

Engineering in the Modern World

Transformation of Society by Engineering

Prof. Michael Littman
Mechanical and Aerospace Engineering
Princeton University

Three Perspectives on Engineering

Scientific: formulas as
relationships

Social: contexts for
construction

Symbolic: changes in
vision



Landscape with a dead tree

Symbolic

Transformation of Vision

Thomas Cole

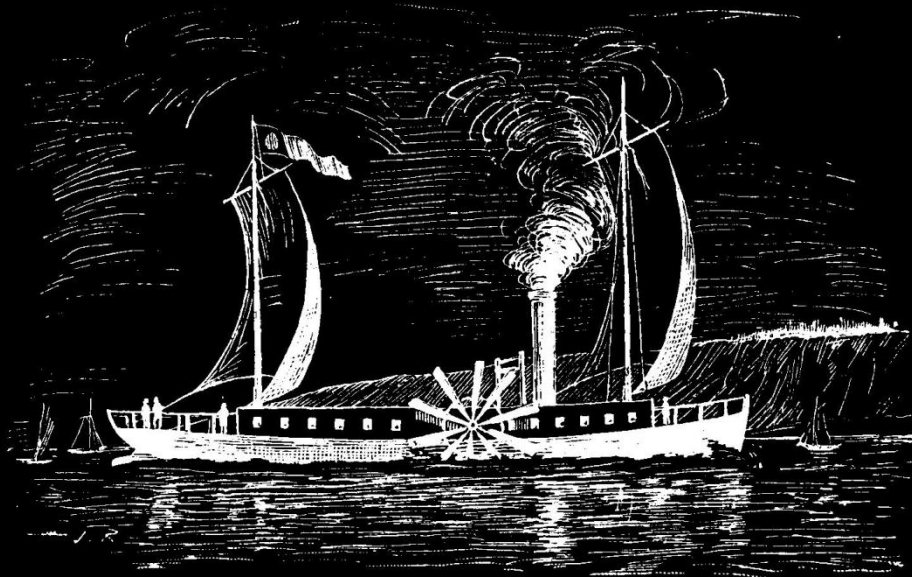
1828 - 1846



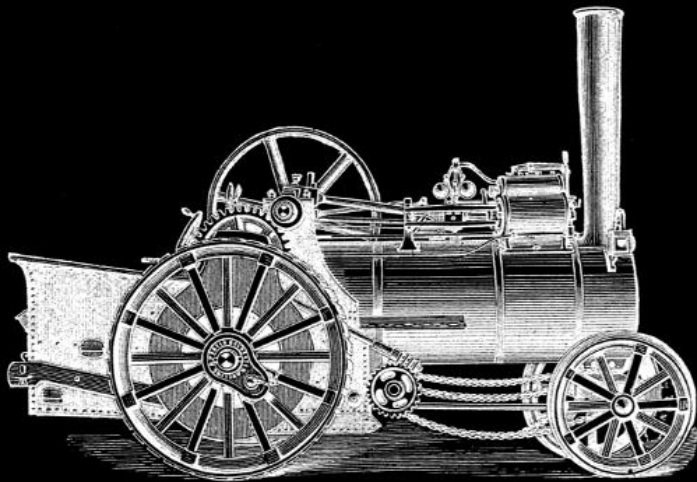
Landscape with a dead tree



The Pic-Nic



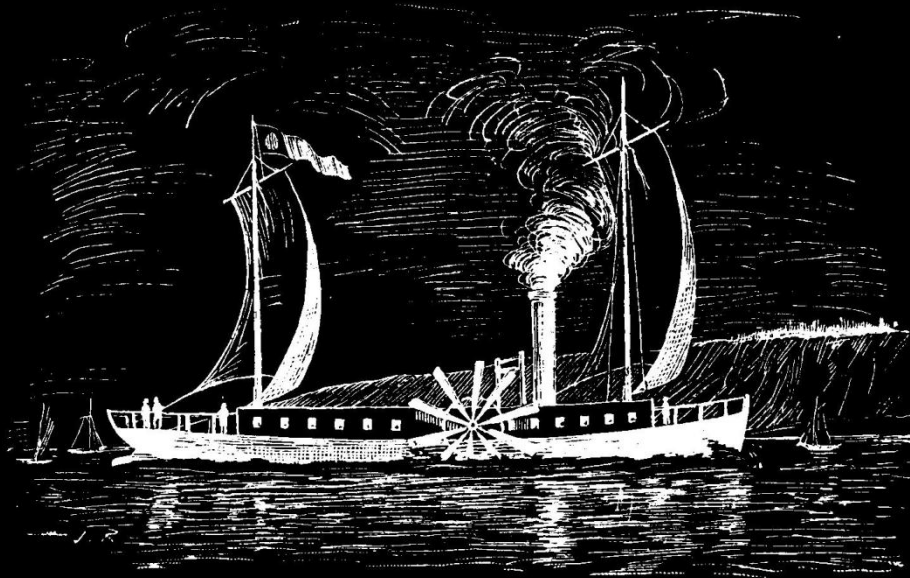
Steamboat



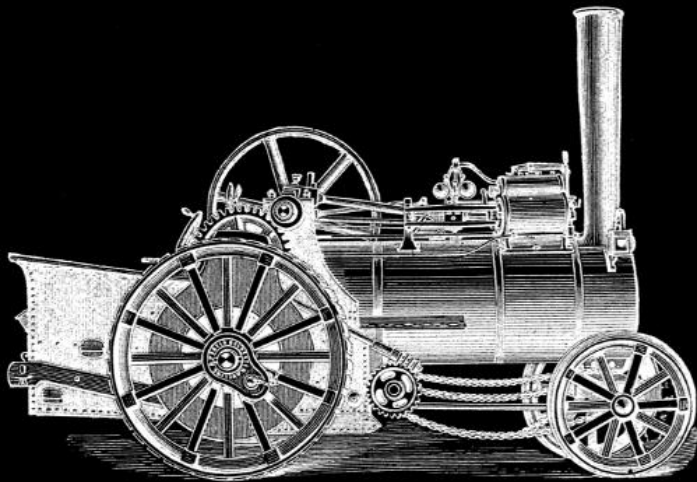
Steam Tractor



The Pic-Nic



Steamboat



Steam Tractor

Building an Urban Society

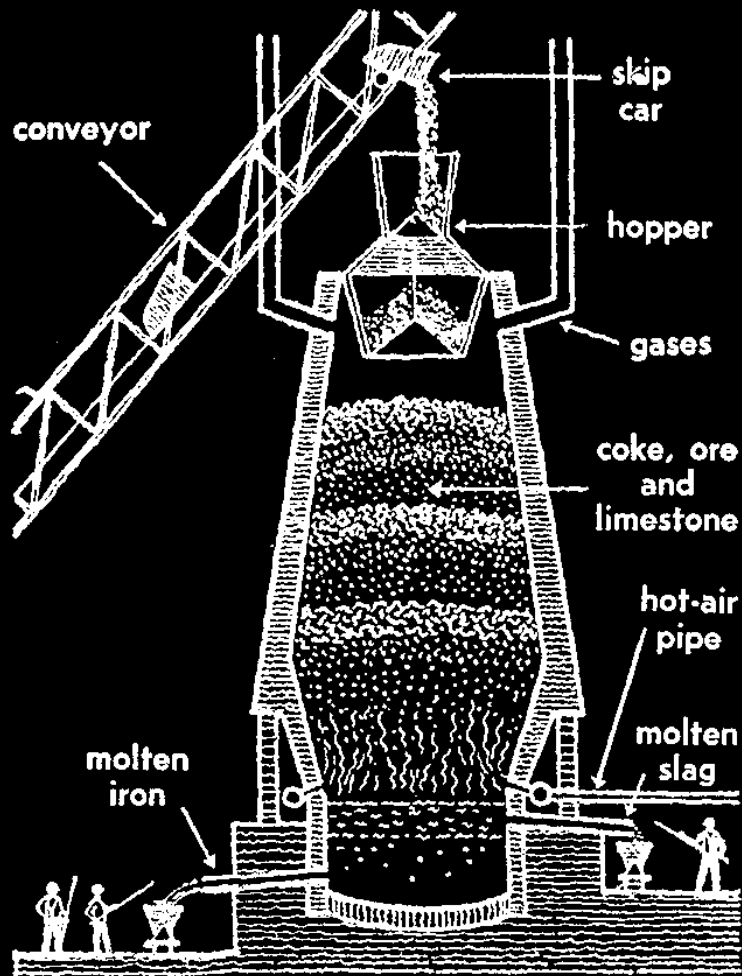
structures

machines

networks

processes

Process: Blast Furnace



Building an Urban Society

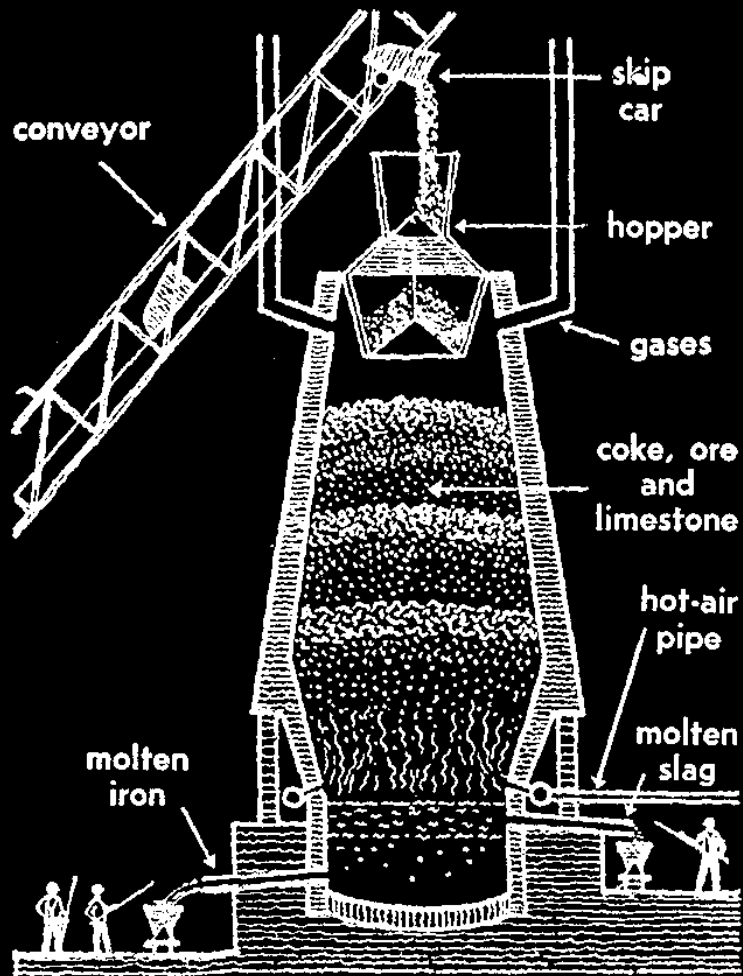
structures

machines

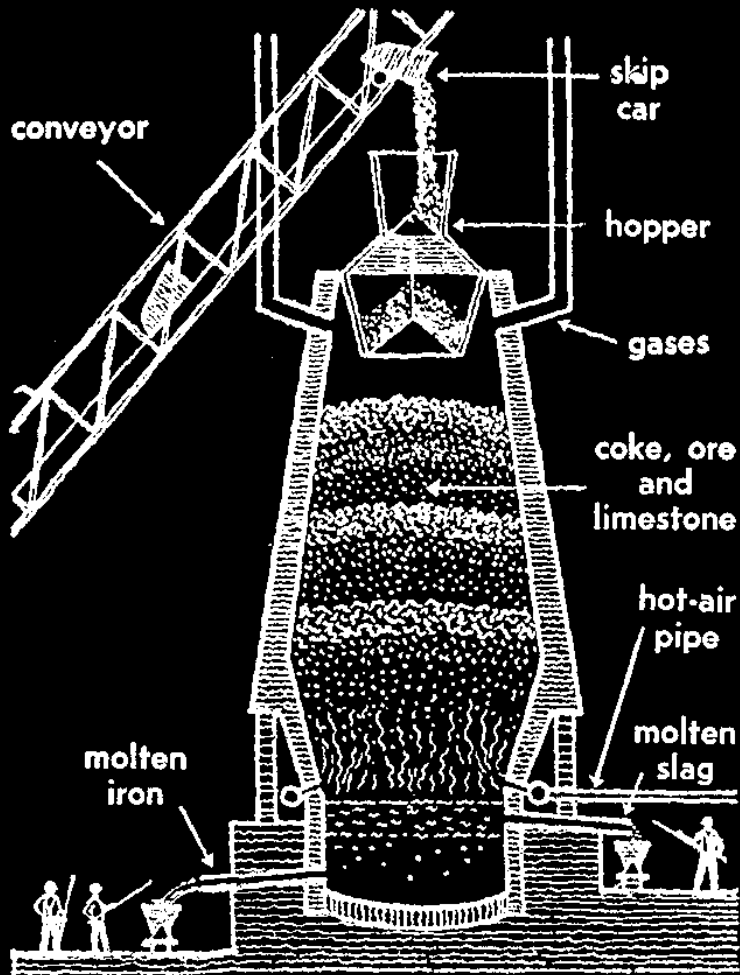
networks

processes

Process: Blast Furnace



Process: Blast Furnace



What?

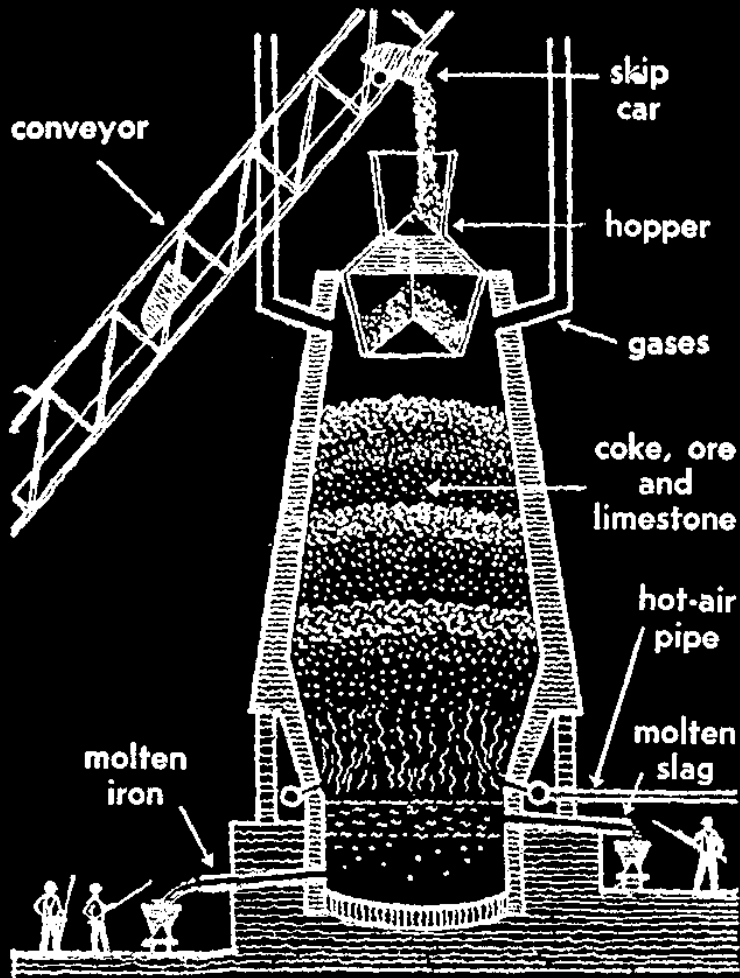
**Transforming raw materials
into valuable products**

