DESIGN PROCESS STANDARDIZATION BY USING KNOWLEDGE-BASED ENGINEERING

Anoj R. Kshirsagar[1], Mr. S.M.Nagure[2], Mr. B.S. Allurkar[2]

[1]M.Tech student, Department of Mechanical Engineering, M.B.E.S college of Engineering Ambajogai, (MH), India.
[2] Assistant Professor, Department of Mechanical Engineering, M.B.E.S college of Engineering Ambajogai, Maharashtra, India.

---***---

Abstract - *The success of equipment and manufacturing companies depends on their ability to produce high quality products at the lowest cost, Knowledge based engineering (KBE) has become a practical method of visualizing manufacturing cost and enabling product analysis by simulating product development activities in design for manufacturing support tools. The aim of project work is to discover how KBE approach which includes engineering design and similar knowledge intensive methods, can be used to improve productivity of design which helps to cater need to Industry 4.0Industry 4.0 (Smart Factory) where computers and automation come together in an entirely new way in which cyber-physical systems monitor the physical processes of the factory, Robotics connected remotely to computer systems equipped with machine learning algorithms that can learn and control the machine. Smart Factory enables new market's needs and customization of products. Design/Engineering plays a vital role in growth, efficiency & profitability of Smart Factory. As technological innovation changes the approach of design, industry now focusing on parametric modelling and master model technique, where they can automate the design process which reduces the mundane task which results designers are involved in more innovation. In Material Handling system each machines vary with different geometry and size as per the customer layout, use of traditional design and manufacturing system requires more time to design, fabricate, inspect, hence use of KBE technology faster the entire process which leads to reduce the design time for many mundane task automated design are error free and we can produce high quality design at lower cost.*

Key Words: Knowledge Base Engineering (KBE)

1. INTRODUCTION

The development of a Machine one the drawing board is part of the overall task of design. If the designer's creation is to leave the drawing board and become a physical piece of hardware, it must be manufacturable. In other words, the design of all the parts if a machine should be such that they can be produced by some manufacturing methods and then assembled at competitive cost.

The designer should have a thorough knowledge of the capabilities and limitations of the manufacturing methods. Only then can be properly design parts, select the materials and manufacturing methods, specify tolerances, consider assembly procedures, specify the reliability of the machine and incorporate human aspects in the design. Modern systems are increasingly becoming more and more complex. A large number of mechanical components, controls, computers and communication subsystems are found interconnected in a complex system. Such a complex system can have many sources of errors. While some errors may be predictable, others are not due to their random nature. Predictable errors are those which can be foreseen based on the mathematical description of the system's dynamics. In order to minimise predictable errors, the use of standards is advocated. The main purpose of standardization of different processes in design is to establish mandatory or obligatory norms for the design and production of machines so as to reduce variations in their types reduce the overall design cycle time and faster the operation.

