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Manpower Planning in a Transformer Manufacturing Firm: Application in Risk Management

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Abstract

The paper presents a graphical approach to man power study in which a function is generated by the time study of the transformer. This function is divided into variable and constant portions. The variable part confers upon the KVA & Voltage Ratio, which changes from transformer to transformer, but the basic four processes are the same throughout the whole process. Man power needs are different for each transformer and are accordingly distributed with reference to the function derived from the graph between sum of KVA (Kilo Volt Ampere) and Voltage Ratio. The time study for manufacturing gives a separate man power planning functions for each section of the transformer and hence it will be very beneficial for manpower calculation and risk analysis of transformer where industry specifications are tight and deadlines are rigid with ever soaring competitors. The proposed model is tested by the historical data available for each section and hence it was found that this type of approach will be very helpful for development of time standards for any particular firm and can be useful for the other firms as a benchmark for increasing efficiency against the leaders of the market.

Keywords: Risk management, Risk planning, Manpower planning and Risk assessment

JEL Classification: L6, L94, O21, O22

Paper Classification: Research Paper

Introduction

Risk related to on time delivery in case of assembly line based manufacturing system is a very crucial factor, especially in assembly lines of technically sensitive, costly and customized product like transformer, where each unit manufactured is a project in itself. Power transformers are very useful for power transmission on large scale and hence the time for project completion in such an assembly line set up is really important and since the size of project is very large, no enterprise which is in installation wants the extra responsibility of having a transformer being constructed at their workshop. Since it requires great skill and resources to manufacture, enterprises go for suppliers, through a tender system and hence the competition is high with the involvement of big players. So cutting edge in work schedule can prove to be profitable for the firm bagging the tender. Such a situation is very competitive and hence the time of project completion needs to be really perfect, so that on time delivery factor can be accurately cited in the tender.

Delays are not permissible as they attract heavy penalty since whole multimillion dollar project of transmission line will be jeopardized. So prediction of manpower requirement and labor cost has to be perfect. Therefore, the present study comes up with a superior prediction method that can be really fruitful for a transformer manufacturing company. An approach is being developed that will give a function for the total man power needed for any transformer, which is generated with the help of time study of the transformer manufacturing process. This mathematical model generates the total man hours needed for any particular section. The model will generate a line of regression and the standard error of the estimate will tell the manufacturing time related risks involved in the assembly line.

So the main benefit of this paper is the exact calculation of time to be needed for manufacturing of each section of the transformer, which is directly related with efficiency of this costly instrument. There is a dire need for such a system since during the project tenure several problems regarding delay in delivery pop up and once the prediction is correct, the profit will rise. Such problems are always present on account of any power sector firm, more so ever, sometimes a transformer can be in service for more than then twenty five years working at an efficiency of more than ninety five percent hence it has to be perfect in all technical aspects and parameters.

It will prove really beneficial for marketing department in fetching the costly project for the firm by having a cutting edge over delivery time prediction accuracy, which is dynamically and amazingly important for risk reduction in power projects in ever expanding electrical grid system in India. In near future, power projects are to be increased at exponential rate as per the Government plan to add thousands of Mega Watts in existing capacity number of transformers will be needed for that prospective increase in power generating and transmitting capacity and hence will benefit the whole nation.

Literature Survey

For analyzing the man power requirements and the risk associated in such an assembly line the case study of a major electrical power transformer manufacturing firm have been taken, in which the technical sensitivity is high and provision of customization needs to be exact. Manpower planning is a major discussion in production floor. This study firstly tries to develop equation for manpower assessment and later on, the error is determined by comparing it with historical data available with the firm. Recent studies on the management of operational problems in project based or non-project based systems in leading industries have been studied extensively (Pajares & López, 2014; Christoph & Konrad, 2014; Serpella, Ferrada, Howard & Rubio, 2014; Ihuah Hussein & Klakegg, 2014; Acebes, Pajares, Galán & Paredes, 2014; Tenera & Pinto, 2014; Papadaki, Gale, Rimmer, Kirkham, Taylor & Brown, 2014; Binder, Aillaud & Schilli, 2014; Obradovic, Jovanovic, Petrovic, Mihic & Bjelica, 2014; Purnus & Bodea, 2013; Sheykh, Azizi & Sobhiyah, 2013; Maravas & Pantouvakis, 2013; Pinheiro, Machado & Tamanini, 2013; Pinto & Dominguez, 2012; Abdullah & Rahman, 2012; Alias, Baharum & Idris, 2012; López & Salmeron (2012); Wang & Li (2011); and Greenberg, Gauvreau, Telleen, Finley & Marsteller, 2011).

