Leadership and the art of predicting the future of healthcare

Rob Moss

Stefan N. Groesser

The Future of Healthcare

Forecasting: methodology, educated guess or science fiction?

Disclosure of interest

• Nothing to declare

Control Questions

Future health expenditure can be forcasted by linear extrapolation of past expenditure using relevant parameters

• YES/NO

Causal simulation models have been developed for describing past behavior and point-prediction of future events

• YES/NO

The purpose of system dynamics simulation modelling is mostly on explaining and thereby understanding past behavior. Scenario-based analysis of likely future patterns can only then be successfully implemented

• YES/NO

The future

2000

Class 1971

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Reality

1971

2017

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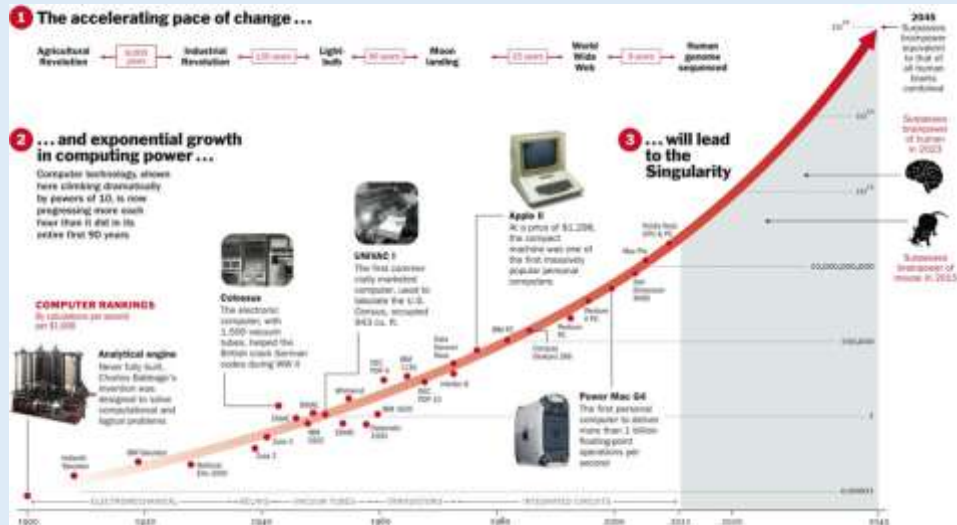
(R)evolution

