This report has been prepared after visiting some of the iron and steel industries of Nepal. The industries we could visit were HIMAL IRON AND STEEL INDUSTRIES & HULAS IRON AND STEEL INDUSTRIES. These industries are located at Simara of Bara district. The report includes the through process which is implied in the making of various iron and steel product like pipes, roof top, rod, high distention poles, towers etc.

This report also includes the challenges and the problems faces by those companies for their smooth operation. It reveals the status of these companies and the service it is providing to the people and the whole nation.

Some facts and figures have been inserted to understand the process that is applied in manufacturing the product.
We always believe that no work is complete without support and inspection. All those unnamed inspires who encouraged us during our project must be credited with whatever merits this will achieve. This project report has been prepared and submitted as a part of industrial orientation for group work and presentation an integral part of industrial engineering program BIE(II / II).

We acknowledge the Thapathali Campus, particularly department of Industrial Engineering for providing opportunity for undertaking this study “IRON & STEEL INDUSTRIES: production process and quality control”. We would like to appreciate our respected teacher who have guided as throughout the preparation of this report. We would like to give sincere thanks to Er. Bharat Regmi, Head of industrial department for ingrate support to carry out the study. We have no words to express our gratitude for the facilitation and encouragement provided to us by Dr. Govinda Raj Pokharel, and also like to mention Er. Shambhu Yadav and other teachers for their support and valuable suggestions.

We would also wish to record our appreciation for the support and cooperation provided by the staffs of HULAS IRON & STEEL, HIMAL STEEL industries for providing there valuable data and sharing knowledge. In particulate we are highly obliged to chief-central office, of himal Parwanipur Er. Gopal Shrestha and the plant manger of hulas iron and steel Er. Yogendra Pd. Pal for providing the valuable information regarding our topics. We are deeply indebted for the supports provided by Er. Narayan Dhungana and Er. Roshan Jha.

We are extremely obliged to all the helping hands who directly and indirectly helped by providing information and suggestions regarding our topic.

TABLE OF CONTENTS
INTRODUCTION:
PRODUCTION:

The word “Production” is often used interchangeably with the word “Manufacturing”. Whereas the term “Manufacturing Engineering” is widely used in U.S.A., the equipment term “Production Engineering” is prevalent in Europe and Japan. The word “Manufacturing” is derived from the Latin words ‘Manus’ and ‘Factus’ meaning hand and made respectively, that is, the literal meaning is ‘made by hand’. However, in the modern sense, the word ‘production’ or ‘manufacturing’ means making of goods or articles from raw materials by hand and/or machinery by following a well-defined plan for each activity required. Thus “Manufacturing Engineering” or “Production Engineering” may be defined as the art of making components and machines of specified quality on the planned production scale with the minimum consumption of materials and maximum productivity of labour. The word ‘Product’ means something that is produced. Production does not mean the making of only goods but in general it includes services also. Quantitatively, the word ‘Production’ means quantity produced of goods or services, that is, volume of production.

TYPES OF PRODUCTION PROCESS:

Generally production processes can be classified as following types:

1) Traditional/Manual processes:
   Processes employing manually or using simple tools to produce goods from raw materials are Manual processes. Handmade paper industries, candle industries and manufacturing based cottage industries are some examples of Traditional/Manual process.

2) Semi automatic processes:
   Process using machines but are not fully automated and use hands to operate those machines to convert raw material to require goods are semi automated processes. Most of the industries in Nepal employ this process. Iron and Steel industries, cement industries etc. Are the examples of this type process.

3) Automatic processes:
   Processes using machines operated through computers, Robotics, CAD, CAM, and CNC etc. are Automatic processes. Modern industries nowadays use this processes as they are programmed and it reduces human error. It has many other advantages which are discussed below. But in Nepal just a few industries such as Hulas cold rolling mill use this.

TYPES OF PRODUCTION METHOD
1) **Piece or Unit production:**
   It concentrates on producing one or several articles like prototypes, experimental products, etc. which are seldom or never to be produced again in that enterprise. It is usually a more expensive method of production.

