Management flight simulators in complex ecosystems

Peter Ylén

Some factors to be considered…

- Tailored products with improved properties and functionalities
- Recycling, sustainability and environmental load
- Legislation, regulation and incentives
- Consumer behaviour and societal transformation
- New technologies, materials and processes
- New business models and earning logics
- Business ecosystems
- Circular, Sharing, Service and Outcome economies
- Digitalization, AI and analytics
- Disruption of work and new ways of working
- Competence management
- …

How to understand and manage the disruption

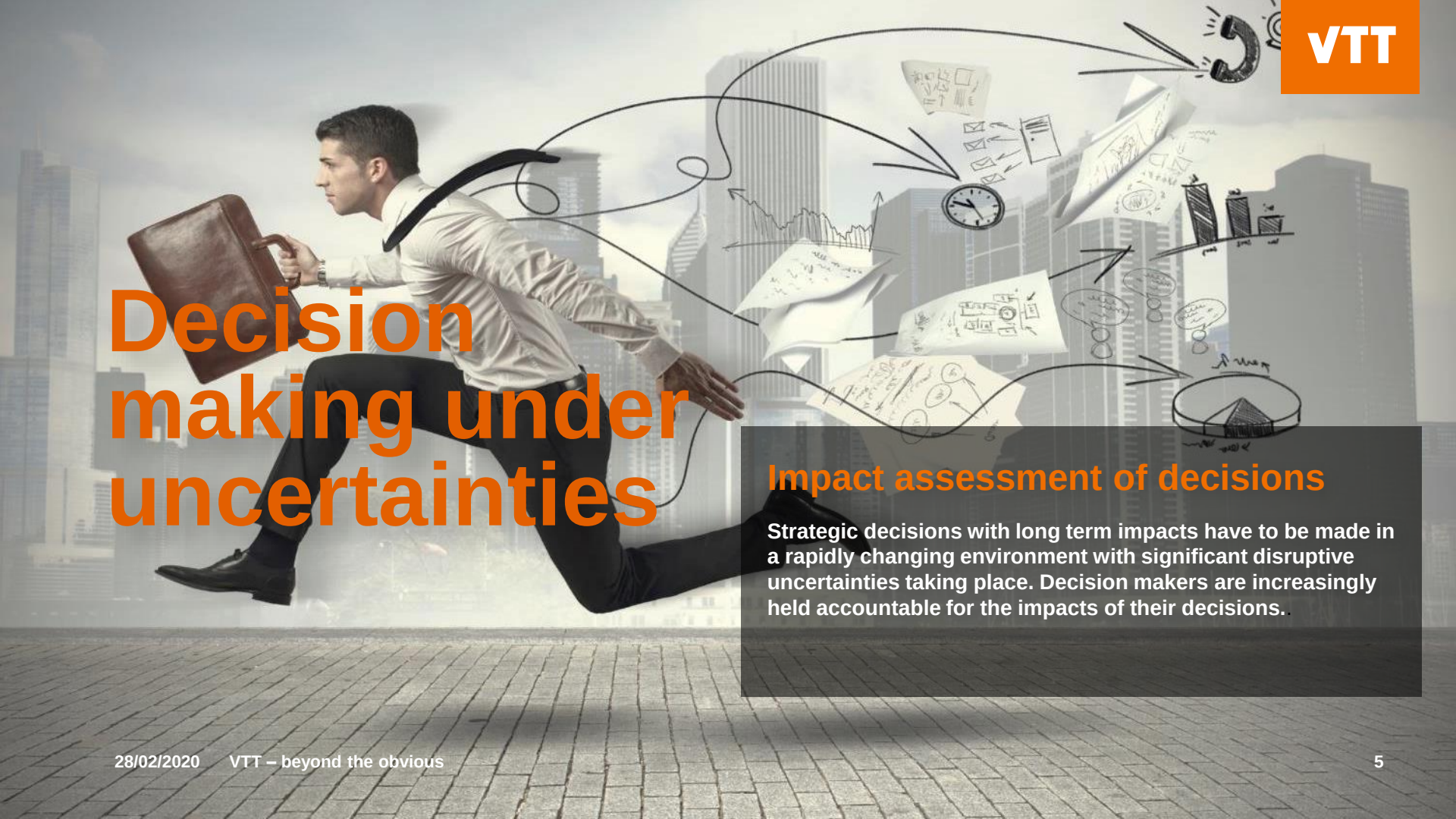
The complexity and speed of change increase

- Technical, business, reputation, societal, market, regulatory, etc. changes take place with increasing speed
- The business ecosystem becomes more complex with new stakeholders with different earning logics
- Uncertainties grow, future is uncertain and data is available only from history

We are facing a systemic problem, which is difficult to handle with conventional tools

