Automated Weight-Roll up for Pipe Fabrication Drafting

Author : Thirumugam Alaguperumal
Company : Tata Consultancy Services Ltd
Email : thirumugam.a@tcs.com
Phone : +91-44-5550 4006

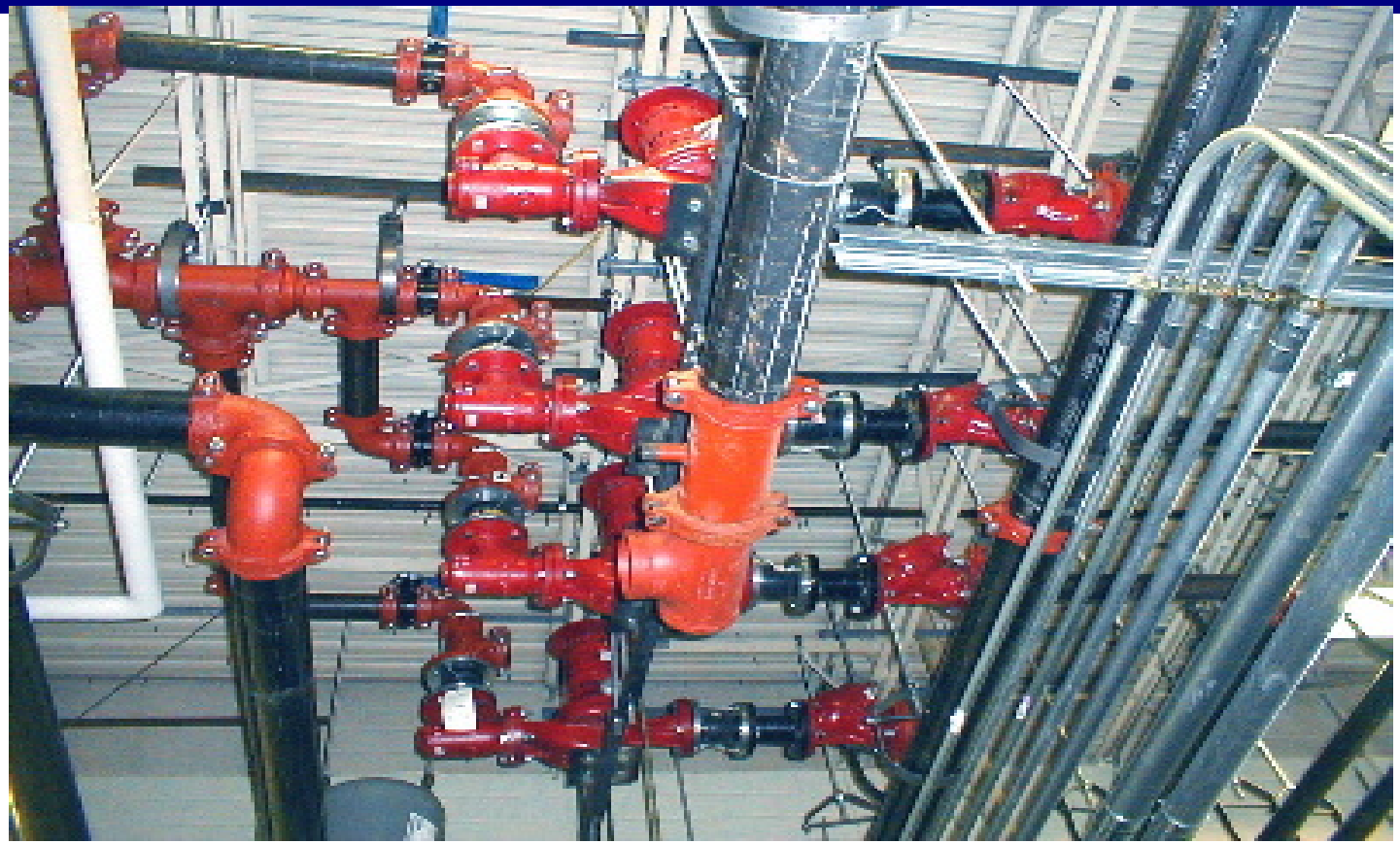
Acknowledgement

- I wish to thank sincerely to Mrs. ***Manikodi Rathinam***, Manufacturing CoE lead, Tata Consultancy Services Ltd. for her encouragement on this paper submission.

- I also wish to thank profusely Mr. ***Balasubramanian Kasiviswanathan***, PLM consultant, Tata Consultancy Services Ltd. He obliged me with a number of suggestions and ideas for the completion of this presentation.

