Lecture One: Intro to Technology and Civilization

September 13, 2011

Understandings of Technology

Technology as Physical Objects: Tools, machines, instruments, weapons, appliances.

Technology as Knowledge: the know how behind a technical innovation

Technology as Activity: skills, methods, procedures

Technology as Process: needs theory

Technology as a Socio-Technical System: interaction between humans and objects.
- this refers to how technology shapes society, and how society is affected by the technologies it uses

Defining Technology

While term technology can be found as early as the 17th century, used to describe treatise or study of industrial (practical arts).

This term only became popular after WWII but the use of technology or material items an be traced to almost 2 million years ago

Prior to this term being used, technical arts, engineering, practical arts and applied science were the terms used to describe technology

The word "tech" refers to the act of creation

1831: Jacob Bigelow wrote a book entitled "Elements of Technology on the Application of Science to the Useful Arts"

Most technologies are not created by just one individual, ideas about technology are often taken fro older sources.

Critically Assessing Technology

Social and cultural factors play a key role in the success or failure of new technologies, why are some technologies successful in one area and not in other

It is also important to distinguish between invention and innovation (making a technology commercially successful)

It is very rare that technology today is revolutionary (or life altering). When considering this, you must look at the impact at the time that the technology was created.

For example, the Internet is considered to be “revolutionary”. When considering the impact on society, the telegraph of the 1800’s was far more revolutionary. That is why newer technologies are considered to be “evolutionary” meaning that they expand on older technologies and improve them.

Ex.telegraph led the way for the radio, the telephone and eventually the TV.

Success and Failure of Technology

People mistakenly associate the success of a technology with how much of an advancement it is compared to previous societies.

There is also the idea that societies that use technology are more civilized, advanced and educated that ones that do not.

Success and failure of a technology has nothing to do with the actual product, rather it has to do with cultural, religious, economic, political factors and the needs of the community. Some societies do not accept certain technologies because it does not go with their culture/society or their needs.

Example: In North Africa, the wheel was used for some time before it was decided to no longer use it. This choice had nothing to do with being unfamiliar or uneducated with it. The wheel would break down often in the desert and was not reliable enough.

In 1600’s Japan, guns were introduced and then not used. Again, it had nothing to do with rejecting the technology because they were less educated about it ect. Japan had a warrior military culture, and the idea of using guns did not fit in with this type of culture.

Three Theories of Explaining Technological Development

It is important to note that there are critiques about each of these explanations, however they still remain to be the most popular definitions today

Theory One: Technological Determinism

Defining Determinism

Technological determinism is a viewpoint that regards technology as the prime agent of social and organizational change.

Technology is seen as an independent entity that changes and shapes society. It is an autonomous force that once invented, seems to have a life of its own.

Although humans are the one's who create the technology, it is the technology that defines how people interact and relate to one another. Societies are often defined by the technologies they use.

Once an object is invented, this artifact then transforms society and the way humans interact with one another, central to this idea is that human agents have almost no control over a technology once it is built.

Historian Heilbroner explains that determinists assume that technological change follows a roughly ordered sequence of development and imposes certain social

Popularity of Theory and Problems with Determinism

Ideas of technological determinism are most pervasive in popular discourse

According to historians Marx and Smith, it is typified by sentence in which technology or a surrogate like the machine is made the subject of an active predicate.

The automobile created suburbia or the robots put the riveters out of work or the Pill produced a sexual revolution.

In each case a complex event is made to seem the inescapable yet strikingly plausible result of technological innovation. It is the simple explanation for something that happened. It makes people focus on the technology that has "caused" the problem, as opposed to other factors which may have also played roles in events that have occurred.

Ironically, what made determinist accounts of technological change frightening is also what makes them appealing. While technologies may appear to e out of control, humans are in turn absolved of their own responsibilities regarding the impact of technological development.

It is very popular because people are no longer considered to be responsible for what is happening. Example: Machines have taken jobs away from people in the workplace.

In this example, the machine has been blamed for the negative social consequence of job loss. In reality, it is the people who chose to implement these technologies and therefore remove the jobs.

<u>Other Critiques of This Theory</u>

In marketing campaigns, the theory of determinism is very present. People are taught to believe that technology shapes them and how they may progress in life.

For example, it is marketed that is is a necessity to own the latest technologies otherwise school, social and other factors of life will be seriously affected.
Alternative Theories

Technological determinists have been criticized for simplifying what is a far more complex relationship between society and technological change.

Theories such as the social construction of technology and the social shaping technology have been developed to refute the notion of technological determinism.

According to historians Williams and Edge, choices are inherent in both the design of individual artifacts.

<u>Lecture Two: Introductory Lecture Cont</u>

September 15, 2011

Technology as Applied Science

This theory claims that science and technology are interrelated, and that basic scientific research can find new technologies.

This theory can be applied to the modern world, however it cannot be applied to most of history. This was because technology and science were believed to be completely different fields.

In the past history of technology was usually subsumed under histories of science or economics.

Technology as "applied science" refers to idea that technology is driven by scientific discoveries

While this might be true to some extent in the modern era, prior to the 20th century science and technology done by different sets of people with different norms and values within their established communities

Scientists and people practicing the technical arts were working in completely different domains, and they did not collaborate in their ideas until the 20th century.

Examples

Industrial Revolution – inventions such as textile machines, steam engines, railways had little scientific knowledge behind them

Today, the debate still continues as to whether modern technology heavily relies on scientific knowledge

Project Hindsight – 1960's – Department of Defense – looked at development of military defense system

Researchers found 0.3% events relied on scientific; 90% had technical origin; 8% applied science

Project Traces – National Science Foundation – contraceptives, electron microscope, VCR's all rooted in basic scientific research

Necessity is the Mother of Invention/The Necessity Argument/The Economic Needs Theory

According to this theory, a technology is created by someone in order to fulfill a need that exists in society.

Economic approach to technological development whereby technologies are created according to the particular needs or wants of society; "necessity is the mother of invention"

Sometimes, technologies are created out of need, but in the majority of instances, this is not true

Assumption is that technological development follows a fixed one-way path and can be explained by referring to economic laws, etc...

While this may be true for a certain category of invention, the major criticism of this idea is the assumption that the inventors of a technology actually know what their technology will be used for

Problems with this Argument

In most of history, technologies have not really been created for necessity. Many have been created out of hate, love, boredom or sometimes completely by accident.

The Time-Lag Argument - this theory doesn't apply because there are some technologies that were created long before society had found a use or need for the technology. Therefore there was no need for that technology when it was created.

eExample: windmills introduced into England around 1185 but spread only in 13^{th} century after landowners thought they could be profitable venture

We are making a huge assumption with this theory. We are assuming that inventors know how their technology will be used. We don't actually know ultimately how the technology will be used.

As we will see time and time again in this class, inventors of a technology may not actually know how users will respond to their technology; in many instances comparisons will often be made to older technologies

This often leads to idea of UNINTENDED CONSEQUENCES related to technological development.

More Likely Approach on This

Instead of necessity as mother of invention, might be more prudent to argue that new inventions often create needs that must then be satisfied by new technologies.
This means that technologies are created which in turn create needs for the technologies that are available.

THEMES OF THE COURSE

How Users Shape new Technologies

If inventors don't know how their technology is going to be used, we have to see how people use the technology to determine whether or not it is successful, and in what shape it will take in society.

This is the direct counter to the Necessity argument. In some cases, “users” can refer to society in general or a smaller subgroup within society.

There are always unintended consequences of using new technologies, which the necessity argument does not take into consideration.

Social, cultural factors play large role in success or failure of new technologies, and in shaping it.

For example, the telephone:

The original intended purpose of the telephone (as stated by the companies and creators) was for the use of emergency only, and that it should not be used to communicate casually with others.

It is evident that this was completely ignored by society. The telephone became a means of communication, and not in the case of emergency only. This was what shaped and solidified the success of the telephone.

Technology and issues of Race, Class, Culture and Gender

When considering technology, one may not think of the fact that even technology is subject to gender, class or racial bias.

Examples:

Robert Moses with highway bridges and the question of racial segregation in New York

Researcher Winner suggested that Moses built these bridges especially low so that trucks/buses would not be able to pass under, only cars.

Cars were only owned by the rich at this time, and these individuals were often white. The highways would connect the suburbs (almost no ethnic minorities lived there) to the intercity. It is believed that Moses was indirectly segregating the community because minorities who had to travel by bus would not be able to get to the suburbs.

Religion and Technology

Religion was used to justify technological advancements, and they were given higher social status by society.

The Relationship between Science and Technology

It began with the ancient Greeks that there was a distinction between people practicing natural science compared to those practicing technical sciences. Since this separation, the relationship between science and technology has changed significantly.

There is a theory that considers technology to be an applied science, however it was not considered to be for a large part of history. To understand this theme, we must analyze what it was thought to be before it was considered to be an applied science.

See relationship between science and technology as intimately connected since time of ancient civilizations; to make distinctions between them is meaningless.

Others see science and technology as two distinct activities with their own methods, norms and communities.

Depending on viewpoint, historical events can be interpreted in number of different ways. Some people consider science and technology to be one field, sometimes referred to as “technoscience”.

Even though some people consider the link between the two to be strong, this does not necessarily mean that they are the same thing.

Example of Thomas Edison: some see his work as separation of technology from science; others state that he could not have been successful without help of physicist employees like F. Upton

Views of Technology

The ways in which people think about technology (in relation) to science is extremely important, especially when it comes to issues of industry and government funded research.

The way people see this relationship is important. One of the main reasons has to do with money and research funding.

An example would be the development of the atomic bomb. This was believed to prove that applied science and technology were one and that there was a significant relationship between the two.

This caused many people to start funding basic science research in the hopes that there would be more innovations like this in the future coming from this funding. This was not the case, and the perception of technology as an applied science was diminished.

The Management of New Technologies

Are certain technologies conducive to a particular management structure?

Some places in the world use or have used technology in order to control their populations. This is done through patents, monopolies and standards.

What is the purpose of large state driven technological programs? (Note: this is not a NEW phenomena as we will see in our discussion of ancient civilizations such as Egypt and Mesopotamia)

The politics of technology policy and regulation.

Lecture Three: Note-Taking Workshop

September 20, 2011

People often read scholarly articles in the same way that they read pleasure reading, which is wrong.

Must look at the PURPOSE of why you are reading to maintain interest. There are two purposes for reading scholarly articles:

1. I am reading in order to learn something new (all the terms, concepts and ideas are brand new to me)
2. To supplement knowledge (to reintroduce ideas you have been already exposed to in order to help understand or go beyond memorization)

This can often change. Sometimes you start reading to supplement, and as you go on realize that sometimes you are actually reading to learn something new. This constant questioning of the article will help you get through it.

You must not treat all paragraphs the same. Some contain more information and should be concentrated on, and others are less important and can be skipped over.

