MULTIPLY YOUR BUSINESS WITH REAL TIME AUTOMATION

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Abstract

Economic success of equipment and manufacturing companies depends on their ability to produce high quality products at the lowest cost this applies to all, manufacturers have a tough job competing in today's global environment, global competition, price sensitivity, time to market pressures, and increasing complexity all make it very difficult for manufacturers to be successful, that aims to create customize designs as per Engineer To Order (ETO) product, Knowledge based engineering (KBE) has become a practical method of minimizing design cost by design automation and enables you to achieve all of these and more by streamlining repetitive, time consuming mundane tasks and leaving designers more time to focus on innovation, improving product quality, adding value, and winning more business.

Keywords: *Customize product, Design automation, ETO, KBE, Streamline repetitive task.*

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1. INTRODUCTION

Traditionally, design solid modeling tools are primarily used to design and visualize the artifact as pert heir application needs later the 2d drafting is released as production drawings, CAM systems are conventionally used to program machining or cutting instructions on the CNC/ DNC machines sometimes prototype is created for complex geometry to check the form fit and function, CAE systems are used to check the reliability of the designed artifact (such as structural analysis for stress, thermal, FOS, etc.), this methods tells a designer what the final design looks like but how it has come to be with the help of CAE tools.

Customized products and services is a great competitive differentiator, leading to more sales, higher revenues, increase in customer satisfaction but in other hand all these customize enquiry required special attention from design and hence designers are involved in handling enquiries and creating GA and supporting sales team to prepare quotation, results in less innovation in product design, Knowledge Based Engineering is a tool which captures knowledge from the product life cycle, these knowledge is stored in database and linked to the CAD system.

If changes are required in the design, a new CAD solid model is recreated using some type of computer-aided "re-do" or "back-tracking" methods or use of Product Data Management (PDM) backdatedrevision, thesecan be extremely time consuming and costly being that late in the life-cycle process, in such cases a geometry and size solid geometry, configuration changes cannot be handled easily, particularly when parts and dimensions are linked. The power of a "knowledge capture" tool comes from the methods used in capturing the design intent initially so that the anticipated changes can be made easily and quickly later if needed by capturing "design intent" sometime custom software is created as per the need or automation need to speed up the operation. [1]

2. REQUIREMENT DEFINITION

It covers all the information relates with product includes, geometry variation, size variable, design logic and calculation, output formats.

2.1 Geometry Variation

Geometry variation are related with shape variation, where subassemblies, parts, features are suppress/ unsuppressed as per the requirements, typical geometric variation includes vacuum chamber type as standard / mesh/ with magnetic separator, structural type, drive head, mid support. .

2.2 Size Input

User will specify the size input includes, No of Chambers, Tank Height, Tank Length, Tank Width, Customer specification

2.3 Design Rules and Logic

All the detail calculation is included in variable table; this includes the analytical, logical, and mechanical or thumb rules, or product knowledge in above format. In traditional approach all the calculation has been done in excel table and for every change in design designer needs to recalculate the required dimension as needed. We are providing all the design calculation to KBE system so for every change in enquiry all the calculation happens automatically

