

Module 8 – Iron and Steel

Describe some of the business practices that Carnegie employed that allowed him to take command of the steel industry.

Hard driving, vertical integration, price making

Which of the following was/is NOT a method used to make steel?

- A. Puddling
- B. Bessemer process
- C. Basic oxygen process
- D. Arc melting**
- E. None of the above

What are the three forms of iron, and what is the associated carbon content of each?

Wrought <.2% Steel .2-2.3% Cast Iron 2.3-4.2%

How did Andrew Carnegie use vertical integration to gain control of the steel market?

Controlled the entire steel making process from mining to final product

Who created the best steel for several hundred years while making swords during the 1500's?

- A. Syria
- B. Egypt
- C. Japan**
- D. England

Describe the difference between forging and casting.

When forging, you beat and hammer the material into the desired shape. When casting, you pour liquid into a mold to shape it.

Describe the difference between steel and wrought iron.

Steel has less carbon

Which of the following forms of iron has a low melting point and is **not** forgeable?

- A. Steel
- B. Pig Iron
- C. Wrought Iron**
- D. None of the Above

What two developments ushered in the transition from the Bronze Age to the Iron Age?

More iron ore and greater ability to change its properties using readily available alloying agent (carbon)

What is the difference between ferrite and austenite?

- A. Lots of carbon can be dissolved in austenite, whereas very little can in ferrite
- B. Lots of carbon can be dissolved in ferrite, whereas very little can in austenite
- C. Less than 0.02% of carbon can be dissolved in ferrite, up to 2.1% in austenite
- D. Less than 0.02% of carbon can be dissolved in austenite, up to 2.1% in ferrite
- E. **Both A and C**

What happens to steel's physical properties when excessive amounts of carbon are added?
Becomes brittle

When you heat steel to 1000°C, what phase do you have?

- A. Wrought iron
- B. **Austenite with lots of carbon**
- C. Ferrite with little carbon
- D. Cast iron

In 1855, what process replaced puddling allowing for the mass production of steel for the first time?
Bessimer converter

What is throughput and what advancement in steel production led to an increase in throughput?
Throughput is a measurement of how much comes into a factory and how much comes out. The invention of the Bessemer converter allowed Carnegie to increase throughput.

Which is a type of heat treatment for iron and steel?

- A. Slow cool
- B. Quench
- C. Tempering
- D. **All of the above**

How is the term creative destruction applicable to the mass production of steel in the mid 1800's?
Puddlers were put out of business by the bessimer furnace

What is the solid waste left over from the smelting of iron ore called?

- A. Wrought
- B. **Slag**
- C. Arc tailings
- D. Compost

What actually occurs, in terms of hardening, with carbon molecules inside steel when it is cooled after smelting the material?

They form carbide particles which block dislocation motion

What happens when you quench Austenite?

- A. Does not transform to Alpha Iron
- B. Carbon forms particles
- C. Makes it much stronger than Bronze
- D. Allows it to form a natural composite
- E. **all of the above**

What is the difference in procedure between bloom iron and cast iron?

When Bloom iron is beaten wrought iron is squeezed from slag

When cast iron is made it is poured into mold

Module 9 – Aluminum

What molten mineral was used to make melting aluminum so much cheaper than producing pure aluminum?

Chryolite

Why does aluminum foil have one shiny side and one dull side?

One side hits the roller

What caps the Washington Monument in Washington DC?

An aluminum pyramid use to

Which of the following statements about aluminum is NOT correct:

- A. Aluminum is one of the most abundant metals on earth.
- B. **Aluminum is lightweight, durable and brittle**
- C. The challenge with inventing a cheap method of producing Al was finding a way to conduct electricity into the bauxite.
- D. Aluminum can be made strong through solid solution hardening, work hardening, and precipitation hardening.

Briefly explain the process of precipitation hardening and state an element that is commonly used for precipitation hardening in aluminum.

The supersaturation and subsequent formation of precipitates after heat treatment results in much great mechanical properties. Silicon is commonly use for hardening aluminum

Why did the price of aluminum drop from \$500 a pound to \$0.30 a pound?

The discovery of cryolite made it possible to produce aluminum by electrical reduction

What are five applications of aluminum?

Cans, foil, aircraft, cookware, bicycles

What is the name of the aluminum manufacturing company that originally had a 100% market share before it was broken up during a court case and decided upon by Justice Learned Hand?