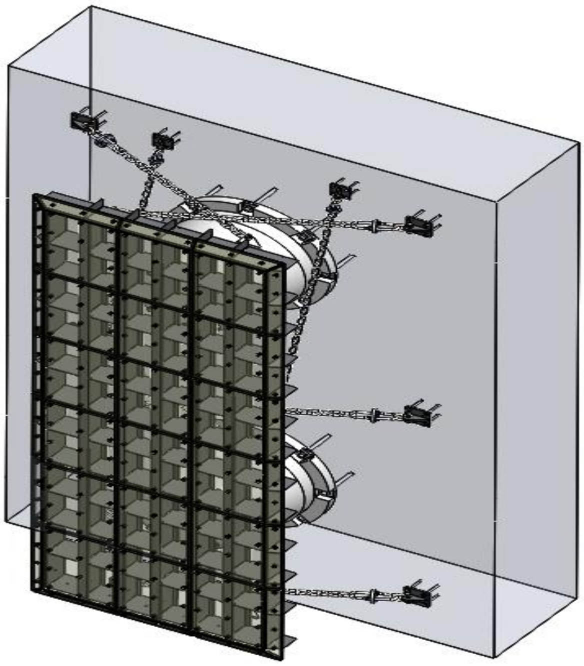

Figure - 1: SKN FENDER

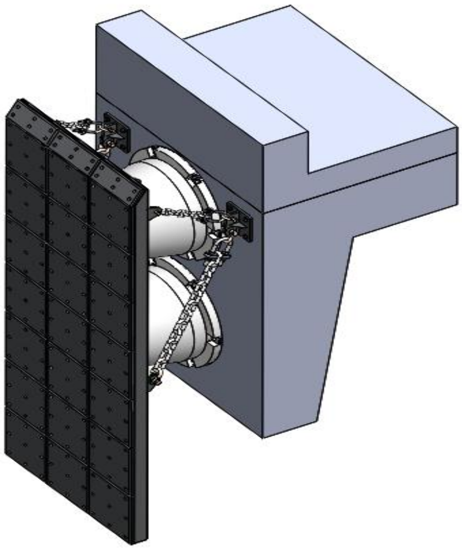

Figure - 2: Fender System

2. LITERATURE REVIEW

E. Jayakiran Reddy et.al discussed about Knowledge Based Engineering (KBE) is a research area for product design that involves complex and iterative processes based on methodologies and technologies for capture and reuse of product knowledge. This review is an effort to collect and review existing literature on KBE evolution, approaches and methodologies.

The evolution of the KBE definition is also briefly discussed along with the current limitation and future trends of KBE. The objective of the review paper is to identify the foundation and research issues of KBE in the light of parametric, function based, web-oriented modelling.

In recent systems CAD (Computer Aided Design) is inevitable in design practices. It is desirable to have an application that supports the entire lifecycle of initial design, detail design and manufacturing. The conventional system of mass production is not suitable for present turbulent markets as the customer needs are changing rapidly. For achieving this, manufacturing sector has been undergoing a shift from mass production to mass customization. For meeting, these market needs in less time a knowledge base is required for designing the required components. If the component is similar, the parametric modelling technique is useful because it can be used where geometrical model changes frequently during the design process. While designing a product, the designer must draw upon different types of information related to the field of customer requirements. The design process must be carefully developed to generate the most suitable design recommendation.

3. EXPERIMENTAL PROCEDURE

It was also accomplished about various KBE methodologies which are available to support the development of KBE applications and systems. The most well-known of these is the Methodology and software tools Oriented to Knowledge-Based Engineering Applications, or MOKA methodology. This methodology is based on eight KBE life-cycle steps and expressed in accompanying case-specific informal and formal models. It is designed to take a project from inception towards industrialization and actual use. The informal model consists of so-called ICARE forms, where the acronym stands for Illustrations, Constraints, Activities, Rules and Entities.

These forms can be used to decompose and store knowledge elements. Subsequently, these elements can be linked to create a structured web of knowledge elements that together make up a representation of the problem domain to which users from multiple viewpoints can relate. When the problem knowledge has been converted into a structured representation, the next step is to formalize this knowledge in order to represent knowledge in a form that is acceptable to knowledge and software engineers and suitable for subsequent development of the KBE application. The formal model uses MML (Moka Modelling Language, an adaptation of UML) to classify and structure the ICARE informal model elements, which are translated into formal Product and Process models.

The main elements of the MOKA methodology are illustrated in Figure 2.3. The main focus of MOKA lies with the 'Capture' and 'Formalize' steps of the KBE life-cycle (see Figure 2.3). Herein lies a root cause for some of the missing ingredients of the MOKA methodology.

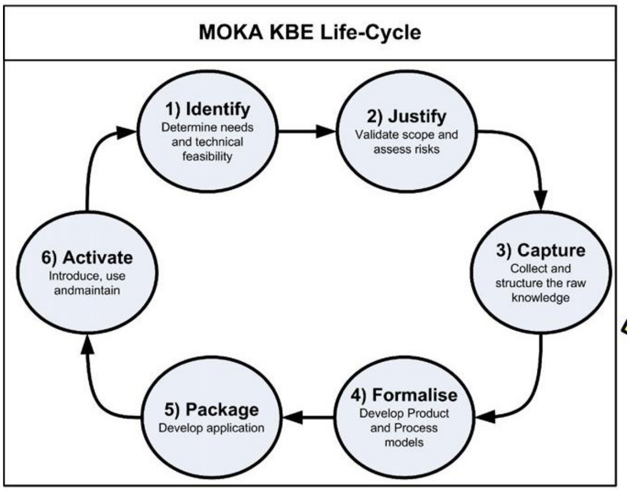

Figure - 3: MOKA KBE life-cycle

4. RDD AND CONFIGURATION OF CONVEYOR

4.1 Geometric Variation (Shape)

Geometry variation are related with shape variation, where subassemblies, parts, features are suppress/ unsuppressed as per the requirements.

