International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 11 Issue 11, November-2022, Impact Factor: 7.957

Automation of Design

Sushant Prashant Laddha[1], Dr. P M Patare[2]

[1]M Tech Design, BE Mechanical, Department of Mechanical Engineering, Sanjivani College of Engineering an Autonomous Institution Kopargaon Affiliated to Savitribai Phule Pune University Maharashtra, India
[2] Professor, Department of Mechanical Engineering, Sanjivani College of Engineering an Autonomous Institution Kopargaon Affiliated to Savitribai Phule Pune University Maharashtra, India

ABSTRACT

Computer-aided product development has become indispensable in many branches of industry, with the discipline of computer-aided design in particular playing a crucial role in the development processes of automotive products. Due to a multitude of changing boundary conditions and requirements (e.g. cost reduction, shorter cycle time for development and manufacturing) automotive development processes have to be enhanced. In order to be able to counteract the constantly changing requirements, a further development in the field of computer-aided design must take place. This further development is based on knowledge which is implemented as automation procedures into existing CAD systems. In this context, this project gives insights into the CAD disciplines used in automotive development processes, lists different levels of knowledge-based automation methods and discusses the potentials, limits and challenges of CAD-automation. Furthermore, selected use-cases of knowledge-based CAD-automation in automotive projects are shown.

Keywords: CAD, Computer-aided product, Computer-aided design, Mechanical manufacturing design, Automation, Solid Works Application, Parametric Modeling, Drawing Automation, 3D modeling, 2 D drafting software.

1. INTRODUCTION

Starting around the mid-1960s, computer-aided design systems began to provide more capability than just an ability to reproduce manual drafting with electronic drafting, the cost-benefit for companies to switch to CAD became apparent. The benefits of CAD systems over manual drafting are the capabilities one often takes for granted from computer systems today; automated generation of bills of materials, auto layout in integrated circuits, interference checking, and many others. Eventually, CAD provided the designer with the ability to perform engineering calculations. during this transition, calculations were still performed either by hand or by those individuals who could run computer programs. CAD was a revolutionary change in the engineering industry, where draftsmen, designers, and engineering roles begin to merge. It did not eliminate departments as much as it merged departments and empowered draftsmen, designers, and engineers. CAD is an example of the pervasive effect computers were beginning to have on the industry. Modern CAD packages can also frequently allow rotations in three dimensions, allowing viewing of a designed object from any desired angle, even from the inside looking out. Some CAD software is capable of dynamic mathematical modeling.

1.1 Background

1. To optimize the time required in designing of the 2 D drafting software's
2. To unveil the skilled manpower for the draftsman and designers for Designing

1.2 Project Undertaken

In order to update and upgrade the drawing and drafting techniques to latest technological trends of automation and industry 5.0 Conceptuals, to eliminate the time acquired in the digital designing processes of the manufacturing parts and to reduce the cycle time of the parts, so as to overall reduce the costing behind all the industrial designing sectors.

1. Easy to operate
2. Sober user interface (Customizable to application)
3. Quick output and drafting's of drawings.

1.3 Problem Statement

In engineering scenarios, we encounter many complex design situations. Previously, designs were drawn on sheets and manufactured manually using old school techniques. But now, things have changed with the introduction of CAD applications and software's. But as a design engineer you find yourself spending excess time in completing repetitive tasks, repetitive designs with minor dimensional changes, modeling standard features, or configuring products to custom specifications which vary with time. Also, as this computer designing and drafting involves human interference it permits errors in drawing, and the manpower is being paid with huge amount of working hours and daily wages. This will overall increase the cycle time of product development and also the cost of the manufacturing.Eliminating this time and cost we could free up more time to focus on projects where you add unique value, innovating to create better products and systems.With the fast pace of modern technologies, designers and engineers constantly have new software's at their fingertips that empowers them to enhance their approach to design complex engineering parts. With this consistent flood of new tools, it's important to consider the "next best thing" to enhance your workflow.