Importance to Manpower planning

Wong, Chan and Chiang (2007); Tang, Wilson and Perevalov (2008); and Wu, Zhang, Shamsuzaman and Wang (2007) have all given importance to manpower planning as it is one such aspect which allows for maximum efficiency and reduces the operating cost. The manpower planning is very important aspect for management of long term reduction of operating cost and hence it is one of the most important aspects of operations management. Existing literature stresses on the need of having a forecasting model for man power planning which according to Wong et al. (2007) mainly depends on many interrelated economic activities. They have suggested vector error correction model for manpower forecasting purposes and have identified labor productivity and output demand as the major factor governing demand for manpower. Other authors like Tang et al. (2008) have developed a simulation model that study the relationship between manpower planning and distance travelled and also between staffing level and percentage of serviced customers. In this study, square root law is used in order to have model verification, the overall relationships mark that risk can be lowered in the man power planning if the assessment is rightly done. Similarly Yan et al. (2006) have evaluated the manpower planning for fluctuating air cargo industry in which constraints are also considered in order to have right man power deployment and hence reduction in risk related to man power planning, All the developed strategic models are used as integer or mixed linear programs and are solved using a mathematical programming solver. Wong et al. (2007) have also devised vector error correction method for manpower planning and have confirmed it against various statistical parameters. The model is based on forecasting and then factors are taken out by the help of multivariate analysis, these factors are then embedded into model and are then verified statistically. Wu (2007) has devised fuzzy logic approach for manpower allocation problem, a computer model is applied which gives optimized cost and hence risk can also be reduced. Wu et al. (2007) talk about a statistical process control system that monitors a multistage manufacturing system and controls the man power requirements. This system also works on the ability to minimize the total man power cost and hence will be helpful in risk reduction also, since lower cost means exact man power assessment and hence less ambiguities due to risk. Similarly in this study, the manpower prediction reduces the risk involved in production line.

The importance of manpower planning in assembly line. The assembly line system is studied in many ways for increasing its efficiency, with different techniques and methodologies (Akturk & Erhun, 1999; Altiok & Ranjan, 1995; Gupta & Al-Turki, 1997; and Herer & Shaolom, 2000. The study of manpower planning is also assisted for such systems by the study of Wingaard (1993) in which the aggregation for such assembly lines is done. Fuzzy network can also be used for man power allocation and assessment for certain organizations (Wu, 2007). However, due to inherent complications in assembly line and non-automated labor intensive nature of transformer assembly line as in this case, conventional man power measurement tool like time study to assess work measurement has been used.

Manpower planning for transformer or related assembly line based systems. Corominas and Pastor (2010) have devised annual working hour's theory in order to have cushion for the risk management in the longer run. Stability of the scheduling of working time is also considered as an objective and will improve the quality and productivity and hence manpower variations will be less. Performance measurement is another aspect of assembly line system which needs to be studied for efficiency and risk calculation. Different studies have given different point of views (Mascolo, Frein & Dallery, 1996; Menches & Hana, 2006; and Neelv, Gregory & Platts, 2005). All the above stated studies have shown considerable importance to be given to performance assessment in manufacturing systems and in this study the performance is measured by the means of time study.

Guerry and Feyter (2011) have studied the push pull based man power planning approach shown in transition matrix and hence it allows to manage the Eigen values which are used to optimize the man power value and therefore, clipping the variations generated due to risks in assembly lines.

Research Methodology

The objective of the study is to analyze the existing manpower through time study and to compute the risk related to manpower requirements of the department by the time study generated function for man power prediction of transformer manufacturing.

Type of Study

Time study is a work measurement technique for recording the time and rate of working for the elements of any specified job carried out under pre specified conditions and for analyzing the data so as to obtain the time necessary for carrying out the job at a defined level of performance, whereas Manpower Planning which is also called as Human Resource Planning consists of applying right number of people, right kind of people by the right place, right time, doing the right things for which they are suited for the achievement of goals of the organization.

Method of Data Collection

At the firm selected for study, no proper method was being followed for manpower prediction of Transformer department. Transformer section is having really great difficulty in handling orders since each one is a different one and needs to be customized. Each transformer manufactured unit under goes same basic procedure of broadly classified sections such as, (i) winding; (ii) assembling; and (iii) tanking.

