AN INVESTIGATION OF DELAYS FOR HUSKPACK SHELL TYPE BOILER THROUGH WORK SAMPLING

Abhijit S. Getme, Assistant Professor,G H Raisoni College of Engineering, Nagpur, and , Shyamkumar D. Chavhan Assistant Professor,G H Raisoni College of Engineering.

Abstract

This paper presents the proportions of various activities identified through work sampling. An investigation was performed on the various types of activities performed under the standard operating procedures defined in a preparatory shop of boiler manufacturing industry. Work sampling has been used as a tool to measure the various proportions of activity levels. It is favored for being less costly, easy to adopt, and able to provide quick information. This work sampling study has tried to distinguish between various types of activities performed on the shop floor in a preparatory shop of a boiler manufacturing industry. This paper proposes a research framework for analyzing the trend over time periods as day wise analysis, shift wise analysis and hour wise analysis.

Keywords: Work sampling, Work Study, Productivity Improvement , Process Cycle Time.

1. INTRODUCTION

Manufacturing productivity becomes the point of discussion quite often in industries in India and in many cases it becomes the most important point of concern. Traditionally, various research studies have defined productivity to suit a specific purpose for the fabrication industry, at either the economic, project, or activity level. Productivity can be generally defined as the "amount of goods and services produced by a productive factor in a unit of time". The most common productivity metrics are: unit rate (ratio of labour cost to units of output); labour productivity (ratio of work hours to units of output); and productivity factor (ratio of scheduled or planned to actual work hours). At the project level, many inputs combine to produce the deliverables, including labour, material, equipment, tools, capital, and design However, today's manufacturing projects involve such complex production processes, that, often, determinations of productivity relate a single input to a given output. In this study, work study results have been used to analyze the manufacturing trend in various ways. One research approach in developing strategies to improve manufacturing productivity is to start at the workface, or crew-level, and determine how to make the crew's performance better. Such efforts require the development of productivity models, which consider the different subjective and objective factors affecting productivity. Existing work-study data collection methods related to crew-level manufacturing productivity include: work sampling (activity sampling), field rating (five-minute rating), rated activity sampling (work

measurement sampling), process analysis, time-lapse (memo-motion) photography, time studies, synthesis from standard data, predetermined motion time systems, comparative and analytical estimating, a method productivity delay model, and simulation modeling .

1.1 WORK SAMPLING

Work sampling (WS), originally developed by Leonard Tippett in 1927, has typically been used to measure standard work times in industrial processes. Its key objective is to determine how the workforce uses its work time, by establishing the direct, support, and delay (ineffective) work-time proportions. Some advantages of Work Sampling include its suitability for activities that are non-repetitive and not easily quantified. It is also simple, requires minimal resources to conduct, and provides quick results. As a procedure, it is less intrusive as compared to other work studies, such as time-lapse photography, and stresses on crew-level measurements. In this study it has been used to identify the trend over time slots over a period of 15 days. Recently several studies have demonstrated its application to productivity improvements. However, since Work Sampling studies do not measure actual output, it does not assess actual labour productivity. Some assumptions have not properly addressed the effects of support work, nor have they established a clear link between the level of direct work and productivity.

1.2 Work Study

One of the most powerful tools to in improving productivity is work study. Work study is:

- The systematic examinations of the methods of carrying on activity
- To improve effective use of resources
- To set up standards of performance

Work study also aims at the following:

- Simplifying or modifying the methods of operation
- Reduces unnecessary or excess work
- Stops wasteful use of resources
- Contributes to industrial safety by identifying hazardous work and developing safer methods
- Cuts down the time of performing a certain activity.

Work study consists of two complementary techniques:

A. Method Study B. Work Measurement

1.2.1 Method study

It is considered to one of the principal techniques by which the work involved in the product or the process could be decreased by systematic investigation. It helps to eliminate the unnecessary movements which results in cutting down the ineffective time.