Table-1: Variable Table

ID	Name	Value	Validation
1	Tank Width		SpecificInp
2	No Of Chember		
3	Inlet Height		Fixed
4	Std Code	"A061"	Char
5	Alpha Code	IF(Tank Width=1600,"F",IF(Tank Width=1000,"G","H"))	Char
6	Depth of Section H	Section Size	
7	Width of Flange B	fixed(Depth of Section H)	Fixed
8	Flange Thk T	fixed(Depth of Section H)	Fixed
9	Web Thk S	fixed(Depth of Section H)	Fixed
10	Section Size	if(and(Tank Width=1000,No Of Chember>=1),100,if(and(Tank Width=1600,No Of Chember=1),100,if(and(Tank Width=1600,No Of Chember>1),150,200)))	
11	s_FRAME SECTION	if(No Of Chember>=3.1,"C CHANNEL","L ANGLE")	DrivenShape
12	s_CHEMBER NO	if(No Of Chember=1,"SINGLE","MULTIPLE")	DrivenShape
13	Frame Section Mate Dist	if(s_FRAME SECTION="C CHANNEL",Depth of Section H,50)	
14	M1	if(s_FRAME SECTION="C CHANNEL",50,50)	
15	M2	if(s_FRAME SECTION="C CHANNEL",50,0)	
16	Inlet Height Customer Specific		
17	Filter Area		SpecificInp
18	Actual Height	if(s_DIRTY INLET HEIGHT="VEERAJA STANDARD",Inlet Height,Inlet Height Customer Specific)	
19	front plate length centre to centre	if(and(Type=1,Tank Width=1600),(Bottom Frame Length+315),if(and(Type=1,Tank Width=2000),(Bottom Frame Length+285),(Bottom Frame Length+240)))	
20	Bottom Frame Length	if(s_VACCUME FILTER TYPE="WITH MESH",(No Of Chember*1000),(No Of Chember*1000)+Bottom Frame Constant)	
21	Bottom Frame Width	Tank Width+10	
22	Bottom Frame Constant	if(s_VACCUME FILTER TYPE="WITH MESH",100,75)	
23	Bottom Frame Pitch	1000	
24	Offset Dist1	if(s_DRIVE POSITION="RH",(Depth of Section H*0.5),40)	
25	Offset Dist2	if(s_DRIVE POSITION="RH",40,(Depth of Section H*0.5))	
26	Dia Front	if(s_DRIVE POSITION="RH",88.90,33.70)	
27	Dia Rear	if(s_DRIVE POSITION="RH",33.70,88.90)	
28	Cutout Dist	if(s_VACCUME FILTER TYPE="WITH MESH",500,537.5)	
29	X1	if(No Of Chember<3.1,0,if(No Of Chember<6.1,1075,2075))	
30	XN	X1-75	
31	X2 For L	if(No Of Chember=1,1075,if(No Of Chember=2,2075,3075))	
32	X2 For XN	(No Of Chember*1000)-(2*XN)	
33	X2	if(No Of Chember<3.1,X2 For L,X2 For XN)	
34	I Section Depth	fixed(Tank Width)	Fixed
35	I Section Width	fixed(Tank Width)	Fixed
36	I Section Web	fixed(Tank Width)	Fixed
37	I Section Flange	fixed(Tank Width)	Fixed
38	Type	if(s_VACCUME FILTER TYPE="WITH MESH",1,0)	Shape
39	s_CHEMBER NO BOT	if(and(Type=0,No Of Chember>2.1),"MULTI C",if(and(Type=1,No Of Chember>2.1),"MULTI I",if(and(Type=0,No Of Chember=2),"SINGLE C",if(and(Type=1,No Of Chember=2),"SINGLE I","NO"))))	DrivenShape
40	Vaccum Brake Tank Widtth W	if(Type of Vaccum Brake Tank=4450,1500,if(Type of Vaccum Brake Tank=1000,700,1100))	
41	Vaccum Brake Tank Length L	if(Type of Vaccum Brake Tank=4450,2010,if(Type of Vaccum Brake Tank=2600,2010,1060))	
42	Brake Tank dist Frm 1st support	if(Type=0,(Position of VBT-X3),Position of VBT)	
43	Dirty Inlet HT	if(s_DIRTY INLET HEIGHT="VEERAJA STANDARD",Inlet Height,Inlet Height Customer Specific)	Shape
44	s_LPATT	if(No Of Chember=3,"Req","Not Req")	DrivenShape
45	First dist	if(Type=1,1000,if(and(Type=0,Tank Width=1000),1025,if(and(Type=0,Tank Width=1600),1000,975)))	
		if(and(s_VACCUME FILTER TYPE="WITH MESH",No Of Chember>3.1),"C CUT",if(and(s_VACCUME FILTER TYPE="WITH MESH",No Of	