2. LITERATURE SURVEY

2.1 Haixianget.al.(2022)

Developed mechanical manufacturing design and automation in China is moving towards high-tech, unmanned and independent research and development.From the above research paper we found some of the major characteristics of the Mechanical Design, Manufacturing and Automation. They are

1. High Work Efficiency and Excellent Product Quality.
2.High Broad Development Prospects.
3.Saving Cost.
4.Enhancing Security.[1]

2.2 Application of Computer Technology on Mechanical Design-manufacture and Automation Fang Li (2020)

In this paper they concluded that continuously improve and optimize the dynamic production process of mechanical products. Computer visualization technology plays an important role in the field of mechanical design and production. On the one hand, computer visualization technology can play a basic role in aided design, which is conducive to reducing manual errors and improving the accuracy of product design. On the other hand, it can greatly improve work efficiency, which saves a lot of manpower and time. Computer aided technology promotes the process of automation.[2]

2.3 Design and Drawing Automation Using Solid Works Application Programming Interface Abhishek C et.al (2014)

This paper aims to developed software application for product design and its CAD model updating by automating repetitive tasks using SolidWorks application programming interface (API). A case study of Winding Machine which is a mechanical product for which a program using Visual basic language i.e. Vb.Net Application is developed. Such developed application is integrated with SolidWorks CAD package through application programming interface (API). Developed application having front end and back end, front end having GUI (Graphical User Interface) through which, input design data/parameter is taken from user. [3]

2.4 Parametric Modeling and Drawing Automation for Flange Coupling Using Excel Spreadsheet

Coupling is a mechanical device which used widely in many big and small-scale industries. 3D solid modeling has been mostly used since last few years as a substitution and complementation of the conventional 2D drafting. However, in general, many draftsmen do not have the skills of performing such 3D modeling as well as it takes lots of time. One way of overcoming this problem is to develop a tool which can perform 3D modeling as well as 2D drafting automatically.[4]

3. SYSTEM DESIGN

Development of a software application by manipulating 'BricsCAD' i.e. 'AutoCAD' with 'Visual Studio', linking application programming interface (API) in which the front end shows the input parameters for the user and in the backend will have the internal programming for design. This system allows you to draw and edit digital 2D designs more quickly and easily than you could do manually using AutoCAD /BricsCad. For that purpose AutoCAD provides interoperability with other applications, by using AutoCAD object model, we can create drawings in AutoCAD.

