ISSN 2277 – 5528
Impact Factor- 4.015

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES &MANAGEMENT

PROCESS FLOW WITH TIME STUDY IN HUMMING BIRD SCENARIO

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ABSTRACT

Sheet metal forming is a secondary manufacturing process which involves various techniques such as shearing, punching, bending, joggling, welding, riveting and finally concludes with assembly operation. The input (raw material) is processed at various stages including secondary operations to obtain finished product / good (output). Total time for a raw material to turn into useful product will be sum of individual time taken for all these metal forming processes. The time required for each of these processes depends upon complexity of the product, material flow, worker performance and mainly plant layout design. The project starts with determination of time required for completion of each process and overall time required for manufacturing particular product. Time and its management play a vital role in shop floor activities. Thus, the main aim of the project is to suggest a better way of material movement which optimizes lead time of manufacturing a product.

Keywords*: Metal Forming, Process Flow, Control time, Time study.*

I. INTRODUCTION

Sheet metal forming is a process that materials undergo permanent deformation by cold forming to produce a variety of complex three dimensional shapes. The process is carried out in the plane of sheet by tensile forces with high ratio of surface area to thickness. High rate of production and formability is determined by its mechanical properties. Friction conditions at the tool-metal interface are very important and controlled by press conditions, lubrication, tool material and surface condition and strip surface condition. Punching [1] a metal fabricating process that removes scrap slug from the metal work piece each time a punch enters the punching die. This process leaves a hole in the metal work piece. Bending [2] of sheet metal is a common and vital process in manufacturing industry. Sheet metal bending is the plastic deformation [3] of the work over an axis, creating a change in the part's geometry. Similar to other metal forming processes, bending changes the shape of the work piece, while the volume of material will remain the same. In some cases bending may produce a small change in sheet thickness. For most operations; however bending produces essentially no change in the thickness of the sheet metal. In addition to creating a desired geometric form, bending is also used to impart strength and stiffness to sheet metal, to change a part's moment of inertia, for cosmetic appearance and to eliminate sharp edges. Joggling is another process with small offset near the edge of a piece of sheet metal. It allows one sheet of metal to overlap another sheet while maintaining a flush surface. Cutting processes are those in which a piece of sheet metal is separated by applying a great enough force to cause the material to fail. The most common cutting processes are performed by applying a shearing force and are therefore sometimes referred to as shearing process. When high shearing force is applied, the shear stress in the material will exceed the ultimate shear strength and the material will fail and separate at the cut location. This shearing force is applied by two tools, one above and one below the sheet. The tools are a punch and die or upper and lower blades, the tool above the sheet delivers a quick downward blow to the sheet metal that rests over the lower tool. A small clearance is present between the edges of the upper and lower tools, which facilitates the fracture of the material. Size of the clearance is typically 2-10% of the material thickness and depends upon several factors, such as the specific shearing process, material and sheet thickness. Riveting [4] joint is one of the important joint methods to permanently fasten two thin-walled sheet-metal parts. It is most basic to efficiently analyze and estimate the deformation of the riveting joint for the performance, fatigue durability and damage of the riveting structure in the aircraft.TIG and MIG welding are most commonly used in sheet metal welding. Tungsten Inert Gas (TIG) welding TIG welding [5], or Tungsten Inert Gas, also referred to as GTAW (Gas Tungsten Arc Welding), is considered by most to be the best method of welding. It is very clean; TIG produces the least amount of fumes and slag. TIG welds can enhance the aesthetics. TIG welding takes all the fundamentals of shielded electrical welding and breaks it down into its primary forms - shielding gas, electrical arc and filler metal. In TIG the arc is controlled

ISSN 2277 – 5528
Impact Factor- 4.015

and the filler metal at the part of welding. One hand feeds the filler metal, the other controls the torch, while a foot (in most cases) controls the arc.MIG [6] welders consist of a handle with a trigger controlling a wire feed, feeding the wire from a spool to the weld joint. The wire is similar to an endless bicycle brake cable. The wire runs through the liner, which also has a gas feeding through the same cable to the point of arc, which protects the weld from the air. MIG welding is most commonly used in fabrication shops for higher productions.