(R)evolution
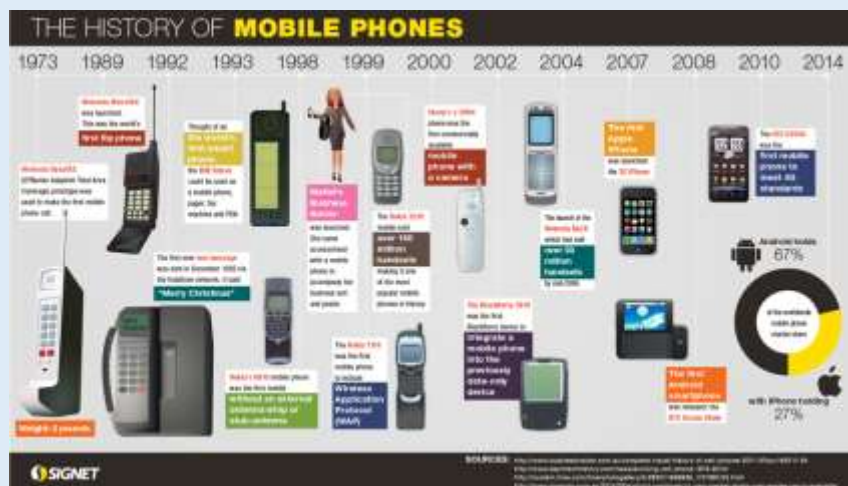
Developments

- Sensor Technology

- Data Analysis and Artificial Intelligence

- Augmented and Virtual Reality

- 3D Printing/Microfluid Technology

Theophylline

101010

Health care versus the real world
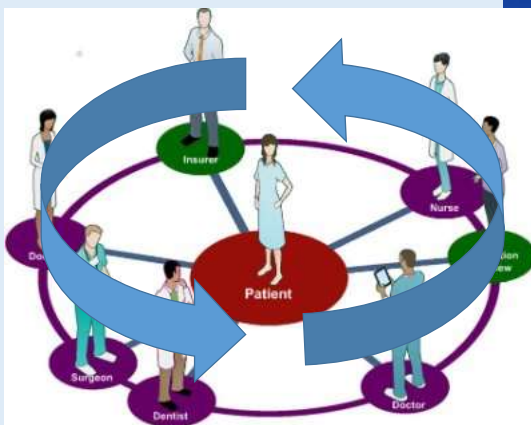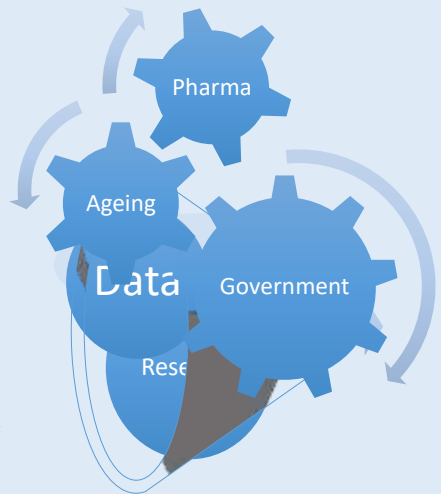
Ways to view the future

Be shaped

Shape
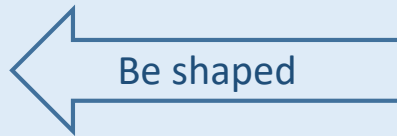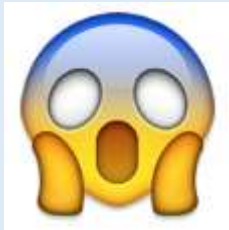
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Forecasting the future of hospital pharmacy

- Strategic planning (years)
- Unknowns (decade ?)
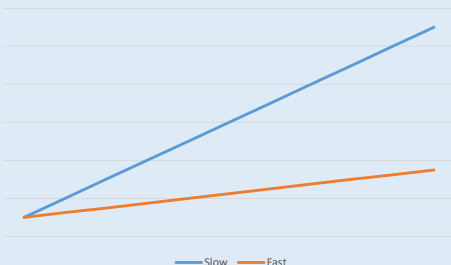
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Linear vs exponential
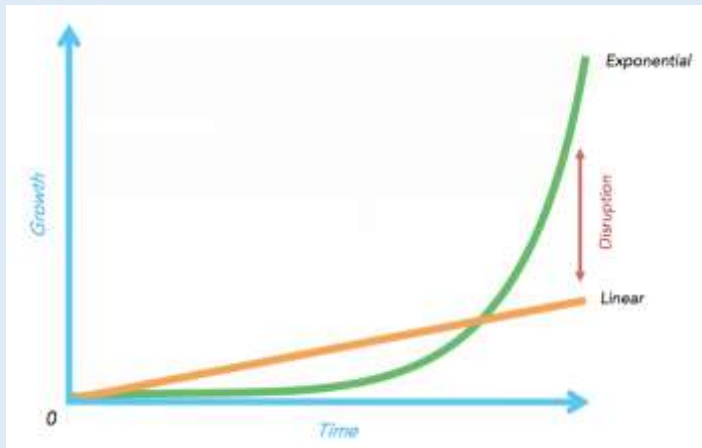
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Forecasting the future of hospital pharmacy

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- Unknowns (decade ?)
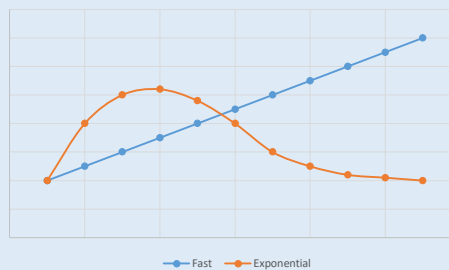
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European Statements of Hospital Pharmacy

1.1 The overarching goal of the hospital pharmacy service is to optimise patient outcomes through working collaboratively within multidisciplinary teams in order to achieve the responsible use of medicines across all settings

