PARAMETERIZATION OF DIRECT TYPE DRIVE WHEEL ASSEMBLY OF AN APRON CONVEYOR USING PRO/PROGRAM

KANNAN .T[1], SREEHARAN .B.N[2]
[1]Kumaraguru College of Technology, Coimbatore, INDIA
[2]Vignani Technologies, Coimbatore, INDIA
Email : [1]kannan_kct@yahoo.com

Abstract

It is necessary to reduce the manufacturing lead time for every product to compete in the global market. There is a potential for time saving in the Computer Aided Drafting process. In the modeling process, the design can be automated by using parametric modeling technique. This paper presents about parameterization of a direct type drive wheel assembly of an Apron Conveyor using Pro/PROGRAM, a feature in Pro/ENGINEER Wildfire 3.0 software by controlling the geometrical parameters. This work is intended to reduce the overall modeling time of an assembly. This process is significantly simplified by reducing the number of modeling steps. This reduces the modeling errors and improves the product quality. The end user need not have design skills or knowledge of using complicated CAD systems.

Keywords: Parameterization, Pro/PROGRAM, Pro/ENGINEER Wildfire 3.0, Direct type Drive Wheel Assembly, Modeling time.

I. INTRODUCTION

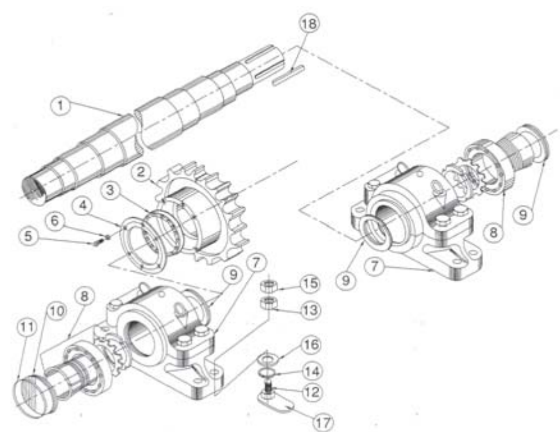
In this competitive world, time-to-market for the products is becoming shorter. It is necessary to introduce new products or models of existing products as quickly as possible to maintain the competitiveness in the global market. If time-to-market takes too long to model a product then it will be hinder through competition. Competitors will be able to control the market through getting their products out faster.

There is a potential for time saving in the design stage. In design stage, the modeling process is repeatable for some designs, which can be captured and standardized. This can be done by parameterization technique using parametric modeling. This technique can be used for different configurations of the same assembly. Each specifications of the assembly have its own modeling approach with all the geometrical parameters. This can be pre-defined at the design stage itself. This ensures that the required specifications can be loaded very quickly without remodeling. This reduces the modeling time and makes modeling procedure very simple and easy, which will increase the productivity of the designing process.

This work presents by a direct type drive wheel assembly of an Apron Conveyor using Pro/PROGRAM, a feature in Pro/ENGINEER Wildfire 3.0 software by controlling the geometrical parameters.

Direct type Drive Wheel Assembly

The direct type drive wheel assembly with all its parts are shown in Fig. 1.



Part No.	Description	Part No.	Description	Part No.	Description
1	Drive Shaft	7	Plummer Block	13	Hexagonal Nut
2	Sprocket Assembly	8	BRG S. R. + AD. Sleeve	14	Locknut Washer
3	Locking Assembly	9	Seal Group	15	Locknut - Hex
4	Plate Cover	10	Cover	16	Washer Machined
5	Hexagonal Screw	11	O – Ring	17	Strip Lock
6	Lock Washer	12	Hexagonal Bolt	18	Key

Fig. 1. Direct type Drive Wheel Assembly of an Apron Conveyor

II. METHODOLOGIES

Methodologies adopted for this work is as follows:

- Initially data related to the direct type drive wheel assembly were collected and tabulated.

- Modeling of the parts and subassemblies were carried out using parametric modeling techniques using family table approach along with relations.

- A program has been developed for parameterization. This was done in two stages. First stage was the creation of planes for the assembly of the parts. Final stage was the assembly of parts over their respective planes.

Parametric Modeling

Part drawings used for the direct type drive wheel assembly have been collected from the industry and standardized. It has been identified that for direct type drive wheel assembly three models were available. They are T – 13, T – 23 and T – 50. Further, data for different configurations of direct type drive wheel assembly were collected based on the pan width.