In order to determine quickly whether or not a paragraph is important, one must read the first and the last sentences of that paragraph.

- The first sentence will tell you what the paragraph is about
- The last sentence will either sum up the information or demonstrate what is coming up for the next paragraphs.

Page numbers - saves a lot of time in your notes

- It is important to put examples in your notes. Without examples, there is no context to the information.

Lecture Four: Technology and Ancient Civilizations

September 22, 2011

Early Civilizations

The Urban Revolution

Occurred about 6000 years ago.

This period of time was characterized by the development of urban civilizations fairly quickly.

Examples: Mesopotamia, Greece, Egypt

All of these urban centers developed because
- geography: there were some sort of barrier such as mountains (brought people together)
- highly populated communities
- simple agriculture was replaced by field agriculture
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Higher levels of learning, technological achievements, scientific achievements, complex architecture were all characteristics.

These were stratified societies (centralized/hierarchical). The majority of the power was held by the smallest groups of people. Most of the population was at the bottom of the hierarchy.

The Hydraulic Hypothesis

This hypothesis makes a connection between the development of certain large scale technological systems, and the development of these social, economical and organized societies.

Water became a precious commodity in these societies for two main reasons
- Not enough water
- Too much water

People needed to control and have water because the new agricultural system required more water (as there was more population to feed). Populations became more static and sedentary.

The building of large irrigation systems was meant to solve these problems for the people. It was because of the need to create and control these systems that caused the development of these stratified societies.

This is a determinist theory because it centers its idea on the belief that the invention of these technologies essentially created and shaped the culture and societies.

Problems with this Theory

Determinism - it is problematic because it assumes that the technology shaped the people and caused social, political and economical changes.

It completely disregards all other factors for why this may have happened.

Some historians believe that the societies were already stratified civilizations, before this technology was even created (therefore there is no reason to assume that the technology shaped the society). It is more believed that the society created the need for these irrigation systems, as opposed to the other way around.

Another criticism is that there were other societies that developed and used large scale water irrigation systems, but did not necessarily evolve into stratified civilizations.

Alternative Theories

Hypothesize that an irrigation system was just another way for the ruling class to gain more power because they were in charge of distributing the water supply.

William Mitchell

Reformulate hypothesis to state that, “it is not irrigation itself, but the centralized coordination of irrigation activities that has important social consequences”

Feedback system

Centralized control of irrigation means greater political integration and this then allows people in power to come up with an “excuse” for more political control (i.e. the right to limit access to water)

Early Science and Technology in Ancient Civilizations

Urban civilizations during this time were able to manipulate and use materials such as bronze, which is why this time period is also referred to as the “Bronze Age”

This is another case of determinism. The civilization is being labelled by only one of the technologies used during that time. It ignores other uses of the technology or other important things that happened during this period of time.

"Bronze Age" - these civilizations could manipulate metals in temperatures up to 1000 degrees, jobs needed specialized workers now, people gained more skills, mining was a new industry, people learnt how to smelt, there was a move away from traditional energy sources.

These civilizations used alternative sources of energy and transportation that did not involve human or animal power. Wind power was used, and travel using the wheel became more widely used.

Early Civilizations vs. Greek Civilization

It is often believed that the beginning of scientific knowledge began in the ancient world, but this is not necessarily true.

The ancient people developed systems of book-keeping, calendars, architecture, engineering, political administration and astronomical predictions.

They used scientific knowledge to make predictions about things around them and to develop systems, rather than actually developing scientific theoretical knowledge.

Mesopotamia

Developed a system of writing (taken from the Sumerian method of writing on clay tables). This created a new job: **scribes.**

The scribes held some power because they had a special skill that not a lot of people had at this time. They had access to the elite because of this skill and had a lot of knowledge compared to the majority of society.

They are also known for their mathematical achievements.
- The place system (dividing numbers into units of 100, 10, or 1 for easier computation.
- The base 60 system (digits to represent units of time, based on the number 60)

Astronomy was important for this society. Their ability with math helped them with this.
- good knowledge of equinoxes, sun and moon movements, planetary motion, solstices

- they were able to make accurate predictions about when these things would happen
- other civilizations used these ideas later on (knowledge transfusion)
- they conducted systematic research as opposed to recording observations

Architectural and Engineering Achievements
- temples, complexes, pyramids

Egypt

Famous for their large-scale architectural projects such as the pyramids which showed off their sophisticated level of engineering knowledge.

Most of the pyramids were built in Giza between 2789-2767BC (approximately)
- The Great Pyramid is made of 2.3 million blocks which weigh 2.3 tonnes each.
- It is believed that there were about 1 million workers over 20 years to build this, about 4000-5000 craftsmen worked all year round.

One of the biggest questions regarding the pyramids is how were they created?
- it is believed that a system of pulleys and levers were used to bring the heavy slabs of rock to the top
- this does not answer the question about how the slabs of rock made it to the site of the pyramid from the quarry

Another big question is: why build the pyramids?
- Most assumed that it was a way to bury the dead to avoid the tombs of pharaohs being robbed (many valuables were left with the dead pharaoh for the afterlife)
- Another coincides with a religious belief that the pharaohs had to be buried in these structures once they died
- The third theory is that the elite were trying to control the labour population in Egypt at this time. They did not want the people to get bored, or more importantly, rebel or revolt against the elite

Egyptians also developed their own method of writing. As opposed to most forms of writing, pictures called hieroglyphics were used.

In terms of math, the Egyptians developed less than the Mesopotamians. However, their math was more practical for everyday use:
- multiplication system
- decimal system
- powers of ten

The Egyptians were also well known for their medical knowledge, and their medicinal tactics were often copied and developed on by future civilizations

Lecture Five: Technology in Ancient Civilizations

September 27, 2011

Differences Between Ancient Civilizations and Ancient Greece

It is suggested that the Greeks were not involved in very much scientific research, and instead engaged in more technological research (today these two fields have some overlap).

In more ancient civilizations, research was done mainly for practical reasons. This was the way that knowledge was used.

In Ancient Greece, this was the opposite. People would seek knowledge just for the purpose of learning.
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In Ancient Greece, there was a focus on the individual researcher/philosopher and recognizing their theories as their own.

In other civilizations, this was done in a more bureaucratic manner. Nameless people conducted research that was generally accepted.

There was a gathering of knowledge (almost in a list-making way) that was catalogued in a encyclopedic manner.

Abstract generalizations, which are attempts to explain natural phenomenon, were popular in Ancient Greece.

In Ancient civilizations, explanations for how the world worked or why it was a certain way was based on a supernatural entity or a religious figure.

In Ancient Greece, the focus of the philosophers was not on religious explanations, but rather on material explanations. They were asking different questions and therefore ended up with very different explanations for why things were certain ways.

Implications of These Different Ideas

It was assumed that the ancient Greeks were more progressive because they studied for the purpose of knowledge. This is why Greece is considered the birthplace of modern science.

This is a problem because people assume that the other ancient civilizations are less progressive and their achievements are not as impressive because they were for practical reasons.

The Western world is based on the Ancient Greek roots of knowledge. It is believed that science is the superior subject. The Eastern world traces its roots back to the other ancient civilizations.

Diffusion of Technology

In Ancient Greece, there was no development of of large-scale agricultural structures. They did some of this on a small scale, although they imported and exported many of their goods.

Because of this constant contact with other parts of the world, the Greeks were able to spread their knowledge to other parts of the world. They were also able to receive and adopt new theories from elsewhere in the world.

Technical Arts versus Natural Philosophy

The emphasis on natural philosophy (learning for learning's sake), as opposed to the technical arts, was prominent in Greece because of many reasons.

Socio-Economic - people who worked with their hands typically engaged in the technical arts because it was practical and helped in their domain of work. They were considered to be of lower status because they worked with their hands and had to consider how much money they made as a way of survival.
Natural philosophers often had more money and more time. They did not need to focus on practical technologies because they worked with their mind as opposed to their hands.

Universal/General Knowledge - The natural philosophers were considered to be more valuable because they developed ideas and theories that could explain things that are occurring all over the world. Those engaging in technical arts were considered to be very subject-specific, meaning that it would only be useful for that one purpose in one specific field.

Explanations - The final reason why natural philosophers were considered superior was because they could explain why things were happening. People working in technical arts often could create technologies that worked, but could not explain why they worked or how they worked.

Aristotle and **Plato** considered the technical arts to be mundane, meaning boring and unimportant.

Why was There less Enthusiasm Towards the Technical Arts in Some Regions?

In regions where slaves were used, there was less acceptance and interest in the technical arts. This is because the civilians were not the ones doing the work themselves. Therefore any technical advancements would not affect their lives in any way, and so they did not bother. It was considered to be of lower status in society.

In regions where slave labour was very scarce, there was acceptance and encouragement of practicing the technical arts. This is because the advancements would affect the lives of the people of that society, and it would improve working conditions and productivity.

The Roman Civilization - Differences Between the Romans and Greeks

Technical-Natural Arts - the Romans were enthusiastic towards the technical arts. This is because during this time, they were involved in war and conquering other territories to expand their empire.

Technologies developed by the Romans

- Aqueduct systems (cleaning the water supply for the communities)
- Modern road system
- Military technologies

The Romans also took part in the natural arts. They would take some theories written by the Greeks and would expand upon them. Although they did this, it was not their primary focus at the time (they were a military society).

Decline of the Greco-Roman Era

This is considered to be the beginning of the **Medieval period** aka the Dark Ages

After the fall of the Roman Empire, there was a decline of interest in the natural or technical arts in the beginning of the Medieval period. Towards the end of the Medieval period, this changed dramatically and people began to gain interest in it again.

Although this entire time period is referred to as the Dark Ages, this really only applied to Europe. China and the Islamic world were reaching their peak of scientific research during this time **(Golden Era).**

One of the reasons for this change in ideas is the **rise of Christianity**. People began to lose interest in science because religious ideals became more commonplace and they did not coincide with scientific research.

Obtaining Religious Salvation - it was believed that people who sought out and discovered "forbidden" knowledge (like Adam and Eve) would lose their privileged status of being able to go to Heaven.

Christian philosophers rejected most of the Ancient Greek philosophers because they made explanations about why things were happening around them (the Christians had religious explanations for this).

Later, Aristotle's ideas became adapted to fit the Christian ideals and he was widely accepted by religious scholars.

Another reason why there was so little interest in the technical arts was because of the preoccupation with what happened to you after you die (the idea of Salvation). Technical arts were designed to make the world around you easier and life easier. The Christian scholars had little interest in the present life and instead focused on the after life.

Lecture 6: Technology in the Middle Ages

September 29, 2011

Medieval Attitudes towards Technology

Changing Christian Views

The Christian church originally rejected all ideas of natural philosophy. However, they soon accepted and used the ideas from **Aristotle**, which they originally considered to be heretical.