The environment
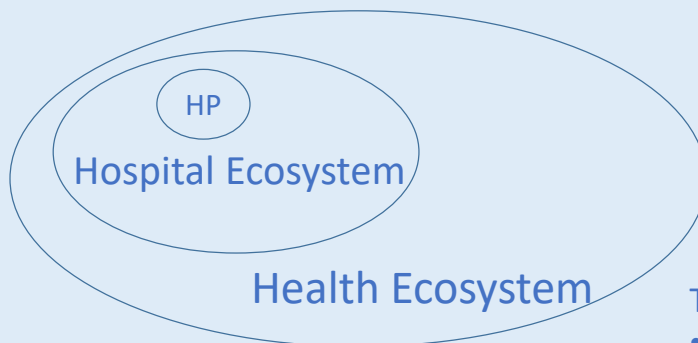
Triple AIM:
- Enhancing patient experience
- Improving population health
- Reducing costs

Health ecosystems

Population outcomes

€

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Health ecosystems

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Personalised medicine

Diabetes

€

1 2
3 4 5
n 6
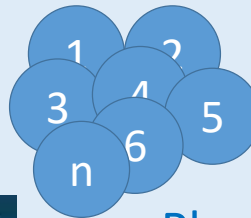
Pharma
Investments ▲
Population ▼

Human Resources

- More patients
- Complex patients

€

Forecasting the future

Drugs in the pipeline
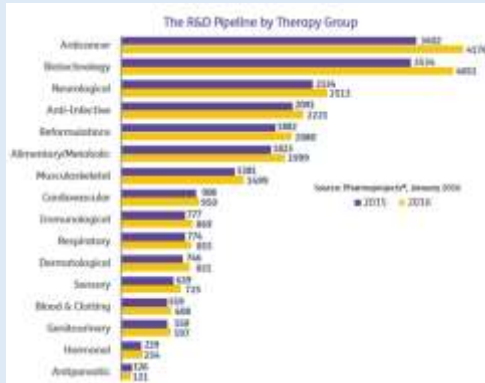
- (Inter) National level

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Population data
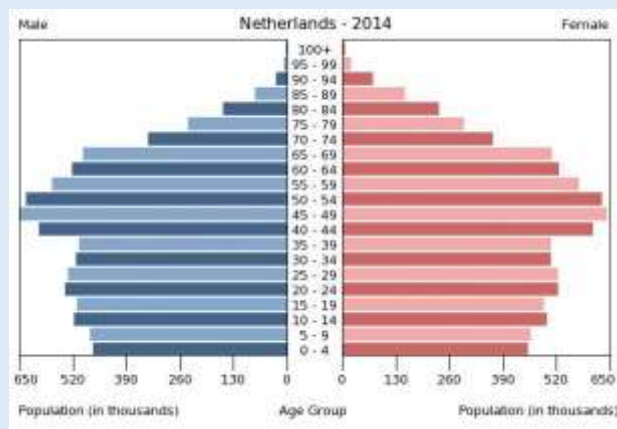
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Health expenditure

- Strategic planning (years)

Slow —— Fast
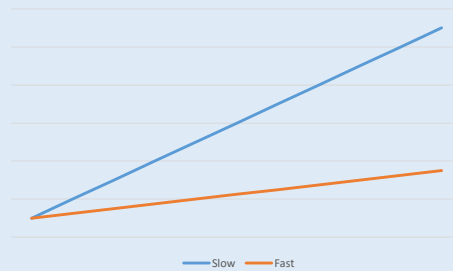
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Hospital ecosystems
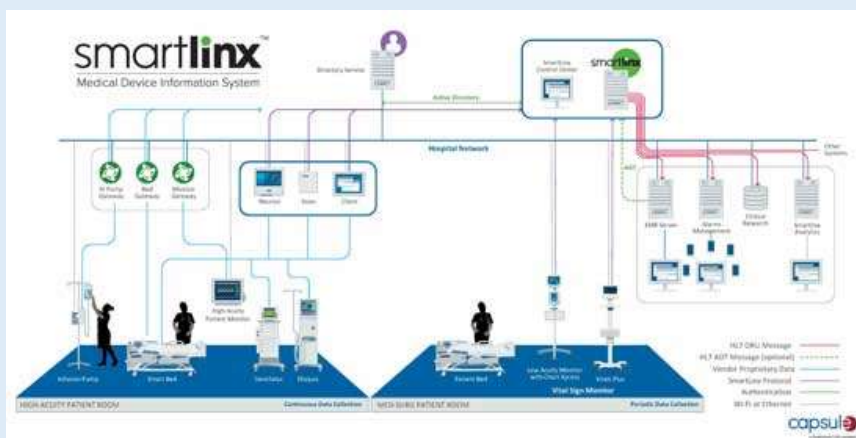
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Learning formulary