2) **Lot or Batch production:**
   In this system, articles of identical shape and size are produced in a lot or batch. Special jigs and fixtures are used as an aid for speeding up the production and for providing ease and accuracy. Articles produced in lot production are obviously cheaper than made in the unit production system.

3) **Mass production:**
   It relates to the manufacturing of a large quantity of standard parts by using specialized workforce and incorporating the principles of interchangeable production. Mass production methods are designed especially for applications involving high-volume runs since this form of production is most economical. Mass consumer goods available in the market are produced by mass production methods. Since the whole system and assets are geared for the mass production of a particular product or a family of products having similarity in design and specifications, this method, therefore, limits the operational flexibility of an enterprise in entertaining great variations in the product varieties and specifications.

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**QUALITY:**
Quality may be defined as the adherence of its parameters. In other words, quality is the degree to which the product satisfies customers. In simple words, quality is fitness for use. Product quality signifies degree of excellence, quality of product consists of quality characteristics specified in part drawing and manufacturing drawing.

**QUALITY CONTROL:**
Quality control aims prevention of defects at the source. It is a system which uses the economical means to produce a quality product. The set of operational techniques are used to fulfill requirement for quality.

In order to control quality we have to be able to measure quantitatively the level of quality and identify all the material and process variables that can be controlled. Quality control finds solution to reduce rejections and defective products.
TYPE OF QUALITY CONTROL:

1) Total quality control:
   It emphasizes the idea that quality must be designed and built into the product. It involves evaluating the product and customer satisfaction. All departments, i.e., development, production, and sales, and staff members should work together to produce high-quality products with high efficiency.

2) Static quality control:
   A quality control system performs inspection, testing, and analysis to judge whether the quality of each product meets quality standards or not. Since 100% inspection of parts is not applicable, certain statistical techniques have been devised to evaluate machines, material, and process by observing capabilities and trends in variation.
BACKGROUND

Nepal is a landlocked country between two economic giants China and India. However, Nepal’s economy is growing in a slow rate. The development of the industrial sector has been limited and suffered decline in the last decade.

The estimate of per capita GDP and GNDI in terms of USD are 383 and 456 respectively (CBS National accounts of Nepal) in the FY 2006/07. About 31% of total population is still below the absolute poverty line facing hand to mouth problems. The share of exports over GDP is found much smaller as compared to share over imports.

Among different industries as per NSIC (Nepal standard industrial classification), manufacturing industries contribute 7.5% in GDP at FY 2006/07 along with 51887 million rupees to the GVA.

The Nepalese Steel & Iron manufacturing industry consists of a few large organizations, many of which operate under government auspices and a great number of small and medium sized production units which provide TMT Bar, Torsteel Bar, Galvanized Sheets, Steel Poles & Accessories, Steel Tower, G.I. Pipe & G.I. Pipe Fitting, Steel Bridges, Steel Truss & Pre Engineering Buildings, and Wire etc.

OBJECTIVES

⇒ The main objective of the study is to find out the production process and quality control of that the Steel & Iron industries in Nepal adopt.
⇒ The specific objectives are
  • To study the types of production processes in Steel & Iron industry in general.
  • To study the step by step production processes of Steel & Iron industry.
METHODOLOGY

The scope of this study is limited to the analysis of visiting of different industries. The methodology adopted in this study is as follows:

a) Different industries such as Hulas Steel & Iron industries (Galvanized sheets, HIPCO G.I. pipe, Colour coated sheets, G.I. pipe fittings & Others casting), Hulas cold rolling mill (CRM), Himal Steel & Iron industries, Himal G.I. wire industries etc were visited as a stage of primary data collection.

b) As for secondary data collection different places. Beside this internet surfing and literature study was also done.

c) Based on group discussion this report was prepared.
Cold Rolling Process Flow

**Input:** The input to the cold rolling industry is hot rolled steel. The hot rolled steel is available in the form of coils.

**The Processes Involved Are**

**HR Slitting:**
These coils are slit into the desired dimensions. The pull through HR slitting line cuts the rough edges of the HR coils, slitting it into narrower widths.