History: Iron

Public Environment and
Private Profit

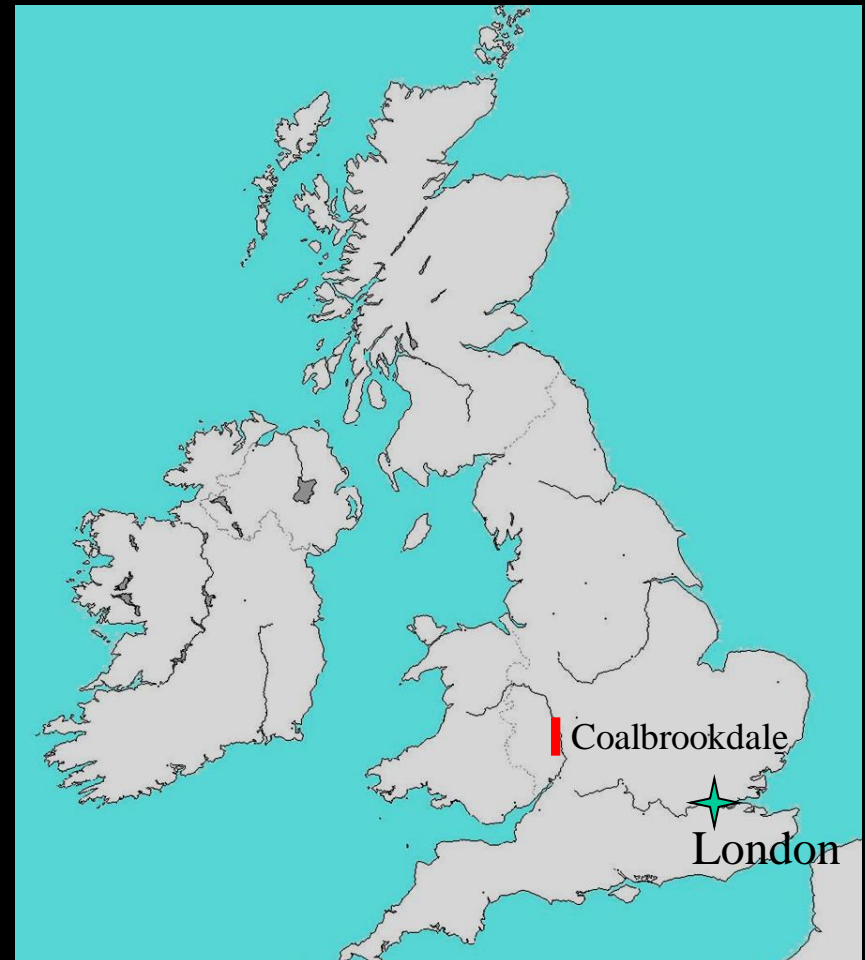


Process: Blast Furnace

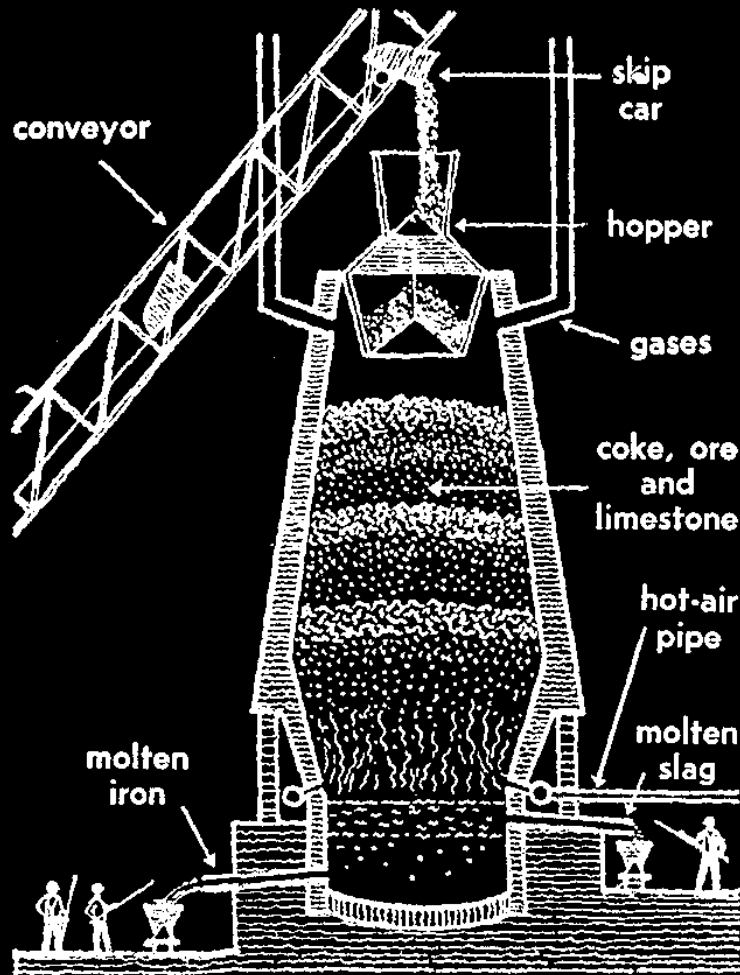


Where?

**Transforming raw materials
into valuable products**



Process: Blast Furnace



Who? When? Why?

**Transforming raw materials
into valuable products**

People: Iron

Abraham Darby I
1708 – 1712

What is the Innovation?

- Smelting Iron Ore with Coal
- Limestone removes sulfur
- Cost greatly reduced

Structures: Metal Bridge



Building an Urban Society

structures

machines

networks

processes

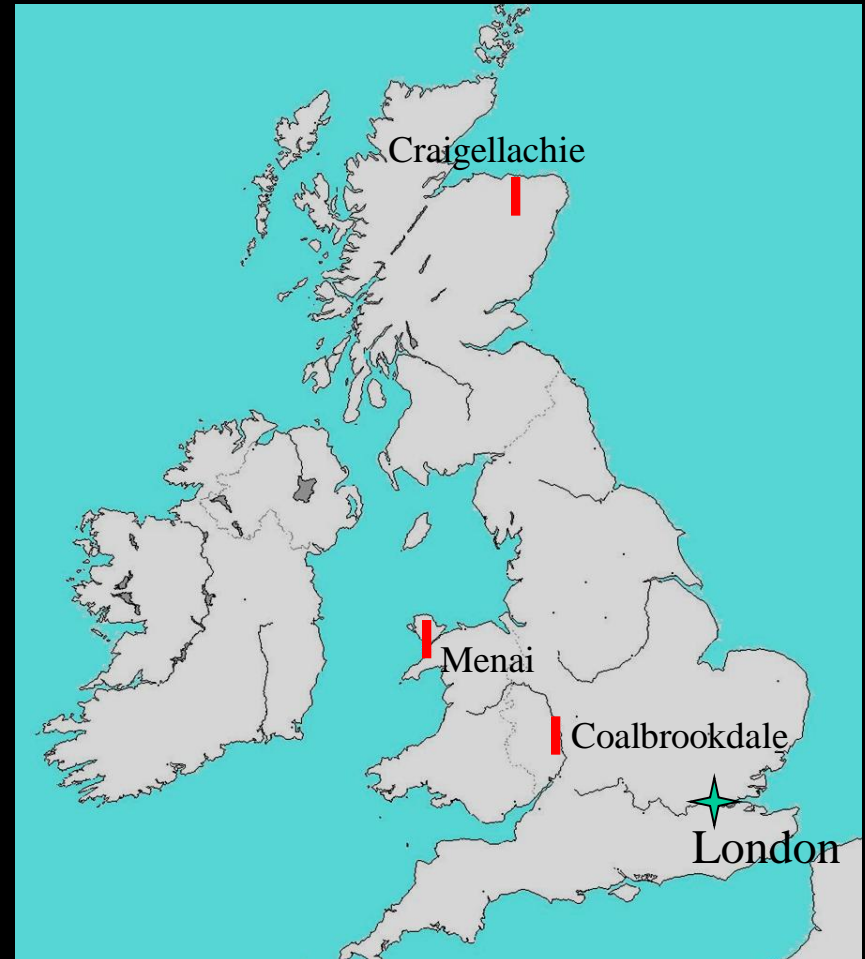


Structures: Metal Bridge



Where?

Transforming the environment



Structures: Metal Bridge



What?

Transforming the environment

History: Metal Bridge

Politics of Public Works



Structures: Metal Bridge



Who? When? Why?

Transforming the environment

People: Metal Bridge

Thomas Telford
1814 – 1824



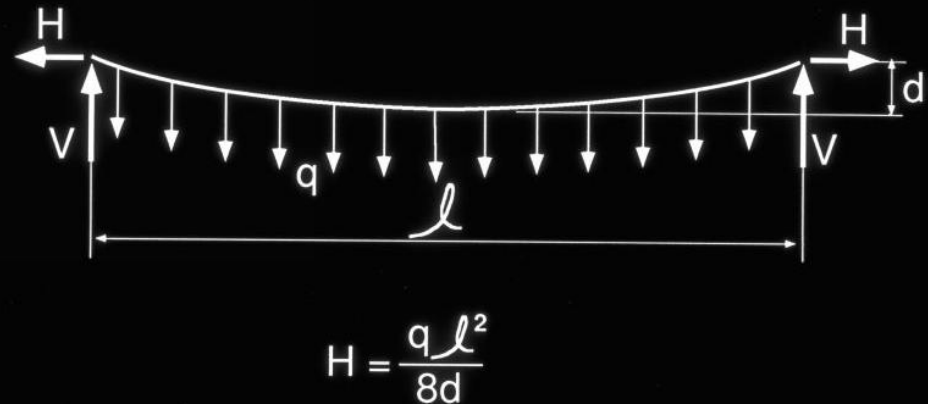
What is the Innovation?

- New material - New form
- Structural Art
- Safety and Commerce
- Public Works Entrepreneur

Structures: Metal Bridge



How?



How?

