Lowell, Francis and America’s First Industry
Integrated Factory and Water Turbine

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Computers for NOTETAKING ONLY
Please - NO Cell Phones, Texting, Internet use
Independence, Iron, and Early Industry
1776 – 1855
Independence, Iron, and Early Industry
1776 – 1855

Engine
Independence, Iron, and Early Industry
1776 – 1855

Engine – Bridge
Independence, Iron, and Early Industry

1776 – 1855

Engine – Bridge – Boat
Independence, Iron, and Early Industry

1776 – 1855

1775 1800 1825 1850

- Watt
- Telford
- Fulton
- Shreve
- Lowell
- Francis
- City of Lowell

Engine – Bridge – Boat – Textiles
Textiles in America

Mechanization and Water Power

Planned Factory Town

Wealth and Education
Textiles in America

Mechanization and Water Power

Planned Factory Town

Wealth and Education
And this is good old Boston
The home of the bean and the cod,
Where the Lowells talk to the Cabots,
And the Cabots talk only to God
Francis Cabot Lowell
entrepreneur

Mathematical mind

Business acumen

Ideal for industry
Francis Cabot Lowell
entrepreneur

Mathematical mind

Business acumen

Ideal for industry
Francis Cabot Lowell
entrepreneur

Mathematical mind

Business acumen

Ideal for industry
Waltham to Lowell

Francis C. Lowell
entrepreneur and innovator

Paul Moody
engineer and manager
Waltham to Lowell

Francis C. Lowell
entrepreneur and innovator

Paul Moody
engineer and manager

The Integrated Factory
Bale to Bolt

Boston Associates - First corporation. Investors responsible up to investment amount – not personal fortune.
This indenture made this first day of November Eighteen Hundred & Thirteen, between the Boston Manufacturing Company on the one part & Paul Moody on the other, Witnesseth, that whereas said Company are about establishing the Manufacture of Linen, Woollen & Cotton Goods at their Mills in Waltham, & said Moody has agreed to superintend the same …
The Integrated Factory
Bale to Bolt
Pawtucket Falls

\[ H_p = \frac{\gamma \cdot Q \cdot H}{33,000} \]

Transforming Nature
FORMULAS: machines

\[ \gamma H \times Q \rightarrow H_p \]

water pressure flow power
Hp = \frac{Q \gamma H}{33,000}

Transforming Nature
FORMULAS: machines

\gamma H \times Q \rightarrow Hp

water pressure flow power
$$Hp = \frac{Q \gamma H}{33,000}$$

Transforming Nature
FORMULAS: machines

\[ \gamma H \times Q \rightarrow Hp \]

water  flow  power
pressure
Transforming Nature
FORMULAS: machines

\[ \gamma H \times Q \rightarrow Hp \]

water flow power
pressure
MERRIMACK

POWER LOOM

JEANS

No. Yds.

75 Young Women
From 15 to 35 Years of Age,
WANTED TO WORK IN THE
COTTON MILLS!
IN LOWELL AND CHICOPEE, MASS.

I am authorized by the Agents of said Mills to make the following proposition to persons suitable for their work, viz.—They will be paid $1.00 per week, and board, for the first month. It is presumed they will then be able to go to work at job prices. They will be considered as engaged for one year, cases of sickness excepted. I will pay the expenses of those who have not the means to pay for themselves, and the girls will pay it to the Company by their first labor. All that remain in the employ of the Company eighteen months will have the amount of their expenses to the Mills refunded to them. They will be properly cared for in sickness. It is hoped that none will go except those whose circumstances will admit of their staying at least one year. None but active and healthy girls will be engaged for this work as it would not be advisable for either the girls or the Company.

I shall be at the Howard Hotel, Burlington, on Monday, July 25th; at Farnham’s, St. Albans, Tuesday forenoon, 26th, at Keyes’s, Swanton, in the afternoon; at the Massachusetts’ House, Rouses Point, on Wednesday, the 27th, to engage girls,—such as would like a place in the Mills would do well to improve the present opportunity, as new hands will not be wanted late in the season. I shall start with my Company, for the Mills, on Friday morning, the 29th inst., from Rouses Point, at 6 o’clock. Such as do not have an opportunity to see me at the above places, can take the cars and go with me the same as though I had engaged them.

I will be responsible for the safety of all baggage that is marked in care of I. M. BOYNTON, and delivered to my charge.