Each of the above mentioned sections perform the same function more or less but on a different scale on different transformers, so the study can develop a tailor made man power prediction system for the same. On seeing the order book, it can very well be said that a really wide variety of transformers are needed to be made.

Variables Studied

The amount of work hours mainly depends on the two factors:

MVA Rating. Mega Volt Ampere is the power measuring unit in which the total power transported is denoted by the product of current and voltage. These two aspects are important as they relate to power bearing capacity of the line.

Voltage Ratio. This particular ratio denotes the voltage ratio between primary and secondary coil of the transformer. It allows introducing the voltage regulatory ability of the transformer which indicates the winding criteria and at a specific MVA ratio it shows the dimensions of the transformer as a whole.

Along with this, there are many other factors like order time, place of installation, but they mainly depend on the design factors to be decided on the drawing board.

Hypotheses and Statistical Tools Used

The major hypothesis is that the time taken for manufacturing a power transformer is directly dependent on the manpower planning related parameters. The main statistical tool used is time study based MS Excel sheet for manpower planning.

A transformer (power) with a long life span of 20-22 years, needs about six months to be manufactured. Therefore, it needs a lot of work to be done on the assembly line, most of which is done manually. Hence a lot of scope for improvement is there. Order completion time can also be reduced if the work can be done with the help of a pre – defined formula which gives more accurate man power to be devoted to each transformer. With the exact work hours required for manufacturing a transformer in hand, the present study can develop a better way for man power planning according to the needs.

Case Analysis

The study divides the assembly line of transformer into four basic sections as shown in the Figure 1.

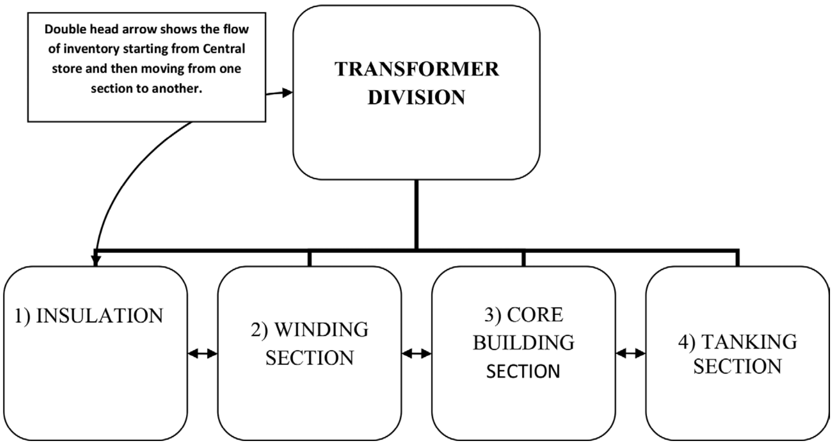

Figure 1. Assembly Line of Transformer Section

To conduct the study following data sheets are used-

- Time study sheet of each section of the transformer (core building, insulation, winding and tanking).
- Comparison between actual data and calculated data sheet.

Primary data source is the time study table that has been prepared for each section. Secondary data sources are the record books, dispatch sheet and production reports given by the firm and also by the discussion from the supervisors, which give total time taken for the transformers and other valuable data for the project.

Data Analysis and Discussion

In this study, the data collected from time study is analyzed with respect to different sub sections of assembly line. The study will now discuss here the time study process which includes allowance and rating related discussions for all the three sections of a transformer one by one and for the fourth section that is tanking section, separate function is generated.

Insulation section

The insulation section's time study is based on the following set of allowances and ratings:

Allowances. (i) A constant allowance of 11% has been given to all activities of insulation; (ii) an additional allowance of 3% is given on band saw operators to compensate for working condition; (iii) where ever weights are employed additional allowances have been given accordingly; (iv) in all the cases of hammering another 4% allowance is given; and (v) contingency allowance is 10% for all operations.

Rating. All the ratings are under a range of 85 – 105% since the workers are doing same work for a long time and under supervision with floor supervisors and pre defined work modules a small variation is seen over all in the work process. In the excel sheet, the normal time is given, which is needed for the overall model development.

Insulation section Result (From Online Resource ESM-I)

Grand total of man minutes	16824
Total man hours of insulation section only	277.59

Core Building Process

The core building section's time study is based on the following set of allowances and ratings:

Allowances. A constant allowance of 11% has been given to all activities. Contingency allowances are 15 % in all the activities of core building, therefore altogether 26 % of allowances are to be given. This is based on the samples of work and discussions with supervisors. After 6th step of core making, an additional 4% is being given for recovering from fatigue from lifting of stampings, but only in case of bigger job.

