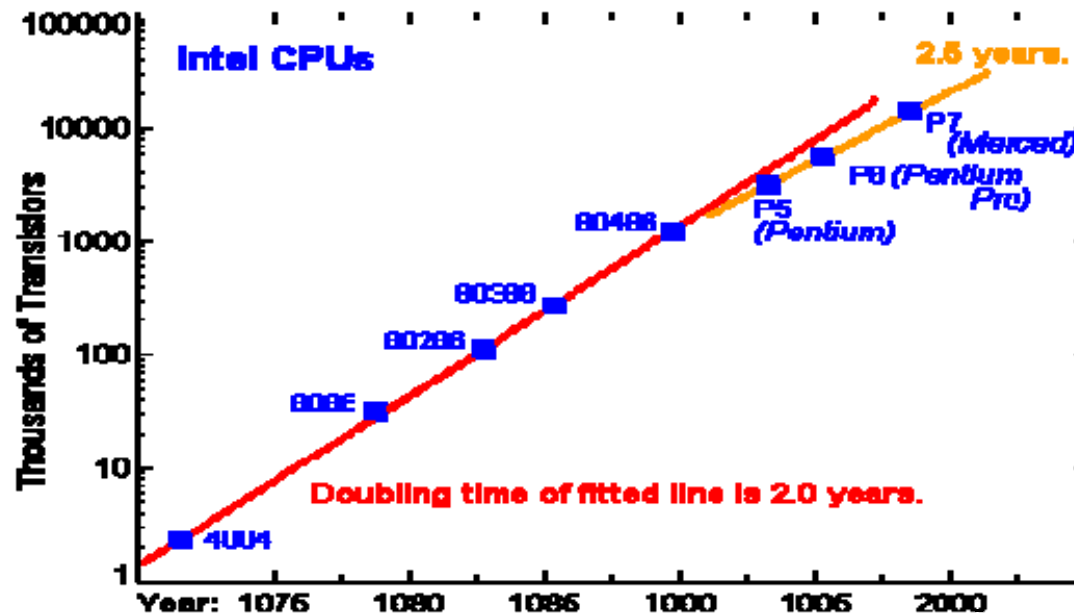


R&D Strategy and Forecasting

R&D Strategy in Companies



<http://www.physics.udel.edu/~watson/scen103/intel-new.gif>

Karel Mulder

January 7, 2010

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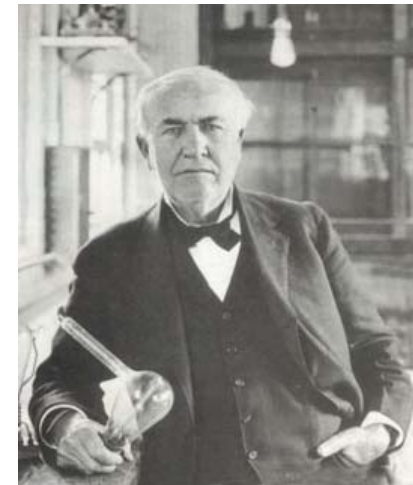
R&D Strategy in Companies

Development

Before 1880: no large industrial corporations
e.g Thomas Edison, General Electric, Langmuir

1910-1930: Science based Industry
e.g Du Pont, ICI, IG Farben, Philips, Rhone Poulenc, Car industry

Merging science and technology: Academic scientists entered industry
e.g Academics in US industry:
8000 in 1920, 17000 in 1927, 42000 in 1938



www.nndb.com

R&D Strategy in Companies

Charles M.A. Stine, 1936

Fundamental research assists one to **predict** the course of development of chemical **industry**.

Pioneering **applied research** enables one to achieve certain **objectives** indicated by fundamental research.

Therefore, the **continued growth** (as distinct from mere expansion) of chemical industry **is dependent upon fundamental research**.

That is the basic philosophy of fundamental research.'



<http://heritage.dupont.com>

R&D Strategy in Companies

Examples

Du Pont
Nylon History
Carothers



R&D Strategy in Companies

Development

First Generation: distinct from corporation

(‘Bright scientists always come up with something new, don’t disturb them’)

Second Generation: R&D Marketing Interface

(For R&D, making Lead from Gold is just as challenging as Gold from Lead, for us only the second conversion is of interest”

Third Generation: R&D integrated in Corporate Strategy

(How to implement real technological change?)