II. METHOD & MATERIALS

Stainless steel 304 grade is the most common of all available grades in steel. It offers good corrosion resistance while maintaining formability and weld ability.Stainless steel does not readily corrode, rust or stain with water. However, it is not fully stain-proof in low-oxygen, high-salinity and poor air-circulation environments. There are different grades and surface finishes of stainless steel to suit the environment. Stainless steel is extensively used in corrosion resistance scenario. Stainless steel differs from carbon steel by the amount of chromium present. Unprotected carbon steel rusts readily when exposed to air and moisture. This iron oxide film (the rust) is active and accelerates corrosion by forming more iron oxide; because of the greater volume of the iron oxide, this tends to flake and fall away. Stainless steels contain sufficient chromium to form a passive film of chromium oxide, which prevents further surface corrosion by blocking oxygen diffusion to the steel surface and blocks corrosion from spreading into the metal's internal structure. Passivation occurs only if the proportion of chromium is high enough and oxygen is present. Aluminium is also a popular metal used in sheet metal due to its flexibility, wide range of options, cost effectiveness, and other properties.[5] The four most common aluminium grades available as sheet metal are 1100-H14, 3003-H14, 5052-H32, and 6061-T6. Grade 1100-H14 is commercially pure aluminium, highly chemical and weather resistant. It is ductile enough for deep drawing and weldable, but has low strength. It is commonly used in chemical processing equipment, light reflectors and jeweler.

Grade 3003-H14 is stronger than 1100, while maintaining the same formability and low cost. It is corrosion resistant and weldable. It is often used in stampings, spun and drawn parts, mailboxes,cabin,tanks, and fan blades. Aluminium is remarkable for the metal's low density and for its ability to resist corrosion due to the phenomenon of Passivation. Structural components made from aluminium and its alloys are vital in the aerospace industry and are important in other areas of transportation and structural materials, such as building facades and window frames. The most useful compounds of aluminium, at least on a weight basis, are the oxides and sulphates.Despite its prevalence in the environment, no known form of life uses aluminium salts metabolically. In keeping with its pervasiveness, aluminium is well tolerated by plants and animals. Owing to their prevalence, the potential beneficial (or otherwise) biological roles of aluminium compounds are of continuing interest.

III. RESULT AND DISCUSSION

The sheet metal forming of HUMMING BIRD project involves various forming operations as explained below.
Process starts with procurement of Raw materials. Then the raw material has to be inspected properly because if there is any flaw in the raw material it will affect the final product. Quality inspection involves following steps,
Check for Quantity: The sheets are counted manually also weight of each sheet is measured.

Check for quality: The raw sheet is checked weather it has got the right thickness, appearance.

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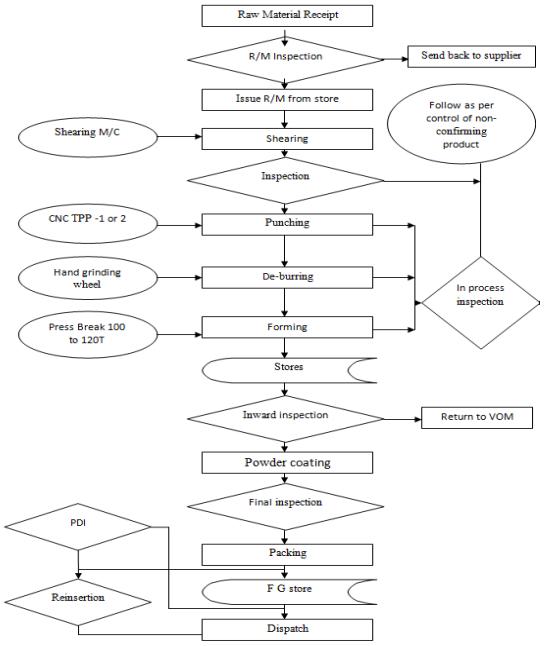

If these criteria's does not match the feedback is sent to the supplier. Inspection time per sheet: 5 minutes Shearing-type operations include:blanking,piercing,roll slitting, and trimming [7].

