section of the app displaying "ERROR! Please only enter one check box. (good or bad)".
- Uncheck both boxes and select ONLY ONE box for the given part based on the investigations team report.
- If the error displayed is "ERROR! The component number you entered does not exist", Then the input text file string has an incorrect entree and needs to be fixed. Make sure the component number is typed correctly and matches the format of the imported file.

If there is trouble exporting the file give it a second for the program to load and make sure there is a place for the file to go. This can be done by already working on the exported file directory. If the app does not respond upon initiation do close the app and open it back once more. If the text inputs work but no buttons do, then restart the app. If the import file function does not work also restart the app.