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Automatic Blank Size Calculation of Sheet Metal Drawn Cylindrical Parts Based on NX Platform

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***Abstract*— The Deep Drawing Process in sheet metal Processing, has wide scope for producing cup shaped components for various applications such as fuel tanks of vehicles, fan cowls, side panels of two wheeler vehicles etc. In Deep Drawing Process the raw material is pressed with the Punch & Die assembly to produce the final shape. The raw material in this case is called as 'Blank'. At present the 'Blank' size required for particular components is calculated by formulas available in books. This paper describes the Automatic Blank size calculation by customizing the CAD package for CYLINDRICAL parts to avoid repetitive, time consuming tasks. The research uses the Moment Area Method for calculation of Blank size. The CAD package used here is Unigraphics(NX) & VB.NET API is used to customize the NX. The Program is tested on a cylindrical component as an illustration.**

***Index Terms*— Deep Drawing, Blank, Moment Area Method, NX, Open API.**

I. INTRODUCTION

The sheet metal processing has wide applications in various industries like Aircraft industry, Automobile industry and ship building industry. There are various types of sheet metal processes out of which the Deep Drawing Process is of concern over here. Some examples of the parts processed with Deep Drawing Operation are fuel tanks of vehicles, fan cowls, side panels of two wheeler vehicles. The raw material for Deep Drawing Process is known as BLANK & which is circular in shape. It is pressed with the help of Die & Punch assembly to transform it into final desired shape. The size of the blank required for particular component is calculated by formulas available in books. But calculating the blank size by traditional formulas is time consuming, repetitive task.

This paper aims to reduce this efforts by automating the blank size calculation by customizing the NX software. The moment area method is used to calculate the blank size. This Moment Area Method is formulated into a program. The programming is done in Visual Basic Language. The BLANK is generated graphically & its size is shown by 'infowindow' function of NXOpen.

S Sivakumar et.al[1] developed system for feature extraction, which uses simplified & generalized approach for obtaining the manufacturing information from the CAD model. P Arunkumar et.al[2] developed system based on programming, databases & modelling tools for extraction of features from CAD model. Joze Balic et.al[3] proposed segmentation approach, to partition the surface of the CAD model into regions & each region is treated as separate surface to extract feature out of it. Sreeramulu Dowluru et.al.[4]proposed an algorithm for extracting features like holes, steps etc. from the CAD model. Sreenivasulu Reddy et.al.[5]proposed a system which obtains features by using Boundary Representation details obtained from step file.NAPSIAH BT ISMAIL et.al [7] proposed a system which uses Boundary Representation model of the part& uses logical method for extraction from the part.

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II. DEEP DRAWING OPERTION

Sheet metal Drawing is the process of forming a flat piece of material into a hollow shape by means of Punch & Die assembly. The flat piece of material is called as BLANK. Fig.1 shows the Blank & Drawn parts.

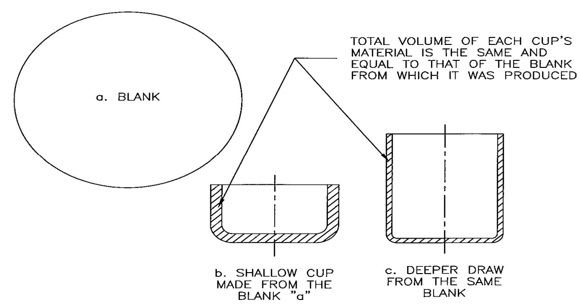


Fig.(1) BLANK & Drawn Parts

III. MOMENT AREA METHOD

A Moment Area Method states that the 'Area of any shape is given by the length of its profile, multiplied by the length of travel of its center of gravity'.

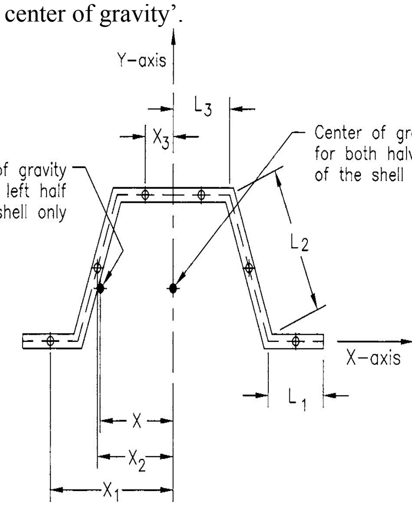


Fig.(2) Moment Area Method

From the Fig.(2) the area according to Moment area Method is given by

$A = 2\pi X (L_1 + L_2 + L_3)$

Where,

L_1, L_2, L_3 are the lengths as shown in fig.(2) &

$X = \frac{L_1X_1 + L_2X_2 + L_3X_3}{L_1 + L_2 + L_3}$ is the Centre of Gravity of whole body.