⇒ **We need systemic tools for the systemic problem**

Decision making under uncertainties



Impact assessment of decisions

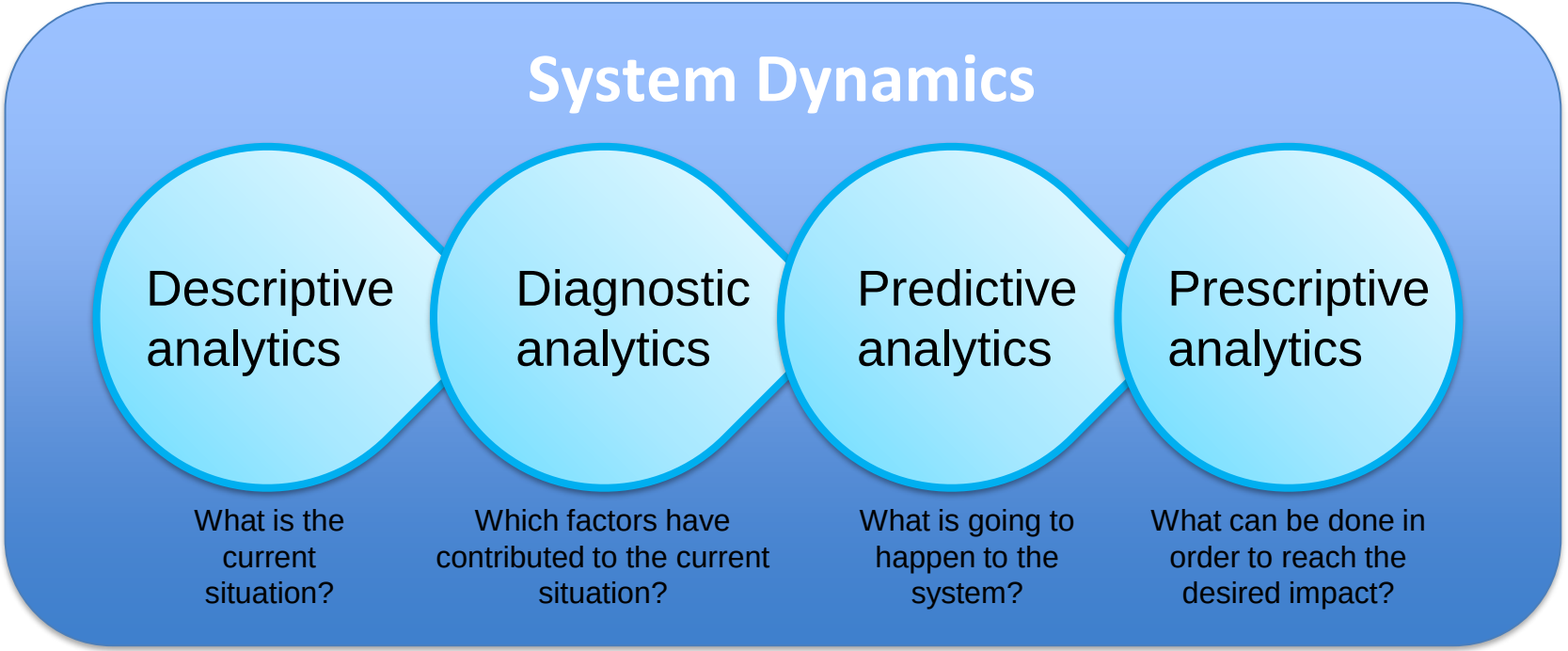
Strategic decisions with long term impacts have to be made in a rapidly changing environment with significant disruptive uncertainties taking place. Decision makers are increasingly held accountable for the impacts of their decisions..

Future oriented systemic decision support tools

Management flight simulators

Systemic impact assessment tool consist of foresight, system dynamic modelling, societal embedding in a impact assessment framework. Different future scenarios, what-if simulations and sensitivity analysis are visualised for evaluating decisions.

Data analytics



Quantitative data based methods

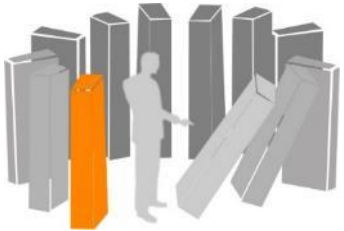
Qualitative narrative methods

Systems Thinking and System dynamics

Identifying complex cause and effect relationships

Tool to help construct and communicate mental models

Understanding the long- and short-term consequences of actions

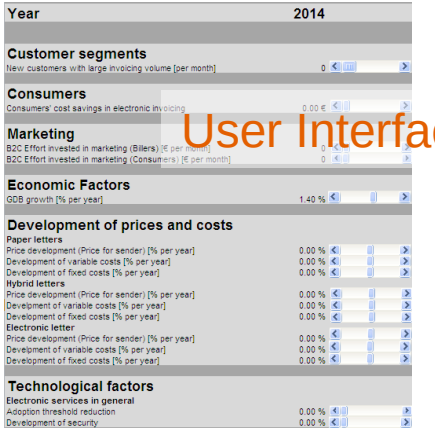


Foreseeing unintended consequences

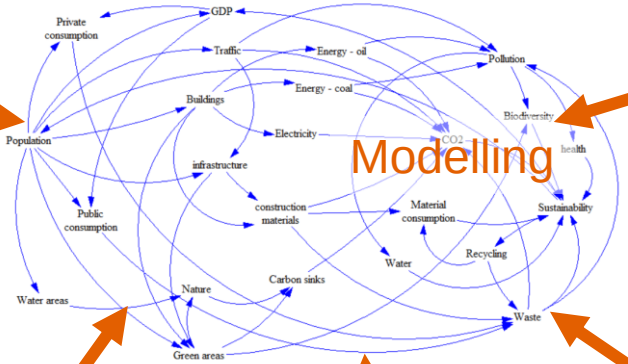
Finding leverage – seeing where actions and change can lead to significant and enduring improvements

