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Practical Technology Forecasting

Introduction

- Society long ago learned the value of anticipating the character, intensity, and timing of major environmental forces on social and economic activities (e.g., weather).
- Today, one of the most powerful forces in our environment – and at times by far the most important for many firms, institutions, nations, and society at large – is technology.

Introduction (cont'd)

- Technology's growing impact stems from the following factors:
 - **The degree of advance** in the technical capability of many devices and materials over their predecessors often is in multiples of improvement – not just a few percentage points.
 - **The rapidity of introduction of technical successors** seems to be increasing in many fields.
 - **The size of resources required** often is so great that the R&D funding capacity of individual firms and even an entire industry is exhausted.
 - **Technology as a national resource** has long been recognized in technical circles.
 - **Technology assessment** has resulted from concern over the negative effects of technology on the environment and society.

Why Technology Forecasting is Necessary

- Governments and firms have been making plans for at least several hundred years without much explicit technology forecasting. What can't society get along as it has in the past?
- The implications of not forecasting.
 - Stable industries can be suddenly inundated with new technology in the products, processes, materials, competition, or distribution systems.
 - The belief that anything of technical significance can be recognized and dealt with after it has materialized and been proven may leave the firm in a very serious situation, having committed itself to products, processes, capital expenditures, and even personnel which may no longer be needed.

What is Technology Forecasting?

- There are many statements and claims about prior forecasts of technology, but these are not what we are calling Technology Forecasting.
 - Science fiction
 - Biblical prophecies
 - Scientific reports
 - After dinner speeches
 - Journalistic articles
 - Philosophical essays
 - Novels about future technological capabilities and their impact on society

What is Technology Forecasting? (cont'd)

- Some common usage of the term “forecasting” can cause confusion, so we give the following definitions for use in this text.
 - **Forecast** – a statement about a condition in the future that is arrived at through the use of a system of reasoning consciously applied by the forecaster and exposed to the recipient.
 - **Prediction** – a statement about the futures based on rationale, if any, that the predictor has not made known.
 - **Speculation** – a statement about the future in which the predictor admits high uncertainty and/or admits lack of supportive rationale.
 - **Prophecy** – a prediction under divine inspiration or supernatural influence.
 - **Propaganda** – statement about the future designed and offered specifically to gain support for the advocate’s position, goals, or concerns.

What is Technology Forecasting? (cont'd)

- **Technology Forecasting** is a quantified prediction of the timing and of the character or the degree of change of technical parameters and attributes associated with the design, production, and use of devices, materials, and processes, according to a specified system of reasoning.

Some of the Methods of Technology Forecasting

- **History as an aid to forecasting**
 - Forecasting can be improved if the process through which technology emerges into social use is critically examined.
 - By studying the sources of technical concepts and those factors that support or inhibit their progress as they develop and diffuse throughout society, forecasters will have a better idea of what to measure, estimate, or consider.
- **Expert opinion and its difficulties**
 - Experts in current technologies may base their predictions on the past rather than the future
 - Read a few of the errors in past predictions

Some of the Methods of Technology Forecasting (cont'd)

■ Intuitive forecasting

- Expert opinion is not a very satisfactory form of prediction, but a committee of experts might give a better result.
- One approach to such a committee process is the Delphi Technique.
- Another is the dialectical approach (Hegel) in which a prediction is made and then an opposite or counter-prediction is formulated; both predictions are then exposed to critical analysis.

Some of the Methods of Technology Forecasting (cont'd)

- **Trend extrapolation**

- Trend extrapolation rests on the assumption that technical attributes generally advance in a relatively orderly manner over time, exhibiting patterns of behavior that form fairly well-behaved trends.
 - Three types of trend functions are the **Exponential Growth Curve**, the **S-Curve**, and the **Fisher-Pry Model**.