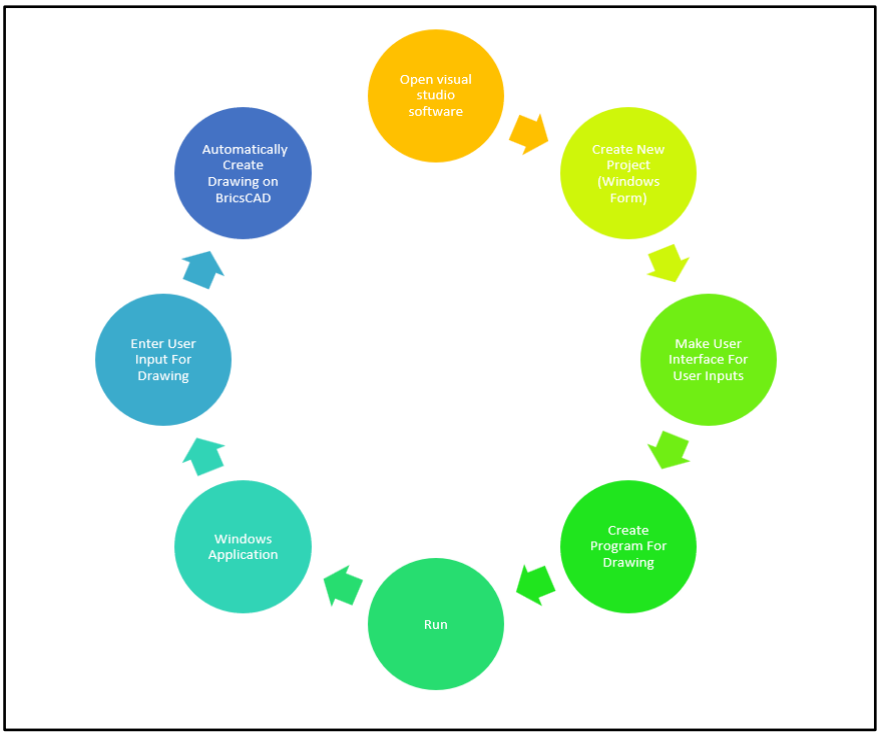

Figure 1: Architecture Diagram

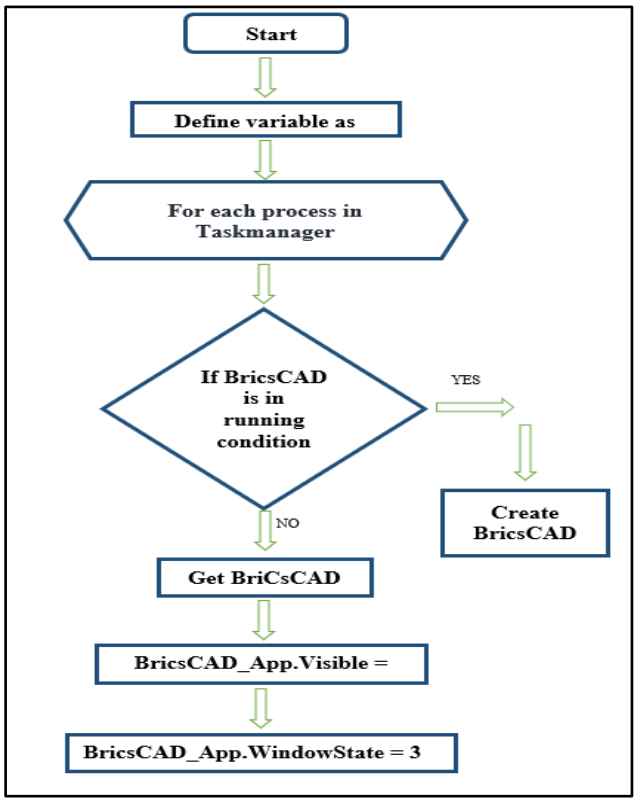

Figure 2: Flow Diagram – Opening BricsCAD software

Program states a private subroutine or a function which declared the BricsCAD application as a true or false vector calling the ACAD application to bring into the processes of a task manager of a computer system, where if it is already open it brings into windows state but if not opened before, the new BricsCAD application file is created as a task in task manager and a new 2D drafting file of the software opensmaking the function true and also making visible into windows state 3(Full window resolution) .

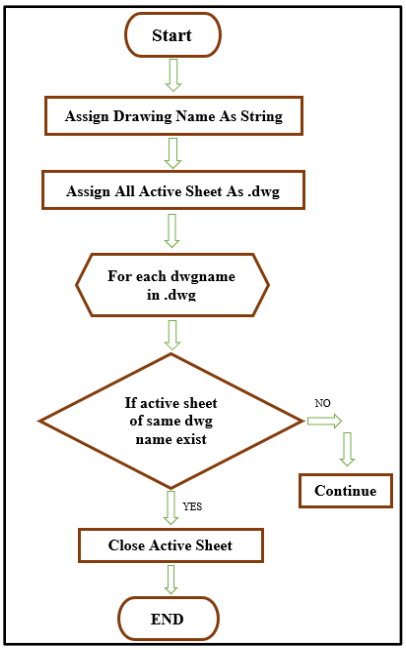

Figure 3: Flow Diagram – Closing active sheets of BricsCAD application

Program states that if the BricsCAD application was previously opened by the unknown user or by any another operator on the shift and the file s not successfully closed then the and filewas been drawn then the newly automated drawn drawing and previous drawn sheet will be overlapped this will create a overlapped drawing mesh, so closing the previous active sheets plays a major part before drawing the new automated drawing, here current drawing will be closed and new files are now ready to be created with the new name and with extension .dwg. So this is the main drawing sheet to perform the automated drawing.