R&D Strategy in Companies

Possibilities

Forecasting:

Future studies (Energy, transport)

Scenario analysis

Portfolio analysis (Cf. the demise of Fokker Aircraft)

R&D Strategy in Companies

Issues

Follower or Leader?

Industry or University?

Make or buy?

Cooperation or not?

Publish or not?

Patent or not?

Centralized or Decentralized?

Business or Corporate organization?

Functional or Disciplinary organization?

Forecasting

Why explore options?

Technocracy?

Improves quality of debating?

Alternatives?

Dilemma of control:

the earlier a debate takes place, the more options there are to control and steer things → entrenchment

Forecasting

Fundamental Problems

Fundamental problem: non-linearities

Problem of Induction

Historic empiric correlations are insufficient if there is no clear causal relationship

Forecasting

Who is the first to buy a telephone?

Some products become more attractive as others buy similar products: especially high-tech products: (computer, fax, phone, car, video)



http://www.falmouthcomputers.co.uk/custom/dfp_500telephone.jpg

Forecasting

Moving on from Forecasting to Foresight: but how?

Monitoring, trend watching

Historical methods

Extrapolation

Analogies

Modeling

'Expert' methods: interviews, Delphi

Experiments

Foresight Methods

Monitoring

Study of:

Professional journals

Patents/patent trends

Searches

Websearches

Meetings

Annual reports/media

Foresight Methods

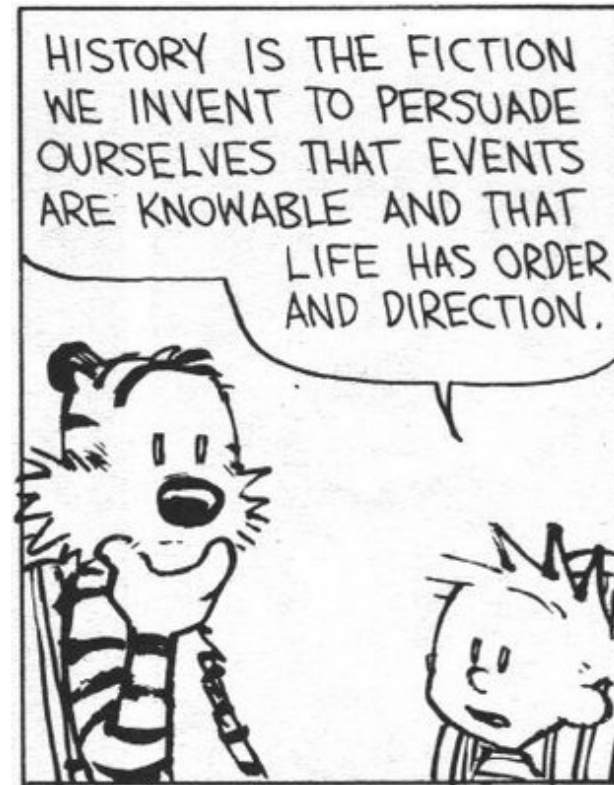
Historic Methods

Presupposition: historic parallels

Historic analogy

Diffusion curves

S-curves



<http://i14.photobucket.com/albums/a321/Mattpmx/CalvinHobbesHistory.jpg>

Foresight Methods

Extrapolations

Based on hypotheses such as

- Linear growth

- S-curve

- Envelope curve

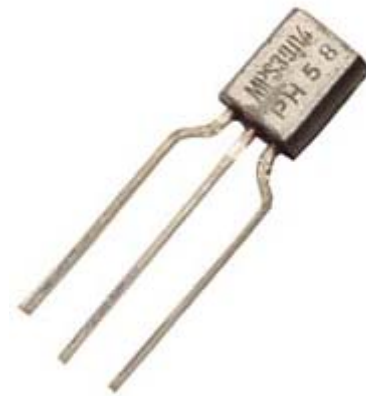
- Fisher-Prey, Gompertz diffusion models

Extrapolations

Moore's Law

Trend describing that the number of transistors that can be placed on an integrated circuit is increasing exponentially, and doubles approximately every two years

The trend was first observed in 1965 paper. It has continued for more than half a century and is not expected to stop for at least the next decade



<http://www.opamp-electronics.com>

Foresight Methods

Expert Methods and Bias

Expert methods:

If there are no reference points for extrapolation



Hydrogen as aircraft fuel?