1.2.2 Work Measurement

The term work measurement deals with the following:

- Application of systematic study
- It determines the time for a qualified worker to complete a specific job
- It defines a level of performance under typical operating conditions
- Time standards provide an indication of expected output
- If any ineffective time creeps in later it can be immediately shown
- Work measurement is used in budgeting, manpower planning, scheduling, standard costing, and in designing worker incentive schemes

1.3 Welding Economy

FCAW welding is usually carried out with a hand held gun as a semiautomatic process. The FCAW process can be suited to a variety of job requirements by choosing the correct shielding gas, electrode (wire) size and welding parameters. Welding parameters include the voltage, travel speed, arc (stick-out) length and wire feed rate. The arc voltage and wire feed rate will determine the filler metal transfer method. Although

the efficiency varies by wire type and manufacturer, it is typically between 75 and 85%. For higher efficiency and faster welding with greater accuracy and acceptance level GMAW is suggested with optimized parameters.

2. DATA COLLECTION AND ANALYSIS

A set of random times was generated by computer in excel sheet and on an regular basis in both the two shifts work sampling has been conducted for a period of two weeks. The sample format and data on a particular day is shown below.

Table1: Sample Format of Work Sampling With Sample Data.

WORK SAMPLING DAILY SUMMARY

DATE: 26/10/2012 SHIFT: 2 PLANT: 13 OBSERVER: MCLIN GHOSAL

			Random Timing																Total
	Time		3:40	3:50	4:40	5:10	5:20	6:00	6:30	6:50	7:20	7:40	8:40	9:00	9:42	10:10	10:30	10:50	10:55	
1	Working On Job weld, deslag	WL	0	0	3	4	3	1	2	3	1	2	3	4	5	5	0	1	0	37
2	Working On Job fitting	WF	0	0	0	2	1	0	1	1	1	1	0	0	0	0	0	0	0	7
3	Working On Job with m/c	WM	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	0	0	5
4	Working On Job other	WO	0	0	0	1	0	0	0	2	1	1	0	0	2	2	1	1	0	11
5	Preparatory Work	PR	0	0	4	1	4	2	3	4	4	2	2	2	1	1	0	0	0	30
6	Material Handling	MH	0	0	3	1	2	5	2	1	0	0	1	1	0	0	0	0	0	16
7	Discuss with sup	DS	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8	Inspection	IN	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
9	Drawing Reading	DR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Forced Idle	FI	0	0	1	0	1	1	2	0	0	0	0	0	2	2	0	0	0	9
11	Wating for load	NL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Wating For crane m/c.	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Idle On the Job	IL	0	0	4	2	1	4	2	2	2	4	1	3	4	4	9	0	0	42
14	Away from Job / Workplace	AW	0	0	0	3	3	2	1	1	6	5	8	5	0	0	3	13	0	50
15	Moving Around On Shop Floor	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
16	Machine Breakdown/ Maintenance	MB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Training/Meeting	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL		0	0	15	15	15	15	15	15	15	15	15	15	15	15	15	15	0	210

The various activities were classified as working on job weld/deslag, working on job fitting, working on job with m/c, working on job other, preparatory work, material handling, discussion with the supervisor, inspection, drawing reading, forced idle, waiting for load, waiting for crane, idle on the job, away from the workplace/job, moving around the shop floor, machine breakdown maintenance and training /meeting. The activities were further clubbed into groups as engaged in work, ancillary work, forced idle, idle on job and training/meeting.The data thus obtained was converted into time scale considering time slots of one hour each throughout a shift.

Table 2: Time slots selected for data analysis and trend observation.

shift	T1	T2	T3	T4	T5	T6	T7	T8	T9
1	6:00-7:00	7:00-8:00	8:00-9:00	9:00-10:00	10:00-11:00	11:00-12:00	12:00-01:00	1:00-2:00	2:00-3:00
2	3:00-4:00	4:00-5:00	5:00-6:00	6:00-7:00	7:00-8:00	8:00-9:00	9:00-10:00	10:00-11:00	11:00-12:00

Operation study was performed and through stop watch time study operation times were recorded. Bottleneck operations were identified and scopes of improvement were suggested and with the help of method study, welding economy and process improvement huge improvements were obtained.