Simulating policies under different assumptions and uncertainties

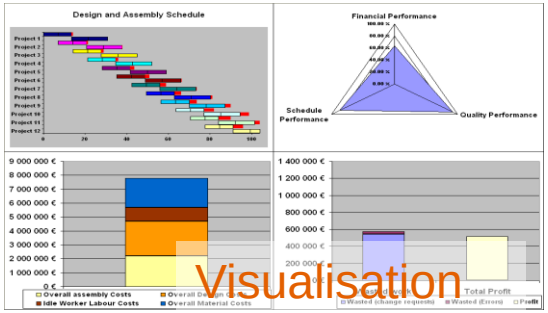
System dynamic model elements



User Interface

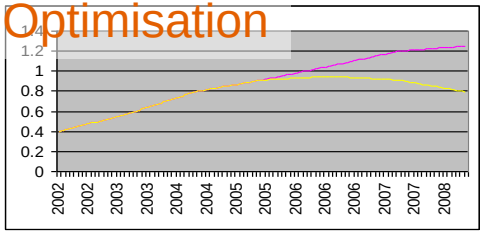


Modelling

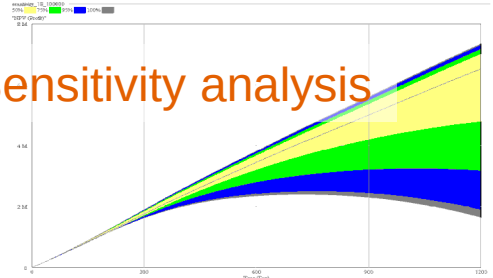


Visualisation & metrics

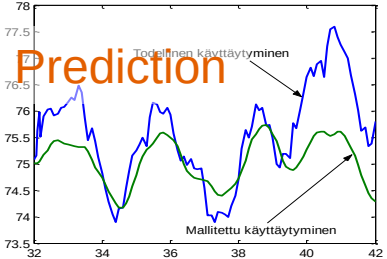
Optimisation



Sensitivity analysis



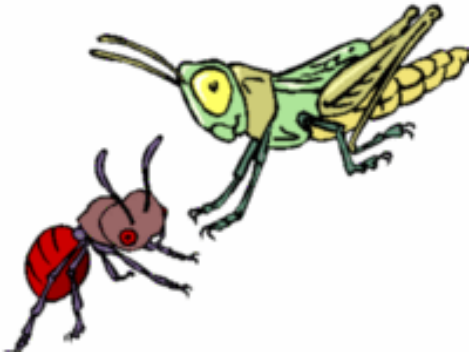
Prediction



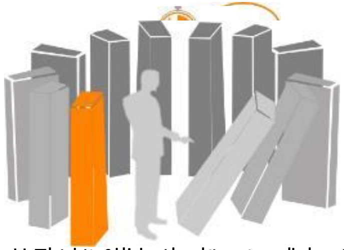
Project Work

Dynamic hypothesis
Case: Project management

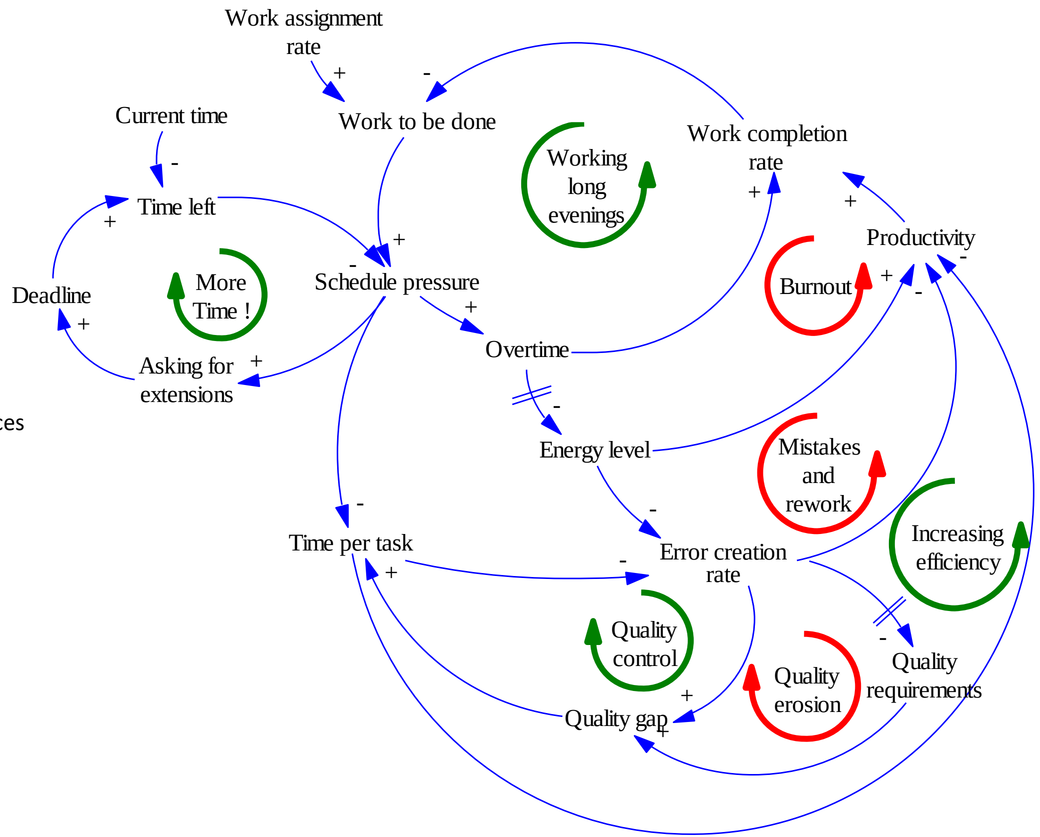
Let's take a simple example of project work