3.1 Creating new file and new sheet for drawing

Program states that when the previous files are been deleted it is important to create new drawing file to store and save the new automated drawing sheet into the destination folder (where all the automated drawn sheets and files are been saved)with the given path and extensions, here we save the template file into the destination folder and then drawing process on a blank sheet begins.The template of the blank sheet is been already saved in the debug folder which contains the blank sheet present of various sizes as per the requirements like A1, A2, A3, A4, with the drawing block and the cost sheet which includes the bill of material (BOM). This blank template of the file is just commanded to copy and paste in the destination folder i.e the folder in which the generated drawing will be saved with all the automated changes. All of the newly drawn automated sheets gets saved in the destination folder with the name as it is given the input by the operator along with the date and time at which it is generated.

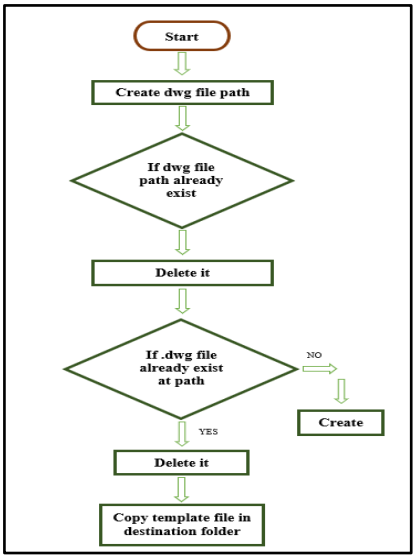

Figure 4: Flow Diagram – Creating new file sheet for drawing

3.2 Software and Hardware Requirements

1. Framework Requirements: .NET Framework 4.5

2. Software Requirements (Platform Choice)
   a) Operating System: Windows 8,10,11
   b) Visual basic community 2017
   c) BricsCAD 20.2.10.1
   d) Language - VB.net
   e) BricsCAD API file

3. Hardware requirements

Table 1: Hardware Requirements

Sr. No	Parameter	Minimum Requirement	Justification
1.	Processor	Intel Core i3 processor	For Fast Processing
2.	Hard Disc	500 GB	For Fast Processing
3.	Ram	4 GB	For Fast Processing
4.	Monitor, Keyboard and UPS	1	None

4. Assumptions and Dependencies
   Following are the assumptions:
   a) System is deployed in single machine.
   b) The coding should be error free.

5. Following are the dependencies: System speed.

6. Functional Requirements
   a) User Environment
      1. The application will be used on the Windows Operating System.
      2. The platform used will be Visual Studio Code. Windows form application for the developing environment (UI).
      3. Front end Visual Basic Code Entities for UI and backend visual Basic VB.Net.

   b) Operating Environment

      The Proposed System Supports:
      1. OS: Windows 10
      2. Framework: VB.Net Framework 4.5.
      3. Platform: Visual Basic VB
      4. Technology: API Linking
      5. IDE: Visual Studio code

7. Software Quality Attributes
   1. Number of functionalities provided must be properly working independently.
   2. System should be reliable.
   3. System performs each function accurately.
   4. System is extensible to any computer with .exe

4. IMPLEMENTATION

The system is been implemented as a prototype for the systematic Design of Flange Coupling