Table-2: Parametric Equation

Index	Parametric Equation	Parametric Value
1	D1@Distance1@STD & MTD DRIVE HEAD ASSLY NEW.Assembly	Tank Width
2	half width@Sketch1@Drive Head Top Support 2.Part	(Tank Width/2)-25
3	half tank width@Sketch1@Drive Head Top Support 1.Part	(Tank Width/2)-25
4	width@Sketch1@Drive Head Top Support 1 For Mesh.Part	Tank Width
5	half of width@Sketch1@Drive Head Top Support 1 For Mesh.Part	(Tank Width/2)-25
6	width@Sketch1@Drive Head Top Support 2 For Mesh.Part	Tank Width
7	half of width@Sketch1@Drive Head Top Support 2 For Mesh.Part	(Tank Width/2)-25
8	Len@Sketch1@Extra Support at Base.Part	Tank Width+50
9	D3@3DSketch1@Top Frame-1@Bottom Tank GA.SLDASM	X
10	D3@LPattern2@Top Frame-1@Bottom Tank GA.SLDASM	X
11	D1@Boss-Extrude1@Bottom Slab and Support_CADEC-1@Bottom Tank GA.SLDASM	Tank Width+100
12	D1@LocalLPattern4@Bottom Tank GA.Assembly	No Of Chember+1
13	D1@Sketch1@TOP FRAME_UPDATED.Part	Tank Width
14	No@LPattern1@Bottom BT PLate.Part	No Of Chember
15	D1@Distance10@Bottom Tank GA.Assembly	M1
16	050Half LSection@Distance6@Bottom Tank GA.Assembly	M2
17	D1@Distance11@Bottom Tank GA.Assembly	M1
18	BOTTOM TANK W@Base-Flange1@Left BT Plate.Part	Tank Width+30
19	BOTTOM TANK W@Base-Flange1@Right BT Plate.Part	Tank Width+30
20	Tank Width plus30@Sketch1@Bottom BT PLate.Part	Tank Width+30
21	D1@Sketch1@Support-1@Bottom Tank GA.SLDASM	Tank Width
22	D2@3DSketch2@Structure Inside-1@Bottom Tank GA.SLDASM	Tank Width
23	D6@Sketch1@Front BT Plate.Part	front plate length centre to centre
24	BOTTOM pLATE l@Sketch1@Bootom Frame.Part	Bottom Frame Length
25	D1@C LPattern1@Bootom Frame.Part	No Of Chember-1
26	D1@LPattern2@Bootom Frame.Part	No Of Chember-1
27	D1@LPattern3@Bootom Frame.Part	No Of Chember-1
28	Hole DiaF@Sketch18@Bootom Frame.Part	Dia Front
29	Bot Dist Front@Sketch18@Bootom Frame.Part	Offset Dist1
30	Half1075@Sketch18@Bootom Frame.Part	Cutout Dist
31	Hole Size@Sketch20@Bootom Frame.Part	Dia Rear
32	Bot Dist@Sketch20@Bootom Frame.Part	Offset Dist2
33	Half1075@Sketch20@Bootom Frame.Part	Cutout Dist
34	D1@Front SideLPattern4@Bootom Frame.Part	No Of Chember
35	D1@LPattern1@Structure Details-2@Bottom Tank GA.SLDASM	No Of Chember
36	nol@LPattern2@Structure Details-2@Bottom Tank GA.SLDASM	No Of Chember
37	D1@LPattern1@Structure Details-1@Bottom Tank GA.SLDASM	No Of Chember
38	nol@LPattern2@Structure Details-1@Bottom Tank GA.SLDASM	No Of Chember
39	D1@LPattern1@Structure Details L BackSide-1@Bottom Tank GA.SLDASM	No Of Chember
40	nol@LPattern2@Structure Details L BackSide-1@Bottom Tank GA.SLDASM	No Of Chember
41	BOTTOM pLATE l@Sketch1@Bootom Frame-1@Bottom Tank GA.SLDASM	Bottom Frame Length
42	Widthplus10@Sketch1@Bootom Frame-1@Bottom Tank GA.SLDASM	Tank Width+10
43	BF@Sketch11@Bootom Frame-1@Bottom Tank GA.SLDASM	Width of Flange B
44	FT@Sketch11@Bootom Frame-1@Bottom Tank GA.SLDASM	Flange Thk T
45	Depth@Sketch11@Bootom Frame-1@Bottom Tank GA.SLDASM	Depth of Section H
46	TW@Sketch11@Bootom Frame-1@Bottom Tank GA.SLDASM	Web Thk S
47	BF@Sketch12@Bootom Frame-1@Bottom Tank GA.SLDASM	Width of Flange B
48	Depth@Sketch12@Bootom Frame-1@Bottom Tank GA.SLDASM	Depth of Section H
49	TW@Sketch12@Bootom Frame-1@Bottom Tank GA.SLDASM	Web Thk S
50	D1@Sketch12@Bootom Frame-1@Bottom Tank GA.SLDASM	Flange Thk T
51	D3@LocalLPattern1@Bottom Tank GA.Assembly	X2-X21
52	D3@Front SideLPattern4@Bootom Frame.Part	1000
53	D19@Boss-Extrude2@Bootom Frame-1@Bottom Tank GA.SLDASM	Depth of Section H