**Pickling:**
The slit coils then are cleaned in the pickling process. Pickling removes ferrous scales from the surface of the HR coils. The pickling line uses three acid tanks and three rinse tanks. A hot air blower at the end dries off the excess water on the strip.
Cold Rolling:
The cleaned coils are passed through the cold rolling mill to reduce the coil to the desired thickness. Pickled HR coil is cold rolled to the required thickness. The mill has automatic gauge control, pass schedule storage, and auto intermediate slow down. The mills give flat strip shape, minimized edge drops, and thinner gauges.

Annealing:
Next the cold rolled steel is successively heated and cooled to ensure that it acquires the required mechanical and chemical properties. This process is called annealing. Annealing is the process of heating, soaking, and controlled cooling of coil in a non-oxidizing atmosphere. Annealing atmosphere varies from 5% Hydrogen and 95% Nitrogen in HNX Annealing to 100% Hydrogen in HPH Annealing. Cooling is done with air and then water followed by natural cooling.

Skin Pass Rolling:
Since annealing process could possibly change the thickness of the coil, it is passed through the skin pass rolling stage to correct any small change in thickness. Skin passing removes stretcher strain or Luder lines. It provides desired finishes such as Matt; Bright on the strip surface imparts flatness to the strip.

CR Slitting:
In the next stage the coil is slit to the exact width required. CR slitter is used to customize the width of the strips to cater to the diversified needs of the customers. They have an independent tension unit thus enabling tension variance.

Packing:
In case the customer requires the steel in coils from it is directly sent to packing stage.

Cut to Length:
In case the customer requires the steel to be in the form of steels then it is cut to the desired length (or weight) and then sent to packing stage. Cut to length machine cuts the cold rolled steel into sheets as per customer requirements. The length can vary from 400 mm to 3500 mm.

Process Variables:
Temperature:
The strip temperature of 50 to 55 degrees centigrade is maintained. This ensures faster rate of reaction with the acid.

Acid Concentration:
Acid concentration in tanks influence the dissolution of scales and oxides. Higher concentration is maintained in the first tank and decreases in the subsequent tanks.
Line Speed:
   It controls the residence time of the strip in the bath. In cold rolling the hot rolled pickled coils are reduced to the desired thickness which is achieved either in.

Reversing Cold Rolling Mills:
   Thickness achieved by repeated passes through the same rolling stand and forth

OR

Tandem Cold Rolling Mills:
   Thickness achieved through series of rolling stands in tandem.

Tempcore Process in Steel Bar:
   Steel billets are heated in a reheating furnace and rolled through a sequence of rolling stands, which progressively reduce the billet to the desired size and shape of the reinforcing bar. Then, the Tempcore process takes over and the bar is subjected to heat treatment.

   After having left the final rolling-mill process (1000-1100 C), the steel rod enters a water-cooling chamber in which it is subjected to strong quenching on its surface. The surface thus acquires a martensitic (bonded iron and carbide) structure, whereas the heart of the rod, being at a higher temperature, acquires an austenitic structure. After quenching, the temperature gradient allows heat to flow from the center to the surface of the bar.

   The martensite surface layer is thereby subjected to self-tempering that continues until the internal and external temperatures of the bar are equaled (600 C). This process is monitored on the cooling bed. The characteristics of the steel thus obtained derive clearly from its chemical composition, diameter, final temperature and intensity of cooling.

Advantage of Tempcore
   1. Excellent bond strength.
   2. Superior bendability.
   3. Weldability
   4. Corrosion resistant characteristics
   5. Dimensional tolerance
   6. Economies in steel
   7. High strength and high ductility
Applications of Tempcore:

Tempcore is perfectly suited for all structures, large to small ranging from dams, power plants, bridges, factories, hotels to all types of commercial and residential structures.

Process of Colour Coated Steel Sheet:

The non metallic compound used for duplex coating is paint. Top class stoving polyester and epoxy based paints suitably primed for excellent flexibility and hardness characteristics, decorative and corrosion properties are used. The galvanized (alloyed) sheets before being painted by the roller application technology are suitably primed using paint primer to ensure proper adhesion and high quality surface finish. Subsequent baking of the sheet up to 240 degrees ensures excellent adhesion between the paint and zinc. Paint coating can be applied in semi gloss or full gloss finishes which are ideally suited for indoor and outdoor uses. It is especially suitable for structural work and consumer durable and usages.