ALCOA

What is cyclic fatigue and how did it affect the shape of airplane windows?

Repeated application of force below the yield strength can result in crack propagation and failure.

Aircraft windows had to be rounded to reduce the stress and associated crack propagation associated with pressurization of the cabin

Precipitation hardening is also known as _____

- A. Water Hardening
- B. Age Hardening**
- C. Copper Hardening
- D. Saturation Hardening

Which of these causes a problem for aluminum in the aircrafts?

- A. An aluminum oxide coating
- B. Cyclic fatigue**
- C. The strength to weight ratio of aluminum
- D. The decline in availability of cryolite

Aluminum resists corrosion because:

- A. It is typically alloyed with chromium
- B. It forms a protective oxide layer**
- C. It has a high melting point
- D. Its structure has excellent London dispersion forces

While still a curiosity, what material was fashioned into knives, forks and spoons for Louis Napoleon in 1848? aluminum

Why is aluminum corrosion resistant?

It forms a protective oxide layer that fits very well

Which of the following is true about aluminum?

- A. Aluminum is easier to weld than steel
- B. Pure aluminum is harder than steel
- C. Aluminum is a poor conductor compared to steel
- D. Aluminum has a much lower emissivity making it had to tell when its hot**
- E. None of the above

What is the major hindrance on pure grade aluminum for industrial use?

- A. It is a scarce resource
- B. It is very expensive to manufacture
- C. Aluminum is soft and very malleable**
- D. The only producer of aluminum was Alcoa and the government shut them down.

What is the Hall-Héroult process?

Mix cryolite and bauxite and then heat until molten and insert electrodes to reduce aluminum from Al_2O_3

What is a volta pile, and what creation was the common household material that first came from this invention?

A battery made from dissimilar metal and it enabled the reduction of Sodium which enabled the reduction of aluminum

In what compound is aluminum naturally found and why does it make it hard to use?

Bauxite which has a very high melting point making electrical reduction very difficult

Aluminum is a very useful metal because of its properties that are similar and different from other metals. Which of the following is **not** a property of aluminum that makes it useful?

- A. Aluminum has higher specific strength than steel
- B. Aluminum is lightweight compared to most other metals
- C. Aluminum is more likely to rust compared to other metals**
- D. Aluminum exhibits cyclic fatigue unlike other metals
- E. Aluminum can be alloyed to increase strength like other metals

What is the difference between the constant return to scale and economies of scale?

constant return to scale means that if one increases the input there is a corresponding increase in output

economies of scale means a savings in cost by increasing production

What is the name of the monopoly firm that controlled the production and distribution of aluminum?

- A. Aluminum Company of America (ALCOA)**
- B. Aluminum Manufacturers of America (ALMOA)
- C. Aluminum Company (Al Co.)
- D. American Metals (AM)
- E. None of the above

What innovation did Boeing begin to use in 1957 that allowed for more structurally sound airplanes?

Rounded windows

Aluminum is corrosion resistant except in:

- A. Water

- B. Limestone
- C. Mercury
- D. Salt water**

What trick did Hall and Heroult figure out in 1885 in order to melt Al_2O_3 ?
Add cryolite

What effect did the success of aluminum have on anti-trust legislation?
Laws were enacted that stated there is no such thing as a good monopoly

What is the most effective method for strengthening aluminum?

- A. Precipitation Hardening**
- B. Work Hardening
- C. Alloying it
- D. Heating it

Module 10 – Writing Materials

What might be the future impact on society if we continue our trend of magnetic memory storage and email use over physical data storage?

May lose information if it is not backed up

Clay tablets did all of these following things, except...

- A. Enabled transmission of knowledge through generations
- B. Delayed rise to laws requiring transactions be recorded**
- C. Started being used as a means of recording around 3000 B.C.
- D. Gave rise to literature, Epic of Gilgamesh an ancient King of Uruk and adventures

Paper can be created by

- A. Breaking the cellulose lignin bonds in wood to yield pulp
- B. Mechanical Pulping
- C. Chemical Pulping
- D. Shaving wood to thin strips
- E. Both A, B, C**

What was the first form of paper?

papyrus

What was the first year in which more information was stored digitally than on paper?

- A. 1986
- B. 1996
- C. 2006**
- D. 2016
- E. never

Papyrus was created around what time, and in which region?