2.4 Parametric Linking

Both KBE system and SolidWorks are independent software, as all the details of 3D model (Dimension Variable) are captured in the form of (D1@Sketch) in KBE system called as parameter, further we have link those parameter with the variable defined in variable table, once the linking is done any change in enquiry details, user will change the inputs and respective link dimension parameter will modify as per requirements.

3. DEFINE PRODUCT CLASS

To configure any product class you must have to open that product class manually or from product class.

To start new configuration, click ‘Class’, select master model (Assembly Or Part) and click ‘OK’. It will ask for database creation for selected product class click ‘Yes’ to create new one.

3.1 Crawler

Crawls into assembly, sub-assembly, parts and captures parts, their features and feature dimensions. The details captured by Crawler are as follows – Part name, sub-assembly, part or assembly’s feature and dimension name.

3.2 Lock Components

Locking of part(s) is applicable only for assembly configurator. Locking of part(s) is used when geometry change of some components (parts/sub-assemblies) is not required. (Accessories e.g. Nut, bolts, Bought out items) Procedure to lock parts/subassemblies: Click ‘Crawl’, a ‘Lock Components’ window will appear in property manager page which shows list of parts and subassemblies. Check parts or subassemblies to lock them. [6]

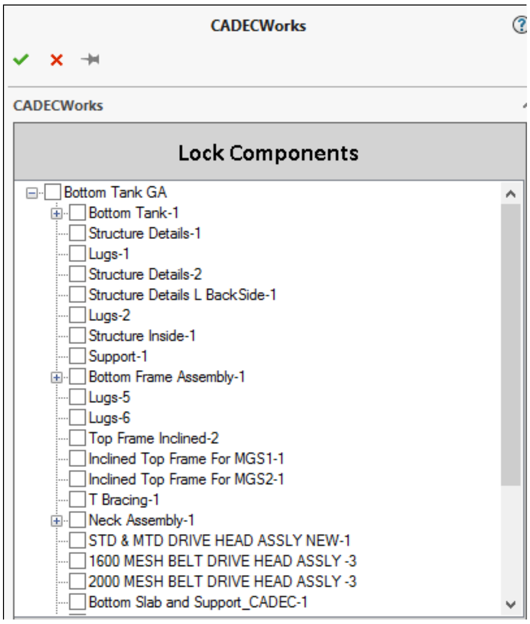

Fig- 1: Lock Component

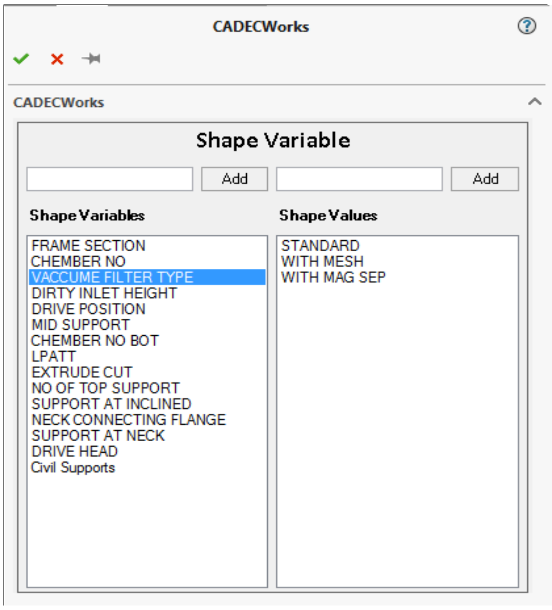

Fig-2: Shape Variation in CADEC

3.3 Shape Variations