Foresight Methods

Expert Methods and Bias

Positive bias towards technology in general
e.g in IEEE research

Positive bias in area of own expertise
e.g in nuclear fusion, self-selection

Foresight Methods

Expert Methods and Bias

Social structure within disciplines prevents open communication:

Dependencies

Interests/benefits

Biases

Delphi method



Foresight Methods

Delphi Method

Delphi:

Survey among experts in several rounds

Anonymous feed back of arguments & estimates

Revision of judgments

Consensus in 3-4 rounds



Wikipedia: Pythia1.jpg

Foresight Methods

Delphi Method

Used since 1959

Good results,

Not just forecasting: it is also intervention in a discipline

But, criticism:

- Group bias remains

- Strategic behavior by mutual contact

- Only for experts within a discipline

Delphi Method

Examples

External propulsion of vehicles

50 experts (global, 50% return, variatie)

14 technologies

4 technologies were promising

Many experts changed their view during Delphi process

Delphi Method

Examples

Misjudgment of:

Speed of Technological change

(1950s, flying cars)

Expert assessment of technologies

(1970s regarding synthetics to be superior)

Citizens judgments

(nuclear power)

Public policy

(glass recycling)



<http://www.svm-pact.nl>

Scenarios

Forecasting

To paint the various possible and consistent futures in a complex situation

not: emergency scenarios

but: credible stories that stimulate the creativeness of people in thinking of future threats and opportunities

Robust options

Cheap precautions

Scenarios

Pierre Wack

During **stable times**, the mental **model** of a **successful decision maker** and **unfolding reality match**.

In times of **rapid change** and **increased complexity**, however, the manager's mental model becomes a **dangerously mixed bag**: rich **detail** and **understanding** can coexist with **dubious assumptions** and **illusory projections**. (Wack, 1985)



<http://www.gbn.com/images>

Scenarios

Ingredients

Technology

Economics

Demography

Culture

Regulation

Environment

Competition

Scenarios

Scenario Results: Stimulating creative discussion

In all scenario's, the corporation meets its goals.

In all scenario's, the corporation does not meet its goals.

In a surprise free scenario, the corporation meets its goal, but not in other scenarios.

In a surprise free scenario the corporation does not meet its goals, in alternative scenarios, it does.

Scenarios – Example

The Panama canal

Between the Atlantic and Pacific Oceans
Approximately 80 kilometers long.

Maximum dimensions of ships:

32.3 meters in beam;

12 meters in draft in tropical fresh water;

294.1 meters long

Narrowest portion, 13.7 kilometers long, is carved through the rock and shale of the Continental Divide.



<http://lostparadise.com/maps>

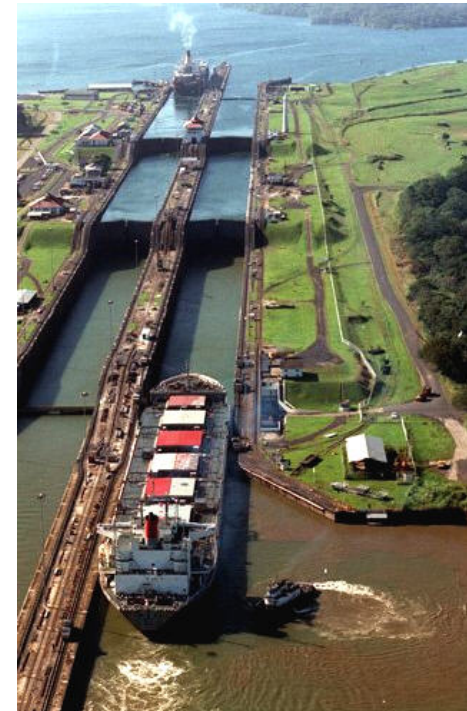
Scenarios – Example

The Panama canal

13 to 14 thousand vessels every year: 5% of the world trade.

Work force of approximately 9000 employees, 365 days a year,

Providing transit service to vessels of all nations without discrimination.



<http://www.photoatlas.com>

Scenarios – Example

The Panama canal

\$1-billion to modernize and improve.

Meet traffic demands and provide quality transit services.

Investment of over \$100 million annually.

\$700 million to be implemented by the Panama Canal Authority.

U.S. Army Corps of Engineers review Canal's physical plan.

Improvements to ensure the waterway remains viable and competitive



<http://www.photoatlas.com>

Scenarios – Example

The Panama canal

How to forecast future shipping
(quantity and size)?

What are main variables for your estimate?



<http://www.photoatlas.com>