Machine name: Godrej Lvd

Max. Shearing Capacity	6 mm
Capacity to shear M.S plate of 45 kgf/mm	
Cutting Length	3100 mm
Range Back Gauge	1000 mm
Minimum Cutting Angle	0.5°
Maximum Cutting Angle	2.5°
Minimum No. of Strokes/Min	12
Maximum No. of Strokes/Min	35
RPM	1500
Electric supply	415V, 50Hz
Oil tank Capacity	120 ltr
Oil grade	Servo 68
Maximum oil temperature	55° C
Blade material	High speed steel
Number of blades	6
Initial setup time	10 minutes
Operation time per sheet	6 seconds

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Impact Factor- 4.015

Punching -The designs provided by the customers will be retrieved in the AUTOCAD software. The programming will be generated for these drawings by using CAMPATH G4 software. Then the program will be checked manually if there are any errors in the program they are rectified and program is loaded to the CNC punching machine. For punching operations, machine used is MOTORUM-2044EZ WIEDEMANN.

Punch capacity	22 T
30 Stations Turret, Automatic sheet repositioning, Electric servo controlled driven Ram	
Maximum sheet size	2500mm x 1525mm
Maximum sheet thickness	3mm
Maximum hole diameter	89 mm
Initial setup time	35 minutes
Operation time for pole mount	9 minutes 21 secs per sheet
Operation time for base mount plate	4 minutes 41 secs per sheet

De-burring Micro joints and flip joints will be left out on the sheet in order to hold the punched material on the sheet these joints are removed manually. The time taken to de-burring operation are listed below,

For pole mount plate: 65 minutes / sheet
For base mount plate: 30 minutes / sheet
Bending machine with the following details.

HDS 1303NT – 143 ton, 10' bed length, 5-axis back gauge	
Program Storage Limited only by network storage capacity	
Maximum Tonnage	130T
Bend Length	3220 mm
Maximum Stroke Length	200mm
Approach Speed	200mm per second
Bending Speed	20mm per second (Max) programmable
Return Speed	200mm per second
Machine Weight	11000 kg Approx
Power Requirements	17 KVA
Input Method	Touch Screen

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Impact Factor- 4.015

Display	15" Colour Liquid Crystal Touch Screen
Bends per Program	99
Set up time for bending operation	10 minutes
Operation time for pole mount	10 seconds / sheet

Joggling, also known as joggle bending, is an offset bending process in which the two opposite bends are each less than 90° (see following section for how bend angle is measured), and are separated by a neutral web so that the offset (in the usual case where the opposite bends are equal in angle) is less than 5 work piece thicknesses. Often the offset will be one work piece thickness, in order to allow a lap joint which is smooth on the 'show-face'.

Pneumatic press is used to apply the required amount of load by using suitable press and die joggling operation is carried out.SEW –SNX 45, High speed un-geared cross shaft power press. The machine specification is listed out below.

Capacity	45 T
Stroke length (fixed)	50 mm
Adjustable stroke	8 - 50 mm
Slide adjustment	60 mm
Slide area	430x350 mm
Tool bore diameter	50.8 mm
Bolster area	840x440 mm
Bolster thickness	110 mm
Floor to top of bolster	800 mm
Strokes per minute	100 – 180 spm
Main motor	7.5 HP x 4P
Floor space required fix	(W x L x H) 1255x1545 x2350mm
Set up time for joggling is 10 minutes	
For base mount plate it takes 8 seconds / sheet	

Welding operations After bending operations the product is welded in joints. Sheet metal welding mainly is done by using Tungsten inert gas (TIG) and Metallic inert gas (MIG) welding. Along with these two operations Spot welding is also used to weld some of the portions. Tungsten Inert Gas welding (TIG)

The machine used is Syncro wave 350LX

Time required for welding operation	15 minutes / sheet
Filler rod used	Tungsten rod
Input voltage	220/230 V
Input Hz	50/ 60 Hz

ISSN 2277 – 5528
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Input phase	1-phase
Wieldable metals	Aluminium, steel, Stainless steel
Material thickness	Steel - 0.3 mm to 15.9mm Aluminium - 0.4 mm to 12.7 mm

Gas metal arc welding (GMAW), sometimes referred to by its subtypes metal inert gas (MIG)welding or metal active gas (MAG) welding, is a welding process in which an electric arc forms between a consumable wire electrode and the work piece metal(s), which heats the work piece metal(s), causing them to melt and join.