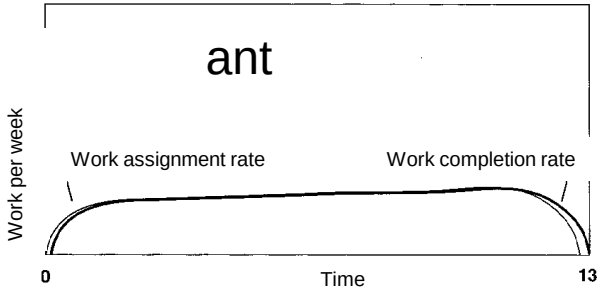
Some of the project participants are grasshoppers and some ants, e.g. procrastinators (with stress, burn-out, low quality work, slipping deadlines) and non-procrastinators (irritating diligent co-workers).

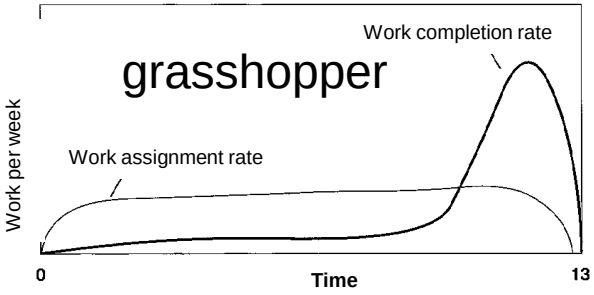


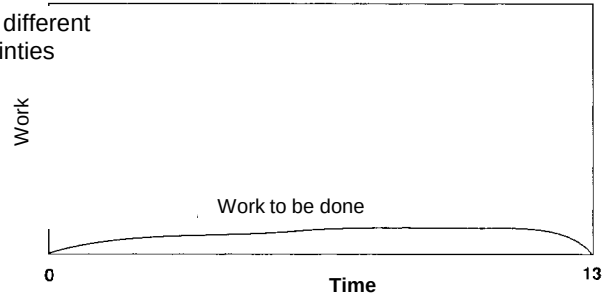
Understanding the long- and short-
Identifying complex cause
and effect relationships
Foreseeing unintended consequences

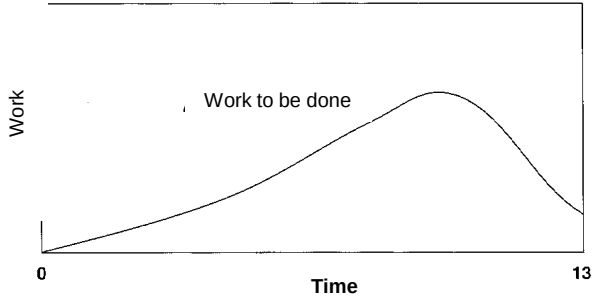


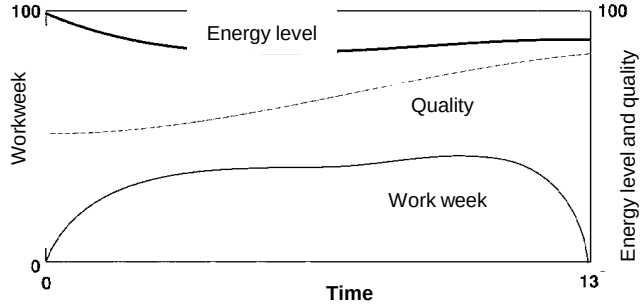
Simulating policies under different assumptions and uncertainties