Others. Two workers carry out core building activities in a group. They get help from two workers for material handling. The time standards given in the sheet include two workers only who are carrying out core building. The other two workers supplying stampings are not included. After completion of each step, there is a forced idleness on the two workers. The stampings have to be replaced and removed and new sizes are to be kept, during this period whatever is the idle time has been included in the time given.

It has been observed that quite often the workers have to wait for the use of crane. Sometimes, the time lost is quite large and this should be accounted separately.

It has been assumed that each time the activity of frame preparation is carried out. If this is not carried out in such cases, the time can be accordingly reduced. In the case of 20 MVA transformers, the frequency against each step is shown in Figure 2. This represents two steps of the same size on both halves of the core.

Core Building Result

Grand total of man minutes	12007.4
Total man hours of core build section only	198.12

Coil Winding Section

The coil winding section's time study is based on the following set of allowances and ratings:

Allowances. A constant allowance of 11% has been given to all activities. Contingency allowances are 15 % in all the activities of core building, therefore altogether 26 % of allowances are to be given. This is based on the samples of jobs analyzed and discussions with supervisors.

Others. The coil winding activity for larger jobs involves one operator and one helper. The time given here is only for the operator, the helper is assumed to be given as per the job requirement.

It has been observed that the workers have to wait quite often for the use of crane. Sometimes this element becomes quite large and should be accounted for separately.

The times given do not include time for "coil former assembly". A lot of time is wasted in this. It could be reduced by systematic stacking of the ribs and drums and co-ordination of various production activities. Supervisory staff has to play a very important role in this. In the case of FT-94 coils the time required for preparing cylinders of LV Coil could not have been taken as it is already been done and no new job was in planned programme.

Coil Winding Section Result

The factors on which the total man hours required depend are calculated on the basis of the time taken for various sections and hence the study can divide the model into various sub parts and then give the summation as the total man hours of the complete transformer.

Assumptions. The assumptions are as follows: (i) This whole calculation is for power transformers which are used on 11 kv – 600 kv range; and (ii) Factors on which this value depends are actually different for each section.

Steps of Mathematical Model Derivation

Total man hours of coil winding section only	164.07
Grand total of man minutes	9944.11

1. Initializing the factors, which are actually the different types of jobs that are accounted during the time study of each section.
2. Weights are associated on these factors on the basis of time taken to perform that job by the help of time study.
3. All the factors associated are added up for very section.
4. Now move up to the second section, repeat the step numbers 1, 2 and 3 and repeat the same for all the sections.

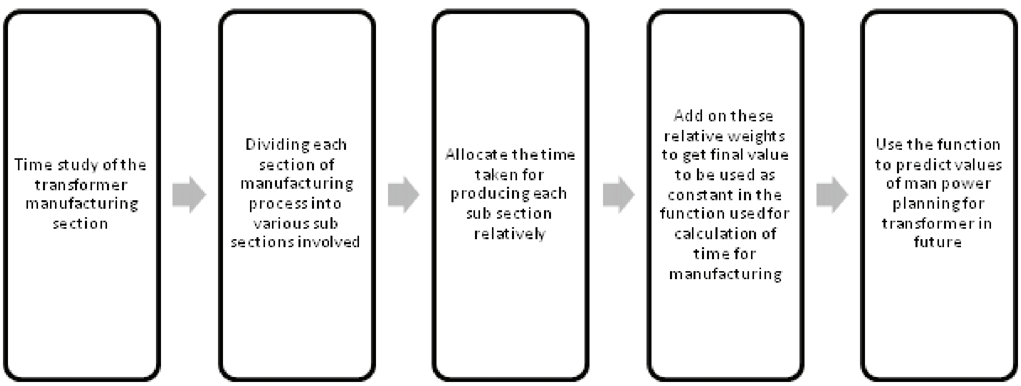

Figure 2. Procedure for model development in risk calculation

5. Then the factors received from all the sections are added and after that the value of constants is calculated by keeping the recorded data value in the relationship derived.
6. Then this formula is validated by the use of pre recorded data and the line of regression can be used to find the variance or risk involved in time taken for manufacturing a power transformer. These steps are also explained in the form of a process diagram shown in Figure 2.