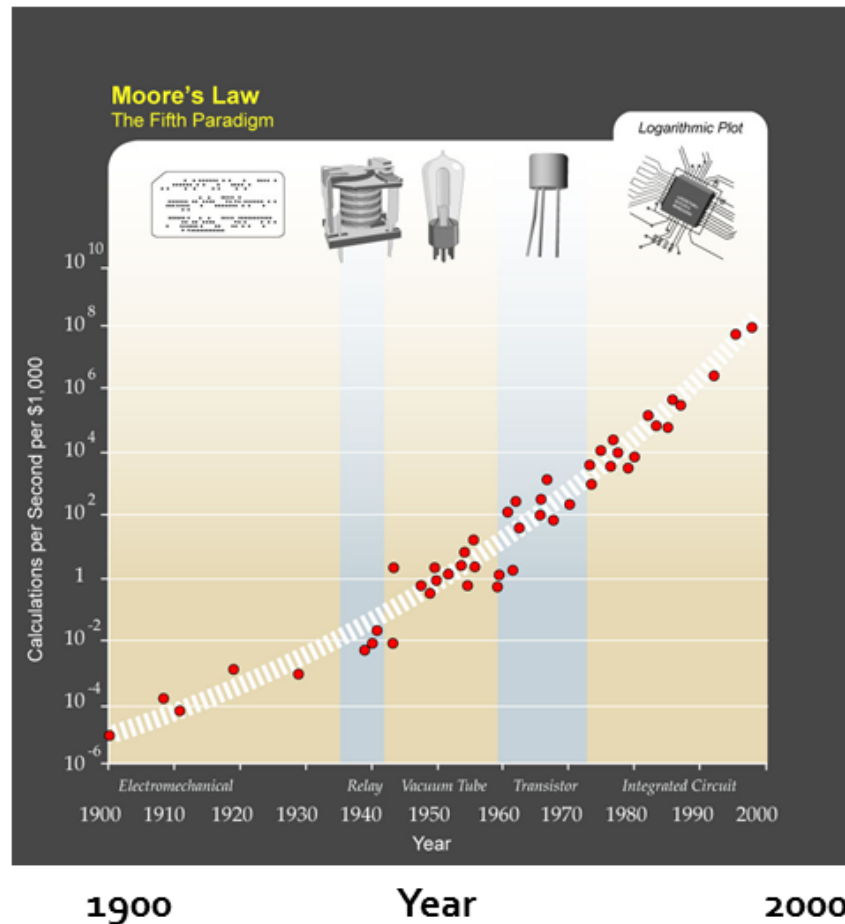
- **Pros and cons of trend extrapolation**

- Simplistic curve fitting is naïve and therefore invalid or useless. Naïve or not, the facts are that many, if not most, technological trends have been quite orderly and trend extrapolation has been useful.
- Extending trend lines for several decades or even centuries leads to ridiculous conclusions. True enough, so do not do this; trend extrapolation loses validity over time.
- There is no proof that past forces will continue to support the trend, so extrapolations are intellectually and philosophically unacceptable. On the contrary, the past trend is historical fact and resulted from a complex interaction of forces; it is up to the critic to demonstrate what forces will change to affect the historic rate of change and by how much.