Structures: Cable or Arch

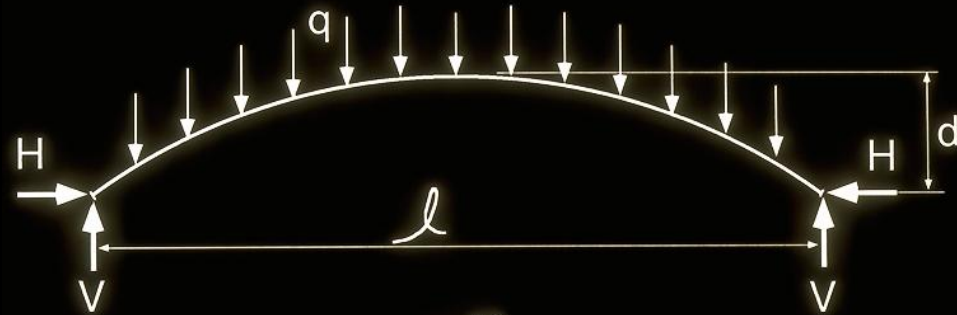
Vertical Weight : ql

Transformed by Form : l/d

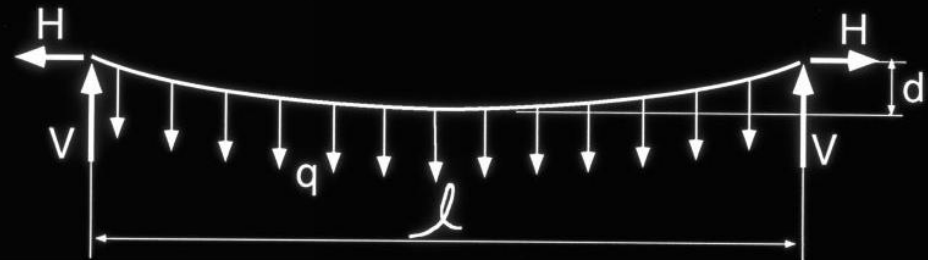
Into Horizontal Force : H

$$H = \frac{q l^2}{8 d}$$

Economics – Art – Science



$$H = \frac{q l^2}{8 d}$$



$$H = \frac{q l^2}{8 d}$$

DEMONSTRATION OF CABLE BRIDGE –
Tension, Compression, Anchor, Load, Cable, Tower

Modern Art of Structures

Structures: Cable or Arch

Vertical Weight : ql

Transformed by Form : l/d

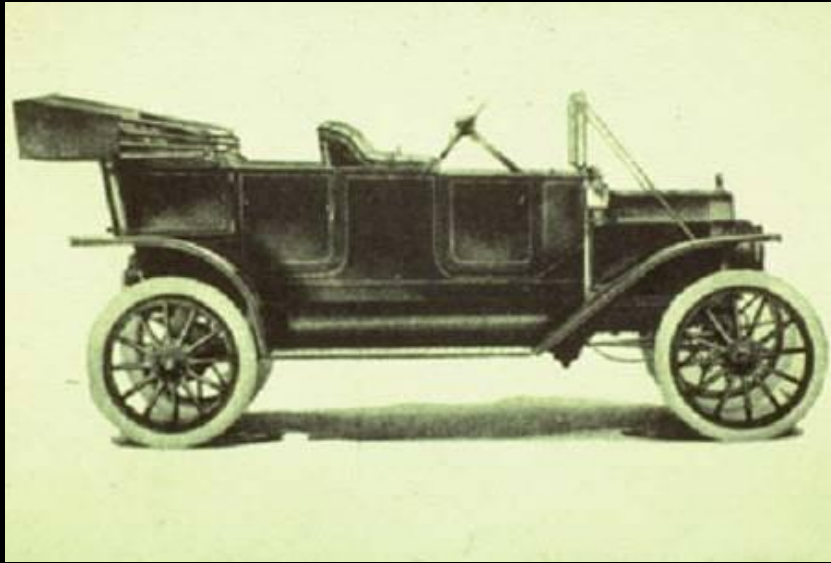
Into Horizontal Force : H

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Economics – Art – Science



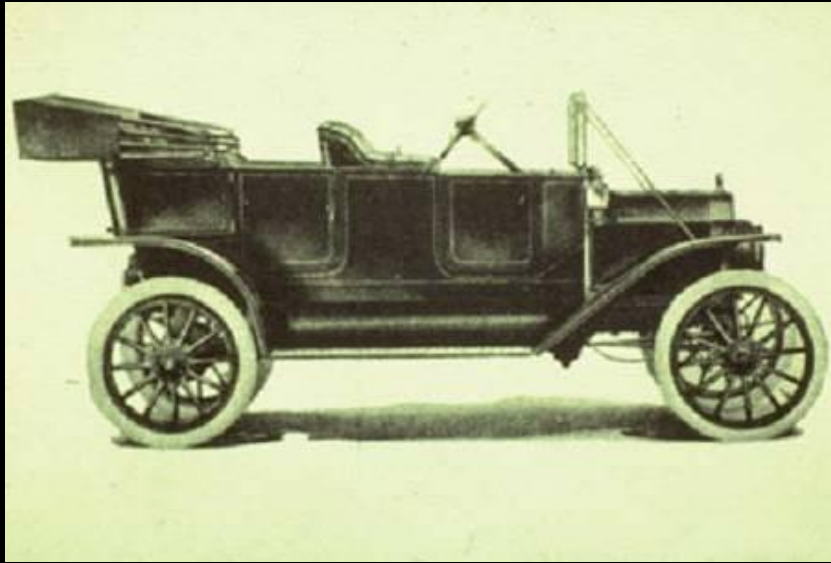
Machine: Automobile



Modern Art of Structures



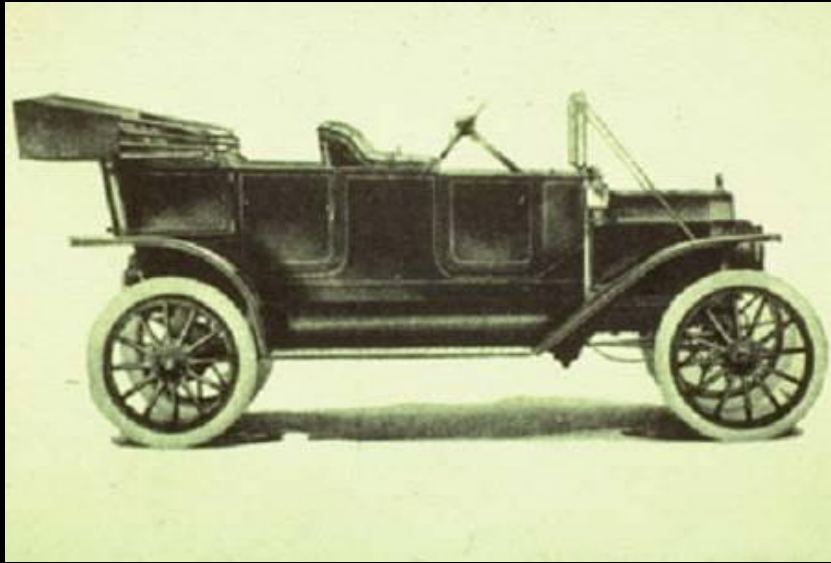
Machine: Automobile



Modern Art and Machines



Machine: Automobile



What?

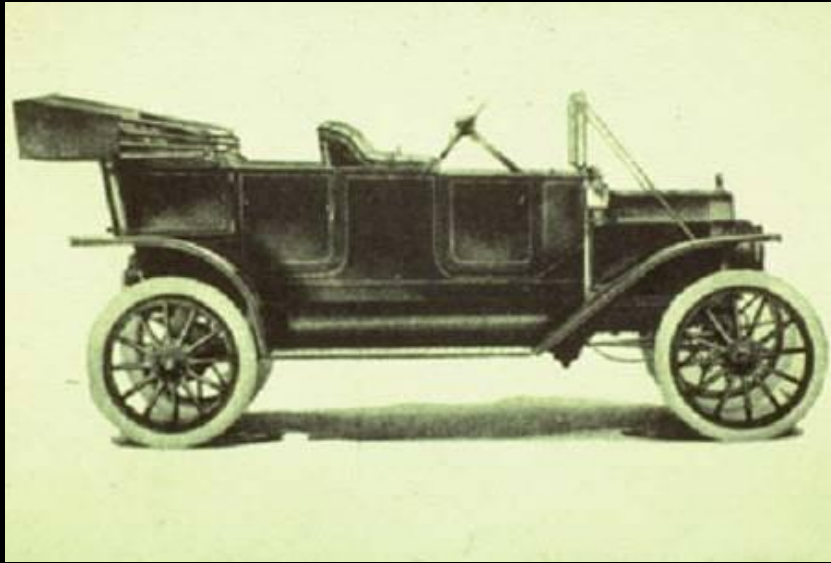
**Transforming America's
Economy**

History: Automobile

Economics of Private Enterprise



Machine: Automobile



Who? When? Why?

Transforming America's Economy

People: Automobile

Henry Ford
1908 – 1927



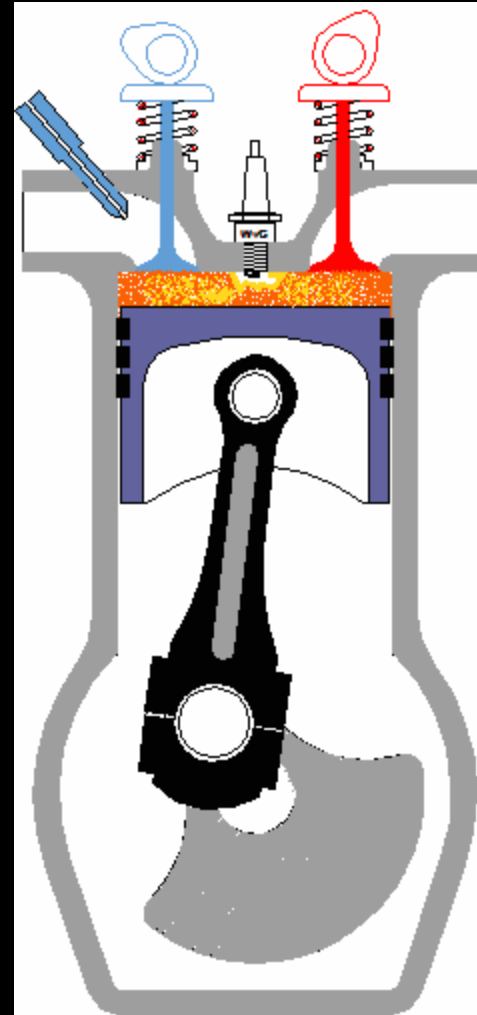
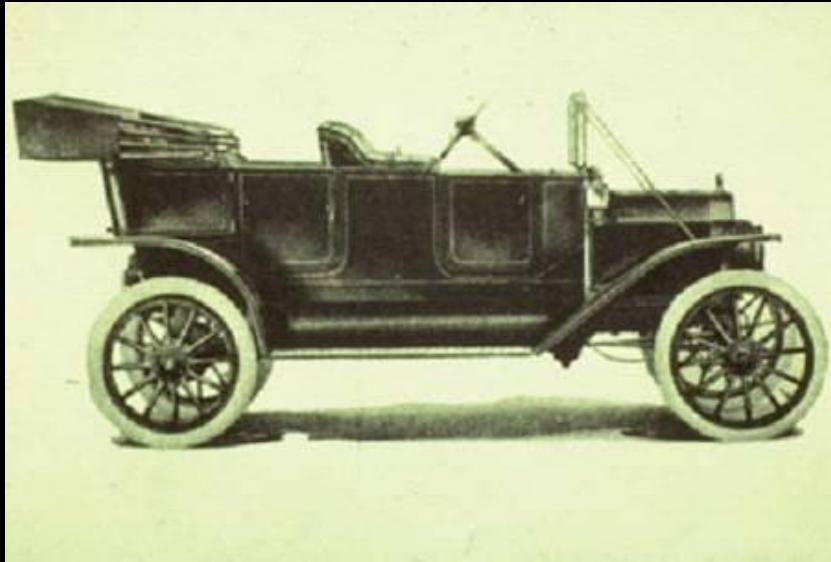
What is the innovation?

- Vision of a universal car
- Internal combustion engine
- Assembly line
- Higher wages



Machine: Automobile

How?



$$H_p = \frac{PLAN}{33000}$$

P = pressure

L = stroke

A = area

N = frequency

How?

