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## Design and Construction of Foundry, Forging and Welding Work-station using Local Available Materials

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### **Abstract:**

To enhance productivity, stimulate competitiveness and bring about economic development, skill development is important. The main aim of the project was to design and construct foundry work-station at Metalwork Technology Department of Federal College of Education (Technical) Bichi. Institutions offering NCE (Technical) programmes are mandated to provide unit workshops in each area of specialization and equip them in accordance with the required list of equipment. Since TED 121 and TED 211 are part of graduation requirements; the project would facilitate the process of teaching and learning of NCE (Technical) students to quench their quest for competent technical skills. It will also equip the students with appropriate technical skills need. Certainly the project would enhance academic performance in term of skills competency for self-reliance of students and as well benefit the lecturers/instructors in term of their teaching activities. It is clearly known that foundry, forging and welding operations employs excessive heat, if then, there should be enough space and provision for effective ventilation in the workshop, but the existing workshop lack this criteria. As a result of this work-station is design in such a way that enough openings are provided, the openings are made at the three walls for effective cross-ventilation. In addition a properly maintained dust removal system was made available at appropriate distance. The work done include a designing of a more durable and suitable lining using refractory bricks. The main materials needed for the construction are block/brick, concreting materials, steel and timber.

**Keywords:** foundry, work-station, design, construction

### **1. Introduction**

Metalwork Technology workshop is a place where students acquire knowledge on the operation of various processes involved in manufacturing and production. The workshop practical courses make students competent in handling practical work in engineering environment. Foundry is one of the manufacturing process by which a desired shape of metal is obtained by heating it up to its molten state (liquid state), and pouring it into mould cavity. After some time metal is allowed to cool and solidify. The solidified piece of metal is known as casting. While mechanical working of the metal is the shaping of the metal in either cold state or hot state. This does not include machining, grinding or casting. This is known as forging. Welding is the process of permanent fastening where two metals are fused at the temperature of 3200°C (when metals are melted).

According to National Commission for Colleges of Education (NCCE, 2012) the philosophy of technical teacher education is the provision of technical teachers with the intellectual and professional background adequate for teaching technical subjects and to make them adaptable to any changing situation in technological development not only in the country but also in the world at large. Consequently, the document outlined the objectives of the programme among which are:

- i. To provide qualified technical teachers and practitioners of technology capable of teaching introductory technology in the junior secondary schools.
- ii. To produce technical NCE teachers who will be able to inculcate scientific and technological attitude and values in the society.

Therefore, to achieve the much-needed change in our developing economy, these objectives must be achieved. As it has been clear stated in the minimum standard, TED 121 i.e. sheet metalwork, fabrication and welding as well as TED 211 i.e. foundry and forging are among the graduation requirements. However, skills acquisition is the bedrock of technical education, equally no skill could be acquired without a workshop and no teaching would be facilitated without practical. Since education is dynamic and is an instrument for effective national development, conducive environment for metalwork students is important for their learning activities in term of skills acquisition and competency.

It is clearly known that foundry, forging and welding operations employs excessive heat, if then, there should be enough space and provision for effective ventilation in the workshop, but the existing shop lack this criteria. As a result of this the proposed shop is design in such a way that enough openings are provided, moreover, mesh wire (4m x 3m) is recommended to be used at the two

opposite sides of the walls for effective cross-ventilation. In addition a properly maintained dust removal system is to be made available at appropriate distance (exhaust halls) Mujeeb and Saeed (2013). Ensuring the roof is high allowing natural convection of gases and fumes, along with ventilation allowing air exchange is very important in this work. Concrete can spall and explode when in contact with molten metal due to trapped moisture, however, refractory brick is a safer floor surface for the foundry area.

The existing metalwork main workshop is in two unit the fitting and the machining sections which has no specific area for foundry, forging or welding section. According to NCCE (2012), institutions offering NCE (Technical) programme are mandated to provide unit workshops in each area of specialization and equip them in accordance with the required list of equipment. Another setback with the existing workshop is the lack of enough space and provision for effective ventilation.

### 1.1. Objectives

- i. To facilitate teaching and learning process in foundry, forging and welding.
- ii. To equip students with appropriate technical skills needed for self-reliance.
- iii. To enhance the skills acquisition and competency of students toward enhancing their academic performance.