Farmadatabase
• 8 hospitals
• Real time data
    • Pharmacotherapy
    • Outcomes

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Learning formulary

Formulary → Real World data → Outcomes → Evaluation → (cycle)

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Negotiating (value based costing)

Predicted outcome RCT's
- 12 month PFS
- QALY: € 60.000

Real world data
- 6 month PFS
- QALY: € 120.000

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Negotiating (two ways)

Predicted outcome RCT's
- 12 month PFS
- QALY: € 60.000

Real world data subpopulation
- 24 month PFS
- QALY: € 30.000

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Value based costing

Farmadatabase

Drug expenditure

Slow — Fast

Fast — Exponential

Hospital ecosystems

Human resources

- Context sensitive dataviewing in hospital ward

Human (?) resources

- PK-PD

Individualized Bayesian dose optimization
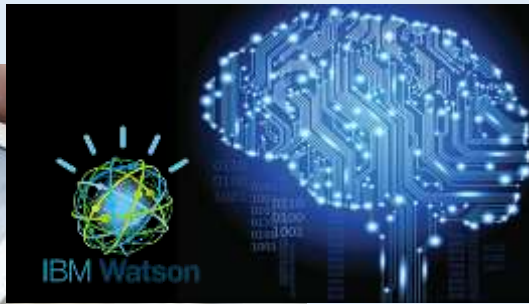
Human resource expenditure
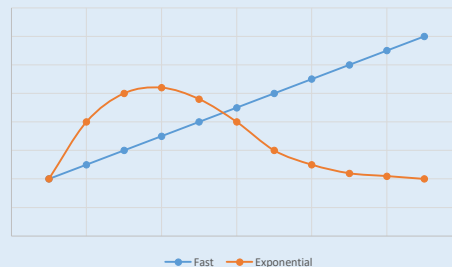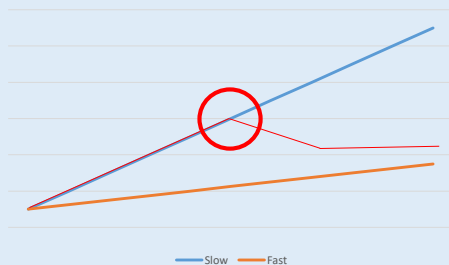
Housing of hospital facilities

California
Zip Code
Income Data

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(R)evolution

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The near future

2020

Class 2017

TRICORDER FEDERATION
MEDICAL SYMPTOM CHECKER

XPRIZE 2017

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Health care versus the real world

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F H

Bern University
of Applied Sciences

Forecasting, Foresight, Challenges and Solutions

Prof. Dr. Stefan N. Grösser, Bern University of Applied Science, School of Engineering

Prof. Dr. Stefan N. Groesser

Forecasting and Foresight

Foresight is…

▸ B. Martin (1995): Research foresight is "the process involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and the emerging generic technologies likely to yield the greatest economic and social benefits"

▸ L. Georghiou (1996): Technology foresight is "a systematic means of assessing those scientific and technological developments which could have a strong impact on industrial competitiveness, wealth creation and quality of life"

▸ I. Miles (2000): Foresight is an approach that integrates three trends since mid-1990's

  ▸ **Futures Studies**: Shift from predictive to exploratory approaches, iteration and involvement of users for embedding /implementation

  ▸ **Strategic Planning**: shift from rational to evolutionary approaches, uncertainty is the norm, economic progress linked to disruptive innovations, qualitative vs quantitative changes within stable structures; long-term planning discredited but still needed.

  ▸ **Policy Analysis**: Shift to open, participatory approach, knowledge is distributed and policy-makers have to find ways to capture it.