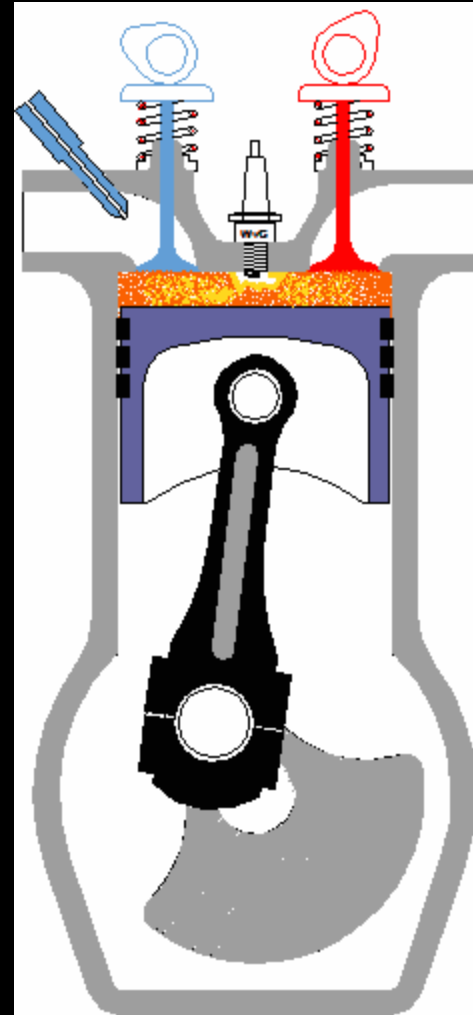
Machines: Reciprocating Engine

Piston Force : PA

Transformed by Velocity : LN

Into Horsepower : Hp

$$Hp = \frac{PLAN}{33000}$$



$$Hp = \frac{PLAN}{33000}$$

P = pressure

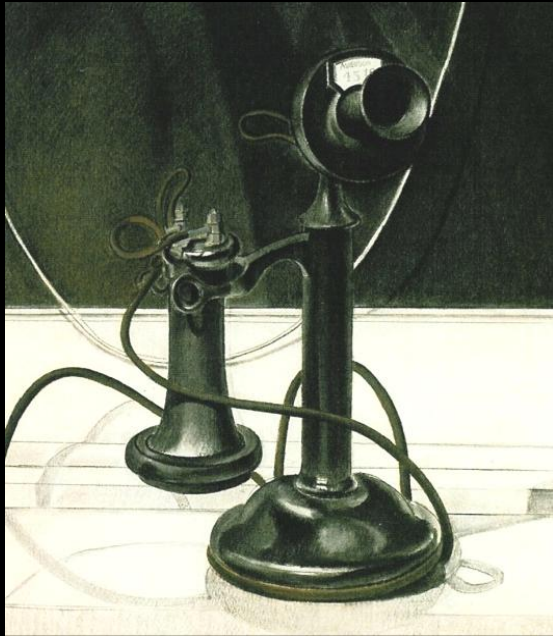
L = stroke

A = area

N = frequency

DEMONSTRATION OF PING-PONG ROCKET –
Fuel-Air, temperature rise, pressure rise, seven-fold

Network: Telephone



What?

Transforming daily life

History: Telephone

Public Network and Regulated
Private Company



Network: Telephone



Who? When? Why?

Transforming daily life

People: Telephone

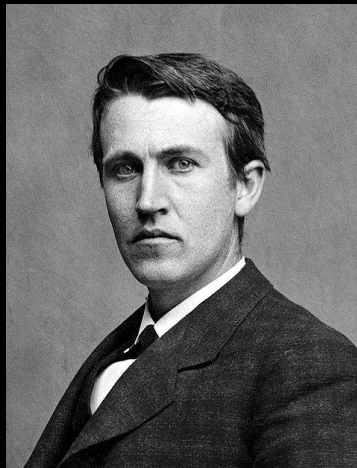
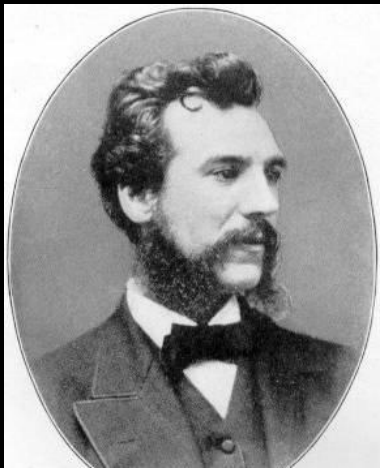
Alexander Graham Bell

Thomas Edison

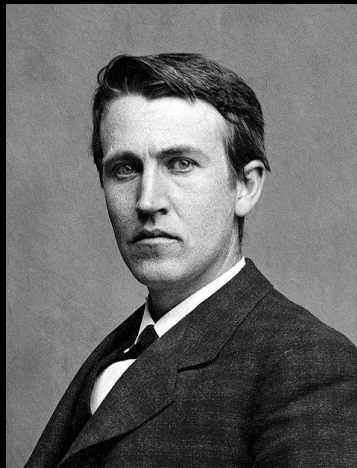
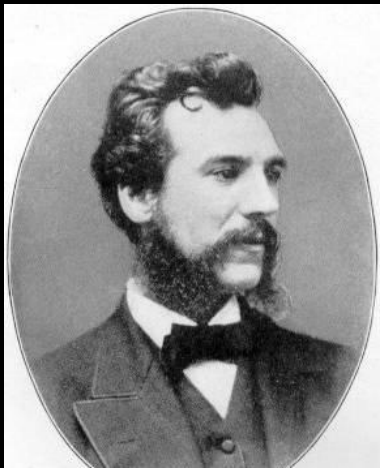
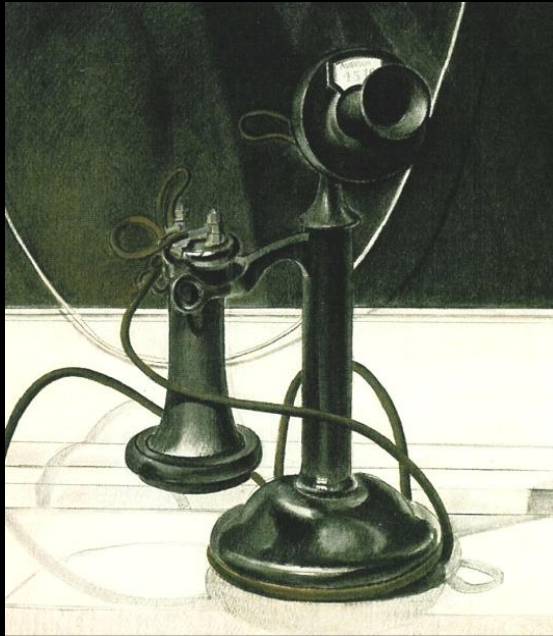
1876 – 1893; 1893 – 1905

What is the innovation?

- Idea of speaking at a distance
- Loudspeaker and microphone
- Piggy-back on existing telegraph
- Single vendor for long lines

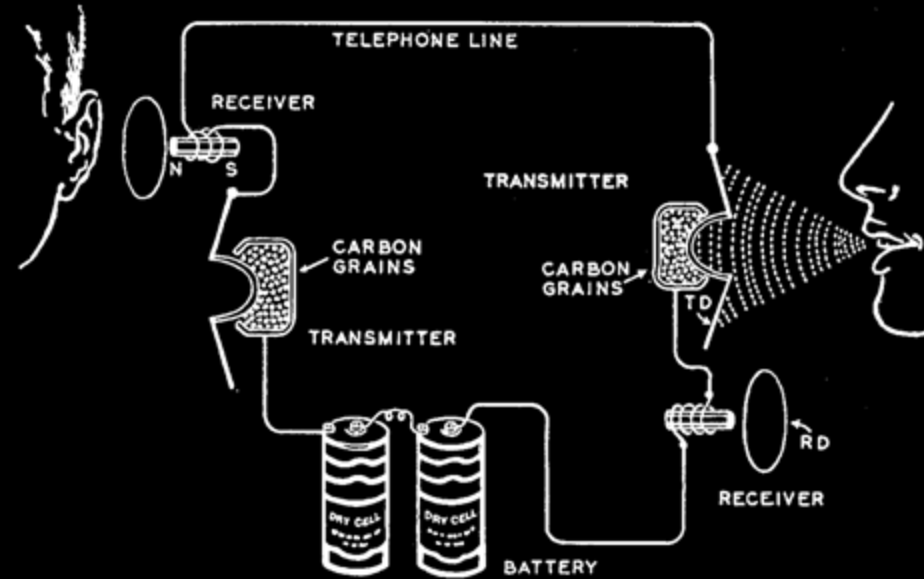


Network: Telephone



How?