Shape Variables are independent shape geometry classification possible in the product, Shape Values are different options available for a particular shape variable, to define Shape Variable and Value enter the Shape Variable and value in the text field and Click Add, repeat the procedure for other shape variable and shape value, all the detail calculation is included in variable table; this includes the analytical, logical, and mechanical or thumb rules, or product knowledge in above format. In traditional approach all the calculation has been done in excel table and for every change in design designer needs to recalculate the required dimension as needed. We are providing all the design calculation to KBE system so for every change in enquiry all the calculation happens automatically.

3.4 Shape Linking

Shape linking is a method of linking shape values to suppress / unsuppressed subassemblies, parts and part-features. After crawling the master assembly, ‘Components’ palette will show part list in Assembly configurator and in part configurator it will show part name as master model. There are two steps to Linking shape values to master model.

3.5 Make Mandatory

Mandatory parts / features are compulsory geometries in the assembly or part. These are always unsuppressed. (The product may/may not have mandatory parts). To make a part mandatory: Right-click on the part, and Click on ‘Make Mandatory’.

It is not necessary that all features of the mandatory component are mandatory. Select a mandatory component and tick its mandatory features in the Feature Tree.

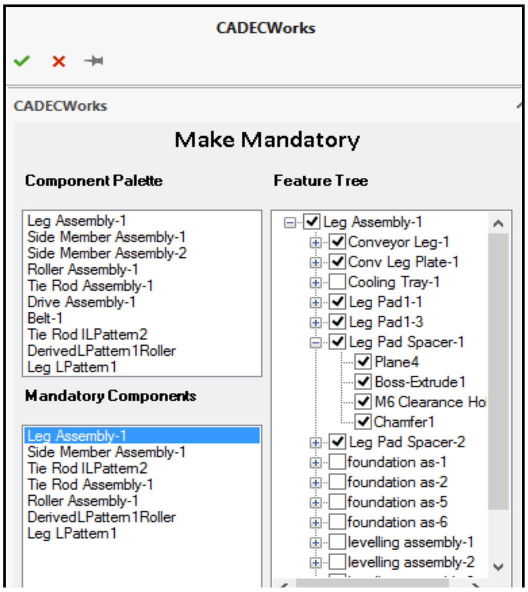

Fig-3: Make Mandatory

3.6 Make Optional

Optional parts / features are unsuppressed based on shape variable and shape values chosen. To specify Optional components, you need to choose ashape value first, then choose the optional components one by one and right-click to add the component to 'Optional Components' palette. It is not necessary that all features of the optional component are optional for that shape value. You can select an optional component and tick its optional features in the Feature Tree. [6]