The significance of this project cannot be over emphasised because it would facilitate teaching and learning activities in the metalwork department. Since TED 121 and TED 211 are part of graduation requirements, hence, the project will benefit the following: students, lecturers/instructors, technologies/technicians. As a result the project would enhance the academic performance of the students in term of skills competency for self-reliance and as well benefit the lecturers/instructors in term of their teaching activities. While technologies/technicians will utilise it to enhance the practical work in the department.

The purpose of technical teacher education is to prepare teachers adequately for successful training of the students from Junior Secondary School (JSS) to higher level of education. In general terms, technical teacher education involves the acquisition of strategies, techniques and competencies that can help the teacher impart knowledge to students, which will lead to the production of technicians, technologies, engineers as well as skilled personnel who will function in small, medium and large scale industrial enterprises. Technical and Vocational Education and Training has been recognised as a major actor in economic growth. It was contended at the UNESCO international experts meeting in "Learning for work, citizenship and sustainability" that "Since education is considered the key to effective development strategies, TVET must be a master key that can alleviate poverty, promote peace, conserve the environment, improve the quality of life for all and help achieve sustainable development, (UNESCO 2004).

It is highly recommended to equip technical students with appropriate technical skills that could improve workforce productivity in our developing economy. Shehu (2009) opined that educational progress at secondary and post-secondary levels need to identify the knowledge and skills that will be needed by the future workforce to successfully work with and maintain the advanced technologies and develop appropriate delivery system for teaching new content. With appropriate and relevant skills in metalwork, students would definitely become self-reliant individual who can create jobs rather than search for jobs. Moreover, Aluwongs and Duwa (2009) reiterate that metalwork technology graduates are lucky enough because a lot of opportunities await them to make them self-reliant individuals as long as they have the expected practical skills. In fact a metalwork graduate who has the practical skills in foundry work can set up a foundry shop with little capital.

Furthermore, appropriate measures should be put in place for enhancement of skills acquisition and competency. Uwaifo and Uwaifo (2009) lamented that, the way and manner training is conducted in technical and vocational education institutions/departments in Nigeria is not very much impressive over the years. Workshops are essential for skills acquisition. They provide room for students' activities such as experiments, designing, construction, and repairs using tools and equipment (Dogara 2012). Unfortunately, these facilities are lacking in our TVET institutions in Nigeria. Enamele (2006), observed that facilities used for skills acquisition in TVET institutions are obsolete and grossly inadequate.

## 2. Materials and Method

The development of the work-station was achieved using the following specifications and figures 1-4 show (see appendix) various views and sections of the work-station. The work done include designing of a more durable and suitable lining using refractory bricks.

### 2.1. Specifications

Foundation:	675 x 225 concrete strip 900 below ground level
Floor:	300 hard core, 150 mass concrete and refractory brick for the floor surface
Wall:	225 sancrete block with internal lining using refractory bricks.
Doors:	D1 = 2100 x 3000 metal D2 = 1000 x 3000 metal
Lintels:	225 x 225 reinforced concrete over doors
Beams:	225 x 225 reinforced concrete and 4000 above floor level
Roof:	25 <sup>0</sup> pitch covered with long aluminium sheets 150 x 50 rafters 100 x 50 purlins 100 x 50 struts 300 x 20 fascia board 600 eaves projection

All Dimensions are in Millimetres

Work Plan/Time Frame (activity by activity in GANTT Chart) Procedure to be followed for the execution of the project by month Operations Activity Move: By Month								
		1	2	3	4	5	6	7
1.	Setting out of foundation trenches	■						
2.	Foundation excavation							
3.	Concrete Laying							
4.	Bricklaying starter course		■					
5.	Starter columns							
6.	Timbering							
7.	Concrete for starter columns			■				
8.	DPC							
9.	Bricklaying up to lintel level							
10.	Steel work for columns				■			
11.	Timbering							
12.	Concrete for columns							
13.	Timbering for lintels							
14.	Concrete for lintels							
15.	Installation of mesh wire							
16.	Bricklaying over-head course					■		
17.	Timbering for beams							
18.	Steel beams							
19.	Concrete for beams						■	
20.	Construction of rafters							
21.	Roofing							
22.	Installation of doors							
23.	Electricity wiring							■
24.	Internal lining with refractory bricks							
25.	Painting and finishing							

Figure 1: A Gantt's Chart showing schedules of activities by month

2.2. Summary of the Findings of the Study

With the construction of the work-station be achieved, there would be great academic performance outcomes in term of foundry, forging and welding skills from the students, since the teaching staff of the department would utilize the workshop for the improvement of teaching and learning activities.