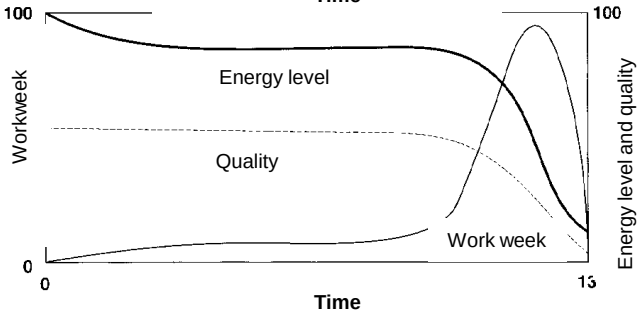




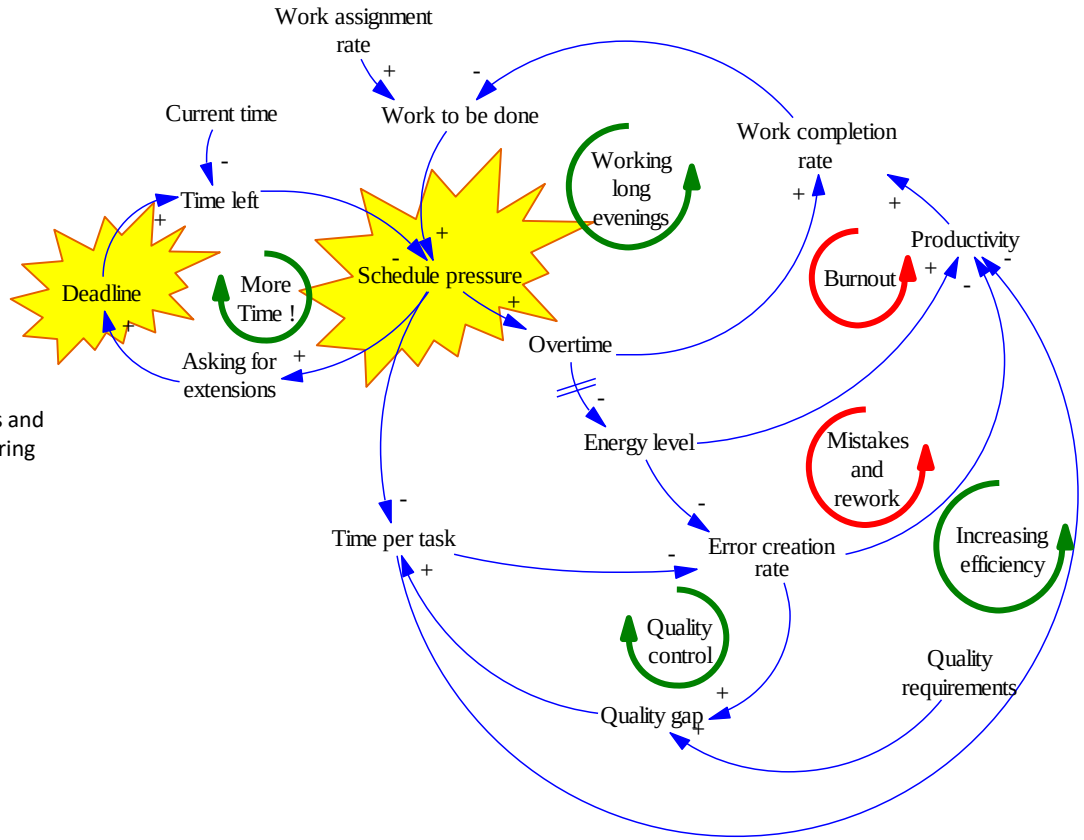








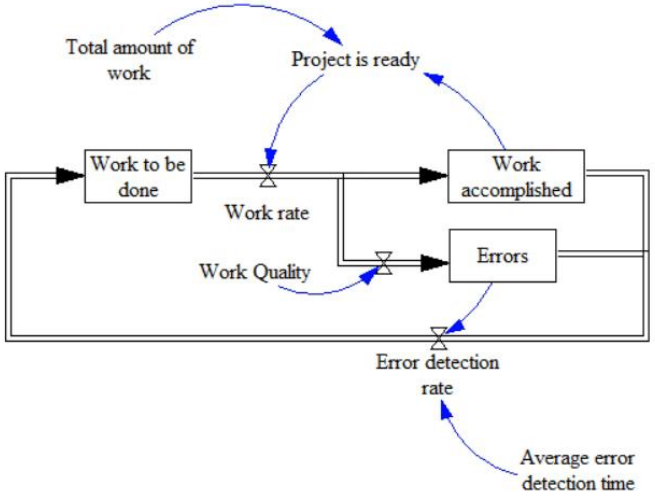
Finding leverage – seeing where actions and change can lead to significant and enduring improvements