Example of Trend Extrapolation

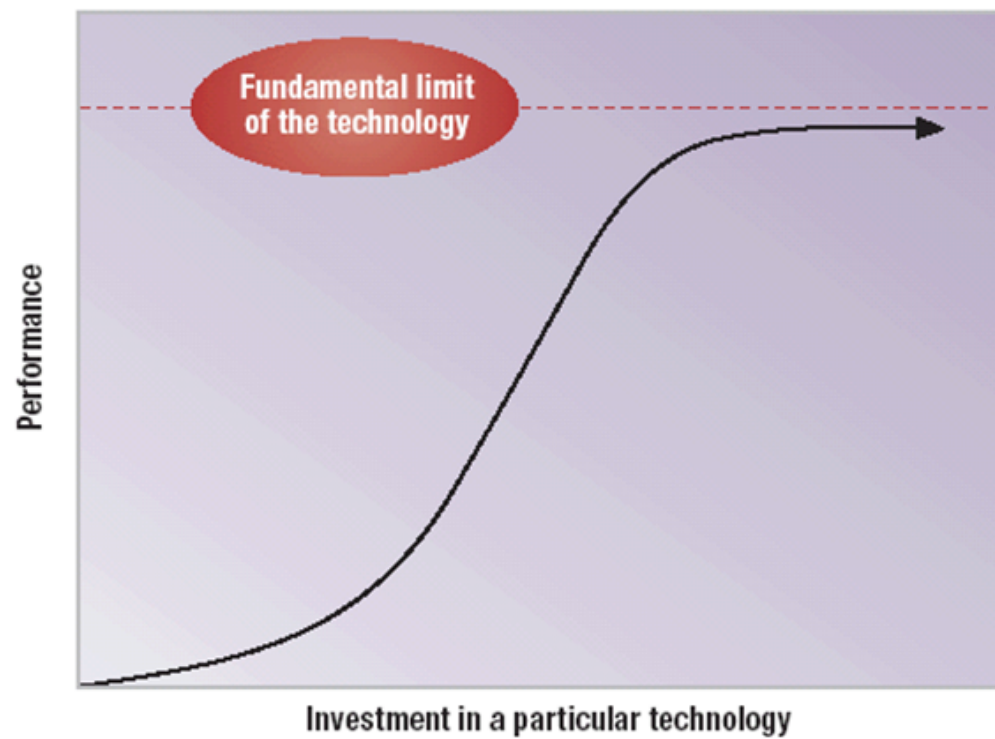
Moore's Law

Calculations
per second
per \$1,000



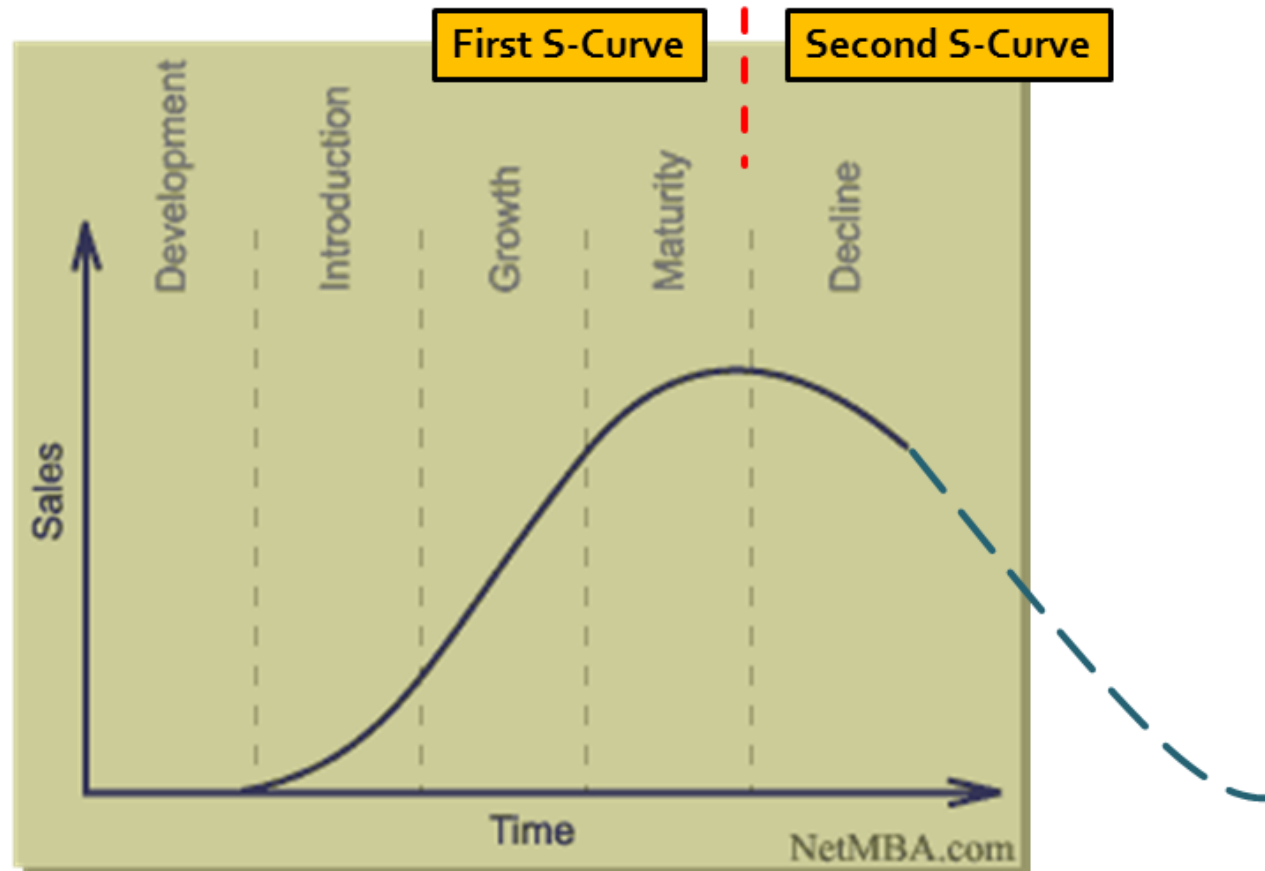
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The S-Curve