Parts and its code numbers of direct type Drive Wheel Assembly for Model T – 50 is tabulated in Table 1. Similarly data were collected for other models.

Table 1. Parts of Direct type Drive Wheel Assembly for the Model T – 50

Parts	Pan Width	
	2000 mm	2250 mm
Conveyor Drive Wheel Assembly	TB 2126	TB 0103
Conveyor Drive Shaft	TB 2116	TB 0084
Sprocket Assembly	TB 2225	TA 6864
Locking Assembly	TA 3240	TA 4216
Plate Cover	TB 2512	TA 6713
Hexagonal Screw	TA 3997	TA 3997
Lock Washer	TA 1233	TA 1233
Plummer Block Assembly	TB 2236	TA 4221
Spherical Roller Bearing	TB 2115	TA 3650
Seal Group	TB 2340	TA 3636
Cover	TB 2496	TA 3639
O – Ring	TB 2337	TA 3640
Hexagonal Bolt	TA 3336	TA 4134
Hexagonal Nut	TA 3317	TA 3841
Lock Washer	TA 2697	TA 0477
Lock Nut	TA 3318	TA 2633
Washer	TA 3351	TA 1379
Strip Lock	TA 6371	TA 6371
Key	---	TB 0726

Now-a-days three dimensional models of the components are used in various stages of manufacturing processes such as design, drafting, manufacturing, and so on. It is a time-consuming process. The most current CAD/CAM/CAE software utilizes a parametric design feature[1,2]. This is the method of linking dimensions and variables to part geometry in such a way that when the values change, the part and the drawing change as well[2].

Parametric modeling is accomplished by identifying and creating the key features of the design with the aid of computer software. The design variables, described in the sketches and features, can be used to modify the design quickly [3]. The implementation of parametric modeling in industrial and design enterprises reduces redundant labor work by the creation of interactive databases. Designers can now just edit these databases rather than redesigning the models [4]. By parameter modeling, the process of modeling the products, it is very easy to modify characteristics of the products such as the size and the designs represented [5, 6 and 7].

Family Table

In this work, using parametric modeling technique available in Pro/ENGINEER Wildfire 3.0 software along with family table feature, parts of the direct type drive wheel assembly were modeled. Family Tables are collections of parts (or assemblies or features) that are essentially similar, but deviate slightly in one or two aspects, such as size or detail features [8]. Fig. 2 and 3 show the family table and modeling of locking assembly using family table respectively. Similarly, other parts and subassemblies were modeled using the above procedure.

Parametric Relation Building

Parametric relations are user-defined equations written between symbolic dimensions and parameters. Relations capture design intent by defining relationships within features or parts, or among assembly parts. In this work, relations were formed for the direct type drive wheel assembly based on the location of subassemblies as shown in Fig. 4.

Location of subassemblies changes with respect to pan width. Relations between the pan width and location of subassemblies such as sprocket assemblies, bearing assemblies, and the drive shaft have been studied and tabulated.