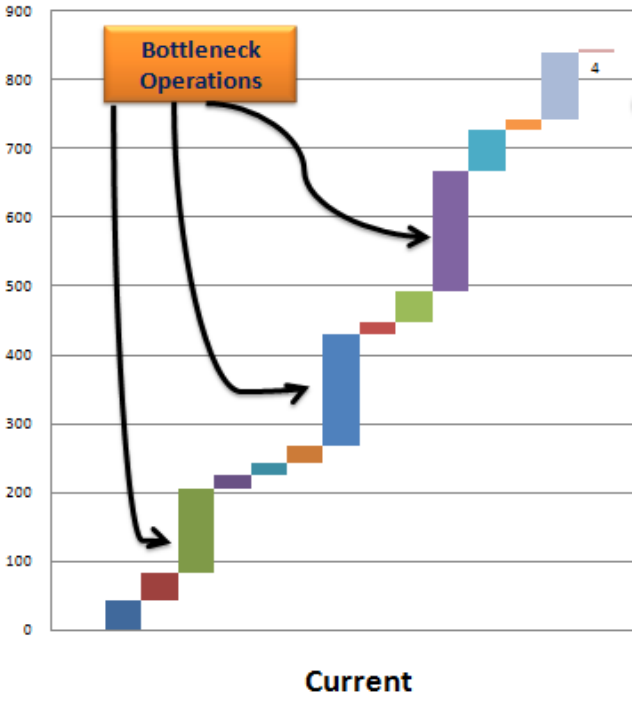


Fig.1: Gantt chart showing bottleneck operations.

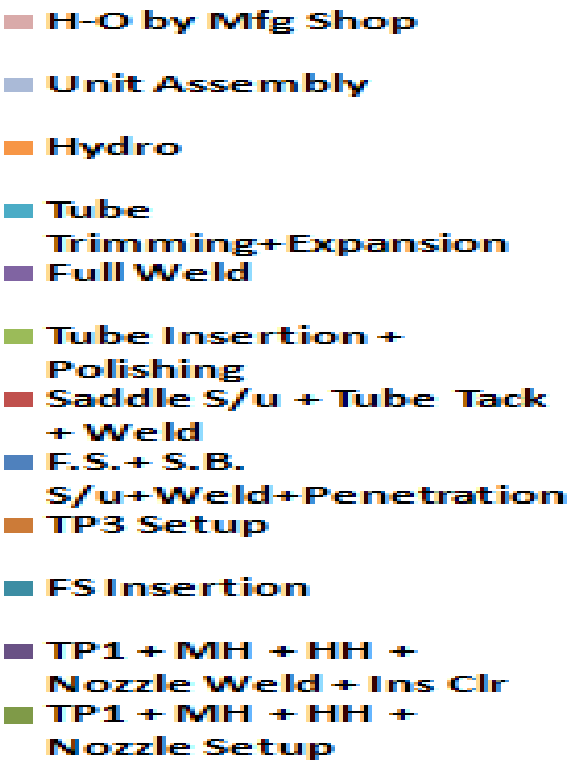


Fig.2: List of operations represented by Gantt Chart.

3. RESULT AND DISCUSSION

On the daily basis summary of the collected data a Pareto chart was obtained in excel sheet as shown in the figure below.

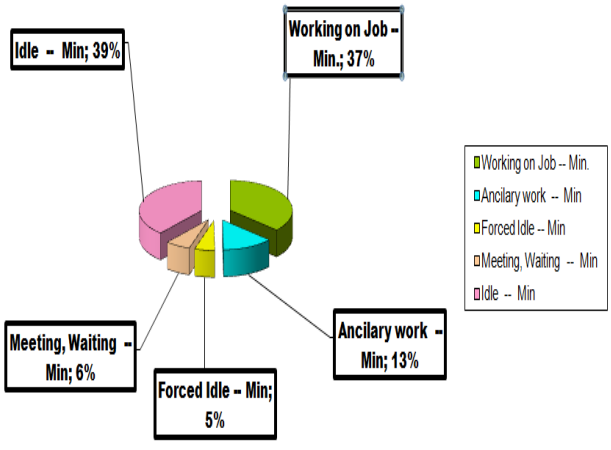


Fig.3: Pie Diagram representing proportions of activity levels in plant no.13.

