RAILROADS

Railroads

- Tracks
- Steam Traction
- Development of Railroads

Ice Railroad Tracks

- Wooden Rails
- Cast-Iron Rails
- Wrought Iron & Steel Rails
- Rail Size & Capacity
- Evolution Of Rails
- Joints
- Track Gauge

Wooden Tracks

- Also Called
  - Wagonways
  - Tramroads - Tram Was Originally A Coal Wagon
- First Wagonways Built In England As Early As 16th Century
  - Coal, Ore, & Stone From Mines Or Quarries
- First Rail Size & Capacity
- Evolution Of Rails
- Joints
- Track Gauge

Modern Rails

- First Cast-Iron Rails
  - British Foundry (1767)
- Toothed Rail
  - Patent - British Coal Miner (1811)
  - Rack & Pinion On Third Rail
  - Still Used - Pikes Peak & Swiss Mountains
- Modern Rails
  - Evolved From Edge Rails in Northern England
    - Early, 19th Century
    - Flange, On Inside Of Wheel

Modern Rails (Continued)

- Prototype
  - Flat-Footed “T” Rail
    - Robert Livingston, Stevens, (1835)
    - President Of, Camden & Amboy, Railroad
  - Still Used
  - Bridge Rail
    - Inverted “U” Shape
    - Longitudinal Timbers
    - Great Western Railway - England Till 1892
Modern Rails (Continued)

- Bullhead Rail - Also Called Double-Headed
  - Evolved From "I" Shaped Rail From 1835
  - Thicker, Wider Head Than "I" Rail
  - Also Called Double-Headed Rail
    - Can Be Inverted In Theory

Wrought-Iron & Steel Rails

- Wrought-Iron Rails
  - Introduced In England In 1820s
- Steel Rails
  - Manufactured In US in 1865
  - Transverse Fissures Inside
    - Controlled Cooling & Inspection
    - Hardened Ends

Rail Size & Capacity

- Early Railroads
  - 40 lb/yd, 3 ft
- Early 20th Century
  - 60 lb/yd, 30 ft
- 1930s
  - 100 to 130 lb/yd, 40 ft
- Today
  - 152 to 155 lb/yd, 45 to 60 ft

Evolution Of Rail Shapes

- Joints
  - Problems
    - Joint Is Weak Spot - Lengthen Rail
    - Expansion & Contraction - Buckling
  - Butt Welded Joints - Up To 0.25 miles
  - Bars Bolted To Sides - Stevens
  - Wider Tie Plates
  - Anticreepers
Gauge
- Distance Between Inner Edges
  - Measured 0.626" Below Head
- Standard - 56.5"
  - US, Canada, GB, Mexico, Sweden, Europe
- Standard - Speculation
  - From Early Tramroads
  - Accommodate Wagons With Axle Length = 60"
  - Head Width - 1.75" On Early Rails
- Narrow Gauge In US - 3 ft
  - Fills & Clearances, Lighter Rails, Tighter Turns
  - 917 miles In US (1871)

Gauge (continued)
- Third Rail ?
- Central & South America - 66 inches
- Spain & Portugal - 66 inches
- Former Soviet Union - 60 inches
- Ireland - 64 inches
- South Africa & Japan - 42 inches
- India - 66 inches
- Australia - Various Gauges

Steam Traction
- Early Developments
  - Trevithick, Rack Locomotive, Puffing Billy, Walking Locomotive, Stephenson
- Early Railroad Lines & Companies
- Rainhill Competition
- Railroads In France
- Railroads In United States
- Evolution of Locomotive
- Increased Speed
- Advancements

Trevithick’s Attempts
- Richard Trevithick
  - Pioneer Of All Locomotive Builders
- 5 Ton Locomotive (1804)
  - Pulled 20 Tons @ 5 mph
  - Cylinder
  - 1.75. B Mtnter
  - 51. State
- Fractured Cast-Iron Rails
- 8 Ton Locomotive (1808)
  - 12 mph

Rack Locomotives
- John Blenkinsop (1811)
- Cogwheel & Rack
- Advantages
  - Heavier Load
  - Steeper Grade
- Colliery Railways
  - Middleton - Leads (1812)
  - Coxlage - Tyne (1813)
- Double-Acting Cylinders

Puffing Billy
- William Hedley (1813)
  - Concerned With Weight/Pull Ratio
  - Too Heavy For Rails
  - Converted to 8 Wheels
  - 1815
  - Converted Back to 4 Wheels
  - 1830
Walking Locomotive