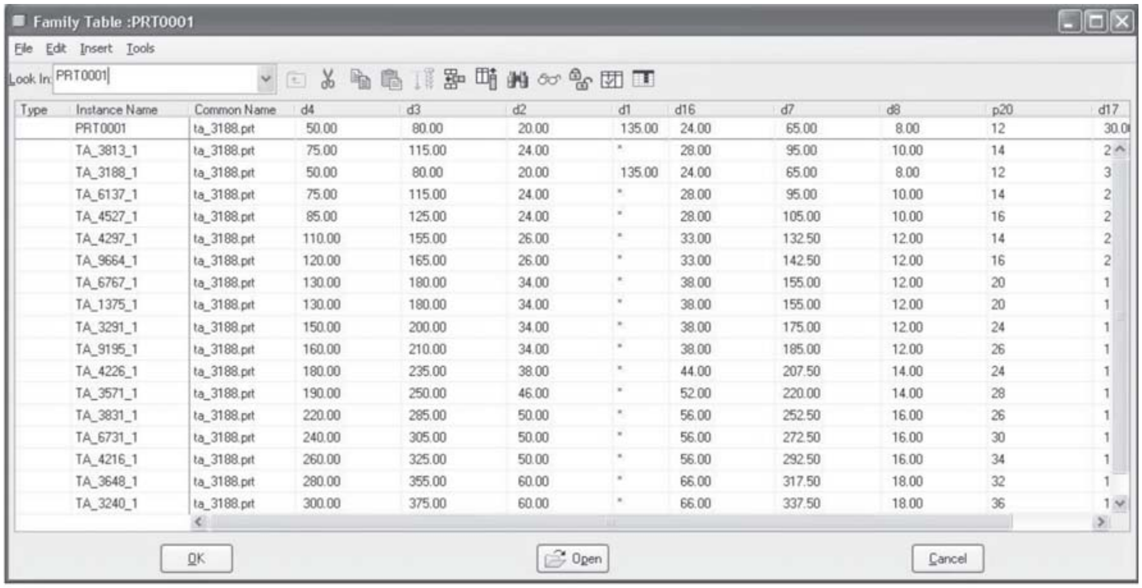


Fig. 2. Generation of parts using family table

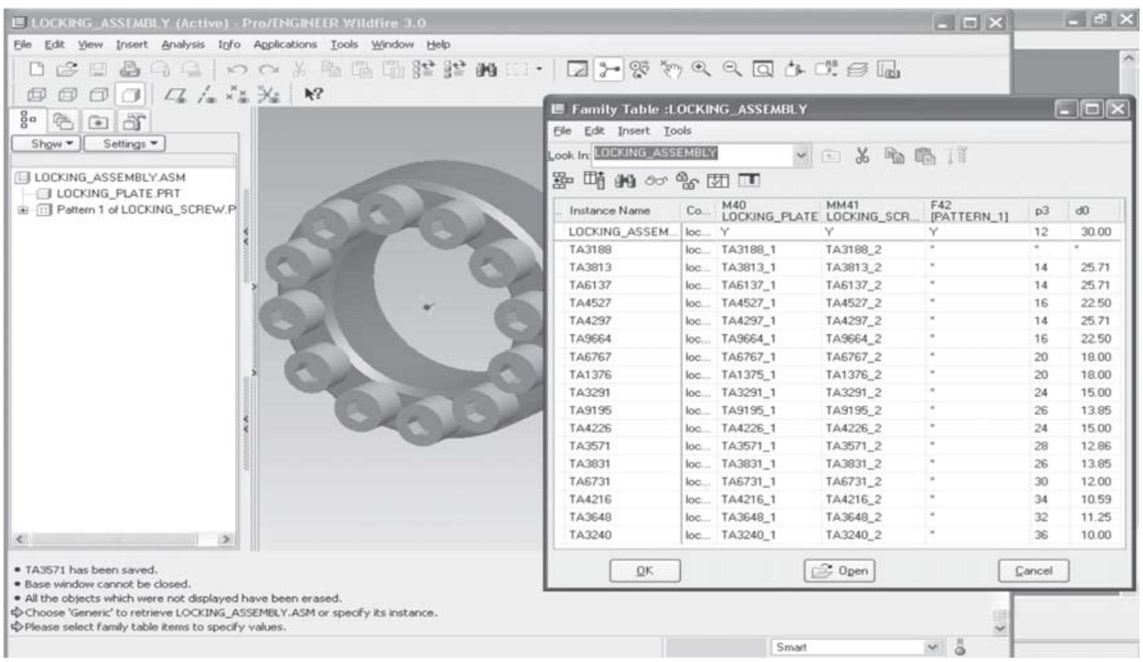


Fig. 3. Modeling of Locking Assembly using family table

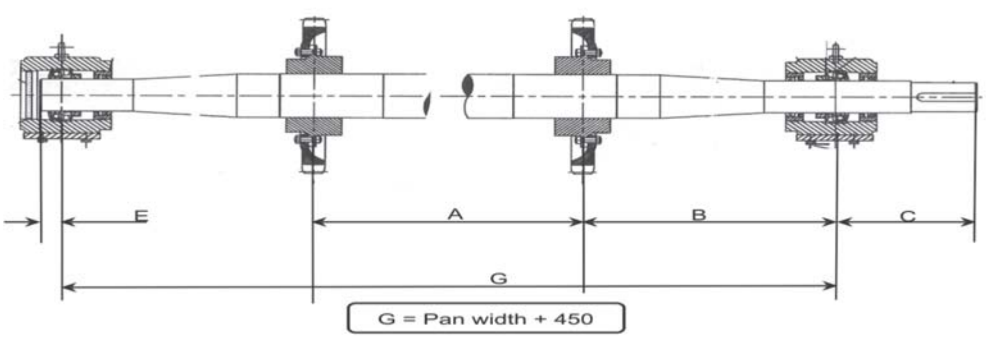


Fig. 4. Relation for location of subassemblies in Direct type Drive Wheel Assembly

Table 2 shows the location of subassemblies in terms of millimeter for Model T – 50.