List of variables -

(i) S - Sum of all the factors from each section

(ii) I - Insulation section weights

(iii) Cb - Core building section weights

(iv) Cw - Coil winding section weights

(v) X = Sum of the (MVA rating + V ratio) / 10, Variable portion of power level of each transformer

(vi) T- Total man hours needed for transformer

Therefore, the sum of all the factors in each section is:

$$S= I + Cb + Cw$$

The relative value of constants for a given transformer, based on sub processes which are common in every transformer is been assigned on the basis of relative time they take as come out of the time study

1) For Insulation section (I)

Coil support packing = .058
Main washer = .00539
Main block = .01734
Coil assembly (plain paper) =.006
LV and HV Guard ring = .011
HV Tapping coil guard ring = .0025
Solid key block = .039
Assembly washer = .0103
Block = .00276
Coil assembly plain strips = .015
Angle ring = .0647
LV Load support = .00807
HV Load support = .0066

Total ------------------- .262

2) For Core building section (Cb)

Frame preparation = .1138
Clamping = .0365
Leg packing & stitching = .0369

Total---------------------- .156

3) Coil winding section (Cw)

Cross over coil= .00126
Helical cord= .0344
Helical of coil section= .0286
Disc coil= .0908

Total --------------------- .188

Hence the total value of

I = .262.

Cb =.188

Cw =.156

So SUM (S) =.61 -------- (i)

The overall time taken rises exponentially with the rating of the transformer and hence the constant is to be associated with exponential function. The other factor which is denoted as constant is derived from the historical data of the log books from the firm. On the two basic factors, that is, MVA and Vratio, the study has simply added these factors since both are directly proportional, and divided by ten to present it on an presentable aspect on the graph for man power prediction.

X= Sum of the (MVA rating + V ratio) / 10 -------- (ii)

So the overall function from (i) and (ii) takes the shape of an exponential function (since the overall time taken rises exponentially with the rating of the transformer and this has been derived from the historical data received from the assembly line itself) described below –

$$T = e^{.61X}$$

Where T = Total man hours needed for that transformer to complete the specified sections.

Tanking section

The line of regression obtained from graph, of time study of tanking section given in Online Resource ESM-II (B) is –

TOTAL MAN HOURS (Tanking) = [{(V.R+MVA)*100} +34115]

Overall expression for whole Transformer (all four sections) giving total man hours required is –

$[e^{.61X}]$+ [{(V.R+MVA)*100} +34115] ------------ (III)

The linear equation (III) hence received indicates risk, since the deviation from standard line of regression accounts for level of risk. This deviation is always due to some kind of risk hence this will give us an account of risk in fixed assembly line systems.

The value of error in the equations of all the three sections can be used in the following manner as an indication of risk. One by one, the study will take all the four sections for risk assessment:

Table 1: The average value of error recorded by the use of model

1.	Insulation section	0.927
2.	Coil Winding	8.19
3.	Core Building	6.02
4.	Tanking	-6.3

The average value of error recorded by the use of model is shown in above Table 1. The value of error is the deviation expressed in percentage for each section; this deviation is due to the unplanned conditions which have emerged out due to risks.

Conclusion

The man hours can be calculated in a very lucid manner by the relationship derived. The error calculated are Insulation section .927, Coil Winding 8.19, Core Building 6.02, and Tanking - 6.3 as per the result. Table 1 shows that manpower planning of power transformer can be done very efficiently with the use of these predictive mathematical models and helps as an aid for the industrial engineers working in these assembly line based systems and it also helps in maintain a timely delivery to the client. Hence, the null hypothesis stands rejected.

Significance/Managerial Implications of the Study

These errors specify the level of risks in electrical transformer section. Now, the total man hours of any power transformer can be taken out with the help of the model and the time study results show the time taken in each section. For the other three portions, the results are checked on historical data that was available and is found to be in tune with the model derived.

Limitations and Scope for Future Research

With time study there is always a chance of error in every transformer. This is because most of the work is complex in nature and in spite of allowances, sometimes one wrong step can give rise to variance in the time range. Time study stresses on each and every step which increases the accuracy of the model but in depth analysis is needed to be done for perfect prediction of errors in manufacturing, like the variation is shown in tanking section for a few transformers. The value of risk changes with the MVA rating and V ratio, hence risk mitigation plans need to be different for each order of the transformer that is placed. Due to the presence of a large number of jobs that are done by hand, only the amount of error in prediction is bound to be higher, even if the study has increased accuracy with the help of the line of regression based prediction. Time study for tanking section needs to be more accurate. Since the tanking process is highly customized, therefore prediction with accuracy becomes more difficult and hence the study need to find a satisfactory answer to this problem in future with the help of dedicated study on the same outlines as this one, but for tanking section separately.