Corporate foresight methods – a start

Market-oriented methods	Integrating methods	Technology-oriented methods
• Customer diaries	• Roadmapping	• Technological Competitor Analysis
• Ethnographic Study	• Scenario Technique	• Technology Scouting
• Socio-cultural Currents	• Quality Function Deployment	• Publication Analysis
• Customer Scenarios	• Internal Delphi Study	• Patent Analysis
• Focus Topics		• Conference Analysis
• Qualitative Survey		• S-Curve Analysis
• Quantitative Survey		• Delphi Studies
• Competitor Analysis		• Learning Curve
• Trend Report		• Option Pricing Models
• Lead-User Analysis		• Simulations
• Lead-Market Analysis		• Benchmarking

More classifications of foresight methods: Foresight categories

Dominant CF-Paradigm	Expert-based Foresight	Model-based Foresight	Trend-based Foresight	Context-based „Open" Foresight
Assumption	Knowability by Expertise	Calculability by Models	Projectability by Developments	Shapability by Interaction
Key Characteristics	Belief in Experts dominant, but: 70s: Turn to the qualitative and wider environment First Opening towards "soft sciences" Scenarios	Quantitative and "subjective" models Extrapolation Systems Dominated by "hard science"	Trends Weak Signals Early Warning Mix of qualitative and quantitative Indicators	Integrating "soft" and "hard" approaches Understanding & interpreting / evaluating change Opening up: Participation, interaction & process Action- and innovation-oriented More attention on discontinuities
Perspective	Exploring Change	Calculating Change	Reacting to Change	Understanding & Anticipating / Shaping Change
Output	Delphis, Roadmaps, Scenarios	Models & Matrixes	Trend-databases Monitoring Systems	Scenarios; Wild Cards; Action Plans & Innovation Ideas

Assumptions of dominant Foresight categories

Assumption:
The future can be foreseen by collecting and comparing the opinions of (numerous) experts.

Expert-based Foresight

Assumption:
The future can be calculated by appropriate computer models based on huge amounts of data and mathematical finesse.

Model-based Foresight

Assumption:
Businesses can understand the future by anticipating the impact of trends on customers and markets.

Trend-based Foresight

Assumption:
Businesses can shape future contexts and markets by anticipating the dynamic interaction between social, techn. & economic forces.