Table 2. Location of Sub-assemblies for Direct type Drive Wheel Assembly of Model T – 50

Parameters	Pan Width		
	1500 mm		1700 mm
	Type – 1	Type – 1	Type – 1
A	880	880	990
B	535	535	580
C	300	350	350
E	45	45	50

III. PROGRAMMING

The programming for direct type drive wheel assembly was done by using Pro/PROGRAM.5.1 Pro/PROGRAM

Each model in Pro/ENGINEER contains a listing of major design steps and parameters that can be edited to work as a program. By running the program, it is possible to change the model according to new design specifications.

Assembly Program

The programming for assembly process was done in the following two stages.

- First stage - Creation of planes for the assembly of the parts.
- Final stage - Assembly of parts over their respective planes.

The relations for the programming were executed simultaneously [9].

Inputs

Based on the user requirements, inputs were decided and program is developed. The following were the inputs to direct type drive wheel assembly:

- Pan width
- Bearing Assembly Number
- Sprocket Assembly Number
- Counter Shaft Extension
- Coupling Diameter
- Coupling Length
- Number of Keys
- Key Number

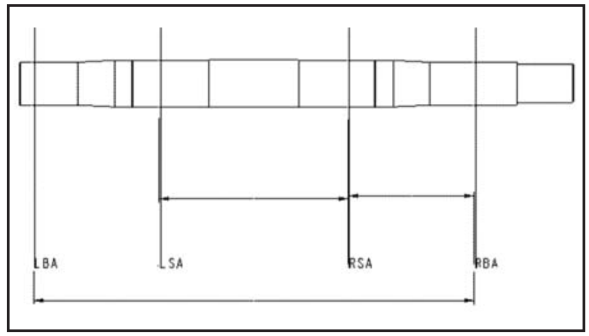


Fig. 5. Relations for location of Sprocket and Bearing assemblies (A & B)

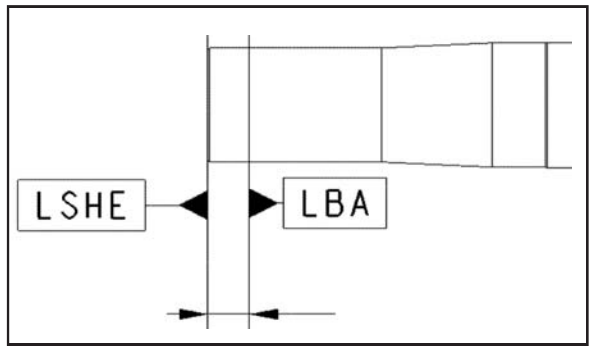
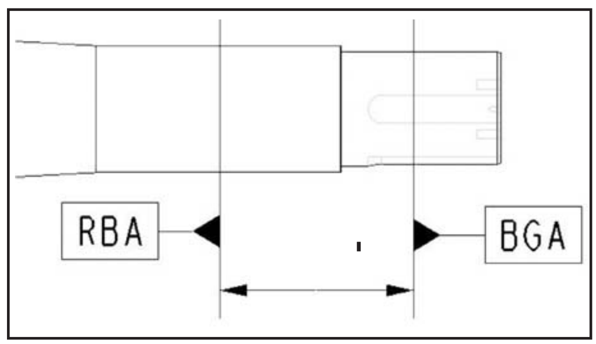
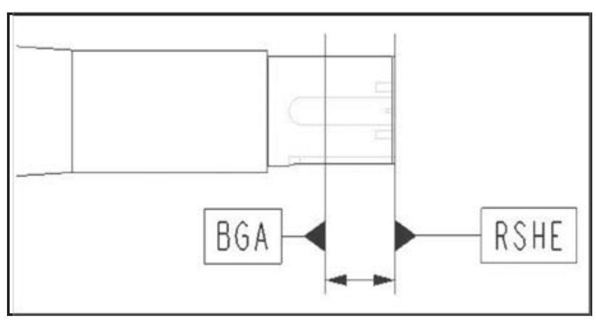