The way in which these ideas were accepted was by blending Christian ideals and Aristotle's ideas.

For example, Aristotle developed what he called "The Natural Chain of Being". The Christian church took this and added in their own things so that this chain would be acceptable.

Aristotle's Chain: Man, Woman, Animals, Plants ect
Christian Aristotle Chain: God, Angels, Man, Woman, Animals, Plants ect

Acceptance of the Technical Arts

The Christian church also began to support the technical arts, which made them more popular and accepted also.

Hugh of St. Victor linked the technical arts to religion so that it would be considered more acceptable.

- He believed that all forms of knowledge and research were valuable
- Claimed that studying different knowledges would solve different problems.

Links to religion

Theoretical knowledge - solve the problem of ignorance
Practical knowledge - solve the problem of human vice
Technical knowledge - solve the problem of physical weakness

He also claimed that studying his type of knowledge would lead the way to religious salvation.

Acceptance of These Ideas

Craftsmen and artisans supported these ideas because they were affected by it. They were happy that their studies would lead them to religious salvation, and also would be more acceptable in their society.

Natural philosophers strongly rejected these ideas. This was because they followed Aristotle, and his ideas were greatly altered to fit in with Christian ideas. The natural philosophers also stood by their belief that the mechanical arts were lesser because they involved the physical and material, rather than the mind.

Islamic Technology During this Time

Although there was no technological advancements in Europe at the time, in Islamic countries this was not the case.

The Islamic countries were very progressive in terms of optics, mathematics and other forms of sciences.

Asian Technology in the Middle Ages

During this time (Sung dynasty), was considered to be the "**Golden Age**" of Chinese Science.

- Also during this time, there was a huge population boom in China

- It is interesting to note that during this time, technical science was still considered to be inferior. Therefore, this does not explain why it boomed at this time.

Historians believe that state-funded technological enterprises were the cause for this Golden Age.
- The government would fund enterprises
- They were also very involved in picking people to work for them (ensure productivity)

Technology developed in one country, which ultimately creates success elsewhere
- Some technologies are created that are not fully embraced in the country they are created
- They have more success elsewhere
- Usually this is because there are social and cultural differences

<u>Examples</u>

The printing press and paper was originally developed in China. However, it was only fully accepted in Europe. Why would something like this happen?
- There was a strong scribe community in China, which would oppose the use of the printing press
- The nature of the Chinese alphabet is too complex for printing presses

Technology that is developed for one purpose, but its success ultimately comes from a new use of that technology.

<u>Examples</u>

Gunpowder was invented in China. However, the use of this gunpowder was for fireworks. It was only by finding another use (powering firearms) did this gain popularity.

Agricultural Revolution in Europe

Huge increase in production, primarily because there were new technologies that increased the productivity of farms.
- This was brought on by a need for more food.
- There was a 30% increase in population at this time

This revolution was not dependent on one new technology, rather is was brought on by a large amount of change in all domains.

New Technologies

The Heavy Plow

- Originally used the Light Plow to turn the land (2-3 oxen, could only move through certain parts of the land)
- The Heavy Plow had many more animals (more power)
- Able to farm land that was previously inaccessible (this was more fertile land)

New Crops

- Potatoes
- Corn
- Maize (used for animals as well as humans)

Domesticated Horses

- Substitution of the ox by horse
- Moved faster
- Could work for longer amounts of time than oxen
- Horse collar: allowed humans to control the movements of the horse

Crop Rotation System

- Used to use the two crop rotation system
- Field was divided into 3 sections
- Two were planted each year and one was left fallow
- This rotation system allowed the soil to replenish nutrients and increased production of food by 30-50%

Communal Agriculture

- Most farmers could not afford to have as many animals as required by the new technologies
- They grouped together and owned animals collectively

Domesticating Horses (Cont)

- The stirrup: made it easier to stay on the horse
- This technology changed the way wars were fought (people wold bring horses to get to the battle and would not use them once they got there. Now, the horses were part of the weaponry)
- Being able to fight and ride at the same time became a symbol of honor and greatness.

Enthusiasm

- People supported labour saving technologies
- Wind and water power was popular and accepted

The Black Death

- Also known as the Bubonic Plague
- Wiped out about a third of the population
- People who had the plague died quickly, it was spread quickly due to poor hygiene and techniques on containing illness

Benefits of the Plague

- More money for survivors
- More land available
- Labour became scarce, so labour saving devices were necessary and therefore widely embraced by the remaining population

Lecture Seven: Technology in the Middle Ages (Con't)

Origins of The Mechanical Clock

Uncertain Past

It is extremely difficult to determine who invented this and when it was invented

- This is because it is referred to as "horologia" in older texts
- Horologia includes all time keeping devices, including sun dials. Therefore when something called a "horologia" is referred to, it is unclear what the actual device was.
- "Cloche" is another word used to describe clocks, however in French it also refers to bells.

One of the main debates is whether the mechanical clock originated in China or Europe.

The Price/Needham Thesis

Derrick Price and Joseph Needham argue that the mechanical clock was invented in China. This is also referred to as the "Fallen Angel Thesis"

The thesis suggests that the mechanical clock was a less sophisticated technology that came out of more advanced Chinese technologies at that time.

The example given for this was the advanced water clock, created by Su Sung in China. This device was extremely complex compared to the mechanical clock, so it is believed that the mechanical clock was a type of by-product of this technology

After the mechanical clock is invented in China, it diffuses its way into Western Europe.

Rejection of this Thesis

The major device associated with European clocks is called the verge and foliot mechanism, which is significantly different than that of the Chinese clocks.

Another problem with this thesis is the difficulty of proving technical diffusion of the mechanical clock from China to Europe.

Why a Mechanical Clock?

It is generally accepted that the mechanical clock was invented in Europe, however the main question is: why would Europeans need to invent this technology?

Mumford and Landes suggest that this came from the needs of the church.

- Monks in the monasteries needed a way to keep time to perform their religious tasks
- This is criticized because other time-keeping devices were fulfilling the needs of the church at this time. It is not till much later that more accurate devices were necessary

Another hypothesis is that other time-keeping devices that were being used at this time became more problematic as time went on.

- The sundial did not allow time to be kept at night
- The water clock could not tell time when the water froze (Winter)

Why was this Popular in Europe?

Landes had many arguments

- Chinese did not have any needs for accurate time keeping devices
- Chinese rejected all foreign technologies
- Chinese had too much ego to accept this foreign technology
- Chinese thought clocks were toys, as opposed to valuable instruments

Counterarguments

- The Chinese were very advanced in technology, and therefore would have the desire and need for this technology
- By stating that the Chinese would have no need for technology implies that they are technologically lacking and that they do not readily accept new technology
- The implication that they are in-advanced and like children (think if it like toys)
- Arguments 2 and 3 are almost impossible to prove, and therefore cannot be considered to be true without proof.
- These represent cultural generalizations about the entire Chinese society

More Accurate Reason for This

- There were less people making clocks and fixing clocks in Chinese society (so this technology may have been less widespread for this reason)

Why Europe? - Technological Improvements

Striking Mechanism

- Clocks in Europe could now be heard at every equal hour of the day
- This lead to the construction of large-scale clock towers
- Helped to increasingly regulate peoples activity according to clock time
- This became a fad in cities, and many competed to build the biggest and most ornate clock towers

Spring Drive

- This was a part of large-scale clock towers, but could be adapted to smaller scale ones.
- This meant that now time keeping devices could be much smaller, and even portable.
- This is referred to as the “portability of time”
- It was now possible to keep time wherever you were, regardless of where you were.
- This emphasized the individual use of time, as opposed to the large scale towers which emphasized communal use of time.

People from all domains now made clocks: blacksmiths, engineers, clock-makers, artisans, ect

- Not only did they make clocks, but they fixed clocks
- This was just as important as making them in the first place
- Huge amount of people who made and fixed clocks

Social Factors

Royalty

- Thought of them as toys, something to be shown off to royals from other cities and towns
- Became a sign of wealth, the more ornate, the more money you had
- Given to princes and princesses as gifts

Le Goff: Merchant’s Time

- Suggested that the merchant class liked this clock because they saw it as a tool of power and control

- Allowed to keep more accurate track of money
- Gave more control over the labour/working classes

Problems with this Idea

- Does not explain why other groups in society embraced this technology
- There are other reasons why other groups liked this technology
- Does not explain why Europe as a whole used this technology
- It is impossible to prove this (the working class liked this technology just as much as the merchant classes)

Time-Keeping in Everyday Life

- Prior to the invention of mechanical clock, time was based on the seasons. This meant that time was unequal
- Mechanized clocks keep equal time, regardless of the season
- The original clocks did not keep minutes or seconds

Lecture Eight: Technology in the Renaissance and Early Modern Period

October 6, 2011

Science and Technology in the Renaissance

Renaissance means "rebirth" in French - represents a revival of classical texts, as well as a renewed interest in travel, adventure and navigation.

Changing Attitudes

Natural Philosophy - was considered to be the pursuit of knowledge for knowledge sake. It was believed to be knowledge about the world that was not necessarily used in a technical way.

There was now a shift away from just learning for the sake of learning. Now, people wanted knowledge in order to use it for some kind of purpose.

Some reasons for studying natural philosophy
- Wealth
- Status
- Fame
- For oneself or their country

Technical Arts - by this time period, those who studied this type of knowledge began to gain popularity. Engineers and engineering pursuits became popular (court sponsorship)

Court sponsorship - The court would pay for projects that were being done for the royal elite such as: military technology, architecture, artwork, writing ect
- The engineer now held more status in society

Another reason why there was a change in attitudes was that there were new techniques being developed in the arts. This increased the quality of the arts and therefore a new enthusiasm in them.

Linear perspective - it was now possible to paint in three dimensions, which never had been done before. This created an interest in painting and artwork.
Before this, people were drawn and painted according to their status in society.
- The higher the status you had, the larger you were drawn or painted
- This was the kind of paintings popular at that time

Linear perspective makes everyone drawn to scale, so everyone was the same height compared to the person beside them.

The Closer Relationship between Science and Technology

Increased Use of Instruments in Scientific Practices

Aristotle was the main philosopher before this, especially when he was inked to the Church.

He did not support experiments, because it was believed that when you manipulate nature, you are not viewing it in its true form. Therefore nobody conducted experiments.

When these ideas became disputed, there was a shift to experimentation. This facilitated a need to use instruments and technology in order to conduct these experiments.

Social Spaces

Social spaces became forums where people would get together and discuss their discoveries and ideas and trade theories.

This brought about the building of coffee houses, bars, salons and other public places where people could gather and talk.

Hybrid-Humans

Those who did natural philosophy stuck with that, and the same with technical arts. By the Renaissance, this began to change. People became interested in both these pursuits and became known as “hybrid humans”

Note - while there is a growing relationship during this time, it does not mean that science and technology were the same thing or accepted to be the same. This took centuries before they became linked.