Implications

Model for man power prediction in tanking section which can explain the variation in some transformers needs to be developed. The method needs to be worked upon to inculcate the conditions such as, strikes etc, in the calculation of man hours needed by our line of regression based predictions. With the increase in automation, the accuracy of prediction can be increased; hence, the study allows advocating for more use of automated machine shops for manufacturing of transformers. The study is particularly helpful in designing the assembly lines for various transformers units. The power industry depends on them and they are the single most important factor for the development of long range transmission lines. The study allows improving the cost and timing factor related with power transformers. The involvement of factors like manpower planning can drive efficiency in the entire power sector.

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Appendix

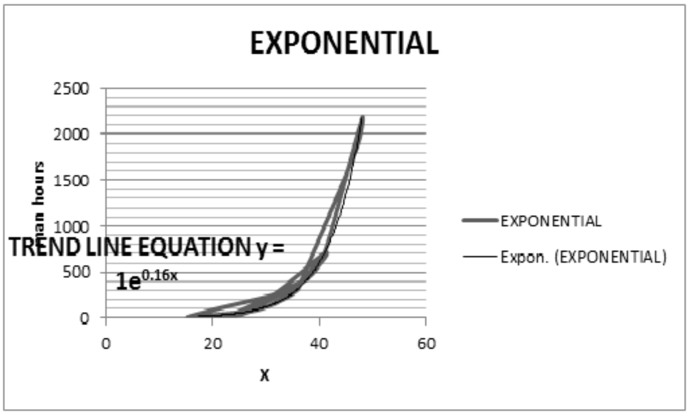

Figure 3. Graph showing Comparison of Model Generated Man-min & Actual Data Man-min with their Linear Line of Regression