Table 3: No of observation in plant 13 and overall plant

FACTORY SUMMARY				
ACTIVITIES	FREQ.	OVERALL PLANT%	PL13(FREQ)	PLANT NO.13%
Work on Job	27001	31.0	1950	36.6
Ancilary work	14391	16.5	698	13.1
Forced Idle	4852	5.6	278	5.2
Meeting, Waiting	6223	7.1	343	6.4
Idle	34631	39.8	2055	38.6
TOTAL=	87098	100.0	5324	100.0

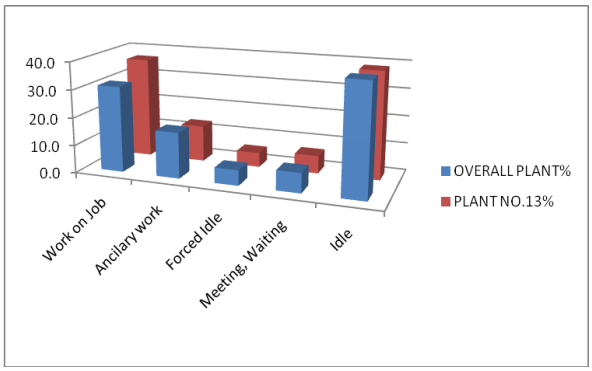
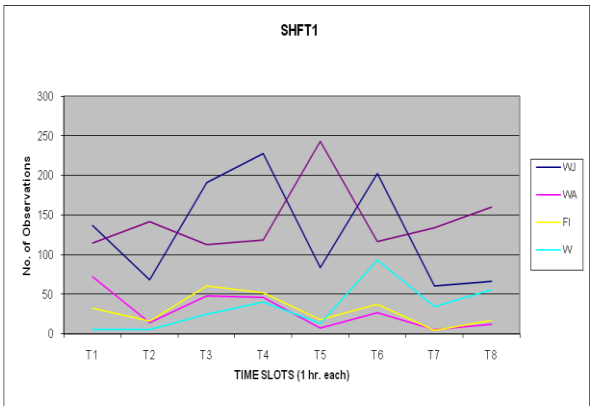


Fig.4: Comparison of plant averages to overall factory averages.

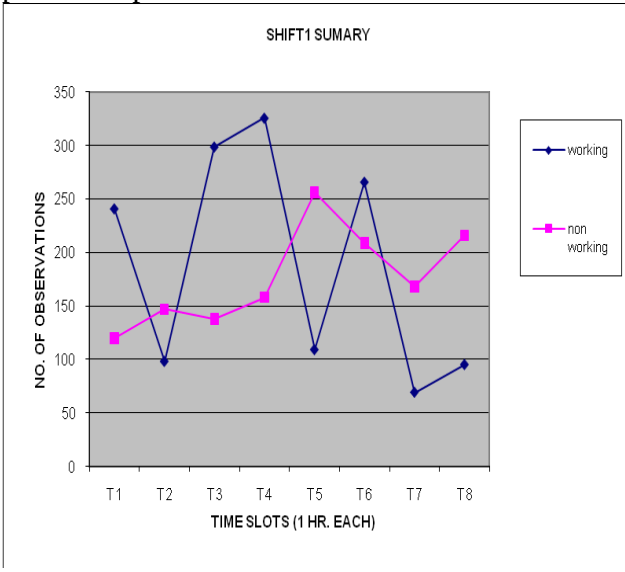
The collected data was then analysed on shift wise basis and a trend was plot in graph as shown in graph1.



Graph1: Trend of activity levels in shift1

The activities when clubbed into working and non working activities the trend was again observed shift wise in order to make

out the working nature in different shift in a particular plant.



Graph2: Shift1 trend when activities clubbed

The work sampling study that was carried out over a span of two weeks resulted in the collection of huge data. On an average 400 sample observations were taken per day that corresponds to 95% confidence level at ± 5% accuracy level. The results of the study shows that out of 8hrs working shift, the workers were found to be indulged 37% of time in actual working on job, 13% ancillary work, forced idle 5%, meeting and training 6% and idle for 39% of time [Fig3]. When compared with the factory averages, the observations of plant 13 were quite close to that of the factory averages [Table3]. The trend of working and its behavior over the shift schedule was then analyzed graphically. The graphs thus obtained proved the authenticity of the data collection since interdependence of the activities was clear from the trends in graphs [Graph1&2]. The data was then analyzed shift wise and it was found that the morning shift had higher contribution towards actual engagement on working as compared to the second shift. It was apparent from the graph plots that before the lunch/dinner hours, the working levels were more as compared to the second half. Thus the conclusion was made that work sampling data represents approximately the exact picture of a plant when carried out on quite enough sample size. A variety of trend analysis is possible as an outcome of this study. It is the first step towards actual production study and suggests the chances of obtaining bottlenecks in the plant. Similar study can be conducted in all the workstations within the plant and analyzed.