Product Life Cycle

Two S-Curves

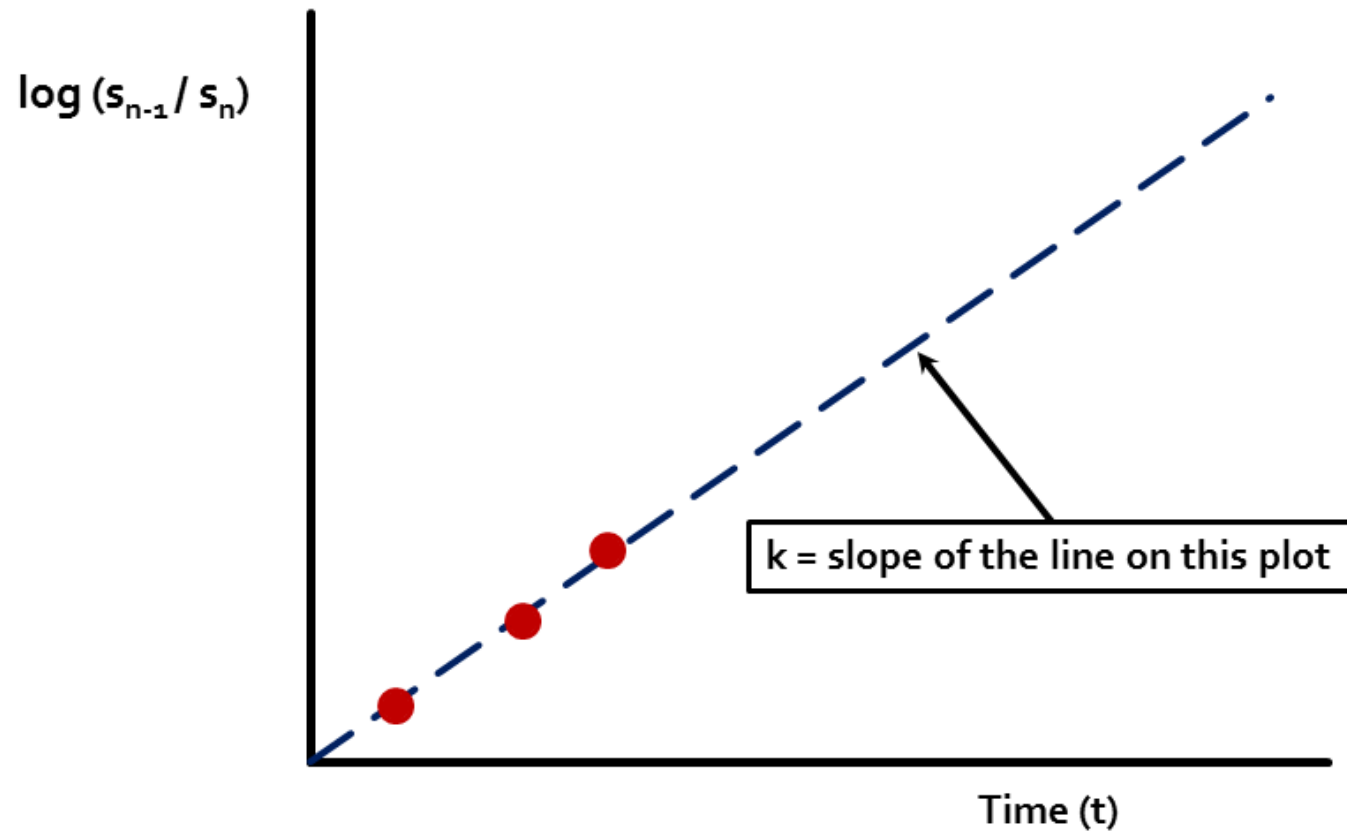


Some of the Methods of Technology Forecasting (cont'd)

- Substitution Theory (Fisher-Pry)
 - Predicts whether an innovation will grow (via the S-Curve) to “completely” replace a current technology.
 - The Fisher-Pry equation is $\log(s_{n-1}/s_n) = kt$, where s_{n-1} is the market share of the old technology, and s_n is the market share of the new technology, k is a parameter, and t is time. Fisher-Pry is a single-parameter model.