Context-based („Open") Foresight

And even more methods for foresight

```
Foresight          Cognitive and          Large samples
methods            appellant
                   methods                 Small samples

                   Statistical and         Extrapolation
                   econometric             class
                   methods
                                           Econometric class

                                           Decision-making
                                           class

                                           Scenario class
                   Structural and
                   causal methods          Simulation class

                                           Valuation class
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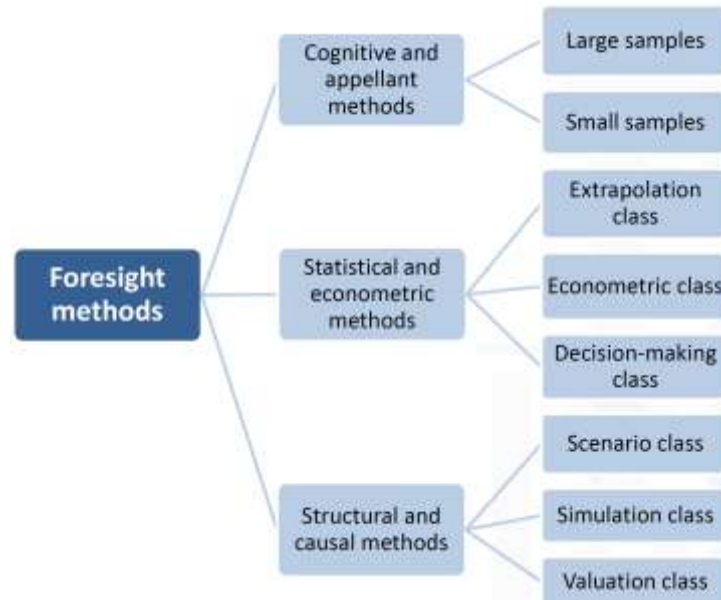
The classification that is always true…

From methods you think you know…

…to methods you think you don't know…

…to methods you don't know you don't know…

Challenges for acceptance and implementation of foresight methods

Methodological problems

▸ lack of knowledge concerning advanced methods

▸ Acceptance of qualitative foresight problematic in upper management

Organizational and managerial problems:

▸ foresight results should be better delivered and better disseminated to relevant target groups and to create a higher commitment for a successful end-results

▸ needs to generate relevant information and result in concrete results and real products

▸ foresight studies need more feedback from the users to trigger off leaning effects and make predictions more accurate and more "user-friendly/customer"-oriented

▸ ways to better measure the benefits of foresight activities on the business success;

▸ too much "uncertified" knowledge in the field prevent from separating good experts from the bad ones.

Case Example: Forecast the Milk Production …

You are the decision maker in the production facility…

Historical milk production (data)

$$Y_i = \beta_0 + \beta_i t + \beta_s A + \varepsilon_i$$

Forecast
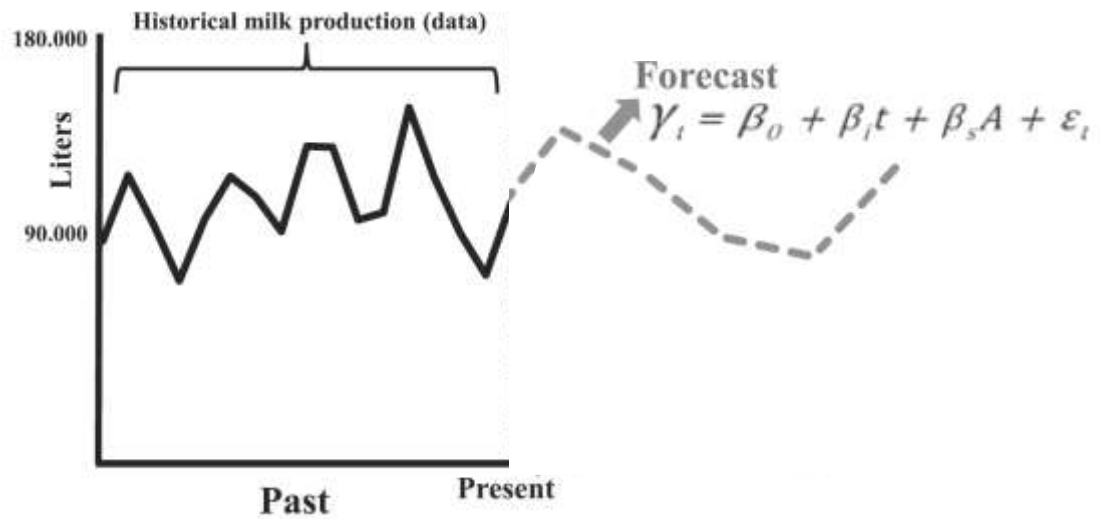
**Complexity and Reactive Behaviors and
Causal Simulation Modelling with System Dynamics**

Dynamic Complexity
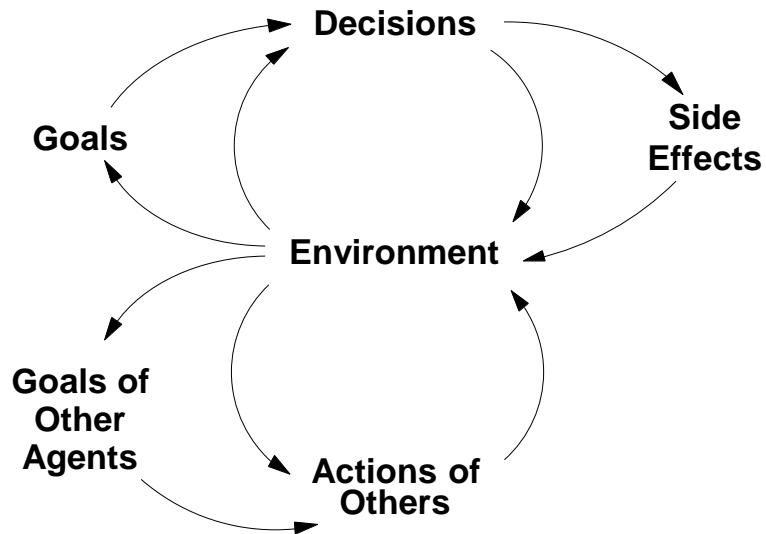
Objectives first…we need a model that works and explains "performance" over time