- I am grateful to Mr. ***Suresh Ramanujam,*** Modeling and Drafting Consultant, Tata Consultancy Services Ltd. for his support in creating the tool to achieve the required output.

Piping Systems



- **Piping systems are vital accessories of the heavy industries like power plants, chemical, oil and gas industries and so on**

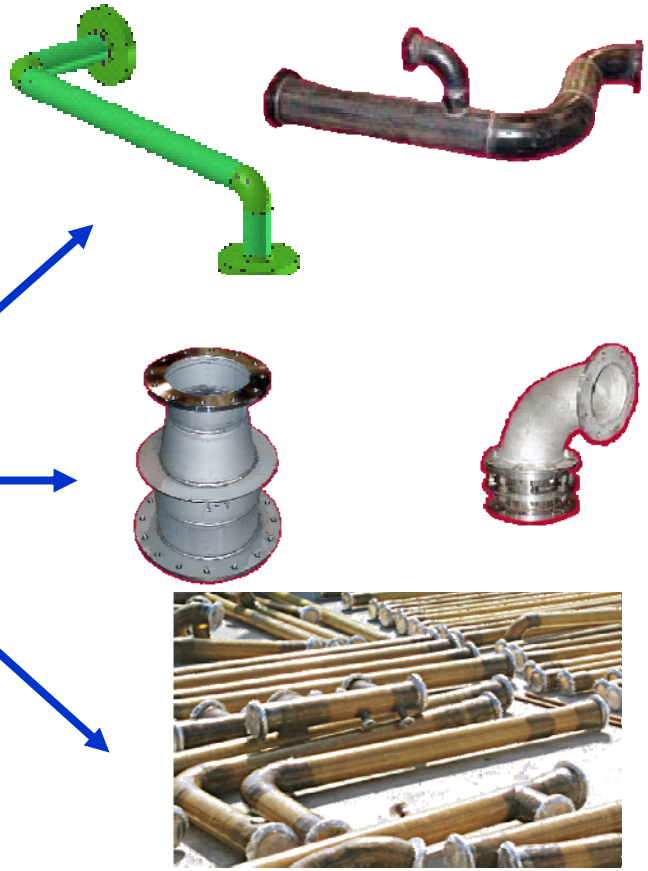
- **Piping systems convey fluids like water, oil, gas, liquids, chemicals and so on from one point to another**

Piping Arrangements

- **Piping arrangements are classified into systems based on their applications like Fuel piping, Drain piping, Exhaust piping, Fire Protection piping and so on**

- **Based on the fluids, piping systems are classified as Gas piping, Lube oil piping, Compressed air piping, CO_2 piping and so on**

Pipe Fabrication

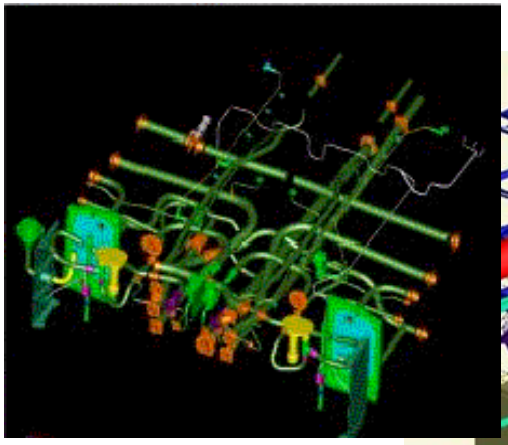
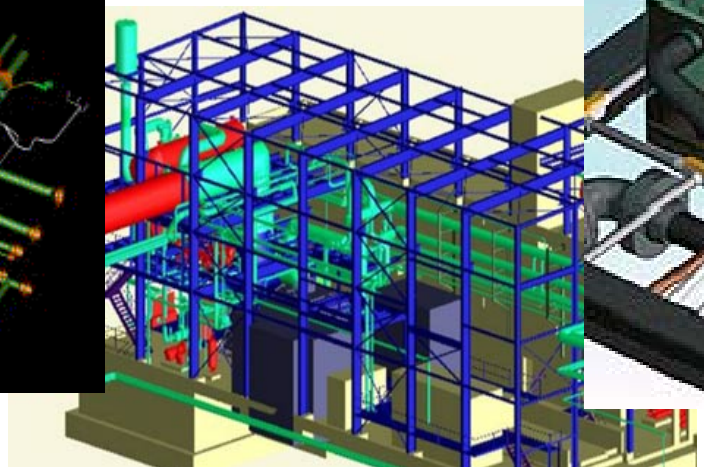
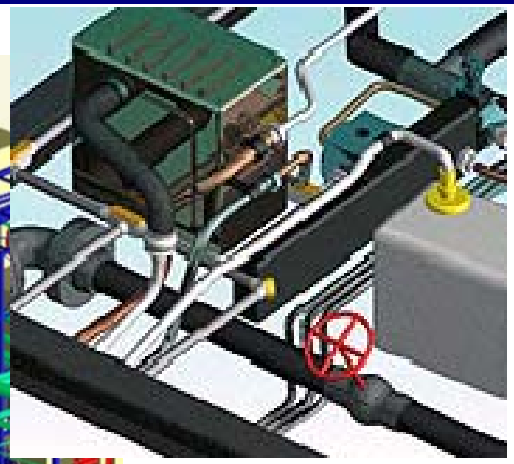