Transforming daily life

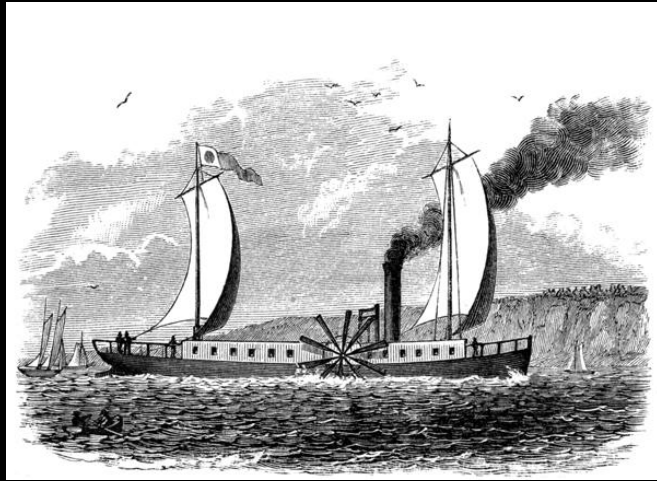


Battery, Receivers, and Transmitters in Series

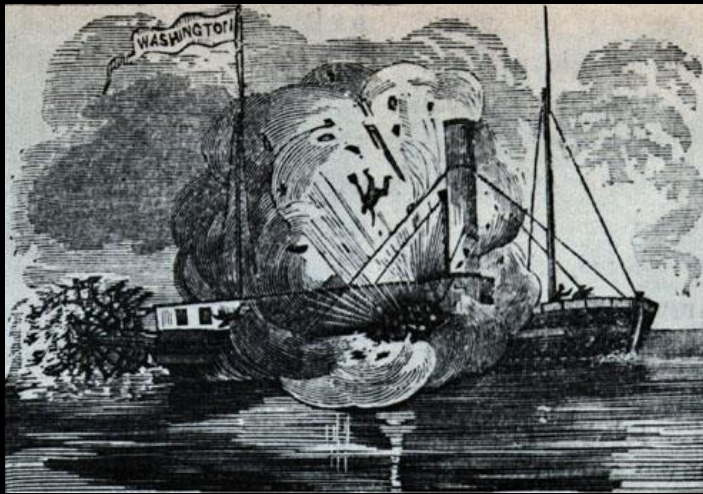
Sound waves converted to waves of current and back

DEMONSTRATION OF Telephone and Amplifier –
Sound to variable resistance; variable current to sound
Vacuum-tube Amplifier allows transcontinental call

Machine: Steamboat



Hudson River 1807



Mississippi River 1824

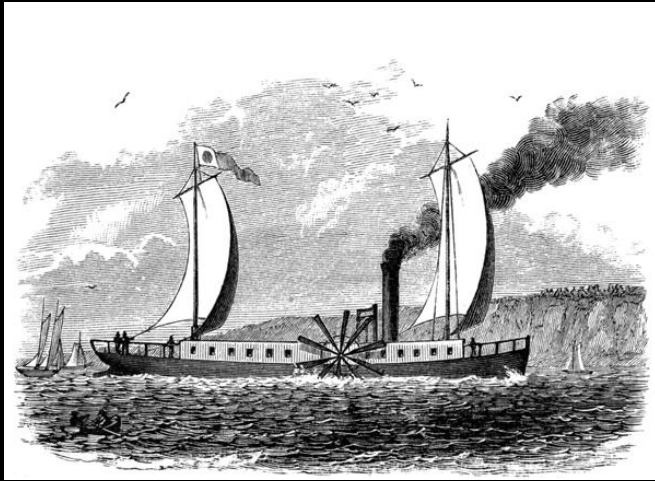
What?

Transforming Politics

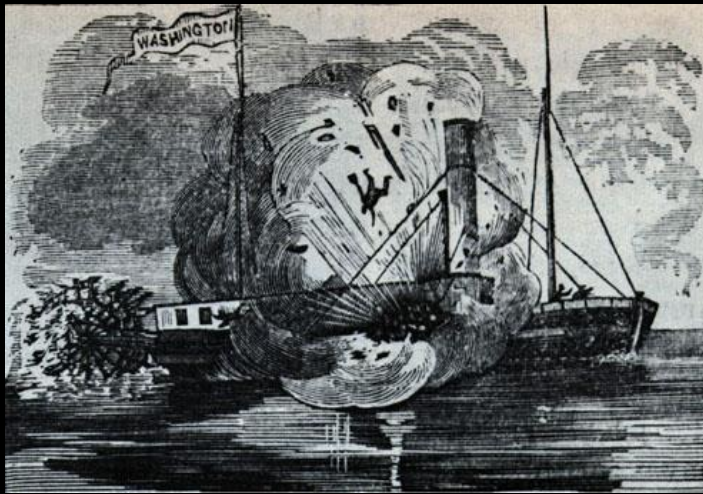
History: Steamboat

Economics of Private Enterprise
and Politics of Public Control

Machine: Steamboat



Hudson River 1807



Mississippi River 1824

Who? When? Why?

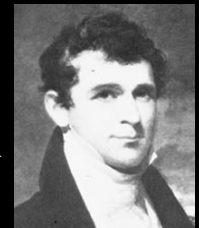
Transforming Politics

People: Steamboat

Robert Fulton

Robert Livingston

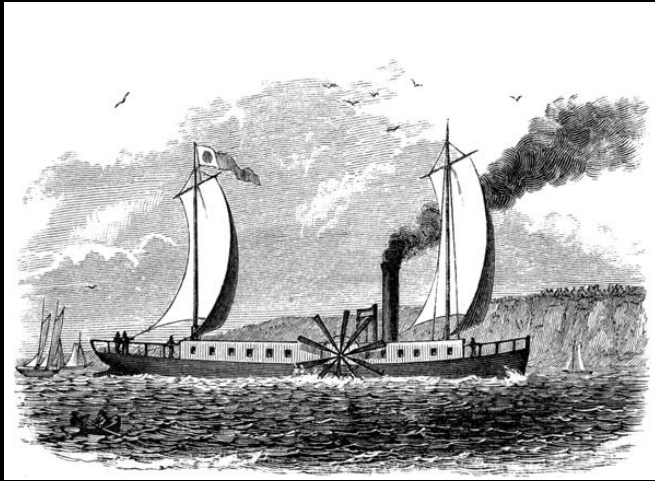
1807 – 1815



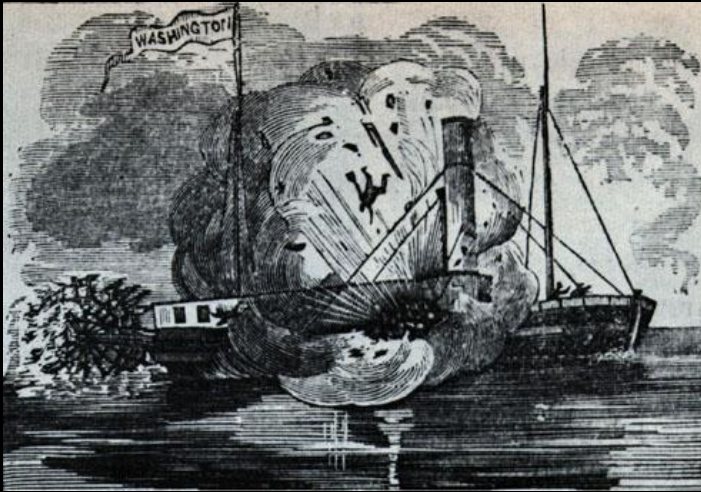
What is the innovation?

- Steam-power paddleboat - Patent
- Albany Monopoly
- Supreme Court breaks Monopoly
- High pressure steam for profit
- Congress regulates for safety

Machine: Steamboat



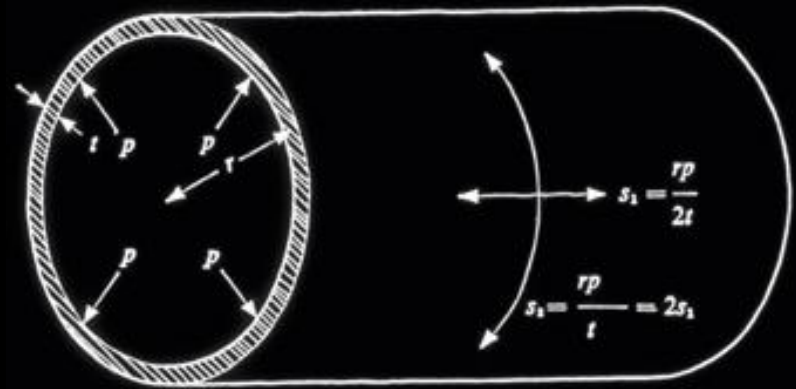
Hudson River 1807



Mississippi River 1824

How?

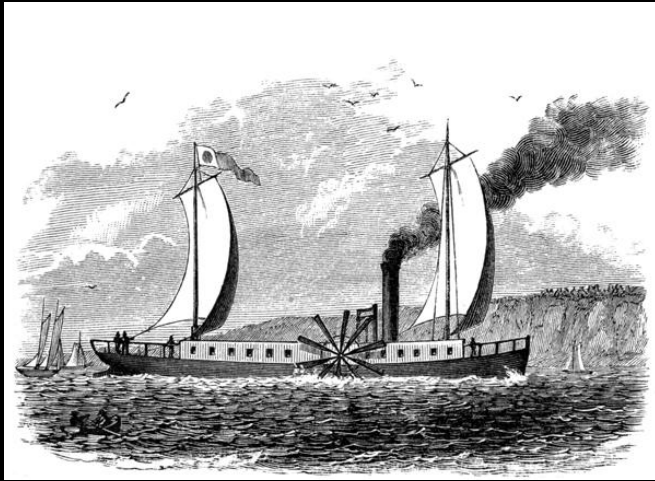
Transforming Politics



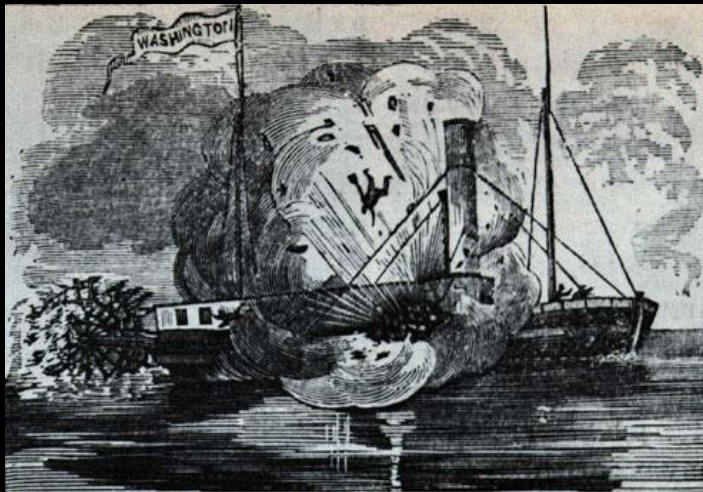
High Pressure Boiler

$$f_1 = \frac{Pr}{h}$$

Machine: Steamboat



Hudson River 1807



Mississippi River 1824

Samuel Clemens – Mark Twain
Riverboat Pilot
Life on the Mississippi
Beauty and the Danger