Technology and Patronage

Royal courts sponsored arts and architecture during this time because they wanted to appear rich, wealthy, prosperous. They also had more practical reasons such as warfare and city-building.

This gave engineers and artisans more status in society.

- The patronage was necessary for this explosion of the arts to occur.

Leonardo da Vinci

He was an illegitimate son, raised by his grandparents. Other than this, not much is known of his childhood.

Became a sculptor and was an apprentice by the age of 14. He was very ahead of his time when predicting future technologies.

3D Drawing - he perfecting this technique. He used this technology to draw images of other technologies.

He drew images of warfare technologies

- Weapons using gunpowder
- Parachutes
- Helicopters
- Cannons
- Crowsbows
- Bridges
- Chariots with daggers on them
- Airplanes and submarines

Worked for many prominent families as an engineer, and worked as an engineer-for-hire for some time before he began to study anatomy.

Lecture Nine: Technology in the Early Modern Period

October 18, 2011

The Printing Press

The printing press was based on an invention which was created in China.

The Chinese deveoped paper, moveable type and wooden blocks which were used for printing on paper.

This did not take off in China for many reasons
- There were too many characters in the alphabet, so it was too complicated to use the printing press with so many different characters
- Scribes had special privilege in society and did not want to give this up by letting the printing press become popular.

Johan Gutenburg is credited with bringing the printing press to Europe.
- The first book printed was the Bible
- The Church liked having the printing press because it helped to facilitate the widespread sale of indulgences, which were pieces of paper that were sold which essentially “granted” a person salvation from their sins.

What was the impact of print technology on the spread of scientific and technical information? These are two separate debates and should be approached separately.

There are always two perspectives to every issue: the orthodox perspective and the revisionist theory.

The orthodox perspective is often the most widely known and generally accepted perspective on a given issue. Over time, people begin to question this perspective and come up with their own ideas, which are called revisionist theories.

Orthodox view on the impact of print: Elizabeth Eisenstein.
- It is important to note that it is possible to believe and reject points in the same theory.

Eisenstein believes that with the invention of the printing press, more people were coming into contact with scientific and technical information, and it was also more accessible to others around the world.

Within a short period of time (less than 50 years) more than 8 million printed books were created.
- This is because they could be created at higher volume
- Could be copied for a much cheaper price
- Prior to this, people had to hand copy each book

In terms of productivity, one person could produce one book by hand. With the use of the printing press, one person could copy thousands of books for only 3 times the cost of printing a book by hand.

Effects of The Printing Press

Before this, books were very scarce and considered to be precious commodities.
- The only place one could find books were in churches and monasteries
- Some wealthy people had a few books at home as well but it was less common

As more people come into contact with information, it became more widespread around Europe.
- People were able to afford books in their homes
- Information became more available
- Over time, literacy rates increased

It was mainly an economic factor for why it became so popular to use the printing press.

Over time, books began to look different than previous hand-copied materials.
- Tables of contents at the beginning
- Indexes at the end
- Helped people find which information they were looking for quickly and efficiently

More debates came from books now because they were now more available
- Scholars now had access to the same materials
- They could read and debate materials
- Look for commonalities and errors among texts

When scholars had access to the same texts, it allowed them to read the printed materials from the same author.
- They would find errors made from copied materials (scribes not writing it down properly)
- This would lead to a better and more accurate version of the printed material

The invention of print also helped to eliminate the errors that were created in visual images.

- Some books had illustrations (biology, medicine, engineering ect)
- Scribes did not often recreate properly these drawings, making it hard to understand or duplicate certain machines or technologies.

How Did the Printing Press Affect Scientific Knowledge?

Before the printing press, scholars did not have access to the texts of study that they needed.

- Because of this, when they got their hands on a copy, they would focus on copying and memorizing the texts instead of comprehending them.
- After the printing press, the focus shifted to adding to the information found in the texts because they had more time to do so.
- They were able to expand knowledge in a way that they had not been able to to previously.

Over time, older knowledge was expanded upon and also corrected. Older copies were often inaccurate and varied from each copy.

- This lead to “confidence in reliability in texts”
- Because of this new confidence, people became more interested in publishing their own knowledge
- This was because now their work would be more widely recognized.

One of the most prominent examples of this is Copernicus

- He had access to books from all around the world, and therefore did not need to focus on studying and memorizing
- Because of this time, he was able to make his own findings, including the controversial (but accurate) astronomical observations which he is famous for.
- He also had a desire for people to recognize his work, and the advent of print helped to get his ideas well known.

Agreeing with this Theory

Most historians agree that this theory is true - the development of print led to the widespread accessibility to works and knowledge that they would never have been able to come into contact with before.

Certain disciplines relied heavily on the advent of print

- Geography
- Navigation
- Cartography

Map-making - people may distort the image as they copy the image. This was significant because people relied on the use of maps to tell them where they were and where they should go. Even a slight inaccuracy in the drawing of a map could lead to fatality for the person using the map to navigate.

Criticisms of This Theory

It is a determinist theory
- It claims that print created definitive and more correct versions of text
- Claims also that technology shaped the way society was and changed it

Does not deal with two main concerns
- Piracy (there was not actually any restored confidence in books because many of them were pirated and ironically exactly the same as an incorrect hand copy of the material)
- Plagiarism (people would claim other work was their own)

To regulate this, social mechanisms were put in place to restore confidence in the print technology.
- Registers were created in order to eliminate plagiarism as much as possible

It was also argued that the illustrations were more accurate and detailed in hand written copies than the print versions.
- Smaller details were lost when mass printing the books

Another criticism is by the choice of examples, namely Copernicus.

Problems
- His work was published only after he died. He was too scared to publish during his lifetime because it was so controversial of a topic
- Even after publication, very few people actually read this book within the first 50 years of its publication
- Of the people who read it, few people could understand it because it was so mathematically dense
- Of the even fewer people who understood it, only about 10 people believed what was written.

The Spread of Technical Information
- Orthodox Theory

Print “opened up the closed world of medieval craft knowledge”
- It was believed that during the medieval times, people did not share their knowledge with others
- Many people made their livelihood on their craft, and it would not be in their best interest to share their knowledge with other people

- With print, this changes. Artisans and craftspeople want to publish their technical knowledge in the hopes of getting recognition, wealth, status and prestige.

Incentives to publish were greater than they ever had been before, and this was mainly due to the fact that people had greater chances for being recognized for their achievements.

Things to Consider

The availability of technical reproductions changed public attitude towards the technical arts

- They were forced to simplify their technical knowledge so that more people could understand it.
- This changed the ways that technical illustrations were drawn. Linear perspective was now used in the images, which created more enthusiasm in the public eye
- Technology was also linked to religion: technology was creating things for the world, which was linked to how God created the world. Technology was seen as God's gift.

Criticisms of This

Puts too much emphasis on the role of print

- People have always wanted wealth, success and recognition for their work
- This was happening long before print was commonplace

Lecture Ten: Science and Technology - The Environment - Religion

October 20, 2011

Nature as a Living Organism

The notion of nature was considered to be a living thing up until the 1500s.

- Believed to be "Mother Nature"
- Compared to a nurturing mother figure who provided resources for people to live.
- Although portrayed as a kind mother, Mother Nature was also feared because it was an uncontrollable entity
- Nature could give and take away just as easily the resources for life

Francis Bacon

A lawyer who had no training in natural science or technical arts

- Despite this, he tried to change attitudes towards natural philosophy and natural arts
- Had a great interest in these subjects

He was an advocate of using scientific knowledge for a specific purpose

- Movement away from knowledge for knowledge's sake
- He wanted to use scientific knowledge to benefit the state
- Placed high value on both natural science and the technical arts

Used the theory of Induction

- Wanted to change the way scientific process was done
- Thought that this method would show people a more accurate and truer way to obtain knowledge

Hierarchy of this Theory

- Lowest level: people who were instructed to obtain facts
- Middle level: people who were instructed to analyze and verify the facts
- Highest level: elites who would take the checked facts and would use them to make theories

Religion

- Francis was preoccupied with the obtaining of religious salvation
- Thought it was important for all humans to obtain their original premier status (get back the status of Adam and Eve before being kicked out of the Garden of Eden)
- Thought it was man's duty to control all of the other creatures of Nature (was believed to be a way of obtaining the status that was lost)
- Saw the story of Adam and Eve as the first step in the loss of the power of humans over nature

Francis saw science and technology as the means to gain control and manipulate nature and the environment.

Nature as a living organism, something to be respected, feared and regarded with awe was the dominant theory until the first industrial revolution. After this, Bacon's theory became popular.

- Bacon theorized that nature was something to be dominated, manipulated and used at will for the benefit of humans

Feminist Claims

- Claim that Bacon's claims were misogynistic (women-hating)
- Believed that the "raping and torture" of nature could be compared to the raping and torture of women.
- When talking about nature, he referred to it as a female
- Language used: see below "bondage"

- Sexual implications: “neither ought a man to make scruple of entering and penetrating into these holes and corners, when the inquisition of truth is his whole object”

Three States of Nature

- **Liberty**: the “worst” state. When nature was uncontrollable by man
- **Error**: freaks of nature, random acts of nature taking back control momentarily
- **Bondage**: nature should be in bondage, dominated, controlled. Should not be an uncontrollable entity, it was to be controlled by man. Man should be able to use nature in any way that they wished.

Why would he speak this way about women?

- As a lawyer, he often participated in witch trials
- These were trials in which women were tortured and beaten because they were believed to be witches
- In most cases, the women that were killed and tortured in the witch trials were women who had power, or who posed a threat to the male population of the society
- May have been influenced by these, a product of his time

The Age of Commerce

Goods produced during this time were characterized by the following

- Very high quality
- Very low volume
- High wages for labour

This later changed in the Industrial Revolution

- Low quality goods
- Mass production of these goods
- Very low wages for the laborers

The **Age of Commerce** centers around a particular region of the world, the Dutch Republic

- During this time, the Dutch Republic reached its peak in terms of power
- Good to do trade with because they were religiously tolerant and peaceful people

The Dutch Republic

- Very interested in engaging in commerce
- Did not have many natural resources, so they imported raw materials
- After manufacturing the raw materials in the country, the goods were then exported

- Due to this enterprise, the Dutch developed their own type of ship which was large, had lots of cargo room and not very much room for people
- They travelled on safer seas to avoid pirates, which is why more cargo and less people would be on each boat
- Developed the first ever Stock Exchange (17th century Amsterdam Stock Exchange)
- The stock exchange would determine the prices for valuable commodities around the world

One of the most popular commodities on the Amsterdam Stock Exchange was the tulip.
- Future stocks: people predicted the value of tulips would go up so they invested in them before they even grew

Lecture Eleven: The Industrial Revolution

October 25, 2011

Characteristics of First Industrial Revolution

England in 1780's had a significant population growth
- This meant scarce resources, such as land (England has no way to expand)

A major shift from manual labour to more machine production
- Machines were operated by water and steam power
- New forms of managing labour
- Factory system of production
- New methods of communication and transportation

Effects of Machine Production
- Larger volume of goods produced
- Lower wages for workers as they became less skilled
- Lower quality goods

Changes in Transportation
- Increased use of canals
- Beginning to use the railways for transportation

Changing Communication Technologies
- Increasing use of the telegraph
- Railway and canal systems also improved communication

Industrialization has been associated with a period of **sustained economic growth.**

- Unlike other periods of time, the growth did not rise and fall very quickly
- Growth continued for very long periods of time

Changes in Transportation

Bottlenecks - refers to an area of production or manufacturing that is problematic, and affects all other areas of production of manufacturing.