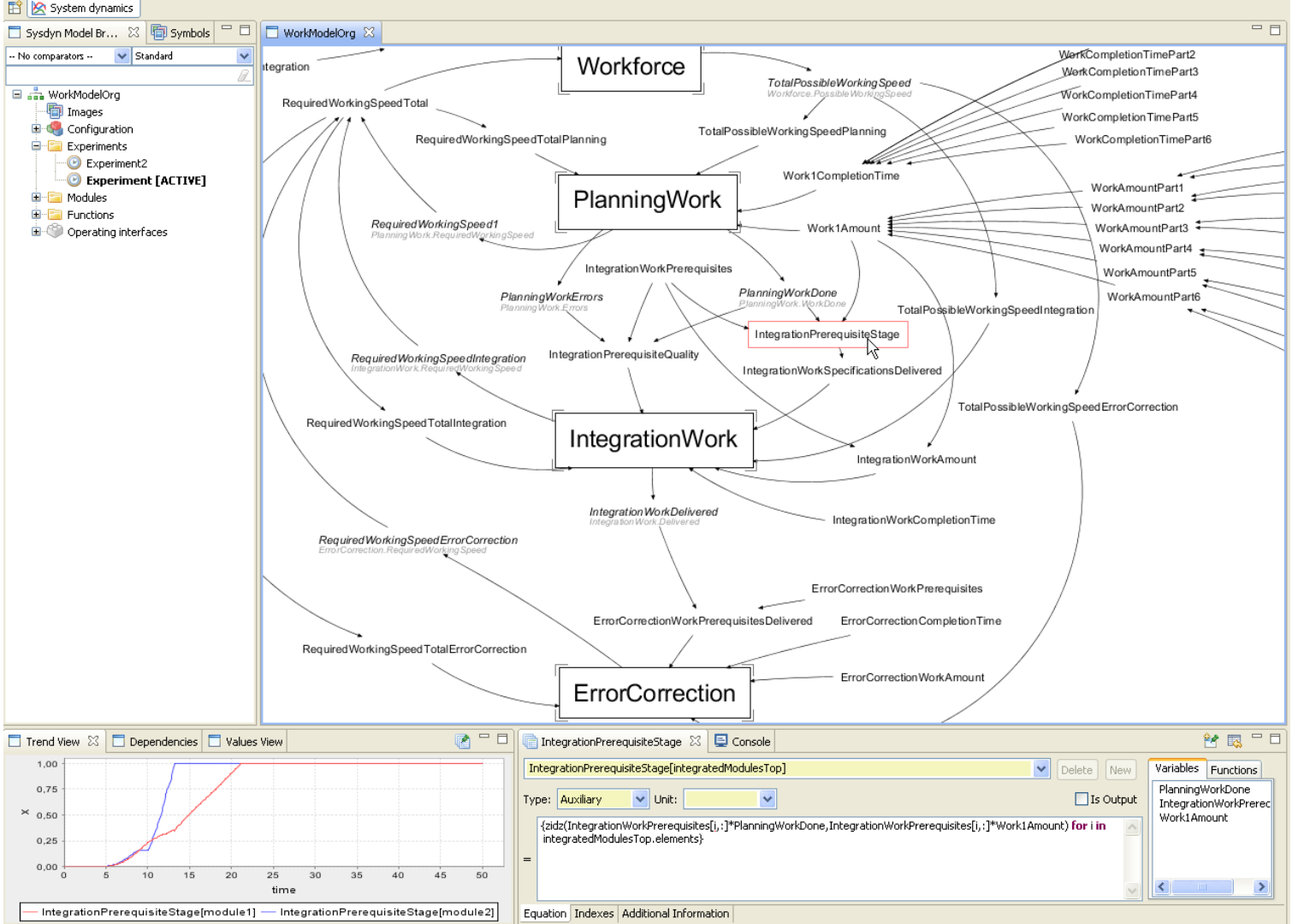


Project Management in software development

CASE: Strategic change in a software company

- An International software company had problems in their product creation process
- Cycle times were longer, quality problems, non-innovative products, fatigue and stress, a lot of money and effort was put into the system but the results did not correspond to the effort…
- The product creation was studied with system dynamic modelling. Based on the model a new strategy and practices were developed.
- The simulation model was used for testing the old and new strategy under different scenarios and uncertainties.
- There was significant policy and change resistance in the company and the benefits of new practices were questioned.
- A simulation game was constructed (management flight simulator), which was used in training and getting the new strategy accepted at different levels of the company.
- The model is continuously updated and further developed

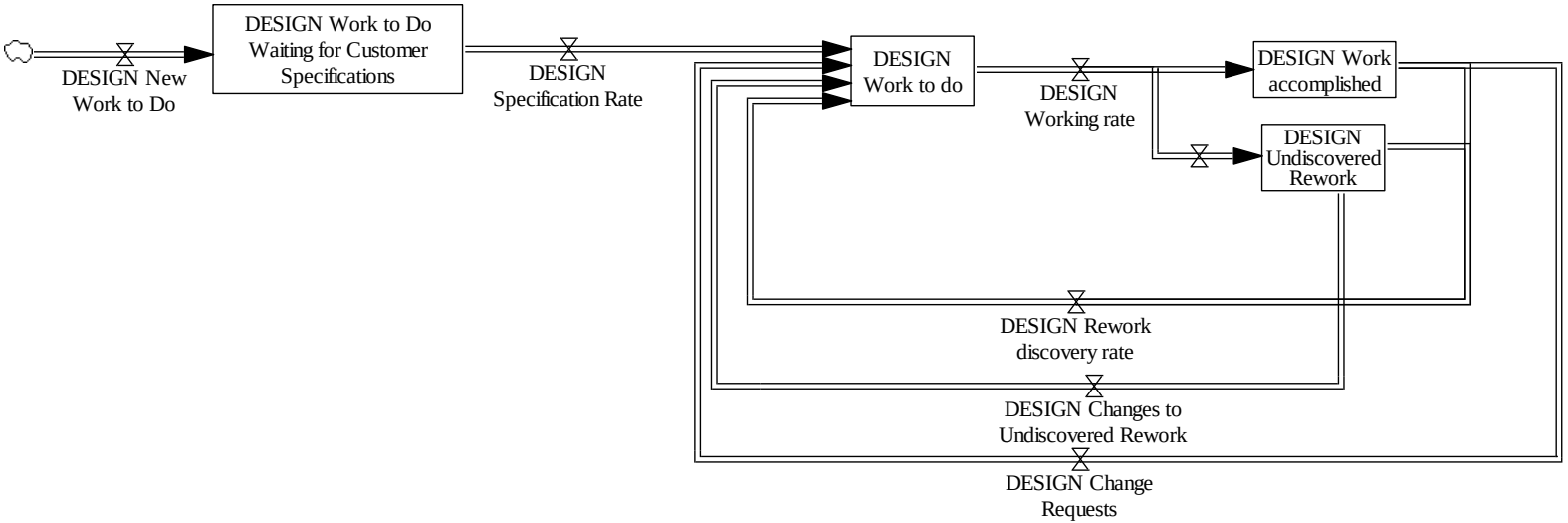

Total amount of work
Project is ready
Work to be done
Work accomplished
Work rate
Errors
Work Quality
Error detection rate
Average error detection time