4.1 Implementation Detail

A) **Design Of User Interference (UI Design)**

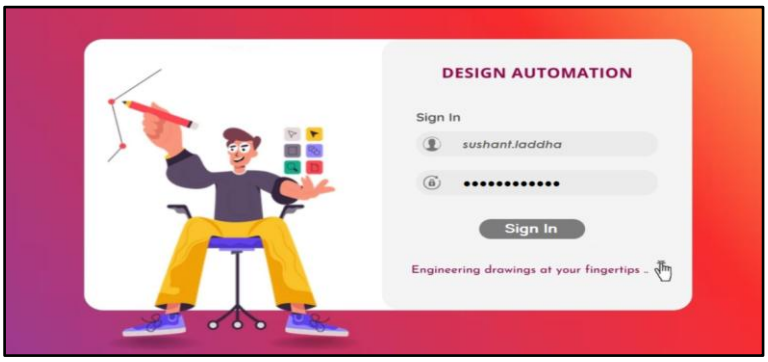

Figure 5 : UI for User Login

The UI design consists of the login page for the user to access the automation software which helps to keep the changes and updation confidential and constrained to the user and operator.

B) **Test Case 1:Design of Flange Coupling**

Here the UI consists of a windows form-based GUI (Graphical User Interface) with the blank textboxes to be filled by the user for the Design of flange coupling component, which consists of

1. Power Input (Watt)
2. No of revolution per minute (RPM)
3. Allowable Stress

C) Design of Flange Coupling for various applications

"User Inputs that are to be take from the user for the design calculations to be performed for dimensions of drawing''

```
P = txtPower.Text
RPM = txtRPM.Text
Ass = txtAll_Stress.Text     … (Textbox Inputs)
```

" Shaft Diameter of the flange coupling ''

```
T = ((60 * P) / (2 * 3.14 * RPM)) * 1000
d = ((16 * T) / (3.14 * Ass)) ^ (1 / 3)
d = Math. Ceiling(d)
```

"Hub Dimensions for the design of hub of the shaft ''

```
Dh1 = d
Dh2 = 2 * d
Lh = 1.5 * d
```

"Key Dimensions for the design of key which is to be inserted in the shaft and the hub to fix and resist its relative motion ''

```
Wk = d / 4
Wk = Math. Ceiling(Wk)
Tk = d / 6
Tk = Math.Ceiling(Tk)
Lk = 1.5 * d … (Imperial relations)
```

"Flange design dimensions''

```
Df = 4 * d
Tf = 0.5 * d
```

"Nut and bolt design dimensions which are used for fastening the flange ''

```
PCD = 3 * d
```

```
If d < 150 Then ..(Design Consideration)
        n = 4
Else
        n = 8
EndIf
    d1 = ((8 * T) / (3.14 * Ass * PCD * n)) ^ (1 / 2)

    d1 = Math. Ceiling(d1)
   EndSub
```

These formulas are been used to calculate the different dimensions of the various parts of the flange coupling component like the Shaft dimensions, Hub dimensions, Key dimensions, Flange dimensions. Some of the calculations were based on the design considerations with the use of imperial relations and formulas from "Design of Machine and Elements" of V.B. Bhandari. And some data from Design data book. [5]