During this time, people were producing more iron and metal than ever before. These were materials needed to build railways.

Prior to the use of railways, the roads were the main way to travel
- As population grew, too many people were on the roads and it was inefficient
- The roads were deteriorating due to over-usage

Agriculture

Closure of common lands
- Made it difficult for agricultural workers to continue growing crops
- Many farmers could no longer afford it and were forced into the growing cities
- Farmers became a main part of the new factory labour force.

New Agricultural Trends
- People switched from a three field system to a four field system
- Clovers and turnips were now more commonly grown
- Meat became in higher demand because the population was growing considerably.

Four Major Features of the Industrial Age

Changes in the Energy Sources

Timber was the main energy source, but it was quickly becoming a scarce resource.
- It therefore became increasingly expensive and less used

There was a switch from **renewable to non-renewable resources**
- Coal and oil were used as the steam engine became more popular
- Steam engines were originally used to eliminate excess water, they were extremely inefficient at first and could only be used in coal mines because that was the only place there was a steady supply of coal

Increase of energy consumption
- Greater population means that more energy is required for basic life

- The building and running of factories required a lot of energy
- The railways required much energy
- Consumption increased 5 to 10 times over
- Switches from renewable to nonrenewable resources
- This caused massive amounts of pollution in the cities

Hygiene

Due to overcrowding and poor living conditions, hygiene was not very good at the time.

Pollution often made everything very dirty.
- People would complain of being covered in soot immediately after arriving in the city
- Water was extremely dirty and disease spread very quickly
- Disposal methods for water would be to dump it off the roof

The Factory System

The factory was essentially a large dwelling for the workers, with a production floor that had many machines for creating goods.

This increased efficiency meant that the quality of goods decreased, while the prices to produce goods also decreased. Subsequently, the wages dropped.

The first factories made traditional goods, such as cotton.

Problems for the workers in a factory
- Most of the workers in factories were children, sometimes as young as 4 or 5 years old
- Children were ideal workers because they were cheap labour, and many of their parents did not care too much about what happened to them
- Children were often given the most dangerous jobs because they were smaller. They could reach and go under machines, which adults were too large for

Hierarchy of Labour
- There used to be a large amount of skilled workers, who would be compensated depending on the amount of skill that they had
- With the machines, people were becoming less skilled because the machines did a lot of the work for them
- This meant that they would be paid much lower wages, while owners saw their profits increase significantly

Exploitation of workers was common - people would work ridiculously long hours and would be paid the same amount. Wages did not increase for a very long time.

- The idea of controlling the workers both inside and outside the factory was widespread
- Jails and schools often were built around factories

Industrialization and New Methods of Financing

Factories were often financed by trade

- The use of slaves
- Commodity of sugar
- These built up large amounts of accumulated capital, which was used to build businesses and factories.

London Stock Exchange was opened in 1773

Public banks also opened. Due to large amounts of accumulated capital, there were very low interest and borrowing rates which favored the building of new factories ect

Colonies were important

- They were a source of raw materials which were not available in England
- They were a built-in market for the produced goods.

England would take raw materials from their colonies, manufacture them in England, and then sell the final products back to them.

- This prevented colonies from becoming industrialized
- England did not want the colonies to industrialized because they would then become competition

Changes in Ideology

Laissez-Faire Capitalism

- Developed by Adam Smith
- “Laissez-faire” means “to leave alone” in French
- The market would control itself and should be left alone

Mercantilism

- Economies are state controlled and free trade is restricted to help boost exports and increase state resources
- Open markets and free trade became less popular

Critics of Economic Philosophy

- Karl Marx and Frederick Engels created a theory called the Social-Class Struggle

- This was a theory that stated there was a continual class struggle between the workers and the owners of factories
- Many workers were unhappy with their jobs and owners. This theory showcased the inequity in the workplace.
- They believed that the only way for equality would be if the workers were able to control the means and modes of production

Lecture Twelve: Science and Technology in the Industrial Revolution

October 27, 2011

The First Industrial Age

Up to the 18th century, the **attempts to use coal** were not very successful
- It was not until the early 19th century that these techniques were changed and made more efficient
- It is important to note that these attempts were not based on scientific knowledge
- Trial and error was used
- This shows the disconnect between science and technology during the first industrial age

The **steam engine** was developed also during the 18th century
- This technology came out of a need that needed to be addressed
- It came from tinkering, trial and error
- No scientific knowledge was used
- Over time, more tinkering led to improvements to the steam engine which also were done without scientific knowledge

In the early 19th century, London wanted to create a **new type of bridge** that was made out of cast iron.
- It was believed that scientific knowledge was even more useless for the development of this technology
- There was no basis of scientific knowledge for this area

The Second Industrial Revolution

This era is characterized by higher volumes of production, lower quality goods and lower wages.

This era has also been referred to as The Age of Steam because of the large impact of steam power and the steam engine.
- However, there were many other factors

In the beginning, the new technologies that were introduced did not necessarily mean that old technologies became obsolete.

- The changes that took place were gradual
- This was a period of sustained, long term economic growth
- New technologies worked alongside older technologies

During the Industrial Age, only one out of ten people worked in a factory setting

- Factories did not take over traditional methods initially
- Ancillary Industries: smaller industries that came out of the bigger industries that were part of this time.
- They served as the connection between the newer, bigger industries and the smaller, older industries
- They helped to bring the industries together

Terms that Came from this Time

Industry

- Came to be known as a place of manufacture
- Before was used as a verb to describe how hardworking a person was

Class

- Before industrialization, this referred solely to schools
- Came to be known as a way to differentiate people of different economic status
- During this time there was the emergence of a distinct working class, and the rise of a new middle class

Culture

- Prior to industrialization, this term referred to biology
- Culture came to signify the spiritual, material and intellectual way of life

Centers of Industrialization: London, Manchester and Sheffield

London

It was believed for some time that London never developed as much as others in terms of industrialization. The numbers actually prove the opposite

- One out of three workers in London worked in a factory
- London had 330 000 people working in the factories
- London also had more steam engines than all the other cities in England
- London expanded 5x over in the span of 150 years (mass production was now necessary and there was also a lot more workers available)
- 3/4 of overseas trade occurred at London docks which were 25 miles long

The beer brewing industry was the biggest industry because the beer was safer to drink than the water
- It was a diet staple for the poor
- People drank it at every meal of the day
- Porter beer was what was mainly produced. It was very low quality
- Created ancillary industries: beer barrels, storage vats ect

Manchester

The main center for the cotton industry, which spurred its industrialization
- Population grew 10x over in 100 years
- This growth was propelled by the cotton industry and the ancillary industries that came with it: dye industry ect

Geography
- The location made it prime for cotton
- The climate
- Lots of available coal
- Damp air
- Many canals

Changes in Labour
- The labour force also had women who were not accustomed to the factories and how the machines worked
- These women would spin and weave the cotton
- They became independent and could make their own money
- The new technologies made it harder for women to be in the workforce because the machines were too hard for them to use
- The women could not compete outside of the factories (homemade ones were higher quality but were more expensive and time consuming to produce)
- Women were paid the lowest wages and given the worst jobs in the factories

Sheffield

Completely different approach to industrialization
- Was a strong producer of very high quality steel and steel products (accounted for about 90% of the total British market)
- No factories: most of the workers worked in small workshops and offices, or in their own homes
- Production occurs in many different buildings as opposed to one central place for the complete manufacturing of one good.

Lecture Thirteen: Science, Technology and Justifications for Colonization

November 1, 2011

Important Definitions

Colonization - "The extension of political and economic control over an area by a state whose nationals have occupied the area and usually possess organizational or technological superiority over the native population. It may consist simply in migration of nationals to the territory or it may be the formal assumption of control over the territory by military or civil representatives of the dominant power" Columbia Encyclopedia.

Imperialism - "Commonly associated with the policy of direct extension of sovereignty and dominion over non-contiguous and often distant overseas territories, it also denotes indirect political or economical control of powerful states over weaker peoples. Regarded also as a doctrine based on the use of deliberate force, imperialism has been subject to moral censure by its critics, and thus the term is frequently used in international propaganda as a pejorative for expansionists and aggressive foreign policy.

The "Civilizing" Mission

The "Civilizing" Mission - an idea of going into parts of the world where people were considered to be savages or heathens, in an attempt to "civilize" the people living there.

- Thought that they were doing a good thing by doing this
- Gave them the tools which they believed would help them become more civil and advanced.

Paternalistic Motive

- Treated the "uncivilized" countries and populations as children
- Europe believed that they were like a father figure
- It was Europe's "duty" to teach the other populations how to be like them

Why did they think they were so advanced?

- Europe justified this civilizing mission because they thought they were extremely advanced
- They had made great advancements in both science and technological fields
- Military advancements: gun powder, firearms ect
- These advancements helped Europe assert themselves on the indigenous people who did not have the advantage of these types of weapons

Attitudes Towards Science

- Natural science and having scientific knowledge was considered to be the only rational way of understanding the universe
- Scientists had a higher status in society because of this knowledge
- Societies who had alternate beliefs or who had other forms of religion were believed to be superstitious and unintelligent.

Goals of the Mission
- Teach “backwards” people some understanding of science and technology
- There was the inherent belief that they were not as intelligent and therefore would never be able to understand the entire scope of European knowledge
- This goes back to the paternalistic theory
- Some people went as far to advocate the killing or extermination of the natives

Economic Justifications of Colonization
- It is well known that colonies provided sources of great economic wealth for the home country
- With this wealth, industrialization was able to flourish and grow as quickly as it did
- This came at a heavy price for the native people living in the colonies; whose impact can still be seen in some instances today
- Industrialization was prevented in the colonies because they would be a threat to the home country, this idea essentially counteracts the initial goal for the civilizing mission because the people of the colonies were actually prevented from moving forward with new technologies.