2.3. Challenges/Difficulties Experienced in Implementing the Project

Although research is always challenging and there's no way someone can carry out it without challenges. The main challenge I faced during the execution of this project is the skyrocketing of the prices of commodities including building materials in the country which is a known factor to everyone, due to the economic recession we fall in. the fall down of corrode oil in the world market was the main reason for this recession right from the end of 2015.

Therefore as it can be seen in the budget proposal of the project each and every item was almost twice or nearer to it previous price. Due to this problem and after do consultation it has been agreed that the capacity of the projects should be reduced and some amendments has been made, since there's no provision for requesting for variation.

The second challenge that has been faced by the researcher was the change of location by the school authority from the initial proposed site which was the eastern part of the main metalwork workshop to the northern part side of the workshop. The challenge in the location was that there's electric cables and water pipes laid down in the field. So this cause a lot of financial implication that was not captured in the proposed budget. Henceforth, the researcher has to do some adjustment in order to achieve the main goal of the design project.

Consequently, with all this challenges the project was successfully done, and the objectives were achieved.

**Final Expenditure details:**

<b>Steel work</b>				
S/N	Materials	Quantity	Unit Cost	Total Cost
1.	3 x 8ft metal sheet	3	N14, 600	N 43,800
2.	2 x 2 metal pipes (black)	25	N 2,400	N 60,000
3.	BR wire 4mm x 20m	2	N 15,000	N 30,000
4.	Steel bar 12"	1 tonne	N 131,000	N 131,000
5.	Bending wire	15kg	N 5000	N 5,000
6.	Material for door		N 29, 500	N 29, 500
7.	Labour			N 60,000
8.	Transport			N 25,000
	<b>TOTAL</b>			<b>N383,800</b>
<b>Roofing</b>				
1.	Aluminium roofing sheet 0.45	29m <sup>2</sup>	N 1,550	N 44, 950
2.	Ridge cap	6m	N 980	N 10,780
3.	Roofing accessories			N 8000
4.	Installation			N 25,000
5.	Transportation			N 15,000
	<b>TOTAL</b>			<b>N 103,730</b>
<b>Masonry work</b>				
S/N	Materials	Quantity	Unit Price	Total
1.	Cement	200bags	N 2,120	N424,000
2.	Fine aggregate (sand)	8 trips	N 6,250	N 50,000
3.	Aggregate	8 trips	N 13,000	N 104,000
4.	Coarse aggregate (gravel)	9 trips	N 8,000	N 72,000
5.	Blocks	1500	N 110	N165, 000
6.	Gravels			
7.	<b>TOTAL</b>			<b>N 815,000</b>
<b>Iron Rafter with 6 x 3 H Channel Work</b>				
1.	6 x 3 H channel	10 length	N25, 000	N250, 000
2.	12mm plate	½ length	N24, 000	N24, 000
3.	Red paint	4 gallons	N3, 600	N14, 400
4.	Labour			N 70,000
5.	Transport			N 30,000
	<b>TOTAL</b>			<b>N 388,000</b>

*Figure 2*Terrazzo for the Floor 29m<sup>2</sup>

N111, 500

Taken care of the electric cables and water pipes laid down in the field and other contingencies  
N197, 760

