Automation of Bearing Modelling and Drafting using CATIA – VBA Approach

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ABSTRACT

Computer aided designing (CAD) is widely used in product development phase to reduce design time with high level of accuracy in the work. The success of manufacturing companies depends on their ability to produce high quality products at the lowest cost. This applies to bearing design industries that aims to create designs that are very similar in alternative products and standardized in the sizes. To reduce the development cost, it may be worthy to focus on the design phase of product development, since most of the product cost is committed in the design phase, also the design phase decides the cost associated in the manufacturing phase, any of the mistake in the design phase may result in to very high losses associated in the manufacturing investments. Use of CAD tools take so much of time and are associated with the risk of errors in design. 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 this work is to discover how knowledge based engineering (KBE) can be used to improve design phase of bearing industry. Further the system is developed in CATIA VBA as an efficient way an organization looks at solving and automating repetitive engineering problems.
The future work is on an automated modelling system for different types of bearing and new way of solving bearing design problems within CAD environment by using knowledge extracted from the conventional design procedures. System uses a set of rule bases for making decisions regarding selection of standard sizes for bearing design.

Keywords: Bearing Modelling, CAD Customization, CATIA VBA Approach.

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1. Introduction

Today's world is a customer driven world. To remain in the market one has to continuously innovate the product. Also it is very important to enhance the productivity. Reducing the lead time from design to manufacturing can do this. Hence to reduce the time span of design to manufacturing companies use different CAD/CAM/CAE software as a tool for completing these tasks. The highly competitive environment makes it necessary to reduce the time and money spent in designing phases while maintaining high standards for product quality. Therefore, using computer-aided design (CAD) has become one of the most important ways to increase productivity. The views in traditional 2D design systems are difficult to understand. It is very hard to identify any interference. Moreover, it is difficult to create and modify drawings. These drawbacks of the traditional 2D design systems make them very time-consuming to learn and use. 3D CAD software uses an intuitive and concrete way to present objects to users, which fundamentally avoids above mentioned problems. New product development involve design activities which refers to multiple disciplines for e.g. surface design, structure design, mechanism design, metal-non-metal parts design, fastener design, material selection, parameter selection depending on varying loading condition, BOM creation and design for manufacture.

1.1 Significance of CAD Automation

In this paper work we discussed about computer system would be developed, which will take the customer specifications, ratings and loading conditions as an input to calculate dimensions identified as an independent variables. The logic for calculating independent variables is built into program, and dependent variables will be calculated by using independent variables and design rules. Based on these dimensions and the relations between them, a 3D model of the bearing will be generated by using High Level CAD Templates (HLCTs). The system will also generate the 2D drawings. Such system will have the benefits given as follows.

As the design procedure will be captured in to the High Level CAD Templates HLCTs, The chances of errors/mismatch will be reduced. Since the common dimensions would be given only once, errors due to mismatch will be reduced. As a 3-D model would be available, the designers can rotate the model and visualizes it from different angles and thus make improvements.

Drafted sheets can be generated by the system very easily. Any changes in the design philosophy would entail modifications in the program and need to ensure proper changes in the individual designs would be eliminated. This would ensure better design control.

Based on above philosophy Automated Design System (ADS) would be developed suitable for the bearing design and manufacturing industries. To do the same task for each & every design changes is time consuming and also prone to   errors. Hence a tool should be facilitated with a database for various standards.

The system would be very comprehensive and generate analyzable 3D CAD assembly and drawings for a large variety of bearing. The system would be designed with menu driven prompts with instructions so that a user without any knowledge of 3-D modelling software or database package can use the system. The only need is that the user should know how to use this system. CATIA software would be used as platform to develop the system due to its strong Knowledge Based Engineering (KBE) approach. The menu screens and coding would be developed in VBA.

2. Infrastructure Automation Objects

This chapter gives the overall methodology and procedure for design and development of the software for modeling of bearing. Scripting languages such as Visual Basic rely on objects. With CATIA, documents, windows, viewers, parts, sketches, pads, even lines and curves are represented as objects in Visual Basic. Scripting languages such as Visual Basic rely on objects. With CATIA, documents, windows, viewers, parts, sketches, pads, even lines and curves are represented as objects in Visual Basic.