Science and the Christian Missionary Movement

Missionaries - those interested in the conversion of people to their religion. They were often among the first people to enter the colonies in order to convert the “superstitious” and “ignorant” people to the “one, true religion”.

Missionaries spent much of their time trying to convert people through schooling and education, as well as trying to assimilate the native people.
- Clothing, food, language, religion and education are just some of the ways which native people were being introduced and assimilated into European culture.

Justification for Conversions
- The Christian Church had strong links to science and technology
- Because they had so much power, the Church essentially chose and accepted which technologies and sciences were to be used in society
- It was said that science and technology were the “handmaids” to the Church. This means that science and technology essentially helped give the church even more power during this time.
- They were the superior religion from the superior continent, therefore they had the right to do these missions

- People from Africa and Asia were believed to be heathens and required someone superior showing them the right path

Inherent Beliefs

- It was believed that people who were not from the West contributed next to nothing to scientific knowledge or technical knowledge (this is false - see all the contributions of Asia and Eastern Europe, as well as Egypt in Africa)
- Also believed that the people's religions were backwards because they did not exist simultaneously with scientific beliefs
- Europe believed that they were superior in all ways to every other colony or continent.

Non-Western Attitudes towards Time, Work & Nature

Time and Work

Europe

- Relied heavily on clocks and mechanized time
- Regulating activities by mechanized time by a city was seen as an indication of superiority and a highly civilized/advanced society

Non-Westerns

- Many did not live their lives according to clock time
- They were believed to be less advanced, ignorant, and uncivil
- Brought about the European belief that these people were lazy and wasted time (not necessarily true)
- Europe did not think that these nations would ever be able to understand or use mechanized time (they did not have the mechanical or mathematical aptitude)

Nature

Europe

- Francis Bacon had strong influence on the ideas of nature at the time
- Believed that humans were the most advanced, and in order for further advancement people must have control over the rest of nature
- Science and technology should be used to control the natural world and to manipulate it in order to exploit it fully

Non-Westerns

- Most of non-Western people did not believe that humans should master nature and exploit it
- They believed in a more balanced system of living alongside nature as opposed to controlling it

- This became a reason for Europe to think that these people were less advanced (Europe thought that they could not control or master their own natural resources)
- Because of this belief, the Europeans took it upon themselves to exploiting the resources of other colonies ("the other natives were so uncivilized that they could not control their own natural resources, and therefore were wasting them").

These Ideas Today
- The oil resource is a perfect example of how these ideas are still prominent today
- Countries in which there is oil often does not have the money or available resources to fully extract all the oil.
- Other countries who have more resources often come into the country and fight for the resources (they think they are superior and have a right to exploit the resources of another country)

Lecture Fourteen: Technology and the Empire

November 3, 2011

Technologies of Control

Technologies which were instrumental in colonization, bringing people to the colonies as well as maintaining economic and social control over the colonies.

Technologies that were mainly used to build empires were not necessarily built to make money. Often, they were not profitable at all.
- Their main goals were not to make money, but to control the people
- These technologies were expensive to create and maintain them. This became an economic drain on the colonies
- Most of the profits associated with colonization were used to control and maintain the colonies.

New Methods of Transportation

The use of the steam engine was important in ships because that was the way that the people wold be transported to and from the new colonies.

The railway and construction of new railways around the world, which is discussed further below, is also an expensive new technology during this time which was widely used.

The Use of Medicine

The most important form of medicine at this time is called quinine.

- It is an anti-malarial drug which was given to the Europeans to prevent death by this disease
- The Europeans often were not accustomed to the climates or germs that were present in the environments in the colonies. They often got sick and died due to this fact.

New Military Technologies

The military made huge improvements, mostly in an effort to control the population, and also to assert their superiority.

- The introduction of gun barrels
- New types of firearms
- Rapid-fire technologies which could kill many natives at once

Why were these not profitable?

One of the most important reasons that these were not profitable ventures is because they were done on such a large scale.

- The railways are a perfect example for this
- Railways were built across land which had been inhabitable by humans
- This required the use of special explosives to level the land and make it usable for railway construction
- Initially, Europeans were eager to invest in these project.
- As the railways were getting built, people began to realize that they were not very profitable
- A reason for this is that the costs often went over the initial estimates (engineers would often gold-plate the railways, meaning they would build more elaborate structures than necessary)
- To gain investors, there was a guaranteed rate of return on the building of a railway. The tax-payers were responsible to pay for these rates of returns.

Industrialization in the Colonies

The colonies were discouraged from becoming industrialized because they would present a threat to the colonizing countries.

Protective Tariffs - there was a tax on goods which are being produced in another country.

- Britain placed a 3% tariff on goods made in India, which made it harder for India to sell their goods

New technologies were gaining momentum in Europe, but they were discouraged in the colonies.

Consequences of Industrialization

The creation of “third world” or “developing” countries
- Countries today are classified according to what degree of industrialization is present in their country
- The less industrialized, the less advanced and generally more impoverished the country is

Pollution

Disregard for safety/fairness in the hopes of making more money

Steamships

The main energy source of steamships is of course, steam.

Faster Travel Between Britain and India

Prior to the use of steamships, communication between India and Britain was very weak.
- A letter mailed from Britain to India may take over 2 years to get to its intended person
- After the use of the steamship, this communication became a lot quicker (took a year to get a letter)

Helped with Wars

It became easier for Britain to bring in more soldiers as they were needed.
- Also could bring supplies in and out of the country a lot faster
- Armies without this could not compete with this quicker technology

Opium Wars

The opium trade constituted about 1/7 of all British trade
- China wanted to stop the opium trade because they found their country filled with opium addicts
- Britain was making lots of money off this trade, and therefore did not want to halt their opium trade
- There were many conflicts between the two countries, with Britain ultimately winning
- This trade did not decline till the early 20th century

Telegraphs

Faster communication
- Messages could be sent across wires, often using Morse code
- The British believed that the telegraph was the most important system to establish first, as opposed to building railways first
- This was a faster mode of communication than any other type available at the time
- It was easier to conduct trade or business, set prices, learn about markets or marketability

Maintaining Control
- Messages which needed to be sent quickly were done using this method
- Military recognized the importance of this technology; it linked stations all across India

The Indian Mutiny
- Large numbers of Muslim, Hindu and Sikh soldiers were resentful to the fact that they were being subjected to the English practice of the Enfield rifles
- Enfield rifles required that the user bite off the cartridges before they could be used
- The problem was that the cartridge often contained remnants of pork (which Muslims do not eat) or beef (which Hindu's do not eat)
- Their protests were not listened to, and so the soldiers decided to revolt
- They attempted to break all the telegraph lines because they knew that once these lines were brought down, there would be no way for other British soldiers to know about this revolt and they could get their point across
- The British however, were able to quell this rebellion

The Railways

Railways as symbols of superiority
- They essentially embodied everything that was associated with industrialization
- One of the ways this was demonstrated was that the railways relied heavily on mechanized time
- Those who could not follow mechanized time therefore were not civilized enough to use or maintain the railways
- Another way is the efficient use of space. The railways were built in areas which previously had been inhabitable lands, making the most of the available land
- Trains were also used to transport people, military personnel as well as raw materials.

Railways as a social tool

- It was believed that this technology would increase the other cultures and improve their social status
- Showing “uncivil” people the importance of speed and mechanized time
- A way of technical education; the workers were from the colonies (the engineers and supervisors came from Europe)
- It was also believed that “you could only teach the natives so much”
- This is why the natives were never exposed to further technical or scientific education past the building of the railways (would never be able to become engineers because the Europeans denied them that knowledge)

Lecture Fifteen: Science, Technology and the Birth of Modern Industry

November 10, 2011

Recap: Relationship Between Science and Technology

Greeks

Philosophers such as Aristotle and Plato

- made a separation between natural science and technical knowledge

Natural philosophy versus Technical Knowledge

- Considered to be superior to technical arts
- Knowledge for knowledge’s sake
- Those who practiced natural philosophy were often of a higher status in society
- Natural science knowledge was considered to be superior because it was about global things as opposed to just subject specific knowledge
- Those who practiced technical knowledge did not always know how they came about some of their discoveries (trial and error)
- Technical knowledge considered to be mundane and average

Not supported by the church

- Natural philosophy was originally considered to be heretical
- Technical knowledge was about the material world, which the church didn't care about that much
- Soon there was a merging of natural philosophy and church (Aristotle’s ideas were changed slightly)
- Hugh of St Victor tried to link technical knowledge to religion to raise the status of technical knowledge

Changing Attitudes

Renaissance

- Moving away from the idea of “knowledge for knowledge’s sake”
- The status of technology is changing in society
- Engineers were raising their status in society (they were aligned to the royal courts and the elite of Europe)
- Natural and technical knowledge were seen as ways to make money, raise status in society and gain fame
- Growing critiques of Aristotle's ideas
- The use of technical instruments in scientific experiments to manipulate nature
- The development of social spaces for people to share their knowledge, creating a space for interaction between people studying natural science and technology
- Hybrid humans: those who had an interest in both fields (this did not happen before)

Francis Bacon
- Critical of Aristotle “knowledge for knowledge’s sake”
- Believed in truth and youthfulness (thought they were the same)
- Linked natural philosophy and technology to the church
- Thought they were both useful tools in helping humans gain control over the rest of Gods creatures

First Industrial Revolution

Steam Engine
- Created with little or no scientific knowledge
- Lead to more scientific knowledge, not the other way around as previously thought

The Second Industrial Age - Overview

Geography

The second industrial age was not concentrated in one part of the world, like the first industrial revolution
- Germany
- United States

These two countries were newly unified and desperate to catch up to England in terms of industrialization
- They were more open to new techniques and practices than Britain
- Britain had created a huge infrastructure based on traditional methods of factories and factory structures
- They were less flexible and open to change than Germany and the United States

Germany

Educational Reforms

Technical Schools
- Formal place where people would receive a technical education
- Prior to this, engineering was a discipline that would not require a formal education
- They would study under someone for a period of time before becoming an engineer
- By the 19th century, engineers had a desire to be seen as a profession, like a lawyer or doctor

Universities
- This was where people would pursue their higher learning
- There was the addition of research laboratories to universities
- Prior to this, scientists in university were learning only the discoveries of past scientists
- Now with the labs, students would be able to generate new scientific knowledge
- This has become the new social spaces for people to collaborate their ideas (scientists and engineers would meet here)

Increased Use of the Textbook
- The universities would now use textbooks to teach science
- This would standardize knowledge (students would all learn about all types of science instead of only learning from one professor)

PhD
- People now had to achieve a PhD in order to call themselves a scientist
- Before, people who were wealthily or had had status would consider themselves scientists because they had the time to ponder about natural science and philosophy

Development of Professional Associations
- Increased the status of engineers in society (put them on a professional level)
- Engineers began to call themselves applied scientists
- This was because scientists had a high status, so by calling themselves applied scientists, engineers would raise their status

Most Important Feature of the Second Industrial Revolution

What distinguishes this time period from any before it?