The bottleneck operations being identified helped to focus on the operations to focus for the improvement in terms of process improvisations, waste elimination, removal of non-value added activities etc. Welding being the major activity in all the bottleneck activities, attempt was made to make improvement in welding process and huge savings were observed as a result.

Table 4: Cost associated welding

CURRENT METHOD	
Cost per metre of weld	GMAW .001143 m
Labor Cost	254.26
Wire Cost	17.49
Gas Cost	2.45
Total	274.19
Effective Arc Speed in m/min	0.4369m/min

Table 5: Cost associated to welding.

IMPROVED METHOD	
Cost per metre of weld	GMAW .000889 m
Labor Cost	182.21
Wire Cost	11.54
Gas Cost	4.02
Total	197.78
Effective Arc Speed in m/min	0.6096 m/min

Thus the improved GMAW method shows great impact on cost saving and also increases the effective welding speed. A bar chart is plot for better understanding of the comparison and benefit analysis.

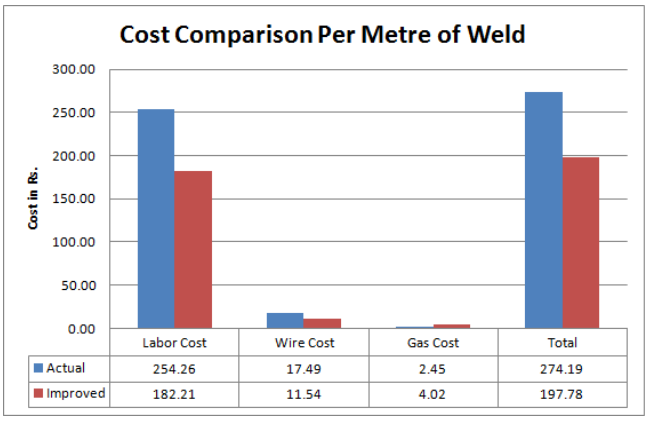


Fig.5: Bar Chart showing cost comparison

Table6: Operation wise savings.

Operation Code	Operation Name	Observed time (Hrs.)	Welding Time (Hrs.)	Welding Metres	Proposed Time(Hrs.)	Saving Hrs	Cost Saving	New Operation Time
360	TP1 TO MS I/S WELDING	12.50	3.50	92.35	2.52	0.97	7057.30	11.53
370	GUSSETS & GUSSET TOPS TO TP1 WELDING	10.50	2.94	77.57	2.12	0.82	5928.13	9.68
520	NOZZLES, MH, HH, F.P.C. I/S & O/S WELDING ALONG WITH COMP. PADS	12.00	3.36	88.65	2.42	0.94	6775.01	11.06
760	F.S.TO TP1 I/S WELDING	18.00	5.04	132.98	3.63	1.40	10162.52	16.60
890	TUBES TACK WELDING TO TP1 & TP3	16.50	4.62	121.90	3.33	1.29	9315.64	15.21
930	CATWALK PAD WELDING	15.80	4.42	116.73	3.19	1.23	8920.43	14.57
1010	TP3 TO TUBES, STAYBAR, MS AND ACCESS SHELL FULL WELDING	36.70	9.99	263.75	7.21	2.78	20155.66	32.92
1030	TP2 TO TUBES AND FURNACE SHELL FULL WELDING (INSIDE IRC)	30.50	8.54	225.33	6.16	2.38	17219.82	28.12
1040	FLUSH GRINDING OF WELDS INSIDE IRC	22.70	6.35	167.71	4.58	1.77	12816.06	20.93
1060	TP1 TO TUBES, LONG STAY BARS, MS & FS FULL WELDING	25.60	7.16	189.13	5.17	2.00	14453.36	23.60
1190	SMOKE CHAMBER WELDING	4.60	1.26	33.25	0.91	0.35	2540.63	4.15
1230	BURNER REFRACTORY WELDING	10.00	2.80	73.88	2.02	0.78	5645.84	9.22
	Total	214.30	59.97	1583.23	43.26	16.71	120990.39	197.59