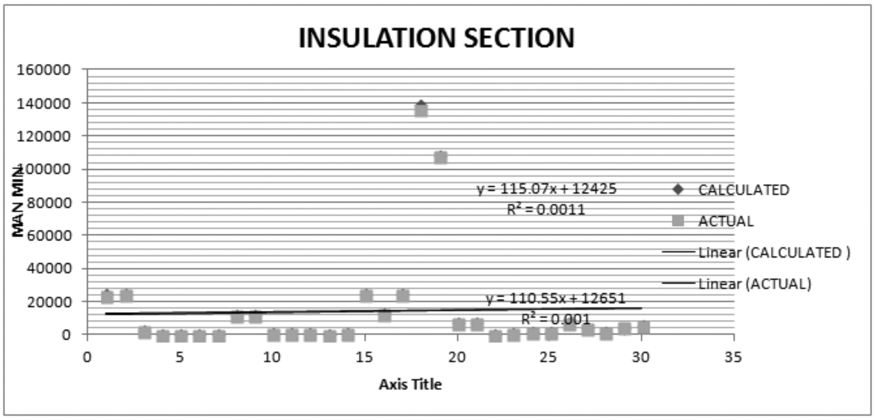

Figure 4. Insulation Section

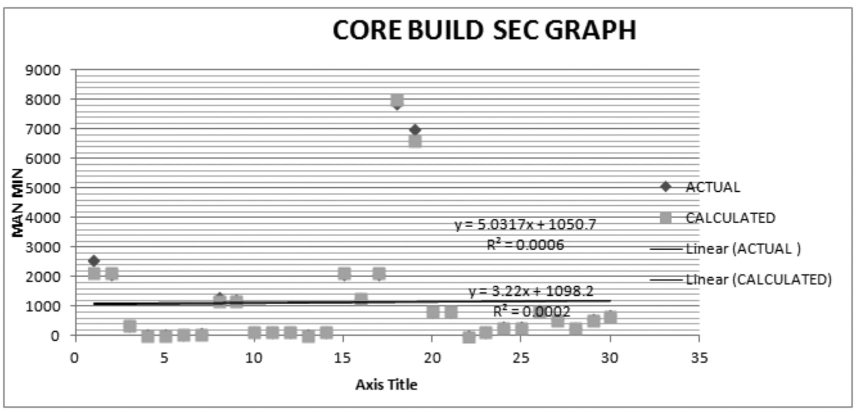

Figure 5. Core Build Section Graph

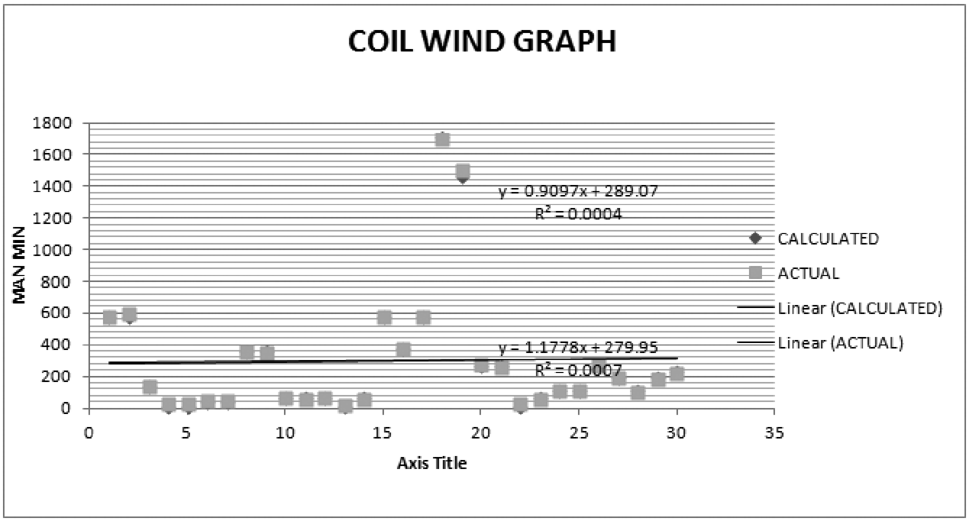

Figure 6. Coil Wind Graph

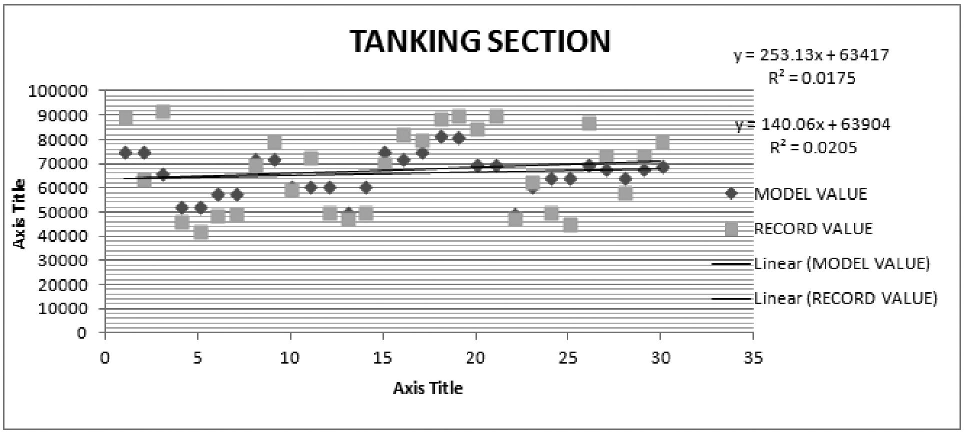

Figure7. Tanking Section

Table 2: APPLYING FORMULA DERIVED IN THE MODEL FOR MAN HOUR CALCULATION OF EACH SUB SECTION OF COIL WINDING SECTION

COIL WIND.				CROSS OVER COIL		HELI-CAL CORD		HELI-CAL CORD		DISC COIL					
Sr no	mva	v ratio	X=(mva+v ratio)\10	X* .00126	EXP^ .00216	X* .0344	EXP^.0344	X* .0286	EXP^ .0286	X*.0908	EXP^.0908	TIME FOR	ACTUAL	ERROR	% ERROR
												WIND SEC	VALUES		
1	180	230	41	0.05166	1.0530177	1.4104	4.09759411	1.1726	3.230381	3.7228	41.3801	576.7794744	585	8.220526	1.4052181
2	180	230	41	0.05166	1.0530177	1.4104	4.09759411	1.1726	3.230381	3.7228	41.3801	576.7794744	598	21.22053	3.5485829
3	100	220	32	0.04032	1.0411439	1.1008	3.00657032	0.9152	2.497275	2.9056	18.27621	142.867839	140	-2.86784	-2.0484564
4	50	132	18.2	0.02293	1.023197	0.62608	1.87026475	0.52052	1.682903	1.6526	5.220327	16.81198458	36	19.18802	53.300043
5	50	132	18.2	0.02293	1.023197	0.62608	1.87026475	0.52052	1.682903	1.6526	5.220327	16.81198458	34	17.18802	50.552987
6	20	220	24	0.03024	1.0307019	0.8256	2.2832503	0.6864	1.986551	2.1792	8.839232	41.32385764	50	8.676142	17.352285
7	20	220	24	0.03024	1.0307019	0.8256	2.2832503	0.6864	1.986551	2.1792	8.839232	41.32385764	50	8.676142	17.352285
8	160	220	38	0.04788	1.0490448	1.3072	3.69581094	1.0868	2.964772	3.4504	31.51299	362.2302285	360	-2.23023	-0.6195079
9	160	220	38	0.04788	1.0490448	1.3072	3.69581094	1.0868	2.964772	3.4504	31.51299	362.2302285	354	-8.23023	-2.3249233
10	50	220	27	0.03402	1.0346053	0.9288	2.53146959	0.7722	2.164523	2.4516	11.6069	65.80001064	70	4.199989	5.9999848
11	50	220	27	0.03402	1.0346053	0.9288	2.53146959	0.7722	2.164523	2.4516	11.6069	65.80001064	59	-6.80001	-11.525442
12	50	220	27	0.03402	1.0346053	0.9288	2.53146959	0.7722	2.164523	2.4516	11.6069	65.80001064	66	0.199989	0.3030142
13	30.24	132	16.224	0.02044	1.0206526	0.558106	1.74735917	0.464006	1.590433	1.4731	4.36291	12.37518725	22	9.624813	43.749149