Object: an entity. Example: Document, Pad, Line.
Property: a characteristic of an object.
DocName = CATIA.ActiveDocument.FullName
Method: an action on an object
CATIA.ActiveDocument.SaveAs "MyNewName"
Collection: a list of objects.
The CATIA collections index begins at 1, and not 0:
For i=1 to CATIA.Documents.Count
Msgbox CATIA.Documents.Item (i).Name
Next
We can also access a collection with the name of the object: Example: msgbox CATIA.Documents.Item ("Product1.CATProduct").Name
We add objects to the collections with the method add:
Set myPartDoc = CATIA.Documents.add ("Part")
The CATIA Application object aggregates two main collection objects:
Documents and Windows.
The Documents collection aggregates any number of Document(s) since the multiplicity is set to *. The Document object is an abstract object, and only its derived type can actually be created, that is the Part Document, Product Document and Drawing Document.
The Windows collection aggregates number of Window(s), which themselves aggregate one Viewers collection which aggregates any number of Viewer(s). The binary association between the Window and the Document objects means that the Document object is the parent of the Window object.

3. System Development

System is developed to yield solution with two different approaches
- Automated Modeling
- Automated Design

In automated modeling approach design parameters are taken through UI, those parameters are used to replace variables in HLCT to give the specific outputs in the form of .CAT Product file. This output can be saved in .igs, .stp such neutral CAD formats. Special Draft command button is provided to automatically generate drafted sheet. General representation of this approach is shown in fig.3.1

In Automated Design approach, solution for design problem is generated on the basis of KB saved in the system. All the KB is saved in the form of VB code and it is integral part of the HLCTs. KB is organized in the form of rules and formulae. General representation of this approach is shown in fig.3.1
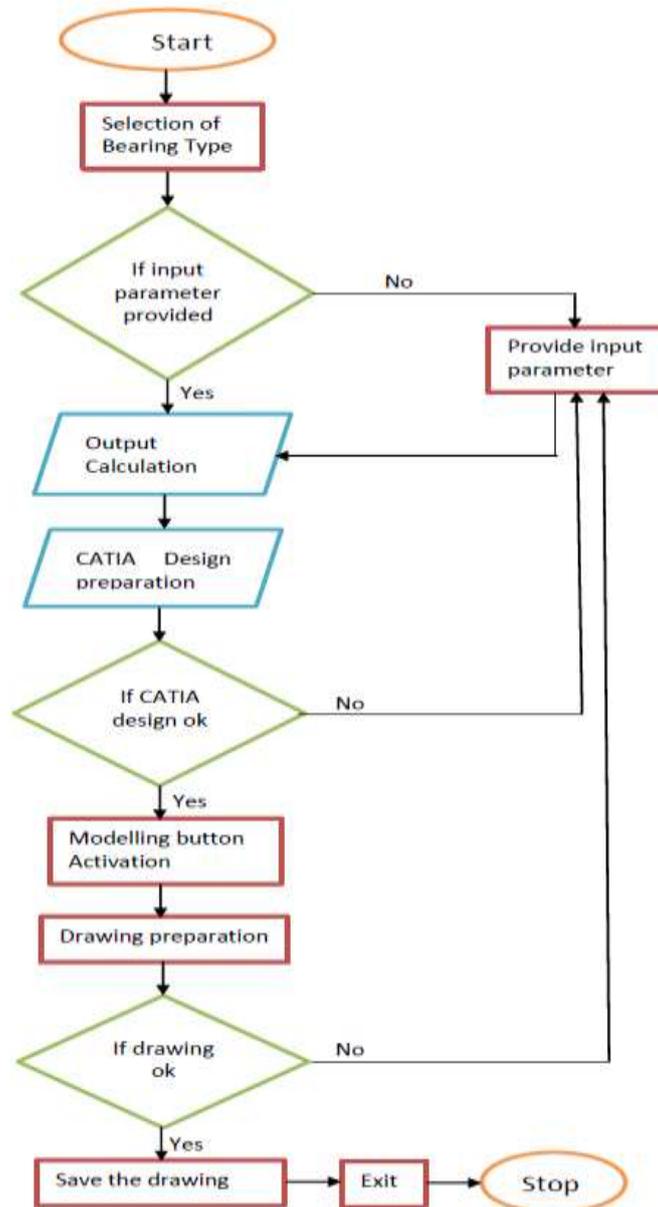
Fig. 3.1 flow chart for automated modeling and drafting approach