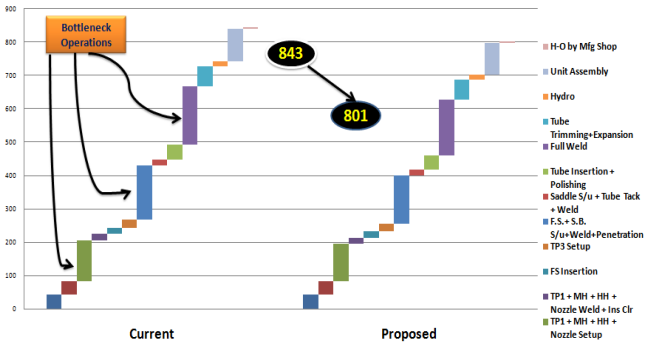


Fig.6: Gantt Chart showing total improvement.

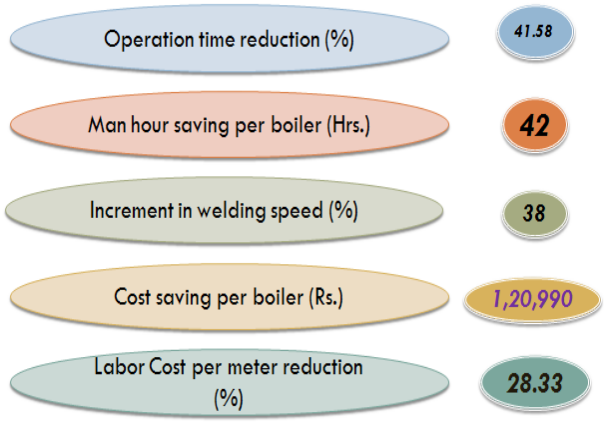


Fig 7: Net savings

4. Conclusion

Rapidly changing technologies and increasing complexities of organizations make it vital to speed up project growth and productivity in any manufacturing unit. The fast growing and global competiveness in the development of new products necessitates to deliver customer high quality product faster. Work study techniques are very effective methodology for cycle time reduction, method improvement and improve the overall productivity of any unit. The working trend was analyzed by the work sampling results and identifying the bottleneck operations, suitable method improvement was done that showed tremendous improvement in productivity along with cost saving and man hour saving. Multi activity charts, material flow process chart and Gantt charts were plot for better understanding and quick improvements to productivity. New standard time for the manufacture of Huskpack shell type boiler was calculated and finalized as a time standard to the various operations.

References

1. "A Research Framework for Work Sampling and its Application in Developing Comparative Direct and

Support Activity Proportions for Different Trades". Abraham Assefa SEHAYAE[1] and Aminah Robinson FAYEK[2]. Construction Research Congress 2012 © ASCE 2012.

2. "Labor Productivity Measurement In Building Projects". Adnan Enshassi [1], Khalid Al-Halaq[2] and Ziad Abu Mustafa [3]Department of Civil Engineering, IUG, Palestine. The Islamic University Journal (Series of Natural Studies and Engineering) Vol.19, No.1, pp 103 - 119 , 2011, ISSN 1726-6807
3. "Manpower Planning Using Decision Analysis: Case of Crown Company". F.A. Oyawale, Ph.D. and O.A. Adegboyega, M.Sc. Department of Industrial and Production Engineering University of Ibadan, Ibadan, Nigeria.
4. "Current Trends In Welding Processes And Materials: Improve In Effectiveness". P. Kah and J. Martikainen, Lappeenranta University of Technology, P. O. Box 20, 53851 Lappeenranta, Finland Received: September 28, 2011
5. "Factors Affecting Productivity of Pipe Spool Fabrication", Seyed Parham Mosayebi, Aminah Robinson Fayek, Laury Yakemchuk, Scott Waters, International Journal of Architecture, Engineering and Construction Vol.1, No. 1, March 2012, pp. 30-36.