MIG 180

Input supply	220/230 V
Frequency	50Hz
Welding current range	30-180 A
Power consumption (KVA)	6.2
Dimension (LxBxH) mm	500x350x590
Max wire speed (m/min):	15

IV. RIVETING OPERATION

A rivet is a permanent mechanical fastener. Before being installed, a rivet consists of a smooth cylindrical shaft with a head on one end. The end opposite the head is called the tail.
Time for riveting operation: 10 minutes / sheet.

Process No	Process name/ operation description	Machine, device, jig, tool for Mfg.	Characteristics		Method					Reaction plan/ corrective action
			Parameter	Process	Product/process specification/tolerances	Evaluation measurement technique	Sample Size	Sample Freq.	Control method	
1	Receipt of raw material	Manual count & weighing machine	Quantity/ Quality	Raw material receipt	As per PO : supplier invoice/ DC	Visual check and waiting machine	100%	Every lot /Batch	GRN thru ERP	Reject / inform & send back to supplier
2	Raw material inspection	Physical check	Raw material	Verification	GI 275 GSM 2.0 thick	Supplier tc lab report	100%	Every lot /Batch	Incoming inspection report	Reject/ inform to materials dept. & to supplier
			Thickness & size		2.0x1250Wx 2500L mm	Micrometer/ vernier	As per the sampling plan form QA 001			
			Appearance		Free from rust, dent, damage	Visual check				
3	Punching	CNC TPP -01, 02	Thickness	As per program	2.0x1250Wx 2500L mm		As per the sampling plan form QA 001	Every lot /Batch	In process inspection report	Rejected / rework with identification
			width		92.80+/-0.2 mm	Micro metre				
			Length		250.00 +/- 0.2 mm	Digital vernier				
			Dimpling		Dia 3.5+/-0.2 mm height 4.00 with sheet thickness @ 4 plcs	Digital vernier				
			Ref dim's		Dim 4.71+/-0.15 mm @ 2plcs, dim45.00+/-0.15mm @ 2 plcs. Pitch 160.00+/-0.15mm	Digital vernier				
4	Debaring	DB;01	Burr, sharp edges and punches joints to be removed	Manual process	Burr, sharp edges and punches joints to be removed	Visual & feel	As per the sampling plan form QA 001	Every lot /Batch	In process inspection report	Reject/ inform to materials dept. & to supplier
5	Bending	PB- 01,02	Bending dimension	Manual process	9.85+/-0.2mm @ 2 plcs	Digital vernier	As per the sampling plan form QA 001	Every lot /Batch	In process inspection report	Rejected / rework with identification
					23.94+/-0.2mm @ 2 plcs					
					24.96+/-0.2mm @ 1 plcs					
			Maintain dimension		80.00+/-0.2mm @ 1 plcs					
			Height		19.00+/-0.15mm with sheet thick					
			Pitch		70.58+/-0.15mm					
6	Sub assy	Spot weld, riveting m/c	Sub assy	Manual process	As per control plan/ WI	Visual, gauge	As per the sampling plan form QA 001	Every lot /Batch		Rejected / rework with identification

Time study is a direct and continuous observation of a task, using a timekeeping device. The application of science to business problems and the use of time-study methods in standard setting and the planning of work. It can be viewed from the above process flow chart.

V. CONCLUSION

From the result we can understand the time required for various operations are different, because of the complexity of the product. In an industry time is of essence. In the light of the above to decrease the time of manufacturing we are suggesting the use of conveyer system for a sequential flow of process.

VI. ACKNOWLEDGEMENT

The authors would like to express their deep sense of gratitude to Principal and Management VCET, Puttur; Vivekananda Vidyavardhaka Sangha, Puttur for their constant support. Special thanks to Mr. Mohan Rai, Manager-

ISSN 2277 – 5528
Impact Factor- 4.015

Finance, Veer-O-Metals Bengaluru for providing us the project. My thanks and regards also go to research community in developing the article and people who have willingly helped me out with their abilities.

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