Fig. 6. Relation for location of Drive Shaft (E)



(a)



(b)

Fig. 7 Relation for location of right end of shaft

First Stage

In the first stage of assembly programming, initial part of a program was developed for the creation of planes required for subassemblies and parts which are to be assembled at their respective locations. This was done based on the relations formed in earlier stages. Calculations of these various design relations parameters, viz. A, B, C and E are explained as follows and also are shown in Fig. 5 to 7.

Calculation of 'A' and 'B'

- PAN_WIDTH < 800 D1 = 550/2
- PAN_WIDTH > 800 & PAN_WIDTH <= 1000 D1 = 550/2
- PAN_WIDTH > 1200 & PAN_WIDTH <= 1400 D1 = 880/2
- PAN_WIDTH > 1400 & PAN_WIDTH <= 2600 D1 = 990/2
- PAN_WIDTH > 2600 D1 = 1430/2
- D2 = 2 * D1
- D3 = ((PAN_WIDTH + 450) - D2) / 2
- D4 = PAN_WIDTH + 450

Calculation of 'E'

- BEARING_ASSEMBLY_NO == "Tb2115" D5 = 45
- BEARING_ASSEMBLY_NO == "Ta1387" D5 = 60
- BEARING_ASSEMBLY_NO == "Ta3650" D5 = 50

Calculation of 'C'

- D6 = COUNTERSHAFT_EXTENSION - (D30/2)/* D30 = COUPLING LENGTH
- D8 = D30/2

The following axioms and guides [10] were adopted during the modeling and building the relations.

Axioms and guidelines adopted for design parameterization

Axiom 1: Maintain the independence of design intents

Axiom 2: Minimize the information content of the design intents.

Axiom 1 implies that changing the dimension of design variables has an effect only on the corresponding design intent. In other words, it is desirable to uncouple the design intents whenever possible. Axiom 2 states that the amount of information (number of dimensions) available to engineer for capturing the design intent must be minimized.

Final Stage

In the final stage of programming, remaining part of the program was developed based on the above relations, so that respective subassemblies along with other parts will be assembled at their respective locations.

A program thus has been developed, for parameterizing the drive wheel assembly of the apron conveyor. Completed direct type drive wheel assembly is shown in the Fig. 8. Using the program it is possible to assemble automatically the various configurations of direct type drive wheel assembly with minimum modeling time.

IV. CONCLUSION

Following are the conclusions arrived from this work:

- A Pro/PROGRAM has been developed for different configurations of direct type drive wheel assembly. It has been estimated that modeling time of assembly takes about 36 hours before implementing this work now it has been estimated that it takes about only 3 hours to generate the drive wheel assembly.
- Modeling process is significantly simplified by reducing the modeling procedures.
- Modeling errors are reduced due to fewer user interactions resulted from the automatic modeling program. As a result, the quality of the product is enhanced.

