Learning Objectives

- Examine very different approaches to forecasting technological change
- Achieve understanding of amount of technological change forecasting that is done
- Achieve understanding of importance of use perspective (and time horizon of interest) on method chosen for technological change forecasting
- Appreciate the multi-dimensional nature of practical technological change forecasting
- Examine technological determinism, construction (social determinism), economic determinism and other approaches

Technological Forecasting Outputs

- Prediction of amount of ***future use of a particular embodiment*** of technology or abstraction of class of embodiments
- Prediction of ***future*** industry ***revenues*** associated with a particular technology
- Prediction of ***substitution*** timing or what is disappearing
- Prediction of a ***technical performance metric*** at a future time
- Prediction of ***social, economic and human change in the future due to technological change***

Technological Forecasting Methods

- Quantitative, mathematical projection methods
  - Extrapolation of fits of past data
  - Models from evolutionary algorithms and "Science of Invention" studies (Altshuller et. al.)
- Qualitative methods such as story telling or scenario building
- Market forecasts (future profit value is "predicted" by investment, IPO and patent values at present time)
- Cooperative consensus projections
  - Delphi studies (blind)
  - Convened committees plus review (OTA, NRC, etc.)
- Organizational Hierarchy (and consensus) decision processes

Classes of people interested (at least implicitly) in technological forecasting (?)

- People ***deciding about investing*** in product development, manufacturing, marketing, hiring, etc. (Business)
- People ***deciding about investments in infrastructure*** (Finance)
- People ***deciding about buying*** a product or service (Consumers)
- People ***deciding about societal allocation*** (Government)
- People ***designing cities and infrastructures*** (planners)
- People ***deciding among educational alternatives***, course selection -and teaching alternatives including department startups and course offerings, etc. (students and educators)
- People ***deciding about war-fighting strategies*** (defense)
- Lots and lots of other ***people (everyone*** in the technologically developed world?) How might method choice differ?

Technological Forecasting Outputs II

- Prediction of amount of ***future use of a particular embodiment*** of technology or abstraction of class of embodiments
- Prediction of ***future*** industry ***revenues*** associated with a particular technology
- Prediction of ***substitution*** timing
- Prediction of a ***technical performance metric*** at a future time
- Prediction of ***social, economic and human change*** in the future due to technological change

- ***Issue: Uncertainty and belief in unpredictability of technology***

Technological Forecasting Methods II

- Quantitative Trends are more reliable when:
  - data covered are **Long term** vs. short term

Consecutive maximum cruising speed of U.S. commercial aircraft.

Graph removed for copyright reasons.
Source: Figure 2-2 in Girifalco, L. A. *Dynamics of Technological Change*. New York, NY: Chapman & Hall, 1991, p. 58. ISBN: 0442005636.

Successive maximum tractor fuel efficiencies.

Graph removed for copyright reasons.
Source: Figure 2-7 in Girifalco, L. A. *Dynamics of Technological Change*. New York, NY: Chapman & Hall, 1991, p. 70. ISBN: 0442005636.

Passenger miles per hour of commercial aircraft (consecutive maximum values).

Graph removed for copyright reasons.
Source: Figure 2-3 in Girifalco, L. A. *Dynamics of Technological Change*. New York, NY: Chapman & Hall, 1991, p. 59. ISBN: 0442005636.