Table - 1: Geometry / shape variation

Classification	Option
Chain type	Stud link
Chamfer	All
Fender Type	SCK
Fender Type	SCN Inside

4.2 Design Calculation and Rules

Table - 2: Design calculation and rules

ID	Name	Formula	Validation
1	'Section Height'	'Panel Thickness'-(2*'Plate Thickness')	
2	'Second Vertical Stiffner Distance'	'Panel Length'-('First Vertical Stiffner Distance'*2)	Series
3	'Side Chamfer Depth'	'Top Chamfer Width'	
4	'Side Chamfer Width'	'Top Chamfer Depth'	
5	'C'	sqrt((pow('A',2))+(pow('B',2)))	
6	'A1'	'Top Chamfer Depth'-'Plate Thickness'	
7	'B1'	'Top Chamfer Width'-'Plate Thickness'	
8	'C1'	sqrt((pow('A1',2))+(pow('B1',2)))	

4.3 Parametric equation

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.

Table - 3: Parametric equation

Parametric Equations	Value
"11TH@Sketch14@Vertical T-Member-1@Front Panel.SLDASM"	'Eleventh Vertical Section Distance'
"ST@Sketch15@Horizontal T-Member-1@Front Panel.SLDASM"	'Section Rib Thickness'
"12T@Sketch15@Vertical T-Member-1@Front Panel.SLDASM"	'Twelth Vertical Section Distance'
"SW@Sketch15@Horizontal T-Member-1@Front Panel.SLDASM"	'Flange Width'
"D2@Sketch14@Horizontal T-Member-1@Front Panel.SLDASM"	'Flange Width'
"D5@Sketch14@Horizontal T-Member-1@Front Panel.SLDASM"	'Flange Thk'
"1R@Sketch16@Vertical T-Member-1@Front Panel.SLDASM"	'First Vertical Stiffner Distance'-+'Section Rib Thickness'
"wT@Sketch16@Horizontal T-Member-1@Front Panel.SLDASM"	'Section Rib Thickness'
"2R@Sketch17@Vertical T-Member-1@Front Panel.SLDASM"	'Second Vertical Stiffner Distance'

4.4 Reference Table

Table - 4: Reference table

'SCK'	400	'D'	25
'SCK'	500	'D'	25
'SCK'	630	'D'	25
'SCK'	800	'D'	30
'SCK'	1000	'D'	35
'SCK'	1150	'D'	40

5. RESULT AND DISCUSSION

End user needs to fill the enquiry details as input for fender application to generate customized model and drawings refer Figure 4.