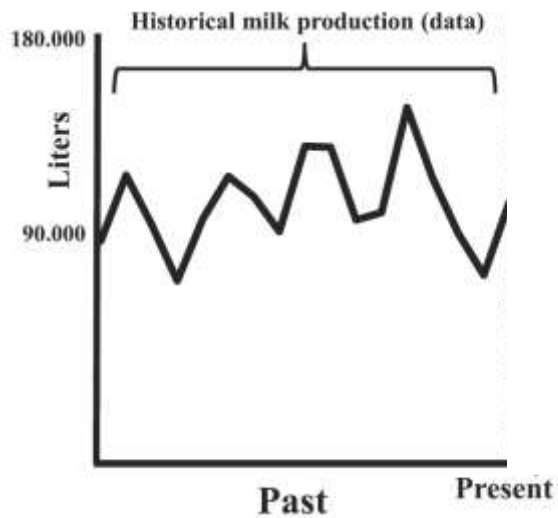
Then second, we need to account for the physical system…

A structural, causal model for the explanation of milk production
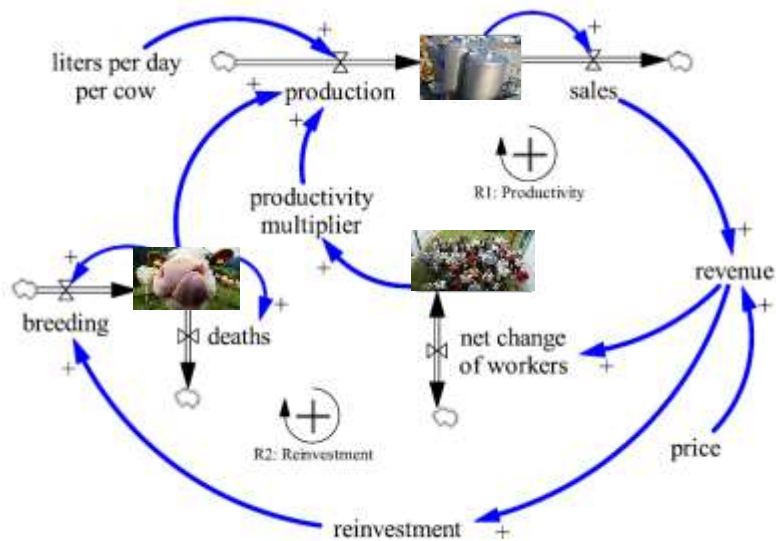
Only after the (most likely) causal structure is uncovered and the past behavior is explained, then there can be scenario analysis and pattern estimation

Objectives first…we need a model that works and explains "performance" over time
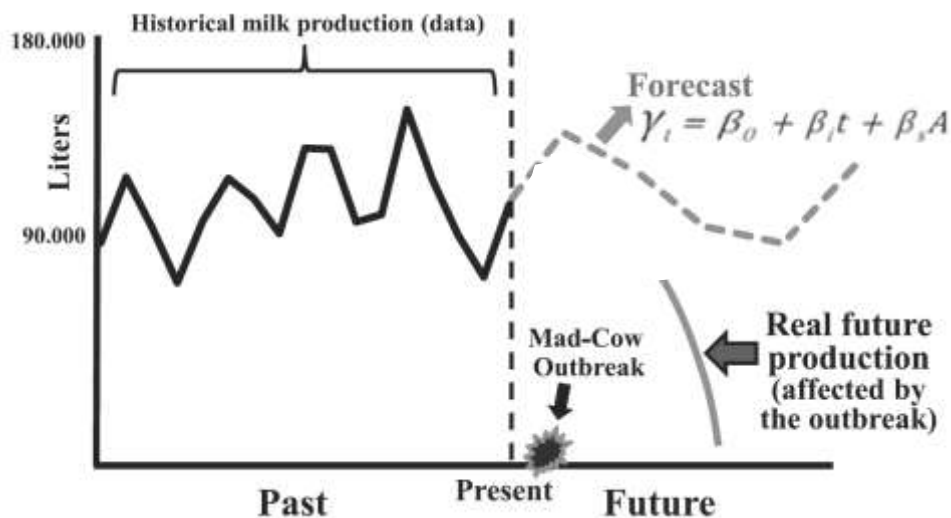
Validation: Models should be capable to replicate the historical data but should also be rich in realistic scenarios
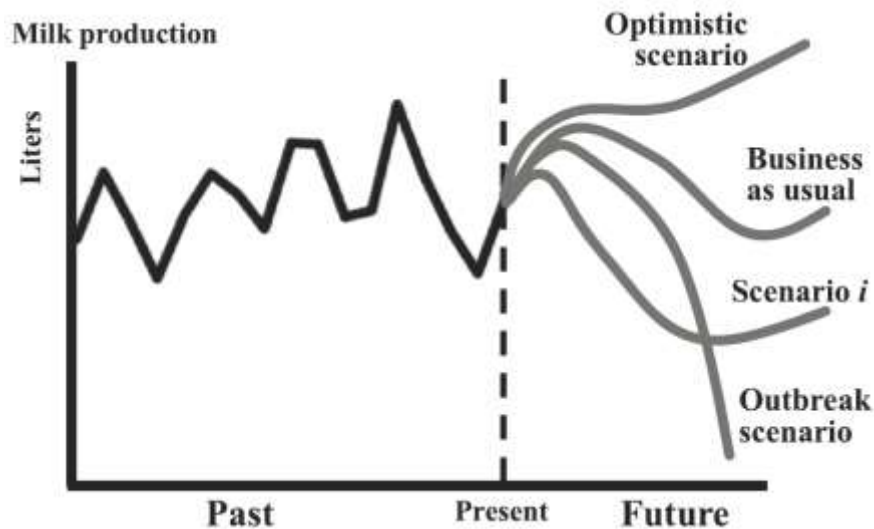
A virtual world (the simulation model helps to uncover and understand the real world in order to design better policies.

The Case of Medicine Shortages:
A project in Switzerland in its initial phase
(start was in Feb 2017)

To understand medicine shortages, we need to understand its causal structure and their agents

Supply Chain	Research & Development	Production / Marketing & Distribution	Logistics close to Production / Pre-Wholesaling	Wholesaling	Distribution

Indirectly linked (f)actors

Healthcare organisations | Trade associations | Industry federations | Patient organisations | Professional organisations | Governmental representatives | Ethics & Lawyers

Seasons | Climate change | Health consciousness of population | Level of public education

Directly linked Actors

Research-Institutions	Research employees		Pharmacies
	Manufacturer		Medical practices
	Bulk producer	Re-Importer	Logisticians	Hospitals
	Marketing	Wholesaler	

Then we focus on the decisions taken und and decision rules/policies that underlie the decisions

1	Defining research field
2	Defining the budget
3	Defining test-range of drugs
4	Selecting bulk producer (API)
5	Selecting marketing strategy / channels
6	Selecting production site(s) (location)
7	Defining amount being produced
8	Defining quality management process
9	Selecting between B-B or B-C
10	Selecting wholesaler
11	Selecting distribution partner (hospitals, pharmacies, etc.)

Chain:
- 1 2 3 Research & Development
- 4 5 6 7 8 Production / Marketing & Distribution
- 9 Logistics close to Production / Pre-Wholesaling
- 10 Wholesaling
- 11 Distribution