IV. CUSTOMIZING ENVIRONMENT OF NX

NX provides certain API's(Application Programming Interfaces) through which it can be customized. There is Grip Programming. Knowledge Fusion & NX Open API's defined for NX. Out of above all the NX Open is the most powerful tool & it is widely used.

NX Open API's:

The API's defined for NXOpen, which are as follows.

A. NX Open For C++API[6]:

Open C++ is an object oriented interface to NX. It can take the benefit of all the features like polymorphism, inheritance & encapsulation. It provides access to all classes defined for NXOpen. The API is capable of extending the functionality of NX as per the customers requirement as it has access to classes, methods defined for NXOpen. It helps to extend the functionality by writing the custom applications. It also provides fully extensible data model which allows user to to define new object that can be trusted like standard NXObjects.

1. NX Open for Java API[6]:

The Java API provides a programmatic access to NX like any other API according to industry standard of Java language. Recording the journal and editing it, is possible by using Java API.

2. NX Open for .NET API [6]:

NX offers an API for use with Microsoft's.

NET framework. Built on the Common API, this interface provides programmatic access to NX core application functionality, making it possible to create advanced automation programs using any of the.NET-compliant languages, including Visual Basic .NET and C#. Because the API is built on the .NET framework, users can take full advantage of all the benefits provided by that framework.

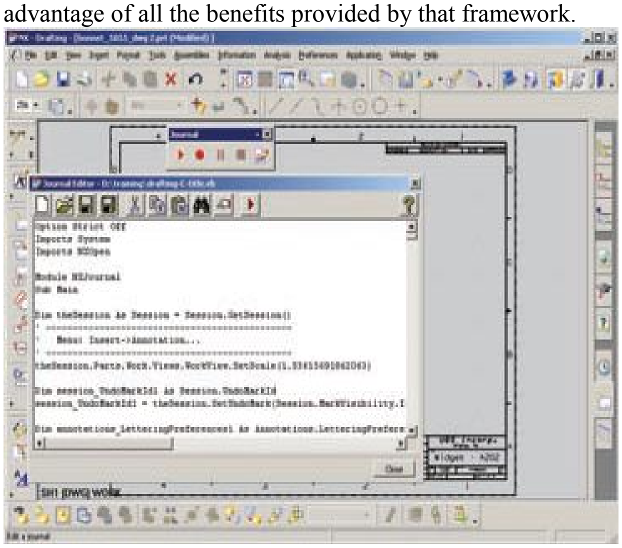


Fig.(3) Customizing Environment of NX

Out of above mentioned API's this paper has used the VB.NET API. For Accessing the functions, classes defined for NX Open the object library can be used as reference as shown in fig(3). The VB.NET API provides the most useful property called as an 'Intellisence' property which shows the programmer the available classes, properties, methods. This property of VB language proves to be dominating over other languages or API's. As a result VB.NET API proves to be a versatile API to extend the functionality of NX by creating the custom applications as per the customer's requirement.

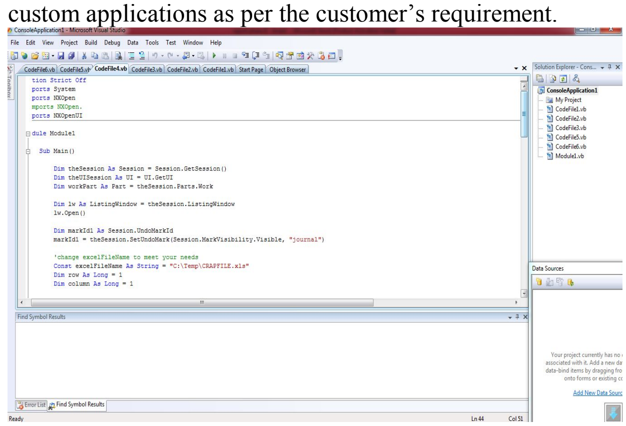


Fig. (4) Programming screen for NX

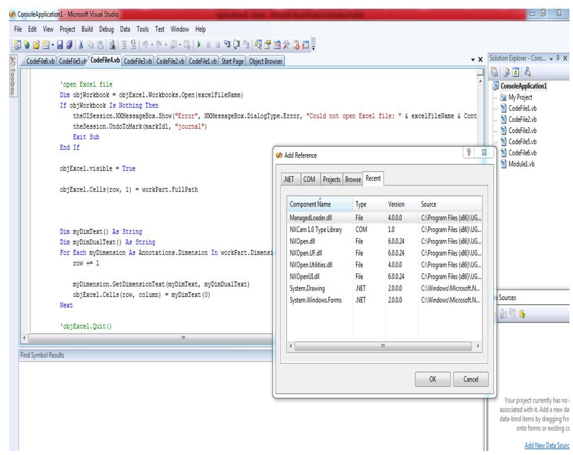


Fig. (5) Adding NX References to VB

Application of moment area method to cylindrical parts

As discussed above the Moment Area Method uses a 2-D sketch to calculate its center of gravity. The 3-d CAD model can be converted to 2-D sketch simply by hiding its features. This is based on a fact that in any CAD package, 3-D model is generated by adding features to 2-D sketch.