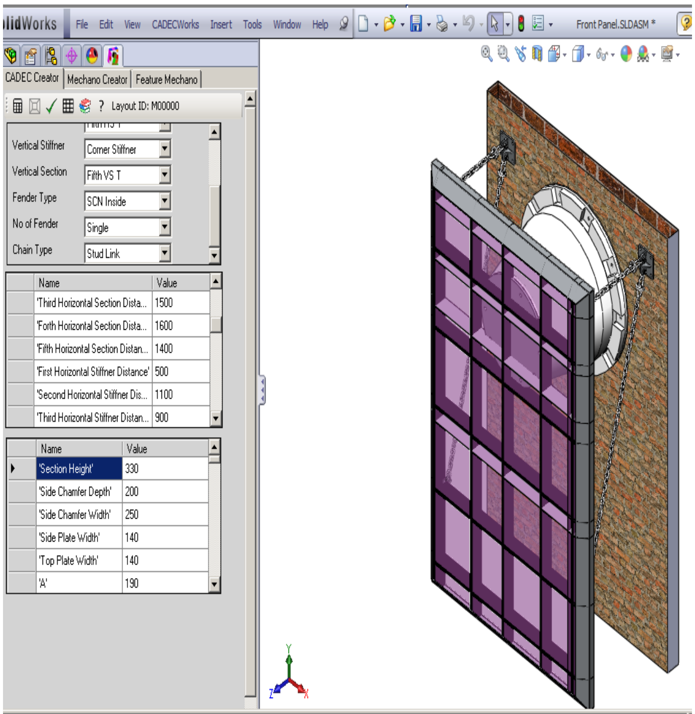

Figure - 4: Model Automation

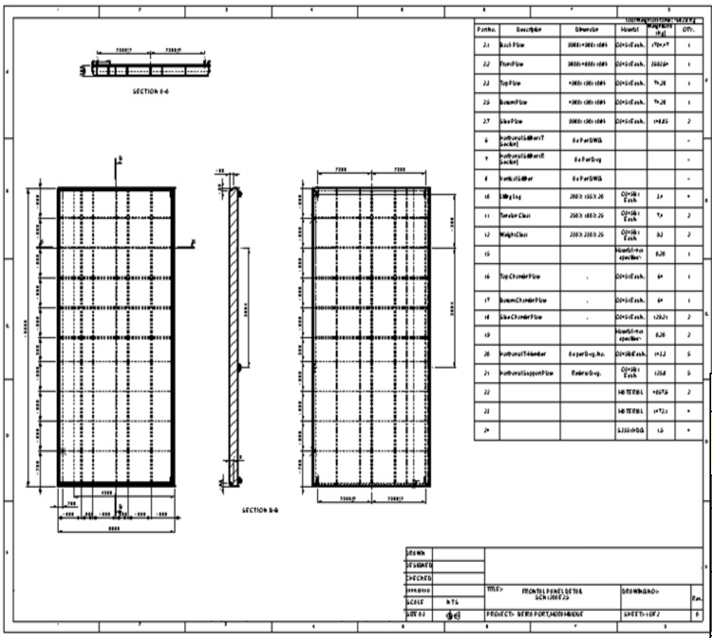

Figure - 5: GA drawing Automation

BOM Automation

Table - 4:

Item no.	Description	Qty./ system	Material
1	Super Cone fender SCN 1200 E2.5	2	Rubber
2	Frontal Frame	1	Q345 / Equiv.
3	40 mm thick Facing Pad (Black)	1 Set	UHMW-PE
4	EC2 Anchors (M42 x 530mm L. Fully threaded)	16	Gr. 8.8, HDG
5	Hex Nut (M42)	16	Gr. 8, HDG
6	Fender Washer M42 (Suitable)	16	Q235 / Equiv.
7	Hex Bolt (M42 x 110mm L.FullyThreaded)	16	Gr. 8.8, HDG
8	Round Washer M42 (OD 78 x ID 45 x 7 thk.)	16	Q235 / Equiv.
9	Weight Chain Bracket	2	Q345 / Equiv.

6. CONCLUSIONS

This project work gives an idea about Knowledge Based Engineering (KBE) in product development. KBE can be seen as a tool for capturing knowledge and reusing it. This automated design tool helps in bridging the gap between design engineers and computational experts when analyzing product development process. An automated design system has been developed as a case study for Marine System. The following conclusions can be drawn from this research regarding the design automation and KBE:

Table - 5: %Identification and Improvements in Design Process Time

% of Design Time		
Area	**% Time Required which can Automate**	**Improvements**
Discussion with Sales	20%	15%
Presales Activity	20%	10%
Technical Quotation	15%	10%
Boughtout Items	7%	4%
BOM	5%	5%
Drawing Preparation	25%	20%
Cost Sheet	5%	4%
Par Numbering	3%	3%

Total Design Time	**100%**	**71%**

KBE is used in product development to automate mundane time demanding tasks. 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.

REFERENCES

1. D.E. Whitney, Designing the Design Process. Research in Engineering Design, 2, Springer, New York, pp. 3–13, ISSN 09349839 1990.

2. T.A. Salmone, What Every Engineer should know about Concurrent Engineering, Marcel Dekker, New York, pp. 45-49 ISSN 08247955784, 1995.

3. G. Evans, Time for change, rapid news Europe, Time Compression Engineering Solutions, Rapid News Publications Plc, Worley Court, Bolesworth Rd, Tattenhall, Cheshire, 9HL, UK, pp. 112-145, 1996.

4. J.B. Quinn, P. Anderson, S. Finkelstein, Managing professional intellect: making the most of the best, Harvard Business Review 74 2 ISSN 00178012, March–April 1996.

5. B.C. Chapman, The design process: A need to rethink the solution using knowledge based engineering, University of Warwick, MSc thesis, pp. 2-6, February 1997.

6. M.M. Tseng, J. Jiao, Design for mass customization, Annals of the CIRP 45 153–156 1996.

7. N. Wognum, A. Trappey, PLM challenges, Advanced Engineering Informatics 22 419–420 2008.

8. S. Cooper, I.S. Fan, G. Li, Achieving Competitive Advantage Through Knowledge Based Engineering –A Best Practice Guide, Cranfield University, Bedford, UK, 2001.

9. P.J. Lovett, A. Ingram, C.N. Bancroft, Knowledge-based engineering for SMEs–a methodology, Journal of Materials Processing Technology 107 pp. 384–389 2000.

10. S. Cooper, I.S. Fan, G. Li, Achieving Competitive Advantage through Knowledge Based Engineering – A Best Practice Guide, Cranfield University, Bedford, UK, 2001.

11. F. Elgh, M. Cederfeldt, —Documentation and Management of Product Knowledge in a System for Automated Variant Design: A Case Study, in: J. Pokojski, S. Fukuda, J. Salwin´ ski (Eds.), New World Situation: New Directions in Concurrent Engineering, Springer, London, 2010, pp. 237–245.

12. Gene Daniels, "SolidWorks Essential and Advanced Modeling tools", 2017.

13. Mark Design Solutions "CADECWorks 4.3", 2016 pp. 20-42, 2016.