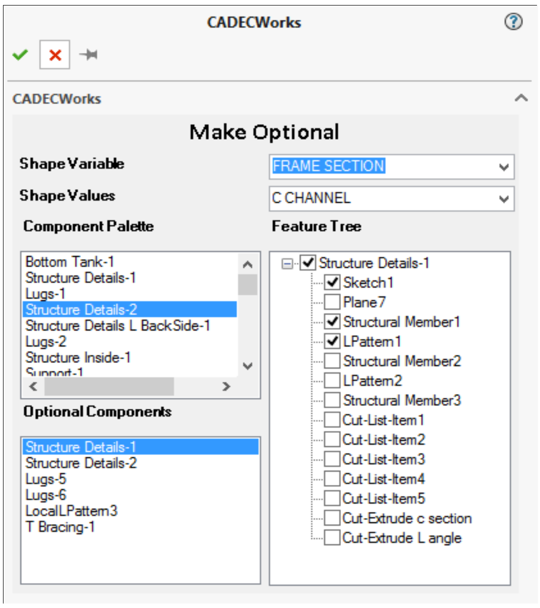

Fig-4: Make Optional

3.7 Variable Table

Variable table is a tool for size calculations where you can add variables in structured table format. You can use simple expressions, conditional expressions, logical expressions, functions for validations etc. Image below shows variable table, Define any variable by simply typing its name in the variable table in the Name column. If user starts to enter a variable name and if it starts with "s_" then CADEC gives you the list of all shape variables. The formula can be typed in the value cell or use equation editor for this. To add formula, select the 'Add' Radio button. You need to create equation LHS = RHS in the Equation Editor. You can add any variable to equation editor by clicking on its name in the variable table. [2][6]

3.8 Size Linking (Parameter Equations)

Create equation in equation editor by selecting a parameter (from crawler information) on Left Hand Side (L.H.S.) and a variable on Right Hand Side (R.H.S.) When equation editor is in 'Add' mode, you can add any parameter (from crawler info) or variable (from variable table) to equation editor by selecting it. The parameter equation gets added to parameter equations list by clicking Add button, parameter equations on RHS side can also contain variable expression, to delete any parametric equation, and you can Right-click on the equation and select Delete. [6]

4. DESIGN AUTOMATION OUTPUTS

User will browse the end user application "Creator" and specifies the enquiry details as following,

4.1 Instance I-Standard Vacuum Filter

End user need to fill the enquiry details as input to generate customized model and drawings

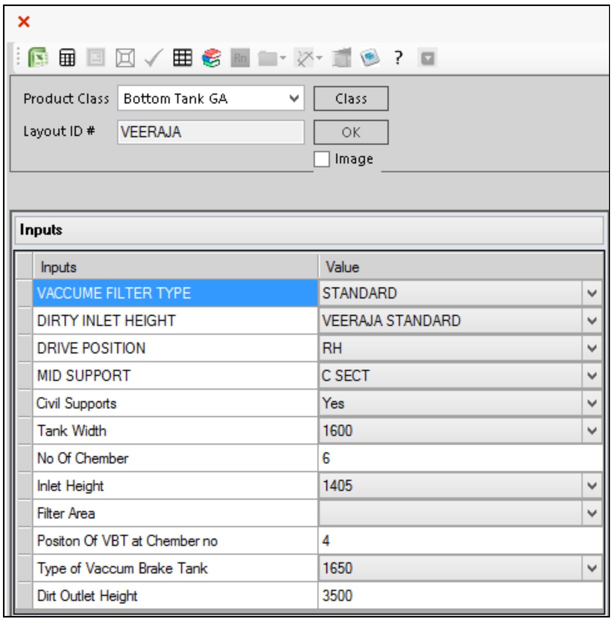

Fig-5: Size Input Screen

4.2 Model Geometry Output:- Instance I

Once user click on "Modify" the model geometry is generated as per the enquiry details specified by user.

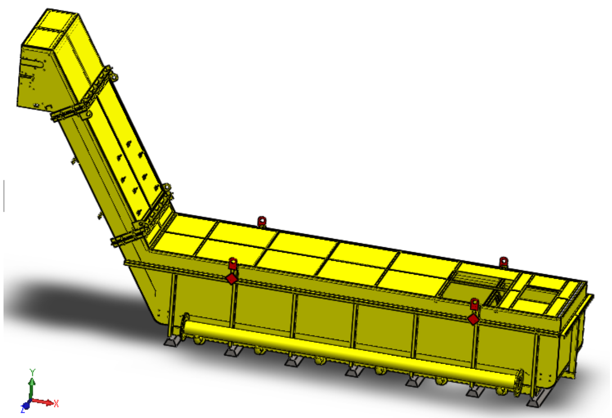

Fig- 6: Vacuum Chambers:-ISO

4.3 Drawing Output:- Instance I

Once user click on "Create" the drawing output is generated includes all GA and manufacturing drawings.