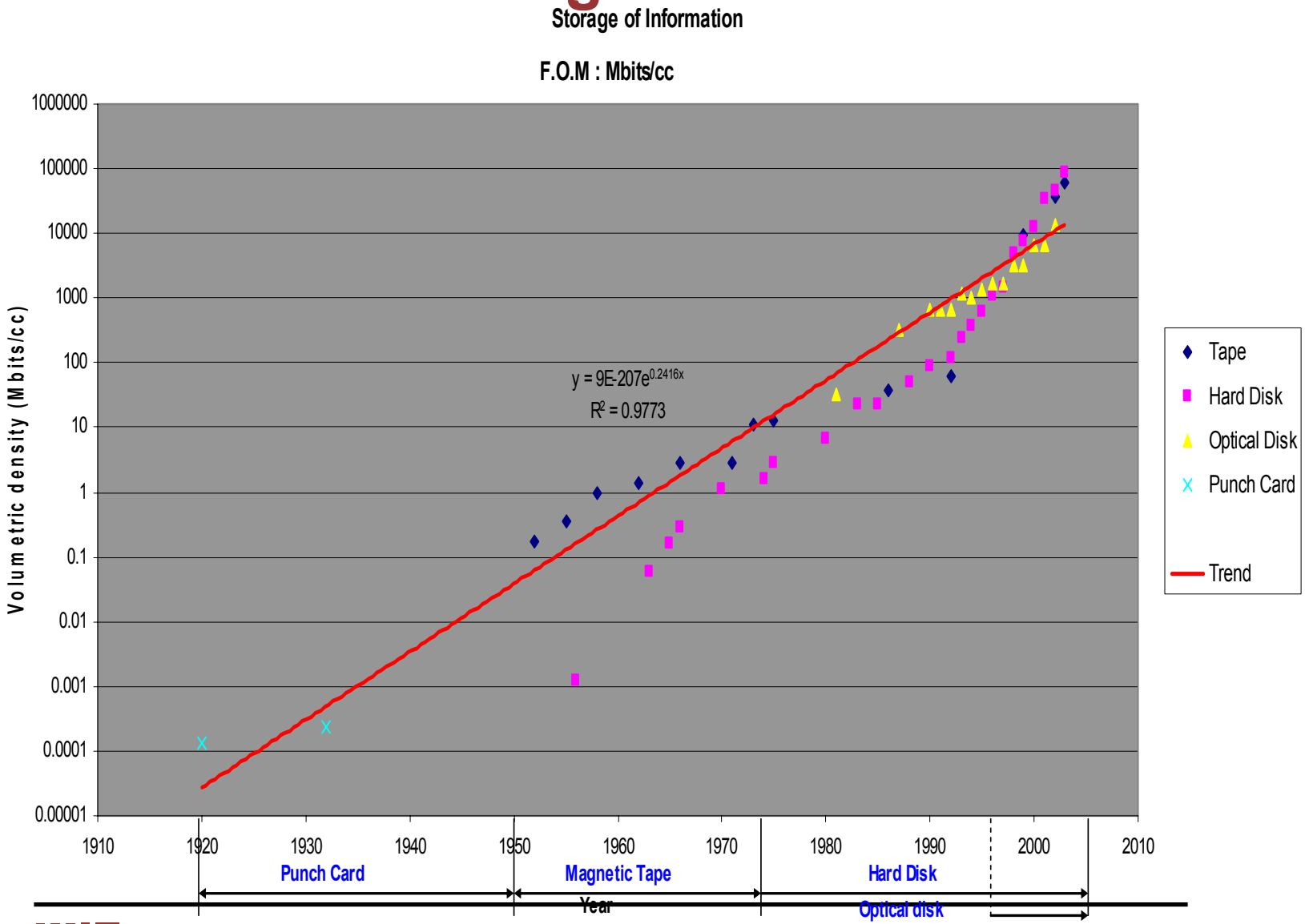
Technological Forecasting Methods IIa

- Quantitative Trends are more reliable when:
  - data covered are **Long term** vs. short term
  - Focus is on General **Function** vs specific embodiment
- Long-term functional trends are more regular (continuing rise vs. "S" curve usually thought about)
- Variability is real but less significant in long-term trends.