- A. 5000BC, Afghanistan
- B. 3000BC, Egyptian Nile**
- C. 4500BC, North America
- D. 2000BC, Greece

What is the difference between primary and secondary storage? Give an example of both in a system. Primary storage is usually the internal working memory of a system, so in a computer it would be the RAM sticks and cache memory, whereas secondary storage is usually an external memory being a hard drive or a solid state drive (SSD) for computers. For computers the primary memory is basically the workings of the computer, the RAM in a computer manages the information and memory first and then passes it onto the secondary one for safe keeping (hard drives).

What does the phrase “the medium is the message” mean?

The medium influences how the **message** is perceived.

Which of the following is not true about lignin?

- A. Lots of aromatic rings
- B. Chemically binds cellulose to give wood many of its properties
- C. Does not lead to yellowing of paper**
- D. Hydrophobic

Briefly describe both hard disc drives and flash memory. Identify one advantage of each over the other.

All of the following are examples of long term digital memory storage except

- A. Hard Disk Drives
- B. RAM**
- C. Flash Memory
- D. Solid State Drives
- E. CD's

What is the main component of wood?

- A. Lignin
- B. Hemicellulose
- C. Cellulose**
- D. Pulp
- E. Sodium

List the following four materials used to write information on in the chronological order of their historical development and use: papyrus, clay tablets, paper, parchment.

Clay tablets, papyrus, parchment, paper

What limited the popularity of papyrus as a form of paper making?

The demand exceeded the supply and there were not enough papyrus plants

How did the invention of the printing press impact the level of education among the masses? Explain.

Enabled the production of book which greatly enhanced the transmission of information

What is Florida's largest crop?

- A. Oranges
- B. Oak Trees
- C. Corn
- D. Pine Trees**
- E. Lemons

What is the chemical formula of cellulose?

- A. CH_2O
- B. $\text{C}_6\text{H}_{12}\text{O}_6$
- C. $\text{C}_6\text{H}_{10}\text{O}_5$**
- D. $\text{C}_{12}\text{H}_{22}\text{O}_{11}$

What did Sumerians use as a means of recording information around 2000 BC?

- A. Papyrus
- B. Wax Tablet
- C. Parchment
- D. Clay tablets**
- E. Paper Flax

How much data did the original Hard Disk Drive store?

- A. 10 megabytes
- B. 7.25 kilobytes
- C. 3.75 megabytes**
- D. 5.5 megabits

Which society was the first to use clay tablet for recording information?

- A. Sumerians**
- B. Egyptians
- C. Lascaux
- D. Romans

Describe the differences between mechanical and chemical pulping and their advantages and disadvantages.

What are some of the adverse effects of the process of chemical pulping used to make paper?

Module 11 – Plastics

What are the two main initiatives in the plastic industry attempting to deal with the large volume of plastic materials used in today's society?

Recycling, disposal, sourcing

What element did Charles Goodyear crosslink early rubber with to reduce its sticky nature?

- A. Hydrogen
- B. Oxygen
- C. Sulfur**
- D. Fluorine

What is the difference between plastics and polymers?

Plastics have additives while polymers are typically viewed as the pure chemical

What was the first synthetic polymer to be created?

- A. Polyethylene
- B. Cellulose Nitrate
- C. Bakelite**
- D. TNT

Side groups such as fluorine (PTFE) have what effect on polymers?

They alter their properties

What was one of the unique selling points of Tupperware, and what affordances of the material allowed this to be marketed?

It burps it could be shaped into appealing shapes and colored and it was tough and durable

Polyethylene crystallizes by

- A. the addition of rayon
- B. condensation polymerization
- C. stretching**
- D. the addition of a natta catalyst

What are the three strategies of advertising brought to light by Tupperware?

Which of the following is not a natural polymer?

- A. Silk
- B. Bitumen
- C. Teflon**
- D. Rubber

What is the most commonly-produced plastic?

- A. Nylon
- B. Kevlar
- C. Polyethylene**
- D. Bakelite
- E. Teflon

Who was the inventor & CEO of Tupperware?

- A. Earl Tupper**
- B. Christian Ware
- C. Roland Garros
- D. Ernst Heinkel

What are the affordances of plastics and how does that impact the materials that are made?

Who invented Tupperware and what are some of the ways that it changed society?