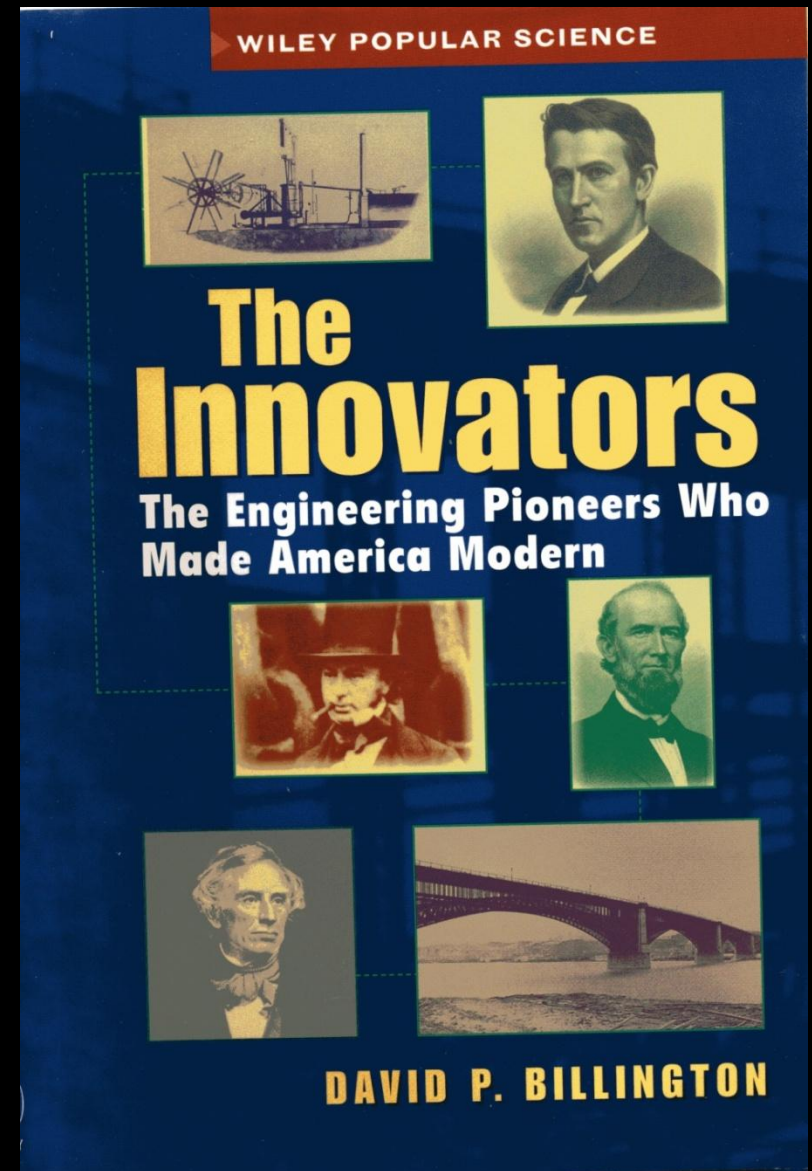
ENGINEERING IN THE MODERN WORLD

The Age of Iron and Steel

1. Independence, Iron, and Industry: 1776-1855
2. Connecting the Continent: 1830-1876

The Age of Power and Speed

3. The Rise of the Great American Industries: 1876-1939
4. Regional Restructuring 1921-1964
5. Information and Infrastructure: 1946-