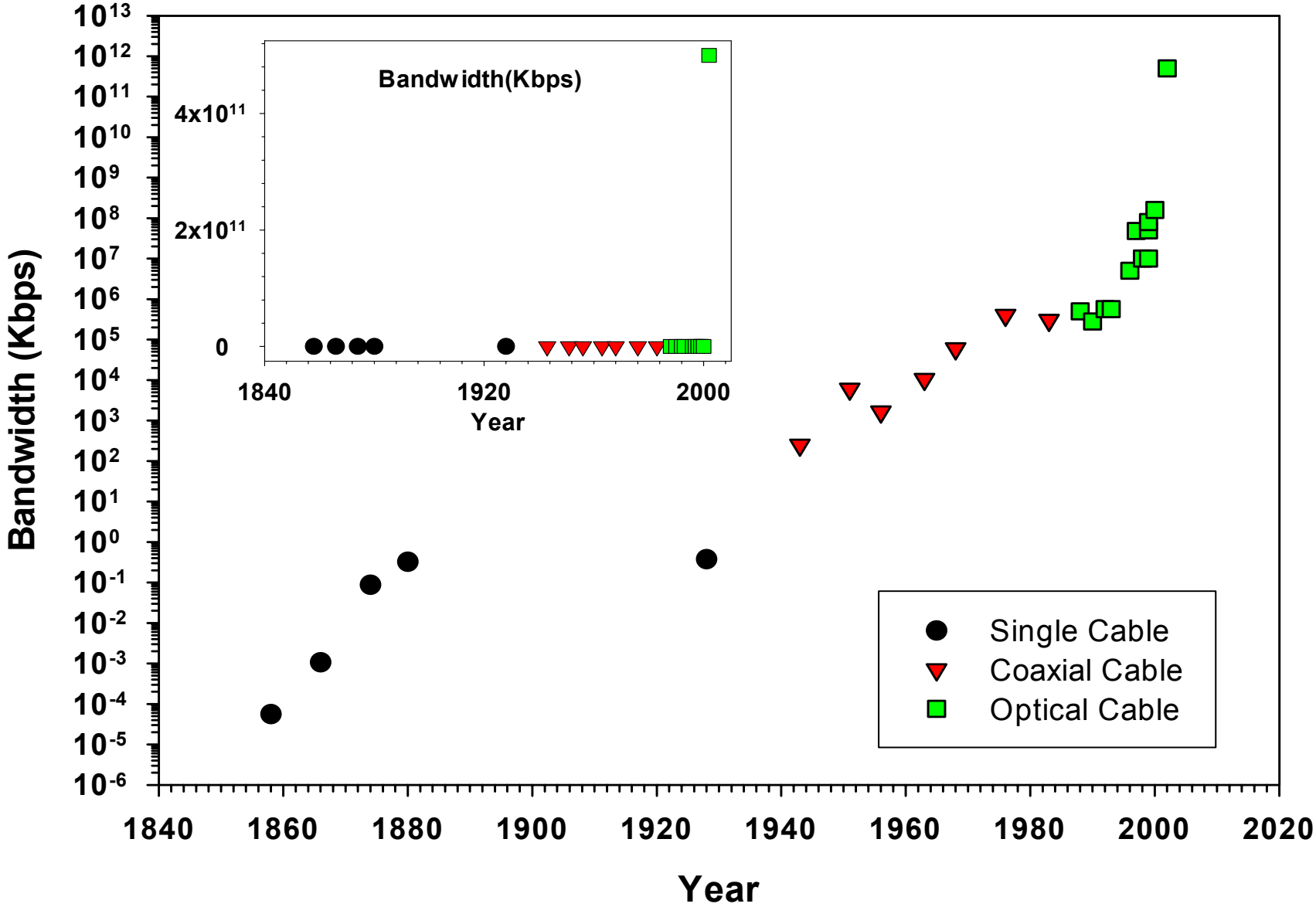
Functional Classification Matrix

Process/Operand	Matter(M)	Energy(E)	Information (I)	Value(V)
Transform or Process (1)	**GE Polycarbonate Manufacturing Plant**	**Pilgrim Nuclear Power Plant**	**Intel Pentium V**	**N/A**
Transport or Distribute (2)	**FedEx Package Delivery**	**US Power Grid System**	**AT&T Telecommunication Network**	**Intl Banking System**
Store or House (3)	**Three Gorge Dam**	**Three Gorge Dam**	**Boston Public Library (T)**	**Banking Systems**
Exchange or Trade (4)	**eBay Trading System (T)**	**Energy Markets**	**Reuters News Agency (T)**	**NASDAQ Trading System (T)**
Control or Regulate (5)	**Health Care System of France**	**Atomic Energy Commission**	**International Standards Organization**	**US Federal Reserve (T)**