Considering the life increase factor, colour coated sheets offer better cost benefit analysis over plain zinc coated sheets. Generally, following parameters are followed for roofing purposes:

<table>
<thead>
<tr>
<th></th>
<th>Coating Thickness DFT Microns</th>
<th>Type of Paint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Coat Primer</td>
<td>7 to 8 Microns</td>
<td>Polyester / Epoxy</td>
</tr>
<tr>
<td>Top Coat</td>
<td>12 to 13 Microns</td>
<td>Polyester</td>
</tr>
<tr>
<td>Bottom Coat</td>
<td>7 to 8 Microns</td>
<td>Polyester Based</td>
</tr>
</tbody>
</table>

Where: DFT = Dry Film Thickness

Rolled-products- TMT Bars/ CTD Bars / Wire Rods (Rolling Mill)

The process involves converting the shape stock, viz. ingots, billets to the desired finished section in the hot condition by way of passing the material between a pair of grooved rolls and providing suitable drafts at various stages. The whole operation is conducted at a particular temperature range and within a limited time span. The stages of rolling operation are comprised of heating of feed stock to roll able temperature, rolling the feeding stock in different mill stands, cropping the hot bar during the process of rolling between mill stands as applicable and subsequently finishing in form of hot rolled deformed bar in straight length. The hot bar coming out of the last pass is then conveyed through TMT line and collecting in a cool bed after shearing. The bars at almost ambient temperature are sheared to commercial length stored and kept ready for dispatch.
The manufacturing process of the rolling mills products can be depicted as follows.

In TMT process hot bars are subjected to quenching by means of an intense cooling installation (cooling installation specially designed spray system). This step hardens the surface layer to martensite while the core structure remains austenite. When the bar is free of water chamber heat flows from core to surface and surface gets tempered to structure called martensite. In the cooling bed due to atmosphere cooling, the hardened zone is tempered by temperature homogenization in the cross section and the austenite core is transferred to ductile-ferrite-pearlite core.

In case of CTD Bars and wire rods the thinner sections of hot bar coming out of the last pass is coiled through a coiler, whereas the thicker sections of CTD bars are collected on a cooling bed. The strength to the CTD bar is given by twisting it on the twisting machines and not by the quenching process as in the case of TMT bars.
Diagrammatic presentation of the existing material flow -

Raw Material Receipt

Heating

Hot Rolling into
CTD rebars

Hot Inspection

Cold Twisting

Physical Testing

Dispatch

Hot Inspection

Hot Inspection

Physical Testing

Hot Inspection

Specially Controlled
Water Quenching through
Patented Thermex System

Hot Inspection

Physical Testing

Hot Inspection

物理测试
PIPE FITTINGS

RAW MATERIALS:

The raw materials required for the production of pipe fittings is pig iron which is imported from various foreign countries but specially maximum portion from friend country India via road transportation.

Yogendra Prasad Pal is one of the leading metallurgist who recently servicing the Hulas steel & industries as Plant Manager who had the degree of B.E. in metallurgy engineering from Durgapur, India since 1974. He had served hulas steels for 4 years & now also continuing job with great enthusiasm. According to him the production process being used in hulas in pipe fittings are as follows:

1. Raw Materials
2. Inspection or testing of raw materials:
   (1) Casting
      (a) Pattern making
      (b) Mould & Core making
      (c) Casting (Melting Metals)
   (2) Cleaning of casting
      (a) Rough cleaning
      (b) Surface cleaning
      (c) Trimming
   (3) Galvanization
   (4) Drilling & Threading
   (5) Chamfering
   (6) Tumbling
   (7) Defect in casting
   (8) Quality Check and Rejection
   (9) Store
   (10) Packing & Marketing

Entry & registration of raw materials:

The raw materials is the pig iron, first examined by visual inspection then after other means are used like dimensional analysis, composition, state etc. If all the required property are met and raw material is oked then it is stored in the store of the industries after registration in the register of the industries.
CASTING:
Casting is the process of making a cavity (or mould) out of sand by means of a pattern. The molten metal is poured into the mould to produce castings. Casting process involve of making of moulds, preparing & melting the metal, pouring the metal into the moulds, cleaning the casting and re-cleaning the sand for use. The product of casting may vary from a fraction of a kilogram to several tones; it may vary in composition, as practically all metals & alloys can be cast.