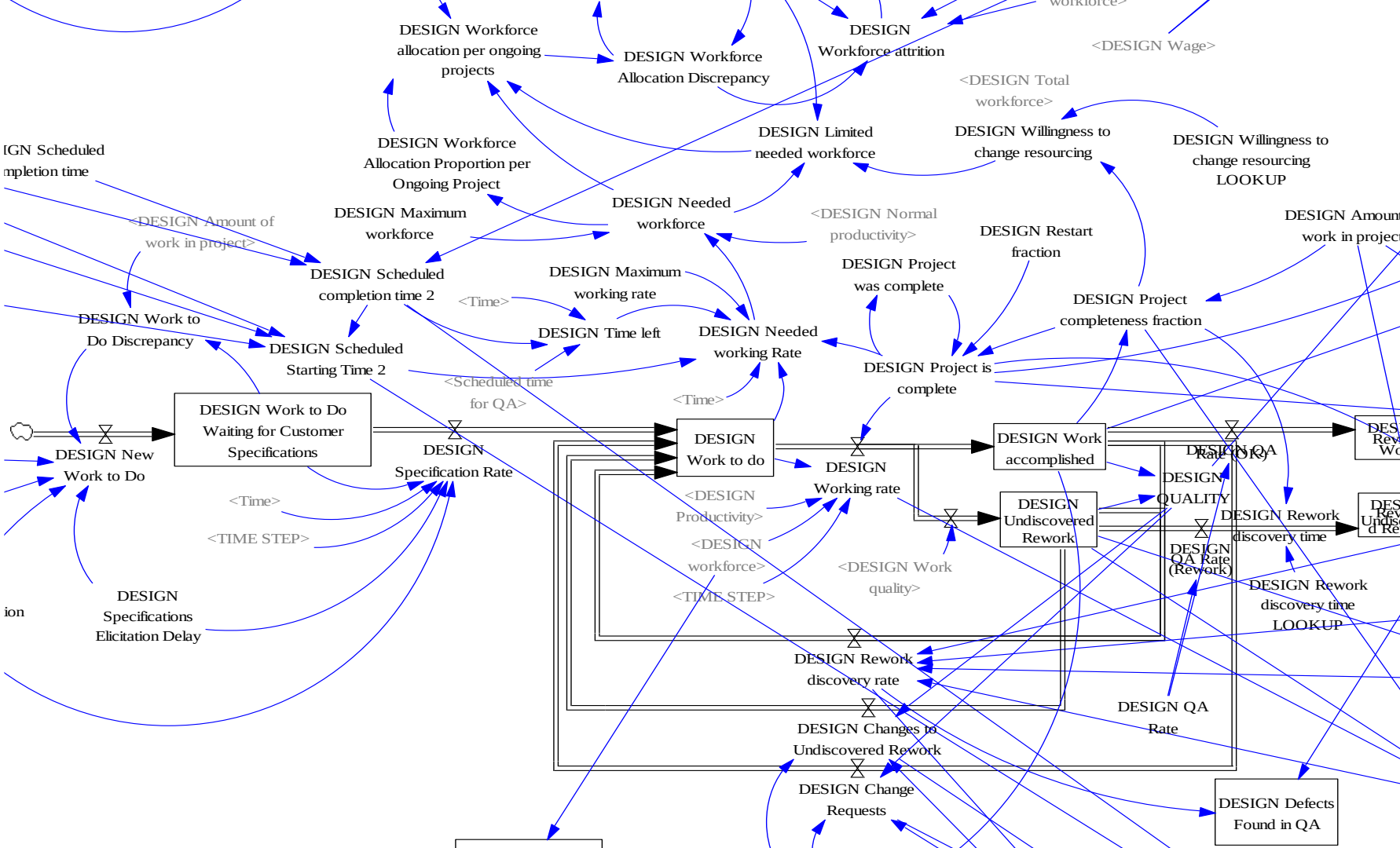

System dynamics
Sysdyn Model Br...
Symbols
WorkModelOrg
Images
Configuration
Experiments
Experiment2
Experiment [ACTIVE]
Modules
Functions
Operating interfaces
Workforce
PlanningWork
IntegrationWork
ErrorCorrection
RequiredWorkingSpeedTotal
RequiredWorkingSpeedTotalPlanning
TotalPossibleWorkingSpeed
TotalPossibleWorkingSpeedPlanning
Work1CompletionTime
WorkCompletionTimePart2
WorkCompletionTimePart3
WorkCompletionTimePart4
WorkCompletionTimePart5
WorkCompletionTimePart6
WorkAmountPart1
WorkAmountPart2
WorkAmountPart3
WorkAmountPart4
WorkAmountPart5
WorkAmountPart6
Work1Amount
RequiredWorkingSpeed1
IntegrationWorkPrerequisites
PlanningWorkErrors
PlanningWorkDone
TotalPossibleWorkingSpeedIntegration
IntegrationPrerequisiteStage
IntegrationPrerequisiteQuality
RequiredWorkingSpeedIntegration
IntegrationWorkSpecificationsDelivered
TotalPossibleWorkingSpeedErrorCorrection
RequiredWorkingSpeedTotalIntegration
IntegrationWorkAmount
IntegrationWorkDelivered
IntegrationWorkCompletionTime
RequiredWorkingSpeedErrorCorrection
ErrorCorrectionWorkPrerequisites
ErrorCorrectionWorkPrerequisitesDelivered
ErrorCorrectionCompletionTime
RequiredWorkingSpeedTotalErrorCorrection
ErrorCorrectionWorkAmount
Trend View
Dependencies
Values View
time
IntegrationPrerequisiteStage[module1]
IntegrationPrerequisiteStage[module2]
IntegrationPrerequisiteStage
Console
IntegrationPrerequisiteStage[integratedModulesTop]
Delete
New
Variables
Functions
Type:
Auxiliary
Unit:
Is Output
{zidz(IntegrationWorkPrerequisites[i,:]*PlanningWorkDone,IntegrationWorkPrerequisites[i,:]*Work1Amount) for i in integratedModulesTop.elements}
PlanningWorkDone
IntegrationWorkPrerec
Work1Amount
Equation
Indexes
Additional Information