14	50	220	27	0.03402	1.0346053	0.9288	2.53146959	0.7722	2.164523	2.4516	11.6069	65.80001064	64	-1.80001	-2.8125166
15	180	230	41	0.05166	1.0530177	1.4104	4.09759411	1.1726	3.230381	3.7228	41.3801	576.7794744	580	3.220526	0.555263
16	180	203	38.3	0.04826	1.0494414	1.31752	3.73414919	1.09538	2.990319	3.4776	32.38321	379.4785221	384	4.521478	1.1774682
17	180	230	41	0.05166	1.0530177	1.4104	4.09759411	1.1726	3.230381	3.7228	41.3801	576.7794744	581	4.220526	0.7264244
18	80	400	48	0.06048	1.0623464	1.6512	5.21323195	1.3728	3.946385	4.3584	78.13202	1707.66121	1700	-7.66121	-0.4506594
19	50	420	47	0.05922	1.0610086	1.6168	5.03694627	1.3442	3.835117	4.2676	71.35019	1462.379233	1500	37.62077	2.5080511
20	140	220	36	0.04536	1.0464045	1.2384	3.4500889	1.0296	2.799946	3.2688	26.27978	265.6447793	278	12.35522	4.444324
21	140	220	36	0.04536	1.0464045	1.2384	3.4500889	1.0296	2.799946	3.2688	26.27978	265.6447793	260	-5.64478	-2.1710689
22	21.6	132	15.36	0.01935	1.0195421	0.528384	1.69618905	0.439296	1.551614	1.3947	4.033716	10.82352061	35	24.17648	69.075655
23	50	220	27	0.03402	1.0346053	0.9288	2.53146959	0.7722	2.164523	2.4516	11.6069	65.80001064	62	-3.80001	-6.1290494
24	85	220	30.5	0.03843	1.039178	1.0492	2.85536591	0.8723	2.392407	2.7694	15.94906	113.2196797	115	1.78032	1.5481046

(Continued...)

25	85	220	30.5	0.03843	1.039178	1.0492	2.85536591	0.8723	2.392407	2.7694	15.94906	113.2196797	118	4.78032	4.0511189
26	140	220	36	0.04536	1.0464045	1.2384	3.4500889	1.0296	2.799946	3.2688	26.27978	265.6447793	274	8.355221	3.0493506
27	120	220	34	0.04284	1.0437709	1.1696	3.2207041	0.9724	2.644283	3.0872	21.91563	194.8129758	201	6.187024	3.0781215
28	85	220	30.5	0.03843	1.039178	1.0492	2.85536591	0.8723	2.392407	2.7694	15.94906	113.2196797	110	-3.21968	-2.9269816
29	120	220	34	0.04284	1.0437709	1.1696	3.2207041	0.9724	2.644283	3.0872	21.91563	194.8129758	185	-9.81298	-5.3043113
30	130	220	35	0.0441	1.0450869	1.204	3.33342399	1.001	2.721001	3.178	23.99871	227.4885711	224	-3.48857	-1.5573978
														MEAN	8.1969038

Authors' Profile

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