GRAND TOTAL = N 1,999,790.00K

**3. Acknowledgement**

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**Appendix**

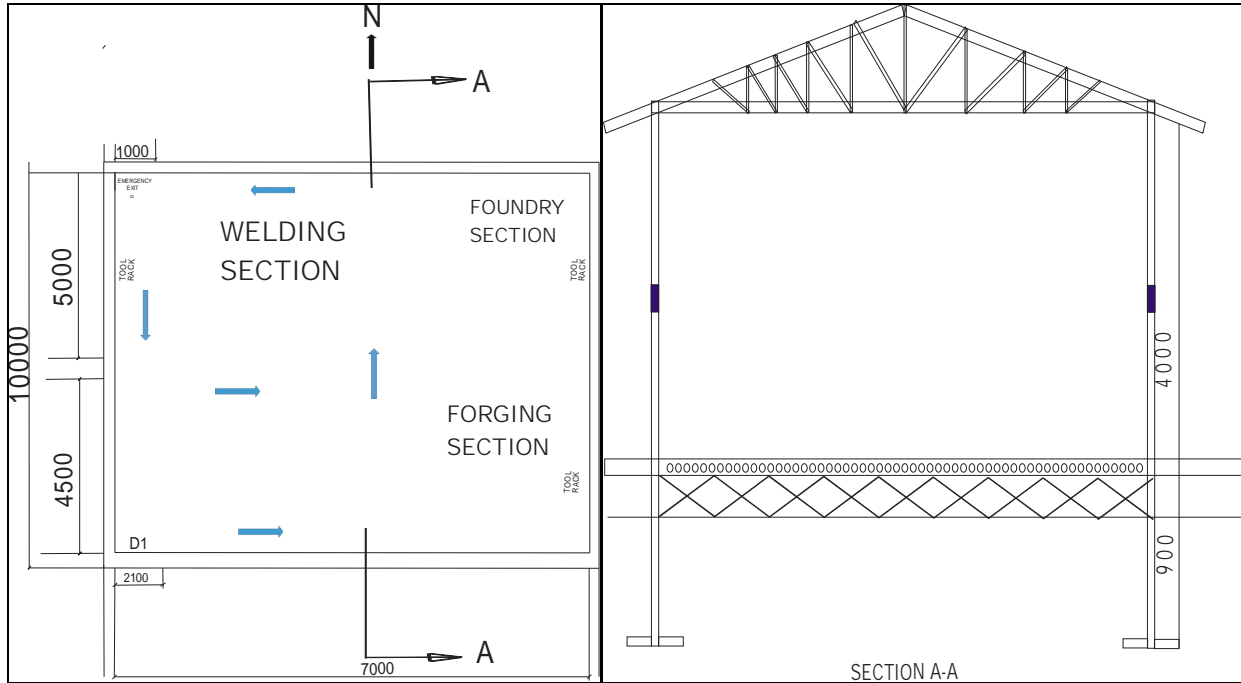


Figure 1: FLOOR PLAN

Figure 2

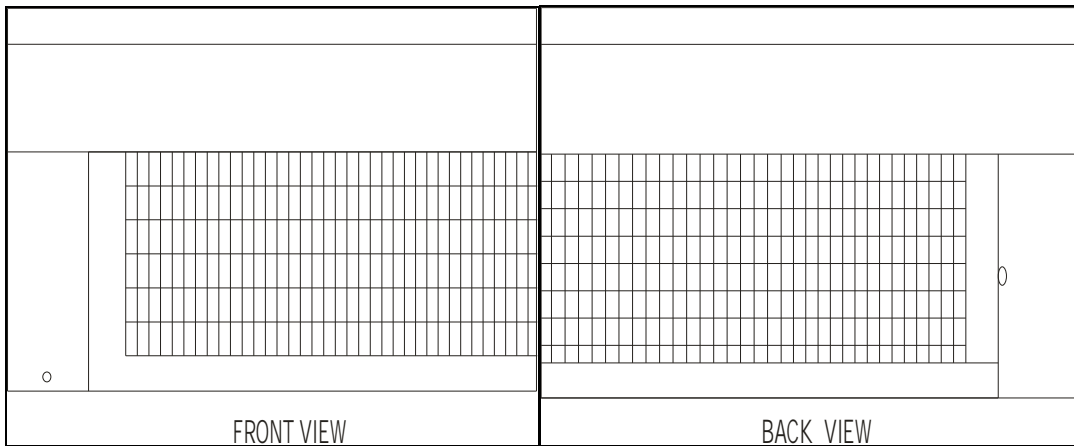


Figure 3

Figure 4