Step 1
User will have to run the project through VBA editor and run command button.
Step 2
User will have to give the user inputs to UI for required bearing design. After giving suitable inputs, user should click on the Calculate command button to get the desired output.
Step 3
Calculation of bearing will be done automatically on the basis of following formula.
$Rou = (10 / 3)$
Static load $= 0.6 *$ Radial Load $+ 0.5 *$Axial Load
Load capacity $=$ static load $*$ Bearing Million $^ (3 / 10)$
Bearing Million $=$ Load capacity /static load $^ (10 / 3))$
Step 4
All these calculated design parameters are then stored in to the database using MS- Access database. Using the Save command button provided in the UI the parameter is stored into the system.
Step 5
All these calculated design parameters are then placed in to the HLCT instead of respective variables and the program is recompiled to give output in CATIA as .CATProduct assembly of bearing design.
Step 6

3DCAD Output is given in to the CATIA V5 –R19 .CATProduct format which can be further saved in .igs, .stp, .3dxml such neutral CAD formats.

Step 7

If the user wishes to generate 2D drawing sheet, Draft command button is provided which can be used to generate front, top and side view.

3.1 Automated Design approach

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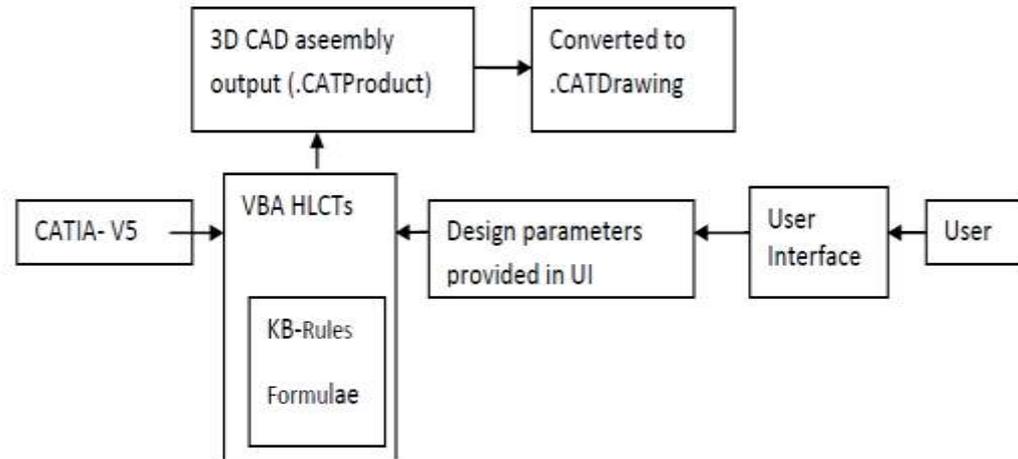
Fig 3.2- Automated Design Representation

4. Results and Discussion

4.1 Automated Modeling

System gives the solution for industrial real time problems by using KBE approach. In this approach loading conditions and material property (strength) is taken as input. By using KB saved in the system and input parameters, optimum design solution is calculated as per the formulae provided in to the system and 3D CAD assembly solution is directly given in to the CATIA V5-R19.