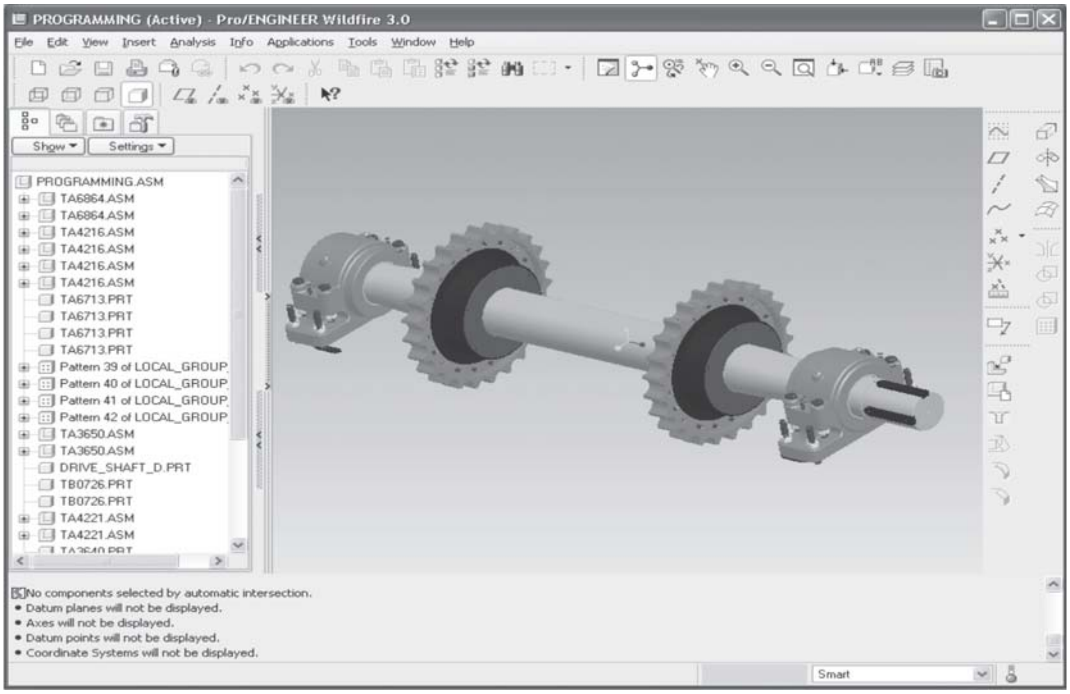


Fig. 8. Modeled Direct type Drive Wheel Assembly

- The end user need not have design skills or knowledge of using CAD systems.
- The complexity of the modeling is hidden from the user.
- Modeling time is very much reduced. Hence, productivity is increased.
- The introduction of this technology significantly enhances the efficiency of the modeling process.

REFERENCES

[1] Abdel-Malek K, Zou H.L, Wang J. Y, Othman S, 1999, "Automated Design and Parameterization of Mechanical Part Geometry", Research in Engineering Design, Vol.11, pp. 206-217.

[2] Kim Yeoung-il, Kim Li-ra, Jun Cha-soo, 2006, “Parametric Design of a Part with Free-form Surfaces”, Journal of Zhejiang University SCIENCE A, Vol. 7(9), pp.1530 – 1534.

[3] Bor-Tsuen Lin, Shih-Hsin Hsu, 2007, “Automated Design System for Drawing Dies”, Journal of Expert Systems with Applications, (In Press).

[4] Alexander N. Inozemtsev, Dmitry I. Troitsky, Mark W, McK. Bannatyne, 2000, “Parametric Modeling: Concept and Implementation“, Fourth International Conference on Information Visualisation (IV'00), pp. 504.

[5] Vasiliki Stamati, Ioannis Fudos, 2005, “A Parametric Feature-based CAD System for Reproducing Traditional Pierced Jewellery”, Journal of Computer-Aided Design, Vol. 37, pp. 431–449

[6] Edwin Hardee, Kuang-Hua Chang, Jian Tu, Kyung K. Choi, Iulian Grindeanu, 1999, “A CAD-based Design Parameterization for Shape Optimization of Elastic Solids”, Advances in Engineering Software, Vol. 30, pp. 185–199.

[7] Kuang-Hua Chang, Sung-Hwan Joo, 2006, “Design Parameterization and Tool Integration for CAD-Based Mechanism Optimization”, Journal of Advances in Engineering Software, Vol. 37, pp. 779–796.

[8] Alberto Jose and Michel Tollenaere, 2005, “Modular and Platform Methods for Product Family Design: Literature Analysis”, Journal of Intelligent Manufacturing, Vol.16, pp. 371-390.

[9] Lin Y. J. and R. Farahati, 2003, "CAD-Based Virtual Assembly Prototyping – A Case Study", The International Journal of Advanced Manufacturing Technology, Vol. 21, pp. 263-274.

[10] Chih-Hsing Chu, Mu-Chi Song, Vincent C. S. Luo, 2006, "Computer Aided Parametric Design for 3D Tire Mold Production", Journal of Computers in Industry, Vol. 57, pp. 11–25.

Kannan .T has published more than 90 papers in various Journals and Conference Proceedings. He has authored 3 books. He has been awarded Foremost Engineers of the World 2008 (UK) and 21st Century Award for Achievement (UK). He is a life member of Indian Welding Society, Indian Institute of Welding, Indian Institution of Industrial Engineering, Indian Society for Technical Education and Society of Automotive Engineers. His research interests include Surface Engineering, Welding Process Optimization and Simulations.