I. M. BOYNTON,
Agent for Procuring Help for the Mills.
75 Young Women

From 15 to 35 Years of Age,

WANTED TO WORK IN THE

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I will be responsible for the safety of all baggage that is marked in care of J. M. BOYNTON, and delivered to my charge.

J. M. BOYNTON,
Agent for Procuring Help for the Mills.
Lowell- Factories and Cities

from FARM to FACTORY
from COUNTRY to CITY
from CRAFT to ENGINEERING
Lowell - Factories and Cities

from FARM to FACTORY
from COUNTRY to CITY
from CRAFT to ENGINEERING
LOWELL OFFERING
December, 1845.

A REPOSITORY
OF ORIGINAL ARTICLES, WRITTEN BY
"FACTORY GIRLS."

LOWELL: MISSSES CURTIS & FARLEY.
BOSTON: JORDAN & WILLY, 121
Washington street.
1845.
James B. Francis
engineer

Efficient Water Motor

“Water Policeman” – the Weir

Canal Walk and Lock Gate
James B. Francis
engineer

Efficient Water Motor

“Water Policeman” – the Weir

Canal Walk and Lock Gate
James B. Francis
engineer
Efficient Water Motor
“Water Policeman” – the Weir
Canal Walk and Lock Gate

VIDEO
James B. Francis
engineer

Efficient Water Motor
“Water Policeman” – the Weir
Canal Walk and Lock Gate
\[ Q = 3.33 \left( L - 0.1n h \right) h^{3/2} \]
\[ Q = 3.33 \left( L - 0.1n h \right) h^{\frac{3}{2}} \]

**Economics vs. Politics**

**WATER TURBINE**

\[ \gamma H \times Q \rightarrow Hp \]

- free resource
- contested supply
- power for profit
\[ Q = 3.33 \left( L - 0.1 n h \right) h^{\frac{3}{2}} \]

\[ H_p = \frac{Q \gamma H}{33,000} \]
\[ Hp = \frac{Q \cdot \gamma \cdot H}{33,000} \]
\[ Hp = \frac{Q \gamma H}{33,000} \]
\[ Hp = \frac{Q \gamma H}{33,000} \]
WEIR

POWER IN

\[
Hp = \frac{\Omega \gamma H}{33,000}
\]

POWER OUT

\[
Hp = \frac{TV}{33,000}
\]
Wheel slides against tight drum. Friction causes it to heat up.

Slide hands back and forth while pressing them together. Palms get hot.
Wheel slides against tight drum. Friction causes it to heat up.

Slide hands back and forth while pressing them together. Palms get hot.

$T$ is force needed to keep wheel sliding at speed $V$.

$Hp$ is power dumped into drum causing it to get hot.

$$Hp = \frac{TV}{33,000}$$
Wheel slides against tight drum. Friction causes it to heat up.

Slide hands back and forth while pressing them together. Palms get hot.

**DEMONSTRATION**

T is force needed to keep wheel sliding at speed V.

Hp is power dumped into drum causing it to get hot.

\[
Hp = \frac{TV}{33,000}
\]
James B. Francis
engineer

Efficient Water Motor
“Water Policeman” – the Weir
Canal Walk and Lock Gate

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James B. Francis
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Efficient Water Motor
“Water Policeman” – the Weir
Canal Walk and Lock Gate
Lowell - Engineering Works

- **Structures:** the river dam
- **Machines:** the water turbine
- **Networks:** interconnected power canals
- **Processes:** cloth making
Lowell - Engineering Works

structures: the river dam
machines: the water turbine
networks: interconnected power canals
processes: cloth making
Pawtucket Dam

Lowell - Engineering Works

structures: the river dam
machines: the water turbine
networks: interconnected power canals
processes: cloth making
Pawtucket Dam

Hoover Dam
1 of 19 Francis Turbines and Generators

Hoover Dam
The Lowell Family

Percival Lowell
  – Harvard Astronomer

Abbott Lawrence Lowell
  – Harvard President

James Russell Lowell
  – Harvard Prof and Poet

Amy Lowell
  – Poet

Robert Lowell
  – Poet

Massachusetts Institute of Technology
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Amy Lowell
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Robert Lowell
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Robert Lowell
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Key Ideas

Mechanization and Water Power
Planned Factory Town
Wealth and Education