RESULTS AND EVALUATION

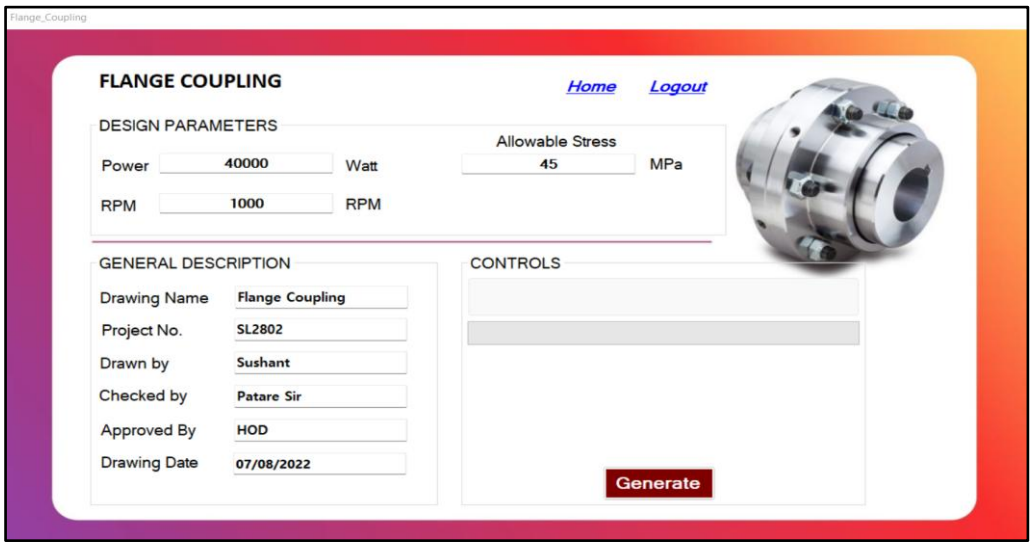

Figure 6 : Input parameter form to be filled by the designer

```
Private Sub OpenBricsCAD()

    Dim IsBricsCAD As Boolean = False

    If New_Project.cmbApp.Text = "BricsCAD" Then
        For Each proc In System.Diagnostics.Process.GetProcessesByName("BricsCAD")
            IsBricsCAD = True
            Exit For
        Next
    Else
        For Each proc In System.Diagnostics.Process.GetProcessesByName("AutoCAD")
            IsBricsCAD = True
            Exit For
        Next
    End If


    If New_Project.cmbApp.Text = "BricsCAD" Then
        If IsBricsCAD = True Then
            BricsCAD_App = GetObject(, "BricsCADApp.AcadApplication")
        Else
            BricsCAD_App = CreateObject("BricsCADApp.AcadApplication")
        End If
    Else
        If IsBricsCAD = True Then
            BricsCAD_App = GetObject(, "AutoCAD.Application")
        Else
            BricsCAD_App = CreateObject("AutoCAD.Application")
        End If
    End If


    BricsCAD_App.Visible = False
    BricsCAD_App.WindowState = 2

End Sub
```

Figure 6.1: Subroutines for the processes to open BricsCAD and draw

Table : 2 Calculations performed for the dimensions to be calculated

Flange Coupling Dimension				
Input Data				
Sr. No.	Parameter	Symbol	Value	Units
1	Force	P	50000	N
2	Yeild Point Strength	Syt	50	N/mm2
3	Factor of Safety	FOS	1.2	
Output Data				
1	Diameter of rod	d	39.10	mm
2	Thickness of cotter	t	11.72943382	mm
3	Outside Diameter of socket	d1	47.30871642	mm
4	Diameter of spigot / Inside diameter of Socket	d2	58.64716912	mm
5	Outside Diameter of spigot coller	d3	68.42169731	mm
6	Diameter of socket coller	d4	93.83547059	mm
7	Distance from end of slot to end of spigot	a	29.32358456	mm
8	Mean Width of cotter	b	62.5569804	mm
9	Thickness of socket coller	c	29.32358456	
10	Thickness of spigot coller	t1	17.59415074	mm