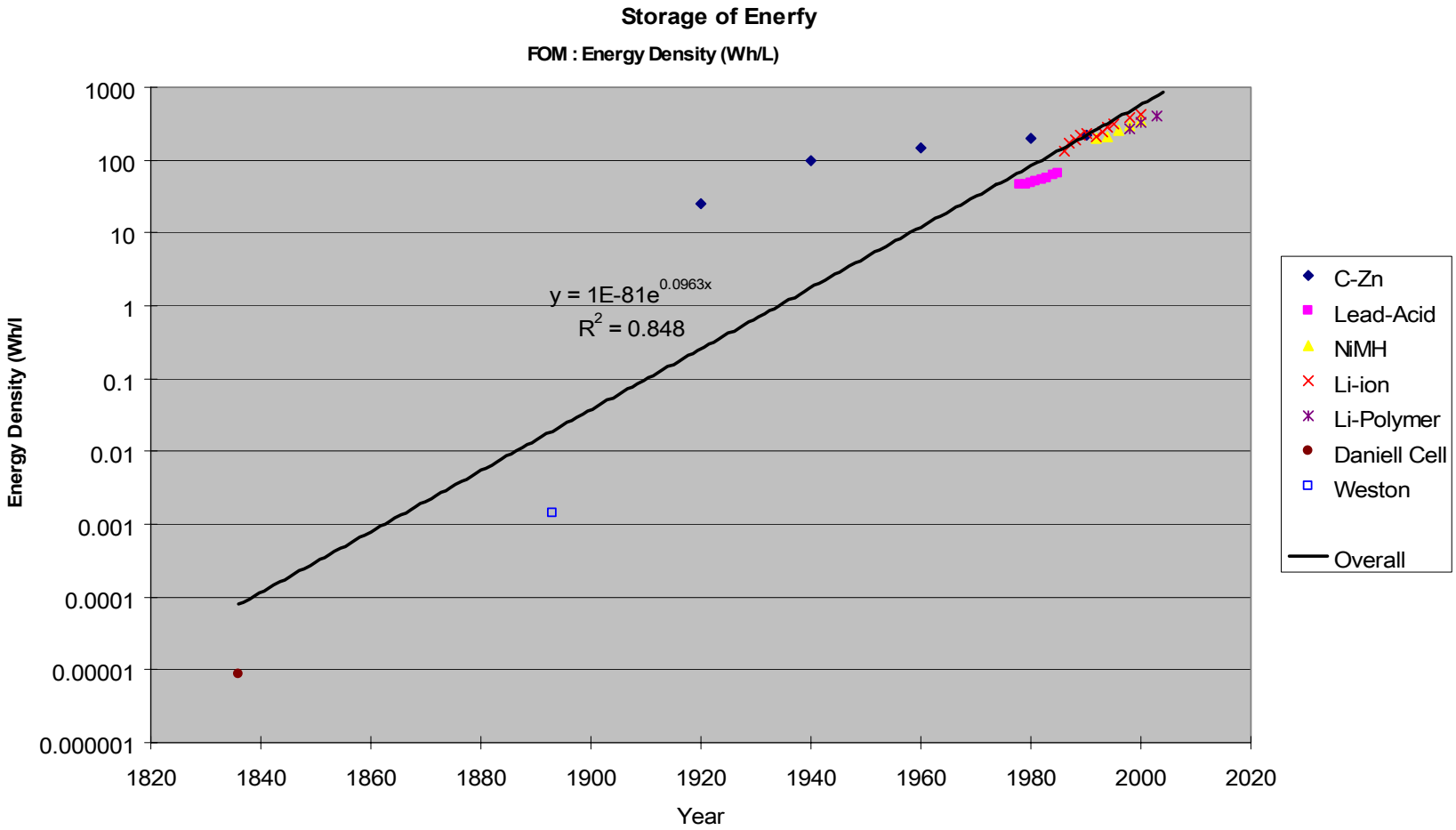
Information Storage



Information Transport



Energy Storage



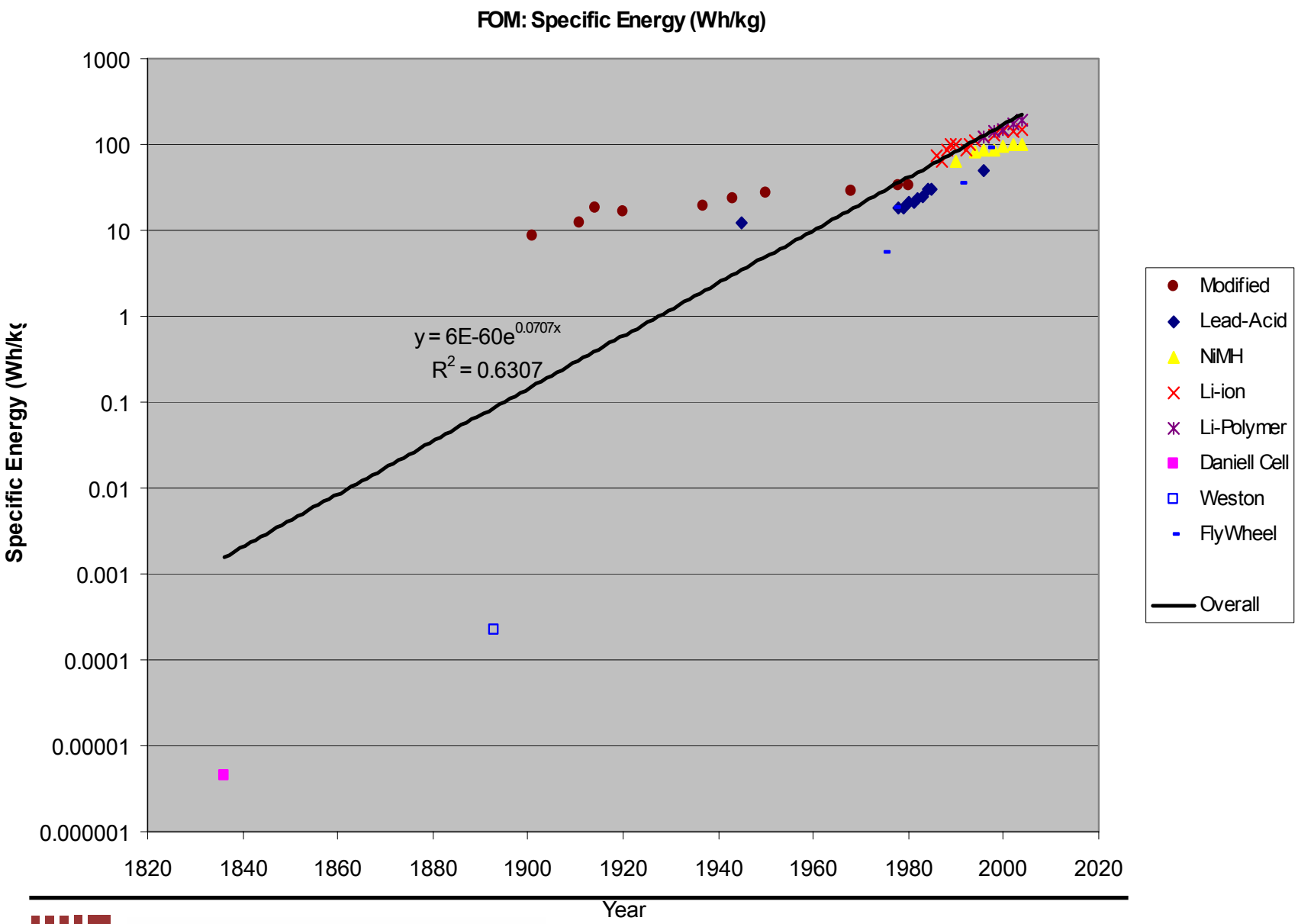
Decision about whether to pursue electrical-mechanical hybrids; Ford Motor Company ~1993/5

- When did Ford (and Toyota) ***first produce*** a modern computer controlled electrical-mechanical hybrid ***for sale***?
- 2004 (1998)
- When did research on automotive electrical-mechanical hybrids start?
- 1915 first production versions
- When did Ford (and Toyota) ***first have a*** modern (computer controlled) working electric –mechanical hybrid ***prototype***?
- 1984 (1988)
- What are factors in the x2 difference in speed?
- What role did for forecasting play?

Electrical-mechanical hybrids; ~1993/5, Forecasting (technological and social); for each area discuss Ford and Toyota

- As implemented (Future) Benefit of Hybrid Technology
- Future (at time of implementation) Cost of Fuel
- Future Cost of Hybrid System (variable and investments)
- Future Desirability of Tradeoff to U.S. Consumers
- Probable Profit/Loss from Program
- Value of "Technological Capital" (Know-how) from program
- Alternative (Pure EV) Technical path value
  - Technical Capital
  - Political and Social Capital

Energy Storage



Technological and other Determinisms

- What does the case suggest about the often derogatory accusations about some that construction or economics or technology or genetics is the overall determinant of social change?
- What does the case suggest about relative care in looking at future social, economic and technological trends or scenarios?
- What might make sense in general for making long-term choices?

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Horsepower to engine weight ratio of reciprocating aircraft engines.

Graph removed for copyright reasons.
Source: Figure 2-1 in Girifalco, L. A. *Dynamics of Technological Change*. New York, NY: Chapman & Hall, 1991, p. 56. ISBN: 0442005636.

Mechanical efficiency of tractors.

Graph removed for copyright reasons.
Source: Figure 2-8 in Girifalco, L. A. *Dynamics of Technological Change*. New York, NY: Chapman & Hall, 1991, p. 71. ISBN: 0442005636.