We start to see the **merging and connection between science and technology** in a certain arena.

- We begin to see the beginnings of “techno-science” based industry
- These industries use scientific knowledge to create new technologies
- It incorporates science into invention
- Shows how technology can be seen as applied science

Examples today - pharmaceuticals, synthetic material industries

What is the difference between the factories in the first revolution and the techno-science industries of the second revolution?

Factories

- Were new places where traditional industries could be done
- People were weaving cotton and wool well before there were factories
- The only difference was that now people would be able to perform these industries in a certain arena as opposed to in the homes

Techno-Science

- The creation of completely new technologies and industries
- Scientific discoveries became the precursor to new technologies to use these new discoveries
- With the large amount of people who were graduating from university and technical schools required a large amount of jobs
- Not everyone would work in the educational fields
- Techno-Science industries would hire these graduates, or commission them which they were still in university to make discoveries for them in the research labs.

The reforms of education and techno-science go hand in hand. They rely on each other in order to be successful.

United States

Mass Production

- The development of the assembly line
- The “American” way of manufacturing (called this by the British)

The Internal Combustion Engine

- This became very popular when Ford used these when producing cars
- This technology was creating to help mitigate many of the problems associated with steam engine technology (pollution, expensive, inefficient)

The Science of Electricity (19th Century)

Faraday
- In 1821 he invented electromagnetic induction
- This is where a magnet creates an electric current in copper wire
- This was useful because he was able to artificially create electricity
- The only problem was that there was only a capability to produce small quantities

Maxwell
- In 1856, he mathematizes electromagnetic induction
- This made it possible for others in the future to create more experiments with electricity

Popularization of Electricity
- A problem with electricity that people wanted it to be cheap, which would require it to be produced in large quantities
- People would use large dynamo's to create electricity in larger quantities
- In 1870's, better dynamos for creating electrical power from mechanical energy of a rotating magnet are created
- In the 1880s, the first electrical cars and trams were on the roads

The Science of Chemistry in the 19th Century

John Dalton
- Was able to apply atomic theory to chemistry
- He was able to suggest that elements could form compounds which had a numerical value to them
- This allowed for chemists to create chemical formulas
- Allowed a more understanding of chemical reactions
- Allowed for people to create their own materials in the process

Synthetic Materials
- These are human made products, they do not occur naturally
- Pharmaceutical and chemical dye industries boomed during this time.
- Synthetic dye was first discovered by a British man by accident (Perkin)
- This industry never took off in England
- This industry was dominated by Germany until about the first world war

The Rise of Techno-Science Based Industries in the United States in the Mid-Late 19th Century

Monopoly
- Refers to one or two companies having the entire market share of a good

- Tools such as patents allowed for these to flourish
- This is a method of control and power for industries

Lecture Sixteen: Rise of Techno-Science Based Industries

November 15, 2011

Techno-Science Industries

- Industries which were able to increasingly control over scientific operations
- Used scientific knowledge and research application for the production of new goods

Patents

One of the **most important tools** to understand when discussing the idea of managing and controlling technology.

Patents existed before techno-science industries, but in the second industrial revolution, the ways in which patents were used were new.
Definition: an official document that allows an individual or individuals to have the sole right to make, use or sell a specified invention for a specific period of time.

- Prevents any other individual from making, using or selling the same product
- All patents have an expiration date

Incentive Based

- A patent was given to an inventor as an incentive to invent
- This is because if there are no rights protecting others from using that information or invention, a person may be more reluctant to share their invention for fear of being copied

Patent-Status

- An invention must be unique
- Must go through the patent office in order to be granted a patent

Advantages of Patents

Incentive-Based

- This gives people the incentive to create new things

Security

- Gives an inventor a sense of safety and security for a given period of time
- When a person had a patent, banks and other financial institutions are more likely to give money to them for further innovations

“A Patent Begets More Patents”

- When a person has a patent, they gain a small bit of fame and recognition
- When they build this reputation, they are more likely to get patents for new inventions in the future

Disadvantages of Patents

Discourages Competition

- When there are limits on who can create and produce certain products, there is very little competition because it is against the law
- This limits consumer choice
- Consumers may have to pay very high prices for that good because there are no substitutes
- Costly legal disputes

Consumer Good vs. Producer Good

- Often, those with patents are looking to make money
- Sometimes the desire to make money exceeds the desire to do good for the whole of society
- Example: pharmaceutical companies create life saving drugs at high costs. Those who cannot afford these drugs must suffer. There are no substitutes and therefore the good of the company is being served, but not the good of the rest of society necessarily.

Opportunity Costs

- There will always be fights about patents and who has the rights to what
- This is costly, and very time consuming
- If people are spending more time and money in the courtroom, they are not spending it in the research lab
- Precious research and development time and money is being squandered.

Electrical Industries in the United States

Patents in the Lighting Industry

Arc Lighting

- Electric arc formed by leaping gap between two electrodes
- In the United States, this technology was not patentable
- It was not deemed unique enough to do so
- This caused much competition

Thompson-Houston Electric

- Began to patent parts of the arc lighting system because they could not patent the entire system
- There were certain parts which were unique enough to be patented
- This caused them to be able to create a superior arc lighting system, and therefore eliminate a lot of their competition
- Gained a lot of control over the industry

Buy-Outs and Mergers

In a buyout, a company purchases another company to form a larger version of their original company
- In this scenario, the company gains the rights to the bought-out company

In a merger, two companies form a new, larger company.
- In this scenario, the new company has access to both sets of patents

Incandescent Lighting

Thomas Edison
- Patented hundred of inventions, some were very successful and others were not
- Was the first person to patent the light bulb
- Created the Edison Electric Lighting Company to sell his products
- Understood that he needed to use these patents to make his product able to compete with other forms of lighting available
- Set up his own research lab where he hired scientists and engineers to invent as many things as possible so that the company could patent them all
- Used this to control his competition and make his product better than the others

Vertical Integration
- Edison thought that he should control all facets of industry, rather than just the selling and distribution
- He used the idea of Vertical Integration
- This is where the company manages the raw materials, and all manufacturing processes, and then sells and distributes it

Mergers
- The Edison Electric Company merged with Sprague Electric & Railway Motor Company to create the Edison General Electric Company
- All smaller companies were bought out by Edison General Electric (those that produced lamps, dynamos ect)
- Westing House was the only company able to compete because they had different ways to generate electricity

Westing House used AC (alternative current), and Edison used DC (direct current)
- By 1896, there were over 300 patent disputes between the two companies
- This was solved by the agreement to share the patents, called patent pooling
- This is when two companies agree to share their patents without any legal disputes.
- This eliminated all other companies and left the two companies to control the science and technologies for this industry exclusively (monopoly)

Chemical Industries in the United States

It was not just companies who could patent inventions, but countries could also patent things so that no other country could make or sell the product.
- Germany dominated the chemical dye industry up until the first world war

Germany Monopolization

Product Patent - this was developed in Germany.

This is a patent that protects the product, regardless of the way it was produced.
- Before, patents applied to a product made by a certain process
- There was no patent on the same good if it was produced in a different way
- This no longer existed

Germany also took out patents in other countries
- They could take out patents in other countries so that nobody in that country could create the same goods that they would create
- This would allow them to be the sole provider of a certain good to that country
- Guarantees exports

Statistics
- 88% of synthetic dyes were coming from Germany before the first World War
- 98% of patents for dyes in America and England were German in 1912.

Resentment
- Some of the inventors and the industries resented that Germany had such a large presence in this industry
- Small companies wanted a protective tariff on their goods so that they could be more competitive
- Larger companies did not want this, and so there was no tariffs placed (Germany goods were reliable and cheap, they did not want to give this up)

World War I
- German rule over this industry could have gone on indefinitely, but WWI ruined it

- When WW1 broke out, Germany and US became enemies
- All the patents became null and void
- At first, US was going to sell all the patents out, but instead they decided to put all the patents together in a trust and created a licensing office
- The licensing system allowed any company to use these patents as long as they paid a small fee to use them (royalties)

Lecture Seventeen: Scientific Management

November 17, 2011

Frederick Taylor and Scientific Management

Frederick Taylor

- Trained as an engineer
- Scientific management was his way of reforming what he claimed to be inefficiencies in the workplace, especially in the factory system
- Published a book in 1911 which expressed all his ideas about this
- Believed that there should be specific laws that could govern workplace behavior (scientific management)
- Despite its name, this was not really scientific

Reforms were made to fix any inefficiencies that were present in the workplace

- Taylor believed that many different groups had to change in order to increase production

Managers

- Believed to lack adequate technical knowledge to properly oversee workers on the shop floor
- Believed that workers had more knowledge of the machines that the managers, which gave them an advantage over their superiors
- Wanted to increase the level of technical knowledge of the managers to help them do their jobs

Foreman

- This is the manager that directly oversaw people on the shop floor
- Believed that they abused their positions of power
- Thought that people were hired on the basis of bribes, family or friend status as opposed to the person who would be best qualified for the job

Workers

- Were believed to have been involved in the process of soldiering
- This is when people work at the slowest rate possible, especially if they are being paid by the hour, to keep their wages up

- This decreased productivity significantly

Four Major Principles of Scientific Management

1. Substituting Science for Individual Judgement
2. Scientific Selection of Workmen
3. Greater Cooperation between Management and the Workers
4. Work should be Governed by Scientific Laws

Taylor wanted to **take away the individual judgement** of the worker, and instead replace all the brainwork by scientific laws which the workers would follow.

Over time, Taylor wanted to **eliminate the problematic position of the foreman**.
- Instead, there would be a new managerial system
- This new system would have a group of people who worked together to find the most efficient ways of doing a certain task

Time and Motion Studies
- The manager would go down to the workshop with a stop watch
- He would ask the workers to perform the same task in a variety of different ways
- The way which was the most efficient and took the least amount of time would be the standard way of doing that task
- Notes would be written up and the workers would be given the instructions
- There was no more liberty for a worker to choose which way they wanted to do a certain task

Managerial Knowledge
- To be able to manage the workers, there would be a necessity for the managers to have more knowledge of the machines
- They needed this knowledge to conduct the time and motion studies
- Managers would only be hired if they had this knowledge of technical arts

Prevention of Soldiering

The Incentive Based System
- There would be a system of incentives and punishments for workers
- You would be paid for the amount of output you create
- Those who produced more would be paid more by the hour

Why Was Scientific Management Introduced in the Early 20th Century?