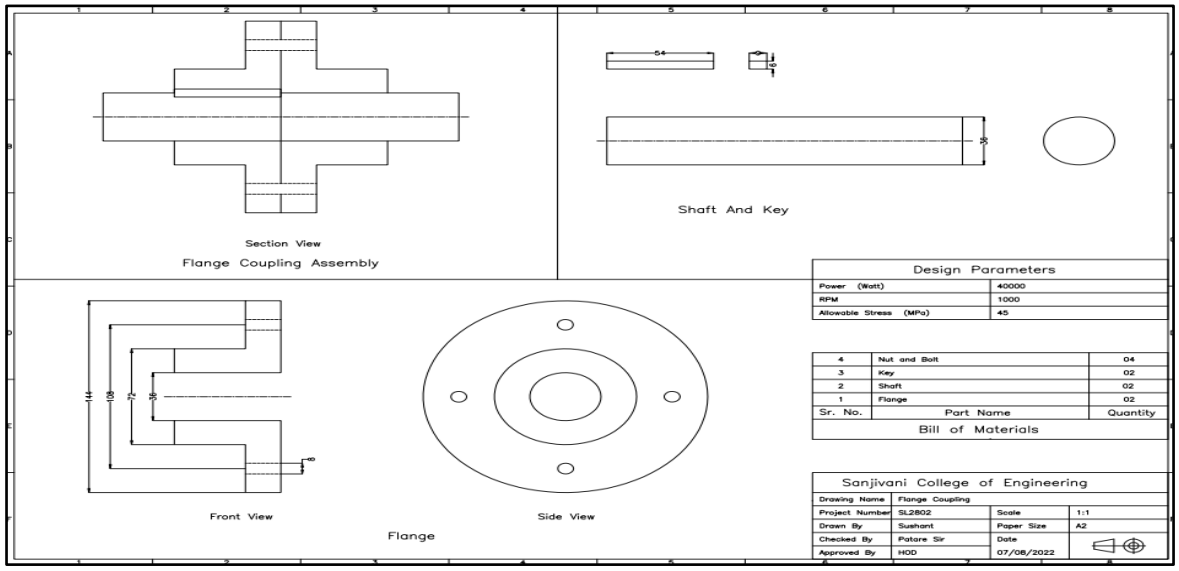

Figure 6.2 : Output Drawing of flange coupling generated by the automation process

RESULTS AND DISCUSSION

By using above developed application, it reduces 80 present time required for overall design process hence significant amount of saving in cost.Using this application just 1 minute is required for design calculation process and generating updated versions of CAD models hence overall cost reduction is 70 to 75%. As there is no 100 percent design and drawing automation is achieve. In this 30 minutes required for drawing sheets checking because design is based on customer requirement and the generated drawing PDF can be exported directly to plotter or the printer for the manual printing or the checking section, similarly the the drawing file can be exported into number of differentexportible formats compatible for various devices. Here for a Drawing Generation inputparameters are meant to be filled by the user in the form and then when the draw button is pressed the formulaes are been processed and the result drawing is been drawn on the drawing sheet.Hence, we are creating a software application by manipulating 'BricsCAD' i.e. 'AutoCAD' with 'Visual Studio', linking application programming interface (API) in which the front end shows theinput parameters for the user and in the backend will have the internal programming for design. This system allows you to draw and edit digital 2D designs more quickly and easily than you could do manually using AutoCAD /BricsCad. For that purpose AutoCAD provides interoperability with other applications, by using AutoCAD object model, we can create drawings in AutoCAD.

CONCLUSION

1. As customers demand highly customized products, creating a situation where CAD design must be drawn quickly and accurately, almost designing is the first prior task in any manufacturing industry.
2. This plays a vital role to eliminate the long repetitive drawing processes.
3. It helps the Mechanical Design Services Company to reduce the chances of rework and optimize profit by saving time on the product development cycle.
4. Engineers excel in designing components or parts in the CAD software that aid in providing better design quality. Reduction in skilled manpower and establishing design standards CAD Automation software over conventional drafting methods.
5. Industry has very less time to re-engineer existing designs, update drawings & carefully check every detail. so these all things can be eliminated by help of drawing automation by our software.

REFERENCES

[1] Haixiang Jiang and Yanhua Tang (2022), Development of Mechanical Design, Manufacturing and Automation, J. Phys.: Conf. Ser. 2160 012060.

[2] Fang Li (2020) Application of Computer Technology on Mechanical Design-manufacture and Automation, J. Phys.: Conf. Ser. 1648 022050.

[3] Abhishek C. Lad ,A.S.Rao, (2014), Design and Drawing Automation Using Solid Works Application Programming Interface. International Journal of Emerging Engineering Research and Technology Volume 2, Issue 7, October 2014, PP 157-167 ISSN 2349-4395 & ISSN 2349-4409.

[4] Dhaval B. Shah (2013), Parametric Modelling and Drawing Automaton For Flange Coupling Using Excel Spreadsheet. Nirma University. [5]Wei Jia. Research on the development direction of mechanical design, manufacturing and automation [J]. Science and technology information, 2015 (08).

[5] "Design of Machine and Elements" of V.B. Bhandari.