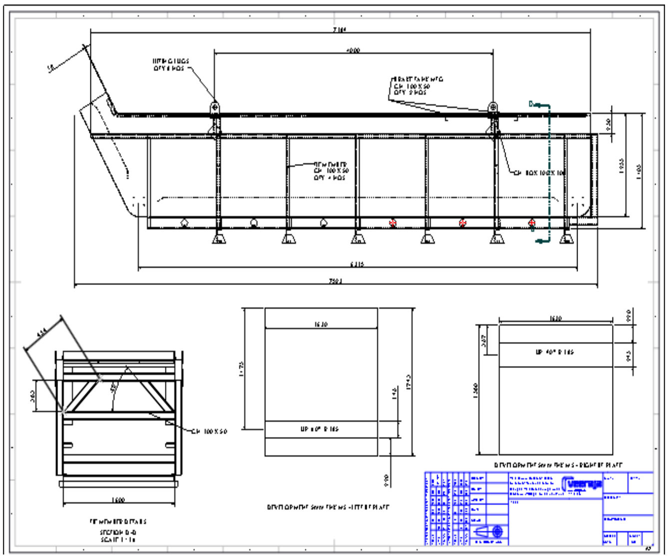

Fig- 7: GA Drawing

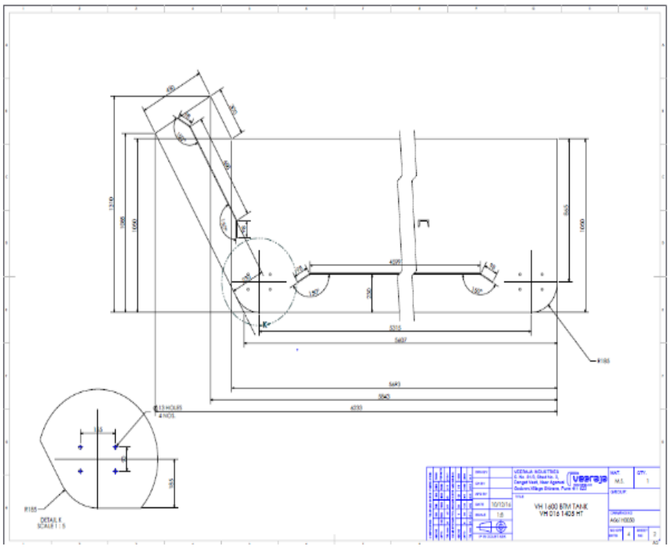

Fig- 8: Fabrication Drawing

4.4 Instance II-Standard Vacuum Filter

Start with defining the input details named as typical enquiry details.

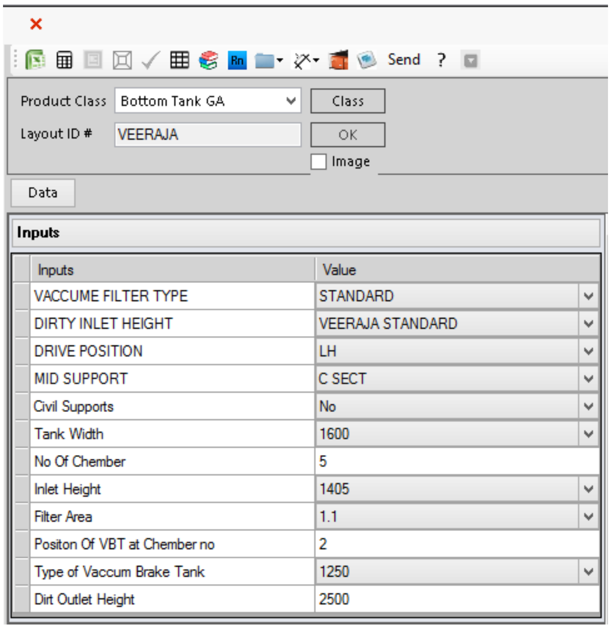

Fig-9: Size Input Screen

4.5 Model Geometry Output:- Instance II

Once user click on "Modify" the model geometry is generated as per the enquiry details specified by user.