- **Piping assemblies include several piping fabrications**
- **Pipe fabrication contains fittings like flanges, elbows, outlets, pipe stocks, and so on**
- **For example, approximately 180 pipe fabrications in power plant contain gas, oil, air and water piping systems**

Importance of Pipe Fabrication

- Easy to manufacture and assemble at site
- Can be sourced to various suppliers and complete the installation on time
- Convenient for shipping
- Easy to handle

UG Routing

- UG Routing Application – Productive module to design piping, tubing, structural, wiring, conduits and so on
- Routing piping module - To create large piping assemblies
- UG routing creates Pipe fittings and stocks and store their unit weight and material information as attributes within UG

Attributes of a Pipe Stock - Example

Information

File Edit

```
Featurable                FALSE
Component Stock           FALSE
-------------------------------------------------------------
Routing Characteristics
NPS                       = 4.000000
DIAMETER                  = 4.000000
PIPEOD                    = 4.500000
WALL_THK                  = 0.237000
WEIGHT                    = 10.960000
MEMBER_NAME               rou_pip009328
SCHEDULE                  40S
MATERIAL                  ASTM A312 TP304L
PART_NUMBER               rou_pip009328_19
PART_NAME                 piping_stock
DESCRIPTION               "PIPE                    4""NB              40S"
APPLICATION               Routing Mechanical
-------------------------------------------------------------
```