1. A successful casting operation can be studied under following subtopics
2. Preparations of moulds & patterns
3. Melting & pouring of the liquefied metals
4. Solidification & further cooling to room temperature
5. Defect and inspection

The two different methods of sand castings according to the type of used pattern are:

1) Removable patterns
2) Disposal patterns

In removable pattern, sand is placed around the pattern which is later withdrawn from the sand. The cavity produced is filled with molten metal to create the casting. Disposal patterns are made from polystyrene and instead of being removed from the sand are evaporated when the molten metal is poured into the mould.

PATTERN AND MOULD:

A pattern is replica of the part to be casted and is used to prepare mould cavity. There are various types of patterns depending upon the complexity of jobs, quantity of casting to produced, problem associated with the moulding operation such as withdrawing the pattern from the mould etc.

1) Solid pattern
2) Gated pattern
3) Match plate pattern
4) Sweep pattern
5) Skeleton pattern

A large variety of mouldings materials used in foundries for making moulds and cores are such as:

- Moulding sand:
The main ingredients of moulding sand are:

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica sand</td>
<td>70-85%</td>
</tr>
<tr>
<td>Clay (as binders)</td>
<td>10-20%</td>
</tr>
<tr>
<td>Moisture (water)</td>
<td>3-6%</td>
</tr>
</tbody>
</table>
Other inert materials 1-6%
Iron oxide 2-3%

- Backing sand: floor or back sand. The moulding flash us completely filled wire backing sand after the pattern is covered with a thin layer of sea coal or coal dust facing sand.
- Facing sand: fresh prepared & well tempered foundry sand mixed with the sand to improve mould ability & surface finish
- Parting sand: This is the material which is sprinkled in the patterns and to the parting surfaces of the mould halves before they are prepared to prevent the adherence of the moulding sand.
- Core sand:

The overall management aspect of HIMAL IRON & STEEL and HULAS IRON & STEEL:

1) Raw Material Management:
To manufacture the rod, the roof top, the towers, high distention poles the raw material needed is hired from India. Those raw materials are in the form of iron roll or the billets. These are stored in the store house after inspecting its weight and quality in the store room.

2) Staff management:
Staffs are categorized in various levels according to the skills experience and knowledge. The number of staffs in Himal Iron & steel company was near about 200 while in Hulas iron and steel company it was near about 1000 (800 permanent staffs and 200 temporary staffs). The staff must follow the strict time and table of their arrival. The working hour for the staffs was from 10 a.m to 4 p.m. also there was evening and night shift as well.

3) Safety management:
Gloves, boots, aprons and spectacles were provided to those staffs who worked closely with fire, furnace, lathe machine, grinding machine and other machine were there was probability of meeting with the accident. But the staffs themselves seem not following those precautionous measures.

4) Power management:
Due to the frequent and scheduled long hour load shedding the company were deliberately cutting their production. Though the companies were forced to work with generator but big crank machine CNC, furnace and other heavy power consuming machine couldn’t operate simultaneously. Himal iron and steel was planning to hire a diesel plant in a couple of weeks. But the grave fact lies there that whenever a company opt for other power option to electricity the cost of production nearly doubles in itself. So their view was that the government should think seriously on this matter as it is not only those iron and steel company that are facing the problem but the whole sector is badly hit by this problem.
5) Waste management:
The waste management in both the companies was below the par. The waste that is generally the by product or the product that is short in length, improper dimensioned or unfinished is generally sold to the scrape collector at the very cheap rate. Even those products were seen scattered carelessly covering a very large area. The Himal iron and steel , in particular, sell the waste product to the other iron and steel manufacturing company at very cheap rate who in turn heat those material and remake them which in turn is a substandard product.