Which of the following is not a negative property of plastic?

- A. Disintegrates
- B. Cracks
- C. Expensive**
- D. Smelly

How was Tupperware advertised, and how did its marketing change the way society views plastics?

Via Tupperware parties, it had a tremendously positive impact on the perception of plastics

What are some of the benefits of thermoplastics?

They can be melted and recycled

What is the difference between thermosets and thermoplastics? Name some advantages for each. Thermosets cannot be melted but thermoplastics can. Thermoset can be made more durable and stand up to wear and temperature better (e.g. vulcanized rubber) thermoplastics can be more easily molded and recycled

Which of the following is NOT a property of plastics?

- A. Low density
- B. Low hardness
- C. High melting/boiling point**
- D. Easy to manufacture

E. Less reactive than metals

Which of the following is not a typical polymer?

- A. Polyethylene
- B. Polypropane**
- C. Polypropylene
- D. Polyurethane

Name 3 characteristics of polyethylene (the most commonly used and produced plastic).

Transparent, made over a range of molecular weights with different properties, can be easily colored

Which industry uses the most amount of plastic?

- A. Construction**
- B. Packaging
- C. Furniture
- D. Medical

What is the difference between nylon and Kevlar? (on a molecular level)

Kevlar has a backbone with lots of aromatic rings while nylons backbone is just a linear carbon chain

What were some of the issues with the first rubber made from Heeve trees?

Very soft and sticky

What property of carbon changes as its chain gets longer?

It becomes stronger, tensile strength goes up

Module 12 – Semiconductors

Explain why silicon has become the preferred semiconductor over the years and where one would look to find silicon in nature. It forms a great oxide and its found in sand

Why would it be better to use MoS₂ for transistors instead of graphene?

It has a bandgap which is critical for the fabrication of a transistor

What does it mean to “dope” a material?

Add an impurity to chemically alter its electrical properties

What does Moore’s Law refer to?

The doubling of the number of transistors per chip every 2 years

What is myopia and why has it increased in correlation with the increase in semiconductors?

Nearsightedness from staring at computer screens

What is the law describes that the number of circuits in a computer chip will double every two years?

- A. Henry's Law
- B. Moore's Law**
- C. Noyce's Law
- D. Jones's Law

All of the following are properties of the semiconductor silicon, except...

- A. High melting point
- B. Electrically insulating (if pure)
- C. Reflects light/shiny
- D. Durable**
- E. Brittle

Which of the following would exist without semiconductors?

- A. The Cloud
- B. YouTube
- C. Texting
- D. Fantasy football
- E. None of the above**

What is experience design? Give an example.

is the practice of **designing** products with a focus placed on the quality of the user **experience**. the Iphone

Explain the concept of "delegation" and list two examples of how humans may delegate or have delegated materials in society.

Describe what is meant when it is said that silicon has a bandgap.

Energy must be supplied to the material in order to create free carriers that enable electrical conduction

If a computer chip has 100 transistors in 2000, in what year will the computer chip have 102,400 transistors? (hint: Moore's Law)

- A. 2012
- B. 2016
- C. 2018
- D. 2020**

Which modern technologies have contributed to the demand for semiconductors?

All of them

When it comes to processing silicon, what is the biggest challenge faced when trying to make larger wafers?

Growing defect free boules

What is the difference between a conductor and a semiconductor?

Semiconductors electrical properties can vary widely based on doping where as conductors electrical properties do not vary as significantly

What percent of Wikipedia Editors are women?

- A. 27%
- B. 9%**
- C. 40%
- D. 70%

Why is graphene not used as a 2-D semiconductor?

Because it has no bandgap

Explain the four reasons for or causes of the digital divide.

What property of silicon makes it effective for use as a semi-conductor?

- A. High atomic mass
- B. Low density
- C. Hybridization
- D. Fission
- E. Band gap**

Per Moore's law, the number of transistors on a silicon chip will double every year since their invention. This will result in faster processors. List a couple of benefits that could result from having fast processors be widely available.

Virtual reality, longer times between charging, faster rendering, smaller easier to wear electronics

Silicon is said to have provided both an industrial and an information revolution. Give two examples (one for each respective revolution) as to how silicon did this.

Our technology that utilizes semiconductors has changed our society socially, economically, and environmentally. Give one reason/example for each on how this has been done.

A.