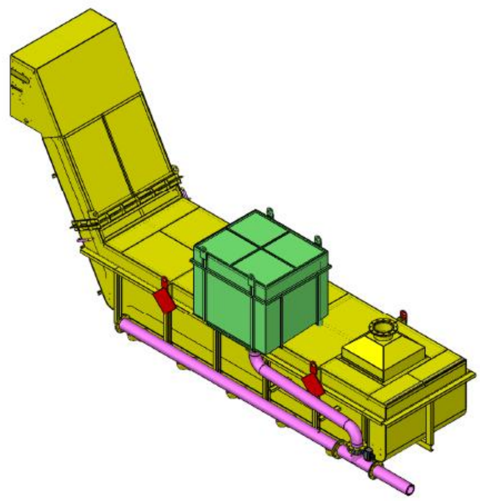

Fig- 10: Vacuum Chambers:-ISO

4.6 Drawing Output:- Instance II

To generate the drawings click "Create", this tool enhance with drawing configurator which rescale and rearrange views and dimension as per requirements.

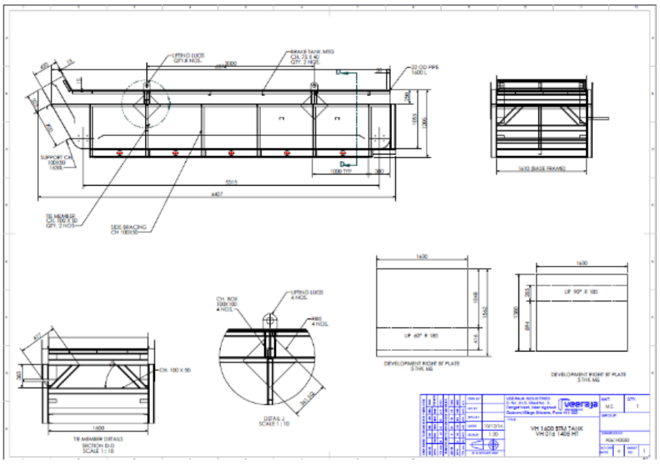

Fig- 11: GA Drawing

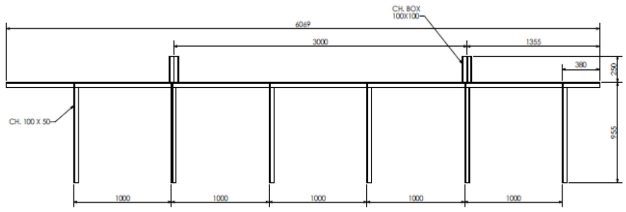

Fig- 12: Fabrication Drawing

5. CONCLUSION

This research gives an idea about how CADEC helps manufacturing companies to grow their business with configurable design, each design is customized as per the customer requirements, which leads to more design variation in same product families lead to more business opportunities. Use of CADEC is a template based approach where mechanical engineer can configure their own product family and used by non-technical person so designers can focus on more product innovation than handling mundane task.

KBE is used in product development to automate mundane task.

Design automation though KBE allows freedom to designer from above routine work so that more time could be used to come up with new innovative solutions.

Automated Process of GA and Manufacturing drawing
Reduction in Design time from 5-10 days to 2-3 hours.

ACKNOWLEDGEMENT

I feel great pleasure in submitting this work "Product Customization through Knowledge Based Engineering"

First of all I would like to take this opportunity to express a deep sense of gratitude and appreciation to my supervisor Prof. S. M. Nagure for his constant support, motivation and continuous encouragement.

I am greatly thankful to Mr. Mandar Parkhi, Director, Mark Design Solutions, Pune, Mr. Pinakin Mate, CEO, Veeraja Industries, Pune for guiding and authorizing him to use the best possible resources of their organization for his successful completion of the Project study.

Last, but not the least I wish to express my gratitude to God almighty, Parents for their abundant blessings, without which this report would not have been successful.

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