Ball bearing, Roller bearing, Taper roller bearing and cylindrical bearing these are the four different types of bearing which can be created by using the developed system. Design parameters needs to be taken as input to the system and 3D CAD geometry can be automatically created within few seconds in CATIA V5-R18 even if user is illiterate to work on CATIA. Drafted sheets can also be created by using   Draft   command button provided on the UI. Runtime outputs of all the types of bearings are given further in this topic.

For all type of bearing we provide Inner diameter, outer diameter, width, thickness, radial and axial load these are the inputs taken from the user through UI as shown in fig.5.1 a) which gives the 3D CAD output as shown in (b)

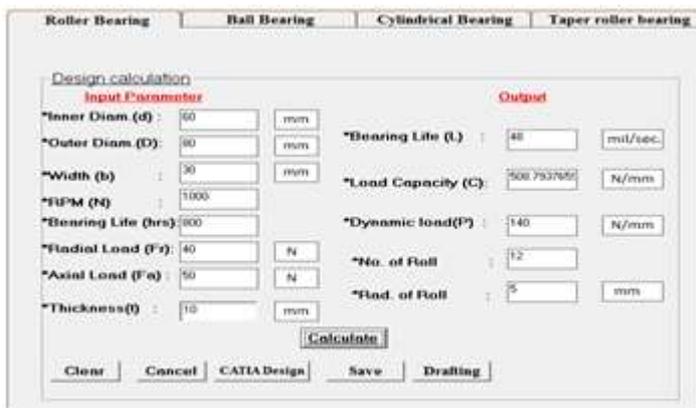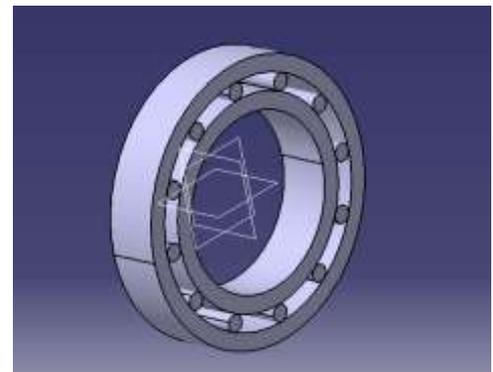   I.   Roller Bearing

Fig4.1. a) UI for Roller Bearing   b) 3D CAD output of Ball Bearing
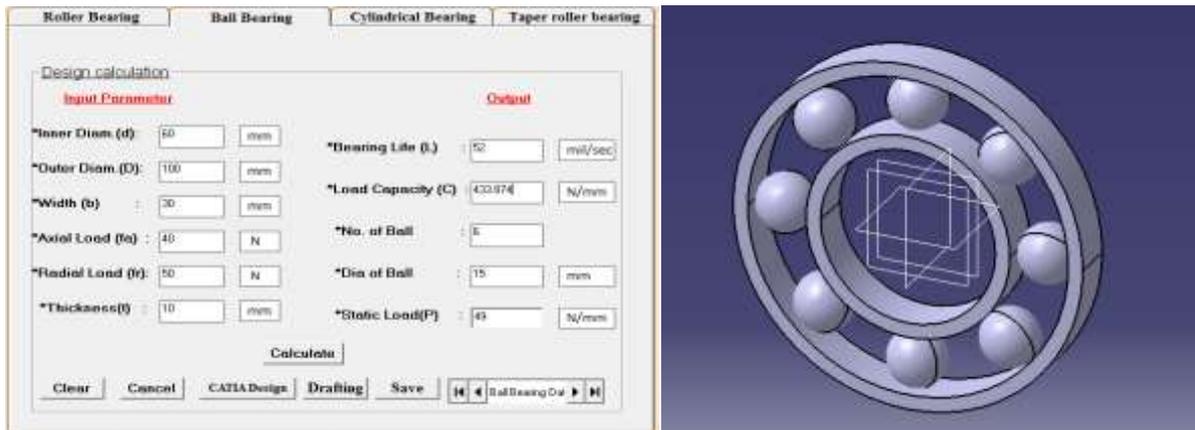
II.   Ball Bearing