- Brunton Of Butterly
- Built In 1812
- Tried to Solve Weight/Pull Problem

Stephenson’s Blucher (1814,1815)

- George Stephenson
  - Worked In Colliery
- Two Vertical Cylinders
  - 8” diameter, 24” Stroke
- Pulled 30 tons @ 4 mph
  - 8 Times Weight, 2/900 Grade
- Innovations
  - Flanged Wheels
  - Connecting Rod
- Patent (1815)
  - Suspension Using Pistons & Steam Pres. On Pillow Blocks

Early Railroad Lines & Companies

- Stockton - Darlington
  - Opened 1821
  - 12 miles Long
  - Chief Engineer
    - George Stephenson
  - Leader In Production
  - Locomotive (1825)
    - R.l.ton, 50 tons, 5 mph
  - Lancashire, W. (1825)
    - 7 tons, 50 tons, 8 mph
  - Passengers
    - Em. (1825)
    - Em. – 2d. Prov. (1825)

Manchester - Liverpool

- Major Traffic
  - Liverpool – Port (1829)
  - Manchester – Preston
- Railway
  - Liverpool, 1824
  - Manchester, 1830
- Reduced Time
  - 56. Hours, 3d. Tunnel
  - 5. Hours, Up, Rail
- First Railroad Bridge
- 21 Stationary Engines
  - Pulled Cable

Rainhill Competition (1829)

- 500 Pounds Plus Cost Of Engine
- Conditions
  - Pull 3 Times Weight, 10 mph, 15 miles
- Stephenson’s Rocket
  - 4.25 tons, Pulled 12.75 tons, Averaged 13.8 mph, Maximum 24.1 mph, Light Load 31 mph
- John Braithwaite’s Novelty
  - 7.7 tons, 13.8 mph, Broke Down
- Timothy Hackworth’s Sans Pareil
  - 4.77 tons, 16 mph, Broke Down
- Two Other Entries

Stephenson’s Rocket

- George & Robert
- Two Inclined Cylinders
  - 6” Bore, 12” Stroke
  - 50” Diameter Front Whe
- Fire Tube Boiler
  - 25 Copper Tubes
  - 3” Diameter
- Exhaust Steam Injected
  - At Base Of Smokestack
  - Advantage ?
Railways In France
- Lagged Considerably Behind Great Britain
- Mine Owners In France Pushed Development
- Saint-Etienne to Andrezieux (1828)
  - 9.5 miles
  - Horses, Carriages, & Cables
- Saint-Etienne to Lyon (1832)
  - United Loire & Rhone
  - Steam, Horses, & Cables
  - Included Tunnel (1st) & Two Bridges
  - 2 hours, 35 minutes (40 miles)

Marc Seguin
- First Builder Of Suspension Bridges
- Built Fire-Tube Boiler For Steam Boat
  - Hot Gases From Firebox
- Patent - 1828
- Copy Of Stephenson's

Marc Seguin
- Bought Engines From Stephenson & Copied Design
- Added Fan & Bellows
  - Increased Draft
  - Shorter Smokestack
  - 36 minutes To Build Up Pressure
- 4.5 tons
- Pulled 15 tons

Evolution Of Locomotive
- Rocket
  - Tubular Boiler, Separate Firebox, Direct Drive Without Gears, Better Steam Distribution
  - Vertical Cylinders Unstable At High Speeds
  - Horizontal cylinder Inside Boiler
  - Increased Number Of Tubes

Planet Locomotive
- Stephensons (1832)
- Built For Liverpool-Manchester Railroad
- 8 tons

Lancaster
- Matthias Baldwin (1834)
- Built For Charleston-Hamburg Railroad
- Front Swiveling Truck
Railroads In United States
- Started Same Time As In England & France
- United States Was Industrially Underdeveloped
  - 13,000,000 People, 5 Cities Greater Than 25,000
- Cost Per Mile
  - 1/4 Of European
  - 1/7 Of British
- Miles
  - 23 miles By 1830
  - 2818 miles By 1840
  - Erie Canal Opened In 1825

First Locomotive Built In US
- Peter Cooper (1830)
  - Built For Baltimore & Ohio Railroad

Best Friend
- 1830
- Built By Westpoint Foundry Association
- Built For South Carolina Railroad

Grasshopper
- 1834
- Built By Cullingham & Winans
- Built For Baltimore & Ohio Railroad