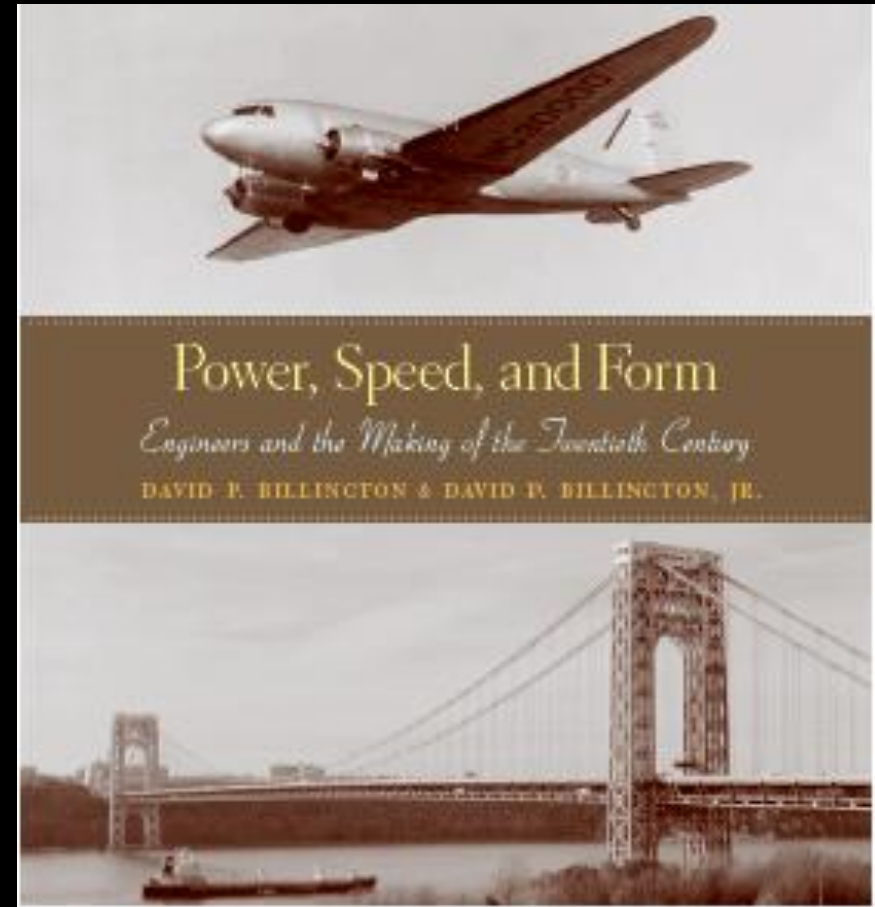
ENGINEERING IN THE MODERN WORLD

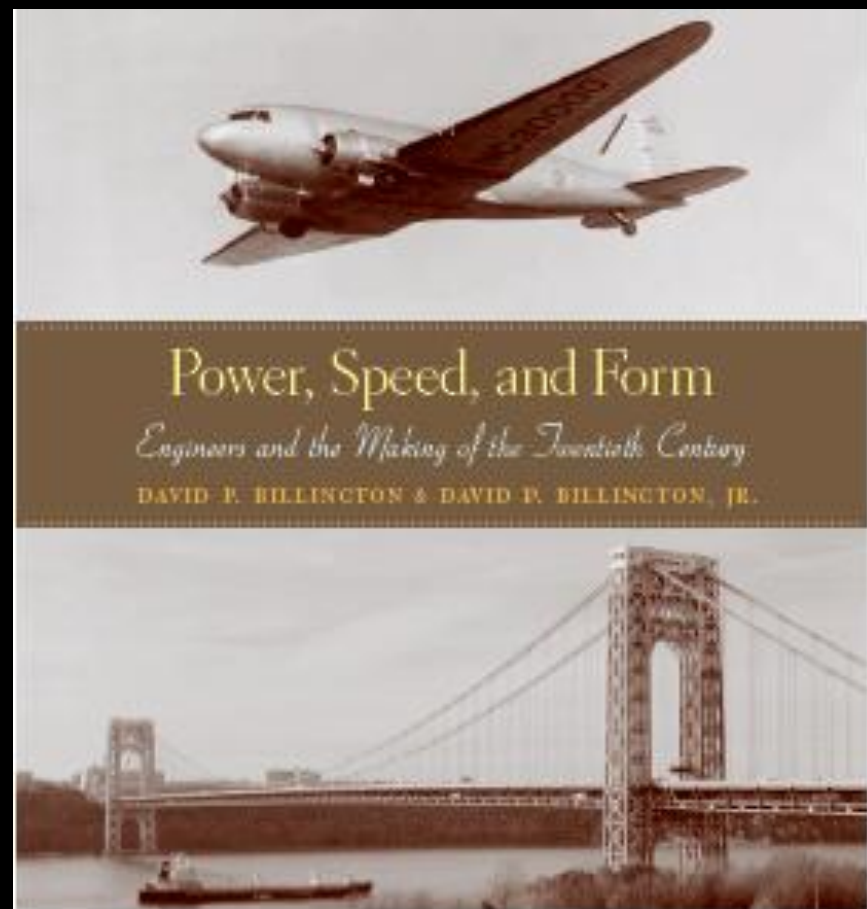
The Age of Iron and Steel

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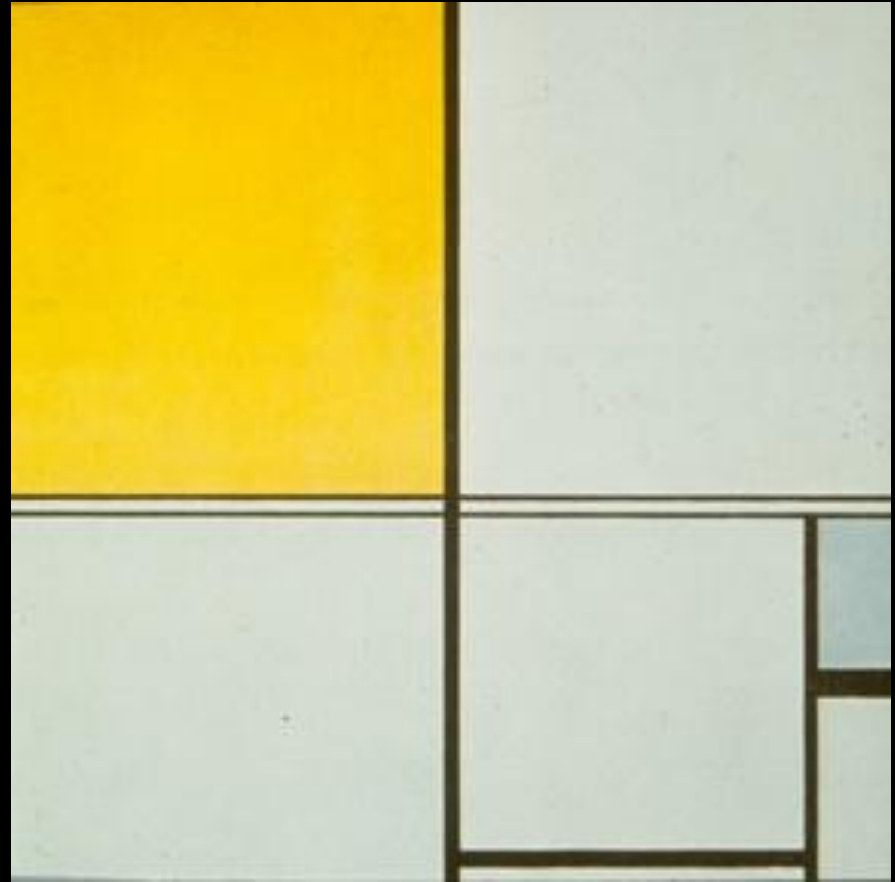




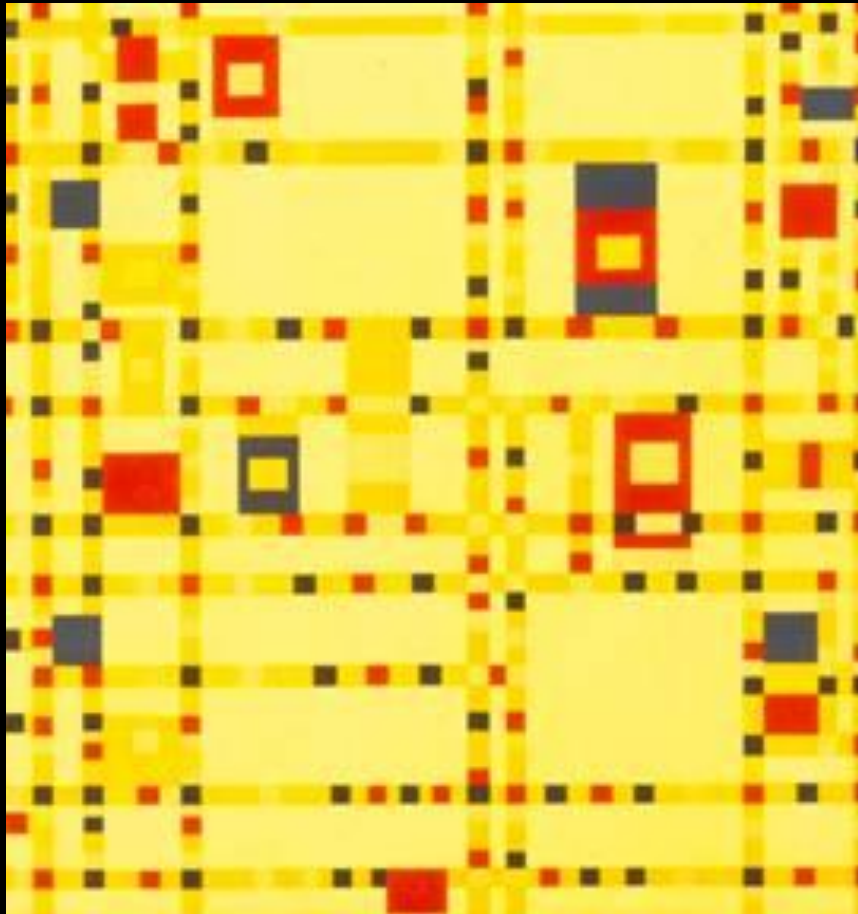
Power, Speed, and Form

Engineers and the Making of the Twentieth Century

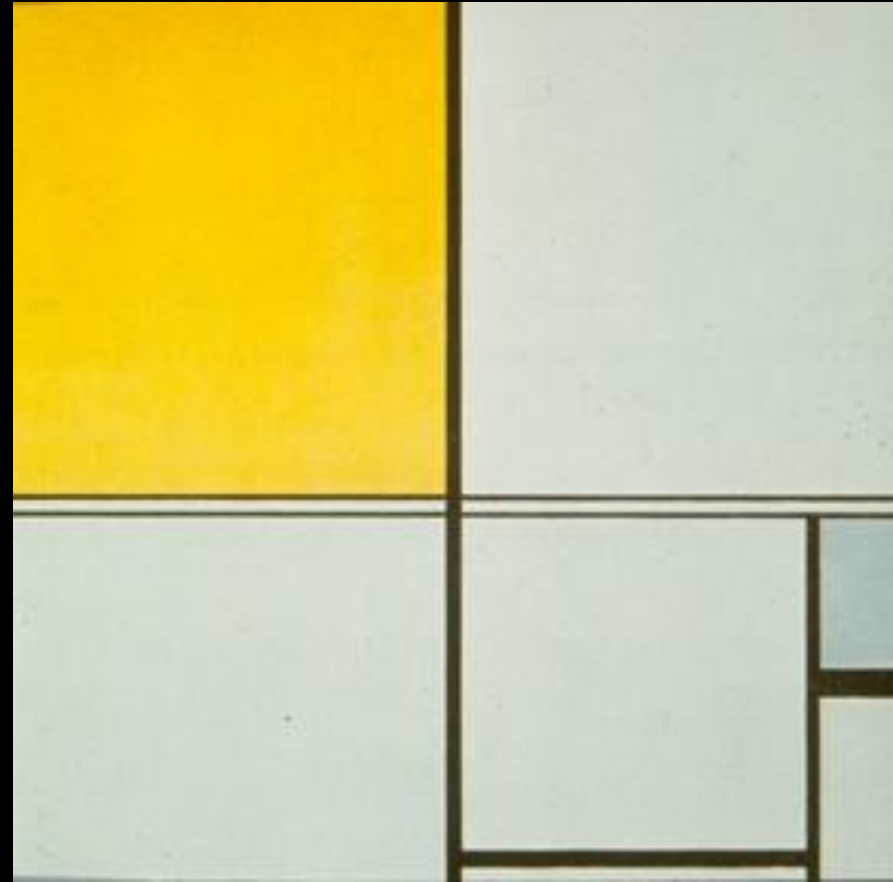