Fig4.2. a) UI for Ball Bearing   b) 3D CAD output of Ball Bearing
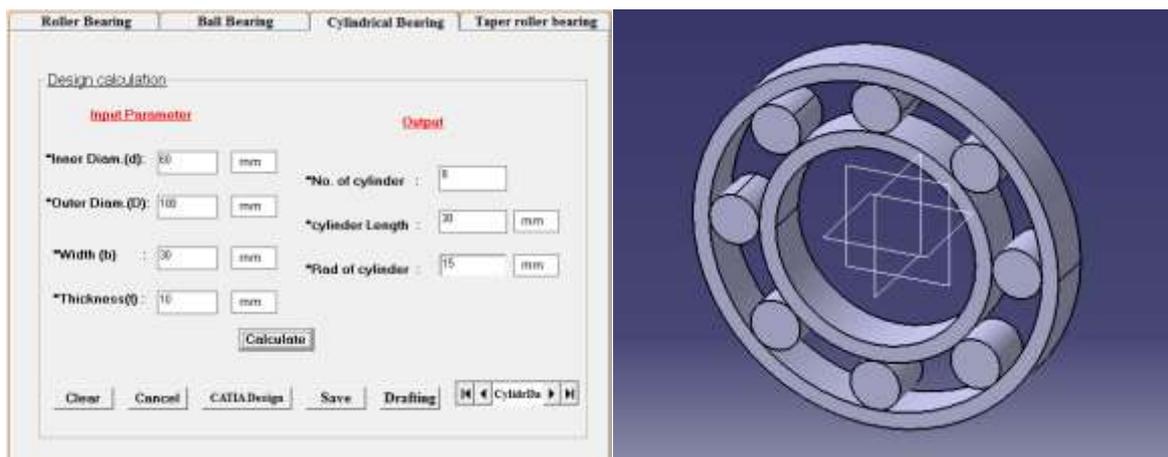
III.   Cylindrical Bearing.

Fig4.3. a) UI for Cylindrical Bearing   b) 3D CAD output of Cylindrical Bearing
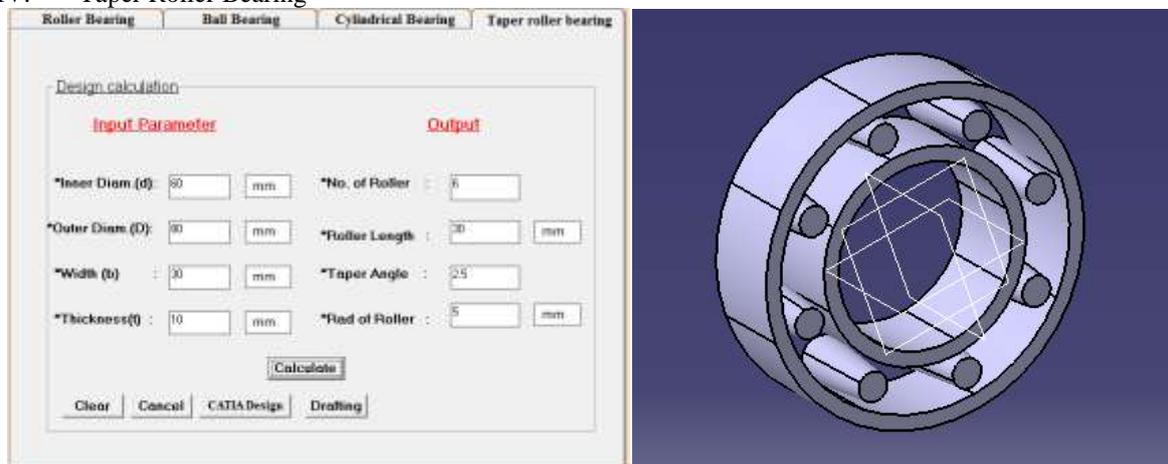
IV.   Taper Roller Bearing

Fig.4.4. a) UI for Taper roller bearing   b) 3D CAD output of Taper roller Bearing

Following table gives the average time required for manual modeling done by any proficient expert in CATIA and automated modeling done by using system developed in this work. It indicates that the required time for automated modeling is very less than the manual modeling with the similar accuracy in both approaches also the design calculation and selection of appropriate standard size for coupling is automatically done within few seconds in automated design approach.