Henry Braverman's Traditional Viewpoint of Taylorism

Ideas of Control

- Believed that Taylor was designed to control the worker
- Wanted to take away power from the worker and give it to the manager
- Told workers the way that they had to do a certain task
- The incentive pay system took away control from the worker of the pace of work

Problem with Bravermans Idea

- It only tells half of the story: Scientific Management = Controlling Labour

Revisionist Perspective of Taylorism

Braverman's theory neglects to account for scientific and technical changes that were happening during this time.

- The invention of the techno-science based industries

Techno-Science

- Required a significant amount of capital, as well as more personnel
- There was a need to make more profit to cover all the costs to start up this industry
- There was too much inefficiency, which is why Taylor came up with Scientific Management

Controlling Labour

- This idea from Bravermans theory is correct, Taylor wanted to control the labour force

Controlling Machines

- Taylor was equally interested in controlling the machines as he was to controlling the labour
- This came from his training as an engineer
- Wanted to make a more efficient workplace by controlling the people working as well as controlling the ways the machines are being used

Controlling the Layout

- If a person had to use two machines, the layout of the machines was important to Taylor
- He would place them next to each other to eliminate wasting time walking from one machine to another
- Tried to discourage socialization on the job by doing this as well

Impact of Taylorism

Braverman and the Orthodox View

Scientific Management as a Capitalist Tool
- Claims that this management tool led to more unskilled and semi skilled workers in the factory
- Claims workers were exploited and devalued

Problems with this Claim
- The factory system from before was already exploiting labour before Scientific Management came along
- It was more the ideas of mass production and the assembly line that created an unskilled labour force
- These things did not happen in the short term. Scientific management in the short term was very unsuccessful
- Therefore this claim is problematic because it is attributing impacts to something that was not even popular at the time.

Actual Short Term Impacts

Very Little Impact
- All the groups involved were very critical of these ideas
- Owners, managers and workers all rejected the principles at first

Workers
- Resented the idea that they were being paid according to how much they were producing
- Did not like the idea of time and motion tests
- Many went on strike and refused to work under these conditions
- This happened at many places that Taylorism that implemented
- Taylor was then fired from the factories because his ideas created more chaos than efficiency

Managers
- Did not like the idea that they would have more work to do
- They would have to go to school and learn more about the machines that they were dealing with
- Did not want to do the time and motion studies

Foreman
- Resented the fact that their position would eventually be eliminated
- Did not want to support something that would eventually cause them to lose their jobs

Owners

- Very strange that this group would reject the ideas because it was supposed to create efficiency (more money for them)
- There was too much chaos at the beginning, and many did not want to put up with this. They did not see the value of these principles
- The owners did not want to pay the workers more for their production
- Did not want to have to invest in the reforms (training for the managers, paying more to the managers, more personnel required)

Actual Long Term Impacts

Over time, people began to support these ideas
- This started around WW1 and into the early 1920's
- After the war, labour unions were concerned with job security and safety
- As a result, Taylorists would humanize scientific management so that workers would want to accept these ideas

Humanization of Scientific Management
- Original ideas were repackaged so that they sounded better for the workers (did not actually change the ideas)
- "Job Description": the worker would be able to know exactly what they were responsible for, this gave them some security
- "Job Safety": the worker had to operate the machinery in a specific way so that they would be safe when using the machinery. If they were given free will to use it as they please this could be more dangerous
- "Job Ladder": the idea that a worker who worked long and hard enough would be able to gain status in the company and climb this ladder

Managers Accept these Principles
- There was now more managerial positions available, most of which were engineers
- Engineers loved Taylor and supported his theories
- The engineers had the adequate technical knowledge that Taylor was looking for

Owners Recognize the Values of these Principles
- As more techno-science industries were arising, owners began to see the value of these principles of efficiency
- More production = more profit
- Needed more profit to cover costs of these more expensive industries

Lecture Eighteen: The Automobile and Rise of Mass Production in the United States

November 22, 2011

Interchangeable Parts

History

Many of these interchangeable parts came from Europe, and not in the United States.
- In Europe, there was an emphasis on craftsmanship
- Therefore, mass produced parts were considered to be inferior

The Americans borrowed these unpopular techniques from Europe and made them better.

Elie Whitney
- Entrepreneur in Europe who brought ideas to the United States
- Interested in using interchangeable and standard parts for the building of muskets
- Asked the government for money to make some muskets using this way
- Promised to make over 10 000 muskets, even though no other firm had ever been able to make more than 5000

Fantasy versus Reality
- Eli Whitney was able to make these muskets, which amazed the government
- However, historians opened up the muskets and discovered that there was only the illusion of standardized and interchangeable parts
- He hand filed down all the parts so that they looked the same, as opposed to actually manufacturing identical parts

Role of Intermediary Industries and the Military

There was an increased role in the creation of new technologies by military and government institutions.
- These institutions are usually leaders when it comes to creating new technologies
- They are highly motivated to create new materials
- They have the largest amount of money that is able to be invested
- Larger amounts of money means that they are able to take the fall for failures (lots of failure usually occurs before one success)

Knowledge Diffusion

Knowledge diffusion is the process in which information is transferred from one person to another, or one corporation to another.

This is crucial to understanding the success of the manufacturing industry.
- Examples of this: bicycle, sewing machine industries, typewriter industries

- These are considered to be intermediary industries because although they were the first to adopt the new manufacturing techniques, they were not able to adopt them in their entirety due to high costs

<u>Lecture Nineteen: Mass Production</u>

November 24, 2011

The Ford Motor Company and Mass Production

Henry Ford's Philosophy

Cars were considered to be luxury items only for the wealthy
- "Toys for the rich"
- Cost $1800 at the turn of the century
- Henry Ford believed that this should no longer be the case

"A car for the masses"
- Wanted to be able to provide a car for all people, not just wealthy ones
- Needed to find a way to make cars cheaply
- Also needed to find a way to make a lot of cars quickly

Research and Development
- Supported his engineers and their experiments
- Very open to new ideas and techniques of production
- These engineers made Ford more aware of the new technologies available in terms of making cars
- This was knowledge diffusion at work
- Exposed to many more ideas about machinery over time by the people that he hired.

James Couzens
- Told Ford that not only should he sell cars, but also sell the parts for the cars
- Introduced him to the idea of vertical integration

Walter Flanders
- Originally a machine tool salesman
- Worked for the Singer company before coming to Ford
- Suggested to Ford that all the parts be uniform, or standard
- Told him the way to achieve this was the use of specialized machine tools
- Told Ford this would increase his production levels

P.E Martin and Charles Sorenson

- Suggested that Ford should look to other industries for inspiration on how to create his cars
- Ford was open to these ideas, more so than anyone else during this time

Changing Location
- Ford originally had his manufacturing facility in the heart of Detroit
- Soon, he bought 60 acres in Highland Park
- He moved his manufacturing and production facility to Highland Park

Causes for This
- Too difficult to expand in an urban area
- The Detroit facility was already a multi-story location
- Easier to bring resources in and out of the Highland Park suburban area than the densely populated Detroit
- "Accuracy, power and economy" - Ford

Power
- Introduction of the assembly line
- Everything used electricity
- Speeding up and slowing down of the machine controlled production rates

Accuracy
- No car was tested until the car came off the final assembly line
- Believe there was no need for tests to be done before the final product was completed
- Strongly believed in the accuracy of the process

Economy
- Everything had to be monitored, managed and controlled at all times.
- Budgets, inventory controls, when machines should be operated
- Avoiding bottlenecks in production

Development of the Assembly Line

Assembly Line - a long, mechanized conveyor belt. People are given small and specific tasks along the line. This was where manufactured goods were assembled.

The assembly line controlled the flow and rate of production. The people had to adapt to the speed of the line to keep everything going smoothly.

Assembly Gang Workers - workers who would come together to put together a specific part of a car before the entire car was assembled.

Problems with these workers
- No matter how fast the assembly line is going, the production is dictated by the speed of the assembly gang workers
- Workers would go slower when someone was tired or sick
- Not mechanical or consistent enough to keep up with demand for cars

Inspirations for the Assembly Line
- Meatpacking industry (a disassembly line: took a large product and broke it down into smaller ones)
- Ford took this idea and reversed it to make the assembly line (taking small goods and building it into one large one)

Use of the Assembly Line

Increase in volume in production
- Only half to one day of training was necessary to be able to work on the line
- Assembly line gangs could produce typically 40 of a given product in a day
- Assembly lines could produce up to 1000 per day
- Time to make one car dropped from 12 hours to 6 hours, to several hours and today it only takes minutes

Costs
- Ford was able to create a car that would cost a person $275, instead of the previous cars (2 decades prior) that costed $1800
- This meant that the car was now more available to more people

Taylorism and Ford's Mass Production Techniques

Time and Motion Studies
- Required to make the layout of the assembly line as efficient as possible

Mechanization of Workers
- Semi-skilled and unskilled workers
- Hired by engineers to run the machines
- Division of labour to make things more efficient

Differences Between Taylor and Ford
- Taylor was focused on making better versions of existing technologies
- Ford was not interested in making improvements
- He was interested in creating entirely new systems that were more efficient
- It was only after the invention of the assembly line that unskilled workers became more widely used

It is important to note that without the approval of the workers, there would be no future for mass production.

Labour Problems

The workers were unhappy with the assembly line at first
- Workers were resentful of the fact that they were no longer skilled
- Assembly line work was extremely boring and repetitive
- They began to leave in large groups
- The manufacturing levels decreased sharply
- Extremely high turnover rate

Ford's attempt to fix this
- Made a 13% wage increase
- Promised bonuses for people who stayed for a certain period of time
- This still did not help with the turnover rates

Radical Changes
- Ford implements a new wage increase
- He paid the workers $5 per day (extremely high compared to the typical wage rate of $2.35 per day of factory workers)
- The workers changed their attitudes and accepted the assembly line with these new wage rates
- Workers were now fighting to work for Ford. There were no more shortages of labour or strikes

Five Dollars a Day
- This gave Ford control over the lives of the workers, both inside and outside the workplace
- Ford wanted to make a 100% "Americanized" workforce
- Immigrants who came to America had to be evaluated by psychologists to see if they were deemed to be "American" enough
- People would enter their homes to teach them how to talk, eat, dress and act like an American
- Being American was the only way to qualify for the high wage
- By giving workers more money, they had more disposable income. The workers now had more money and often would purchase the cars that they were paid to make.

Ford and General Motors

Model T
- Ford produced the exact same car, the Model T the entire time

- At first, this was not a problem when everyone was buying cars
- In the 1920’s, people were tired having the same car as everyone else
- Came to an end in 1927, 20 years after it first was made
- Ford was unable to adapt to change in the long term

Changes in Preferences
- People in the 1920’s had more money
- They did not like that they had the same car as everyone else
- There was a demand for more types of cars
- Wealthy people did not want the same cars as poorer people, so there was a demand for luxury cars

General Motors
- “Flexible mass production”
- They were able to adapt to changes in preferences on a yearly basis

Lecture Twenty:

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