DAVID P. BILLINGTON & DAVID P. BILLINGTON, JR.



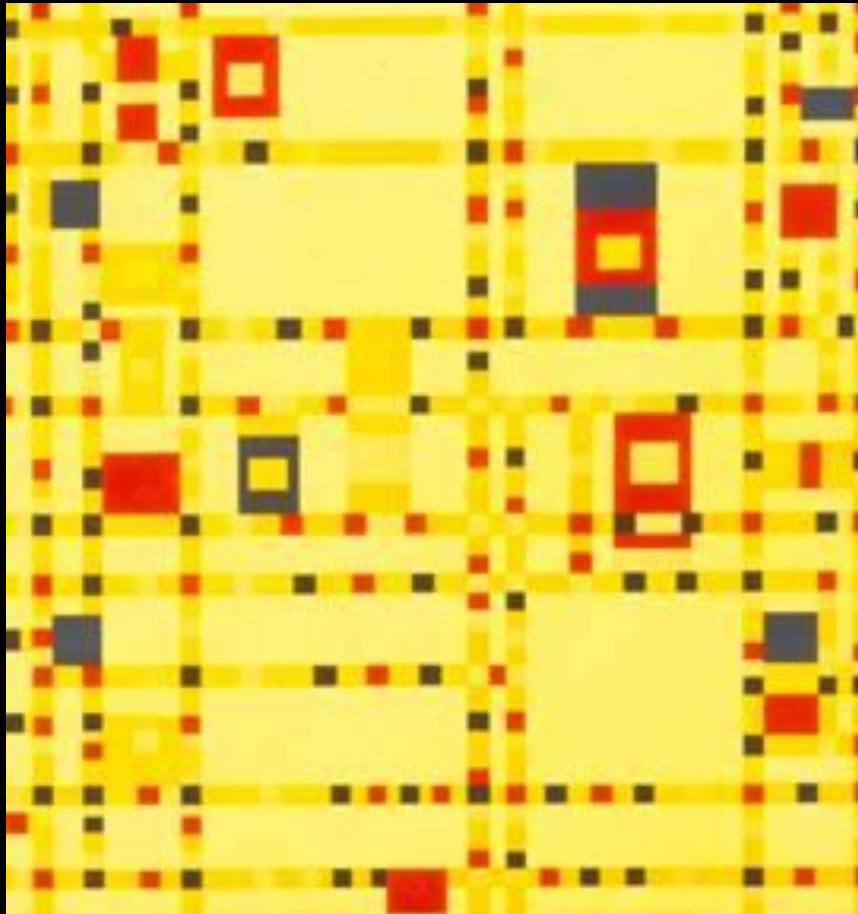
Mondrian 1932



Mondrian 1942-43



Mondrian 1932



Mondrian 1942-43



Course Objectives

What are the great modern works of engineering?

Who are the key people?

What did they do?

What is a radical innovation?

How, when, where, and why do innovations happen?

How has the modern world been transformed by engineering?