Types of Bearing	Manual modeling	Automated modeling	Automated design Calculation
Modeling of Roller bearing	2 – 3 hours	5 sec.	5 sec.
Modeling of Ball bearing	2 - 3 hours	5 sec.	6 sec.
Modeling of cylindrical bearing	1.5 – 2 hours	5 sec.	5 sec.
Modeling of Taper roller bearing	2.5 – 3 hours	5 sec.	2 sec.

Table-1: Comparative Results between Manual Modeling, Automated Modeling and Automated Design

5. CONCLUSION

A system has been developed with two approaches one automatic modeling and design solution to give the design solution for Bearing Design. This automated design tool helps in filling the gap between design engineers and computational experts when analyzing product development process. The following conclusions can be drawn from this research regarding the developed system.

1. Ball bearing, Roller bearing, cylindrical bearing, Taper roller bearing, these are the four different types of bearing identified for automation and modeling procedure is automated.

2. System also gives the automated design solution for required customer specifications i.e. bearing life and loading conditions.

3. Drafting activity is also automated partially. System saves the parameter using MS Access database. System gives output within few seconds and time required in design process is minimized.

4. Automation of 3D CAD modeling by using HLCTs helps in reducing manual errors during modeling as user has to give few inputs in a single UI without using any of the CATIA commands.

The work can be further improved to make the modeling more realistic, dress up feature automation objects can be used to automatically generate fillets, chamfers and corner radii. In drafting activity, automatic dimensioning can benefit greatly towards reducing repetitive tasks. In automated design approach work is done only for four different bearings, further work can be extended to include other types of bearing. It can also serve as an aid in the manufacturing planning to evaluate manufacturability and life cycle simulation of product for cost estimation.

REFERENCES

1. Indraneel, Chakraborty, Vinay Kumar.: (2003); Rolling element bearing design through genetic algorithms, Advanced Engineering Informatics, Vol. 35, No. 6, pp 649-659

2. Y.H. Lee, C.L. Li.: (2009); automation in the design of edm electrodes, Compute Aid Des, Vol. 24, pp 600–613

3. Ching F. Yong, Eddie Y. K. Ng, Wei D. Zhou, Wan K. Ng.: (2010); Design and modeling of femto air bearing slider, J Des Manufact, Vol3,pp 841-854

4. Durupt A., Remy S., Ducellier G., Bricogne M.: (2010); KBRE: a proposition of a reverse engineering process by a KBE system, Int J Interact Des Manuf, Vol.4, pp 227-237

5. R. K. Naffin L. Chang.: (2011); An analytical model for the basic design calculations of journal bearings, , Int J Adv Manuf Technology.

6. Hak-Soo Moka, Chang-Ho Kim , Chang-Bong Kim.:(2011); Automation of mold designs with the reuse of standard parts, J Mater Process Technology, Vol. 139, pp 81–89

7. Ruchik D. Trivedi, Dhaval B. Shah, Kaushik M. Patel.:(2013); 3d parametric modeling for product variants using case study on inner ring of spherical roller bearing, Procedia Engineering 51 pp 709 – 714

8. Yu Wanga, Kai-Min Yua, Charlie C.L. Wangb, Yunbo Zhangb.:(2011); Automatic design of conformal cooling circuits for rapid tooling, Compute Aid Des, Vol. 34, pp 1000–1010

9. Hak-Soo Moka, Chang-Ho Kim, Chang-Bong Kim.:(2011) Automation of mold designs with the reuse of standard parts, Int J Mach Tools Manuf, Vol. 36, pp 367–378.

10. Konrad Sickel, Sajjad Baloch , Rupen Melkisetoglu , Vojtech Bubnik , Sergei Azernikov Tong Fang.:(2013); Toward automation in hearing aid design, Compute Aid Des, Vol. 37, pp 113–123