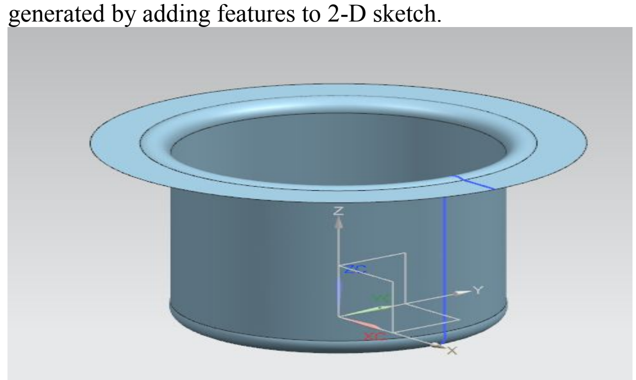
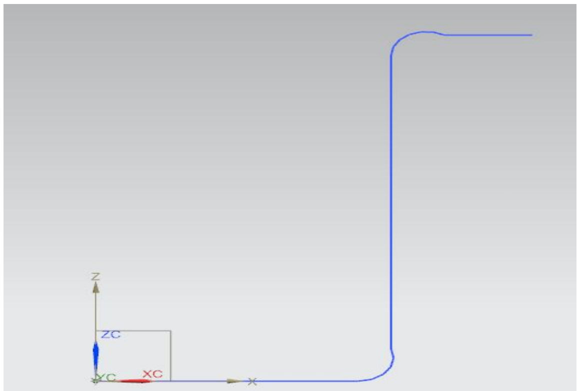
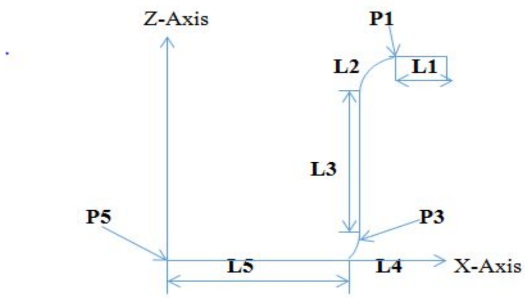


Fig.(6) 3-D Model of Drawn Cylindrical Part



Fig(7) 2-D Sketch

Above 2-D cad be divided into lines and arcs as shown in fig(8)



Fig(8) Lebelled 2-D sketch

The ctentre of gravity of above part can be written as

$$X=\frac{X1L1+X2L2+X3L3+X4L4+X5L5}{L1+L2+L3+L4+L5}$$

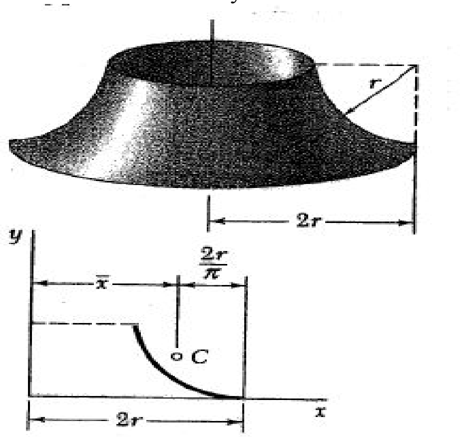
Where ,

L_1, L_2, L_3, L_4, and L_5 are the respective lengghts and X_1, X_2, X_3, X_4, X_5 are the centre of gravity respectively as shown in fig.(8)

Calculation of Centre of Gravity of line.

The center of gravity of a line lies at its midpoint[9].

Calculation of Centre of Gravity of Individual arc.



C.G is given by formula

$C=2r-2r/\pi$[9]

From above two cases the centre of gravity of sketch mentioned in fig (7) are shown below:

X_1 = x coordinate of P_1 +0.5*L_1

$X_2 = P_{1x} - P_{1x}/\pi$

$X_3 = P_{3x}$

$X_4 = p_{3x} - P_{3x}/\pi$

$X_5 = P_{5x} + 0.5*L_5$

Where

P_{1x}, P_{3x}, P_{5x} are the x coordinates of line 1, 3, 5 respectively. L_1, L_2, L_3, L_4, and L_5 and $P1x$, P_{3x}, P_{5x} are obtained programmatically. The area of blank is calculated by the formula

$$A=2\pi X(L_1+L_2+L_3+L_4+L_5)$$

And the diameter is calculated by formula

$$D=2\sqrt{\frac{A}{\pi}}$$

The BLANK is generated graphically by programmatic access to NX.