1. **Selecting region** which provides the greatest opportunity to influence the market access capability

2. **Collaboration** with Wholesaler or implementing **direct-to-patient distribution channels**

3. Investing in new **technological innovations** to improve the SC (e.g. Big Data) or *improving already existing tools* (e.g. data analytics

4. Adjusting the SC to the products (**standardising SC**) or adjusting product portfolio to current SC (**segmenting and specialising**)

5. **Collaborating** with other to achieve a more effective supply chain or use SC to differentiate from cometitors

6. **Selecting an investment priority** to meet GDP guidelines *(passive solutions, risk assessing, consolidating, finding new transportation service provider, reassessing and changing strategy for freight)*

7. Investing in preventive solutions to fulfill **global serialization requirements** (e.g. regulations for *falsified Medicines Directive*) or wait for external industry-wide solutions

1 - 7

Supply Chain

Another example: A management flight simulator as learning and decision support tool

Sources used for this presentation

▸ Meissner, D. Research Laboratory for Science and Technology Studies, National Research University. Access: January 2017

▸ Olaya, C. (2015). 'Cows, agency, and the significance of operational thinking', System Dynamics Review, 31, pp. 183-219.

▸ Sterman, J. D. (2000). 'Learning In and About Complex Systems', Reflections, 1, pp. 24-51.

▸ Sterman, J. D. (2000). Business Dynamics: Systems Thinking and Modeling for a Complex World, McGraw-Hill, Boston, MA.

7-4-2017

Control questions

Future health expenditure can be forcasted by linear extrapolation of past expenditure using relevant parameters

- NO

Causal simulation models have been developed for describing past behavior and point-prediction of future events

- NO

The purpose of system dynamics simulation modelling is mostly on explaining and thereby understanding past behavior. Scenario-based analysis of likely future patterns can only then be successfully implemented

- YES

Take Home Messages

1. Technological advances will reshape healthcare in near future
2. Simulation Modelling is for learning, not primarily for forecasting
3. Applying structural modelling techniques provides additional insights compared to statistical modelling