6) Land management:
The land allocated by the Hulas for its operation was 80 biggha where as land allocated by the Jyoti group was almost 400 biggha of land. The various machineries were set up accordingly as planned so as to make the production easy and suitable. Areas for various process like machining, storing, melting, processing, labeling, packing etc were pre planned and was managed accordingly.

HULAS & HIMAL steel industries perception regarding the Industrial Engineer:

Hulas iron and steel personals:
The plant manager of hulas iron and steel Yogendra Lal Pal provided us with his most valuable time & solved our quarries regarding various matters. A high degree of dissatisfaction over the running condition of the plant due to the continuous banda, strikes and equate power shortage could be judged.

Although he was very much excited and was eager to know the contents of our syllabus and our status in Nepal. Everyone co-operated with us right from the time 4:00 am in the morning till our departure time 4:00pm .we were guided by an engineer of the plant Er. Narayan Dhungana and engineer Roshan Jha.

After taking all the facts and figures of hulas iron and steel company we moved to Birjung where we spent the night in a hotel. The evening at the Ghariawarwa Pound was really a most memorable moment of the trip.

Himal iron and steel company personals:
The next day we were accompanied by an officer of the hulas iron and steel industries Er. Jha who took us to Mr Rimal, the head of the human resource management of hulas iron and steel industry. He was even very pleased to know about the establishment and running of the
industrial engineering in Nepal. He eagerly queried about the contents of our syllabus and what we were in fact going to do. After knowing all the things regarding the industrial engineer he in no time assured us to publish the vacancy of industrial engineer as soon as the first batch completes its term. Himal iron and steel industry is a part of Jyoti groups of industries.

Then we visited the whole hulas iron and steel industry there Er. Jha and Er. Shrestha detailed us the processing of the material and the manufacture of the steel from the billet which is hired from India also we visited the chemical lab of the hulas company where we got the knowledge regarding the test of the steel.

The difference in the governance policy between the private sector and the government sector:

Though the government formulates various policies during the establishment of any industries under the government sector but in the mean time hardly there remains anyone who would like to be abided by the rules and regulation imposed, as soon as you enter any government organization you would see a batch of passive staffs finding various means to spare the time whether going under the sun or predicting about the next government and its steps. Even the table of the reception (if there exist post) is all occupied by the dusts and hardly you could see any person on the chair. The negligence has crossed the leaps and bonds in such offices.

But the scenario is totally opposite in the private sector industries. Everything is well managed. A high degree of sincerity is paid by all the staffs and its members. The plans and the polices and the rules and the regulation formulated by the organization is equally applied to all.

Enthusiasm, punctuality, discipline, high caliber and skilled staffs, changing plans and policies according to the time, a mind to tackle the upcoming challenges etc. are the measures to success whether it is any type of organization or institute. We can say almost null of these significant measures has lag the country far behind.

On the other side a promise to work with the above mentioned measures has lead the private sector to bring a drastic change within them, banking sector I would like to mention, one among many private sectors. So it’s high time that the persons on the top level should start thinking on this regard so as to bring the industries and the overall sector on the right track.
CONCLUSION:

Production plays a vital role in the economic growth of any country. Companies like hulas and himal iron and steel are playing a vital role in this aspect. A country march towards progress only if there is industrial revolution. The product that these companies are producing adheres to the international standards like ISO and NS. The dissatisfaction of the management team was over the situation of the country where bandas and strikes are frequent. So government should create sound environment for the smooth running of these industries.

RECOMMENDATION:

In overall, all the aspect of the hulas and the himal iron and steel company we visited was well off. The management side was strong enough to formulate the plans and policies. The only thing that we dissatisfied was over the waste management. Waste here means the byproduct of the raw material. If the company could utilize the waste in the proper way than the wastes that were produced could be utilize in making other products that adhere the same properties. The per-piece-pay system that those company has adopted is superb in the contest of countries like ours where bandas and strikes are very frequent.
APPENDIX:

Manufacturing Process for Iron and Steel