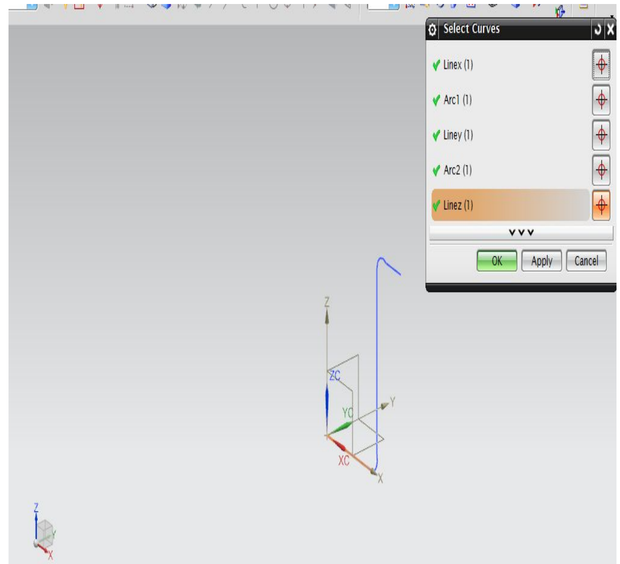


Fig.(9) NX Dialog Box to Select Lines

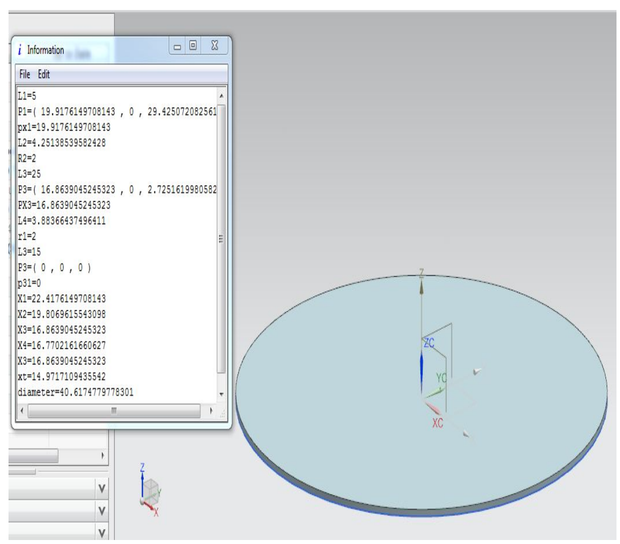
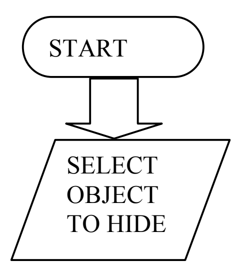
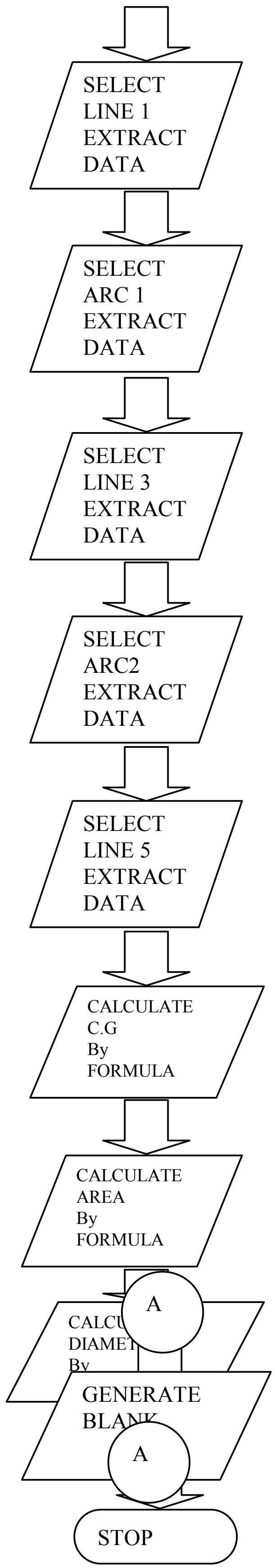


Fig.(10) BLANK generated & Data Shown

ALGORITHM





Results and Discussions

The program was operated on the cylindrical Drawn part it. After execution, it generated a dialog box which asks user to select lines and arcs from which data is to be extracted and which is given as input to the formulas mentioned above to calculate the diameter of BLANK & generate the BLANK graphically. The total time saved as a result of automation was found to be 70.4% over the traditional practice.

Conclusion

The paper presents a computerized 'Automatic BLANK calculation of cylindrical Drawn parts'. This approach has eliminated the repetitive time consuming tasks. The approach has reduced the time required to calculate the BLANK size by 70.4% over traditional calculation calculations.

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