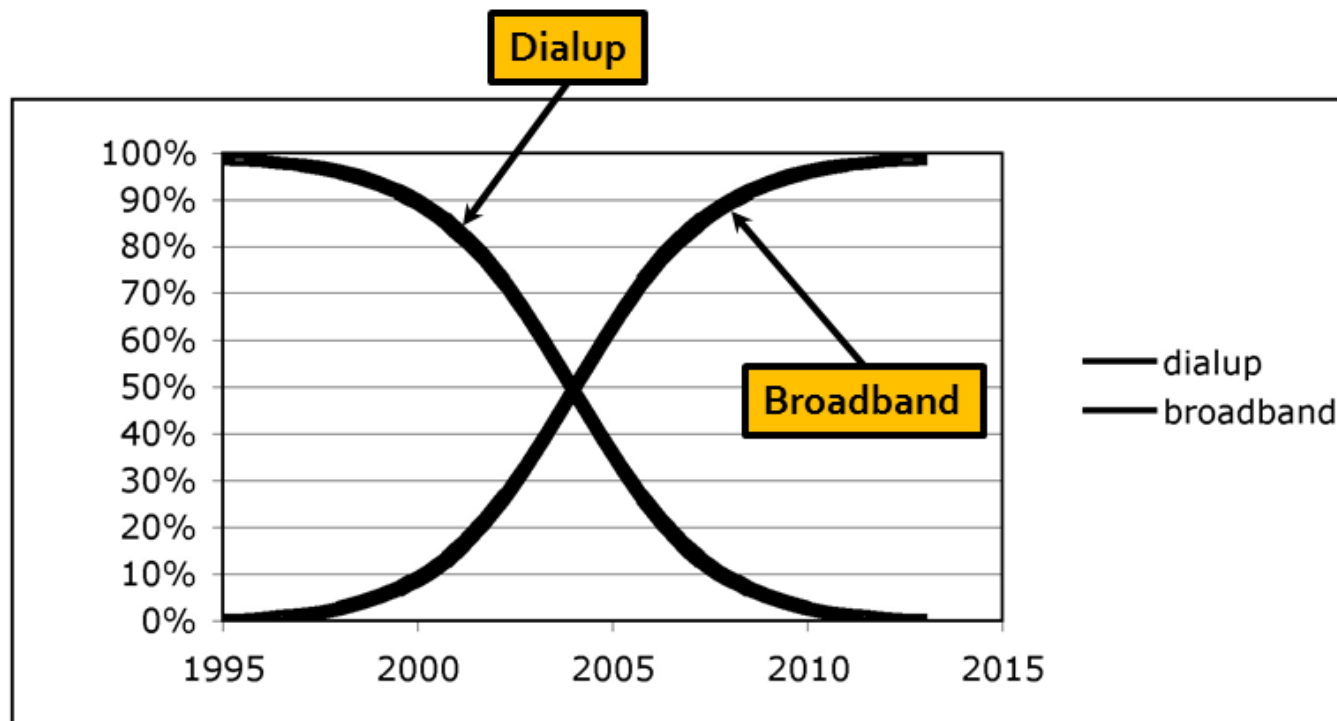
Fisher-Pry Model

Example of a Fisher-Pry Plot



Example of a Fisher-Pry Forecast

S-Curves created from Fisher-Pry Plots



Forecast based on the Fisher-Pry Model

Some of the Methods of Technology Forecasting (cont'd)

■ Scenarios

- A scenario is like a story of the future.
- Strictly speaking, scenarios are not forecasts. In essence, the planner concedes that the “real” future cannot be predicted, so the planner looks at several possible futures with the idea of being prepared for several eventuality.
 - Often, probabilities are assigned to each scenario.
- Scenarios incorporate more complexity than can be obtained from extrapolation of one parameter.
- Many times, scenarios provide the only way to develop a business plan.

Some of the Methods of Technology Forecasting (cont'd)

- **Forecasting by Monitoring**
- Since new technology emerges from idea to physical reality and then is applied and adopted at some gradual rate rather than instantaneously, it follows that it might be useful to monitor this progress so as to react wisely at some future time.
 - The next slide shows the Stages of Technical Progress, which are monitored to determine whether a technology appears to be making a successful emergence into the market.

Stages of Technical Progress

- It can be generally stated what stages are undertaken in the emergence of a new technology.
 - By knowing these stages, the rate of progress of its emergence can be determined.
- The stages are:
 1. Origin
 2. Proposal of concept
 3. Verification
 4. Laboratory demonstration
 5. Field trial
 6. Commercial introduction
 7. Widespread adoption
 8. Proliferation