Attributes of Fittings - Example

Information

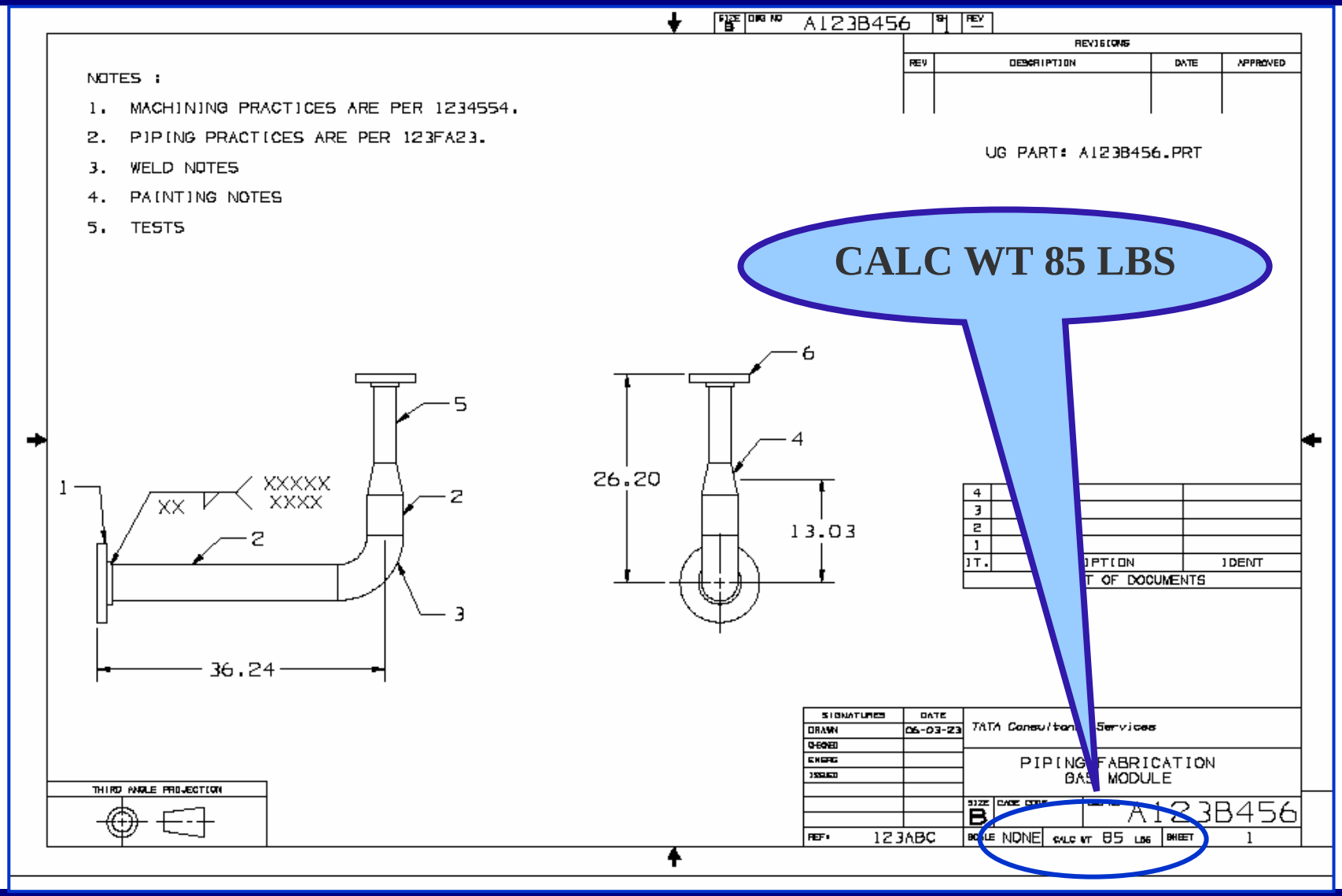
File Edit

```
Routing Characteristics
NPS                    = 4.000000
DIAMETER               = 4.000000
NPS_OUT                = 4.000000
PIPE_OD                = 4.500000
WALL_THK               = 0.237000
FLG_OD                 = 10.000000
FLG_THK                = 1.250000
INS_LEN                = 1.880000
WEIGHT                 = 22.000000
MEMBER_NAME            rou_pip001895
FACE_TYPE              RF
FLANGE_MATERIAL        ASTM A182 F304L
MATERIAL               ASTM A182 F304L
CLASS                  300
FLANGE_TYPE            NORMAL
PART_NUMBER            rou_pip001895_02
PART_NAME              pipe_flg_so
UNIFIED_NUMBER         UNKNOWN
REMARKS                NIL
REFERENCE_SET          SOLIDS
DESCRIPTION            "FLANGE RF/SO        4"" x 4""NB   CL 300"
GENDER                 FEMALE
CONNECTION_TYPE        FLANGE
ROUTING_LEVEL          0
-------------------------------------------------------------
```

Pipe Fabrication Drawing

- Pipe fabrication drawings are generated with dimensions, manufacturing information, tests to be performed, welding details and so on
- Weight of pipe fabrication is placed in the title block of drawing for shipping and cost estimation

Pipe Fabrication Drawing - Example

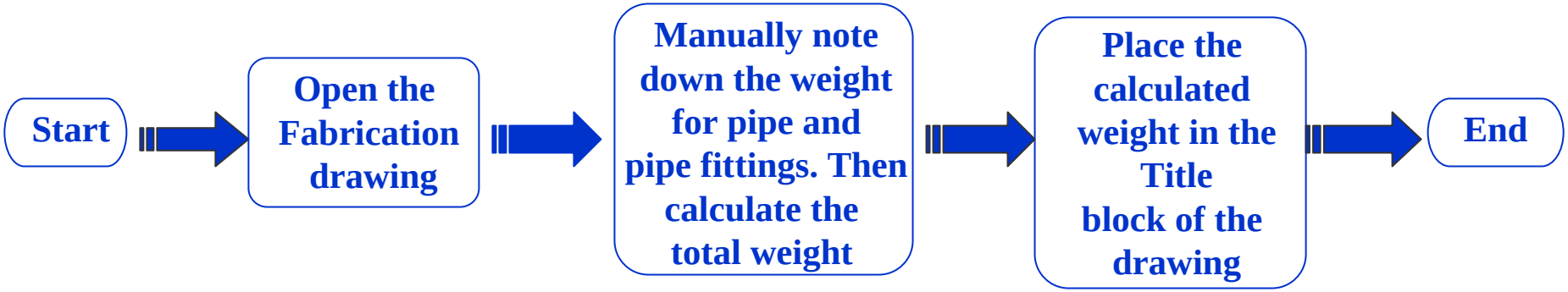


Pipe Fabrication Weight Estimation – Manual Process

1. Measure the length of pipe stocks
2. Find the unit weight of pipe stocks from attributes
3. Find the weight of each pipe fitting from the 'Info' option in UG
4. Add the weights of pipe stocks and fittings to provide the total weight of pipe fabrication
5. Place the total weight in the title block of drawing

Manual Weight Calculation - Demo
Placing Weight in Drawing - Demo

Process Flow - Manual



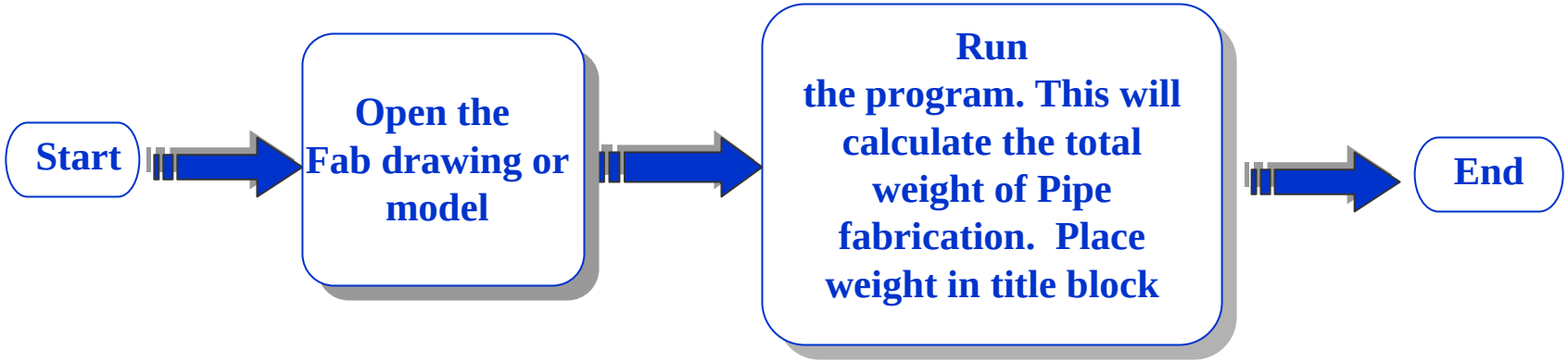
Problems In Manual Process

- Difficulty while calculating weight for huge and complex piping systems
- Estimation and Cross checking is more time consuming
- More errors due to manual work
- Fatigue due to repeatable work
- There will be a chance of getting at least 6 errors per pipe fabrication

Approach

- A new tool “total_wt.dll” has been created using UG/Open (Ufunc) program
- Program will measure the lengths of each pipe stock
- Unit weight of each component and pipe stock is taken from their attributes
- Total weight is calculated using the above data
- The units are converted to suit to the drawing, if the unit of the components or pipe stock is different
- The weight is automatically placed in the title block of the drawing

Process Flow - Present



Automated Weight Calculation - Demo

Unique Features of the Tool

- Works in both Metric and English unit Unigraphics files
- Identifies the components without weights in their attributes, prompts for input from the user and calculates total weight
- Calculates the weight of a component added at any level of assembly
- Works in native UG V18 and NX2 and Team Center Engineering (TCE) V9.1 environment

Weight Calculation (Attributes without weight details)- Demo

Benefits

- Increased Productivity
- Quality in Delivery
- No fatigue

Savings Estimation

A gas piping systems in a power plant contains approximately 30 pipe fabrications. A pipe fabrication contains 4 to 6 pipe segments and around 10 fittings. The savings by the automation for an entire power plant is estimated as follows:

Before Implementing the program

- **Time spent for calculating Pipe and Pipe Fitting = 13.5 Min**
- **Piping Fabrication Drawings per power plant = 180**
- **Time spent per plant = (13.5 * 180)/60 = 40.5 Hrs**
- **Piping design completed for 18 plants/Year = 40.5*18 = 729 Hrs**

After Implementing the program

- **Time spent for calculating Pipe and Pipe Fitting = 0.22 sec**
- **Time spent per power plant = (0.22 * 180)/60 = 0.66 Hrs**
- **Time spent per year = 0.66 * 18 = 11.88 Hrs**

- **Savings per year = 729 - 11.88 = 717.12 Hrs**
- **Effort in developing the tool = 40 Hrs**
- **Return On Investment per year = ((717.12 – 40)/40)*100 =1692.8%**
- **Cycle Time Reduction = ((13.5-0.22)/13.5)*100 = 98. 4%**

Questions?