Special Product Creation

Special product creation

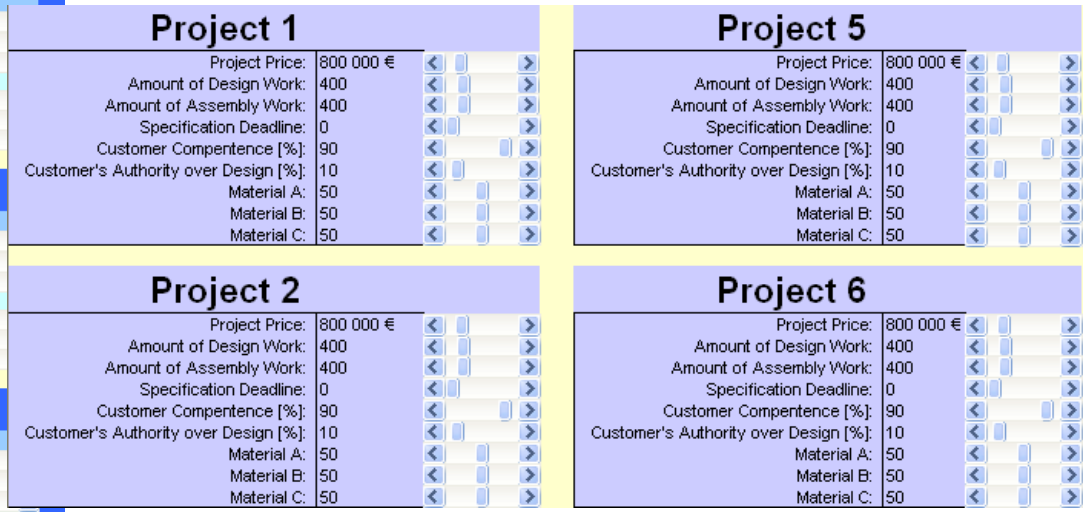
- The customers and suppliers are collaborating closely to develop a product tuned to correspond customer's specific needs



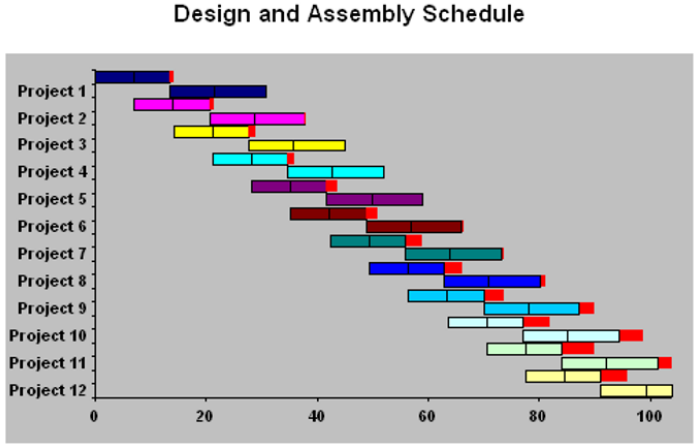

DESIGN Workforce allocation per ongoing projects
DESIGN Workforce Allocation Discrepancy
DESIGN Workforce attrition
<DESIGN Wage>
<DESIGN Total workforce>
DESIGN Limited needed workforce
DESIGN Willingness to change resourcing
DESIGN Willingness to change resourcing LOOKUP
DESIGN Workforce Allocation Proportion per Ongoing Project
DESIGN Needed workforce
DESIGN Maximum workforce
<DESIGN Normal productivity>
DESIGN Restart fraction
DESIGN Amount
work in project
IGN Scheduled
mpletion time
<DESIGN Amount of work in project>
DESIGN Scheduled completion time 2
DESIGN Maximum working rate
<Time>
DESIGN Time left
DESIGN Needed working Rate
DESIGN Project was complete
DESIGN Project completeness fraction
DESIGN Work to Do Discrepancy
DESIGN Scheduled Starting Time 2
<Scheduled time for QA>
DESIGN Project is complete
DESIGN Work to Do Waiting for Customer Specifications
DESIGN New Work to Do
DESIGN Specification Rate
<Time>
DESIGN Work to do
DESIGN Work accomplished
DESIGN Working rate
DESIGN QA Rate (OK)
DESIGN QUALITY
DESIGN Undiscovered Rework
DESIGN Rework discovery time
DESIGN QA Rate (Rework)
<DESIGN Productivity>
<DESIGN workforce>
<TIME STEP>
<DESIGN Work quality>
DESIGN Rework discovery time LOOKUP
ion
DESIGN Specifications Elicitation Delay
DESIGN Rework discovery rate
DESIGN QA Rate
DESIGN Changes to Undiscovered Rework
DESIGN Change Requests
DESIGN Defects Found in QA

Portfolio of projects

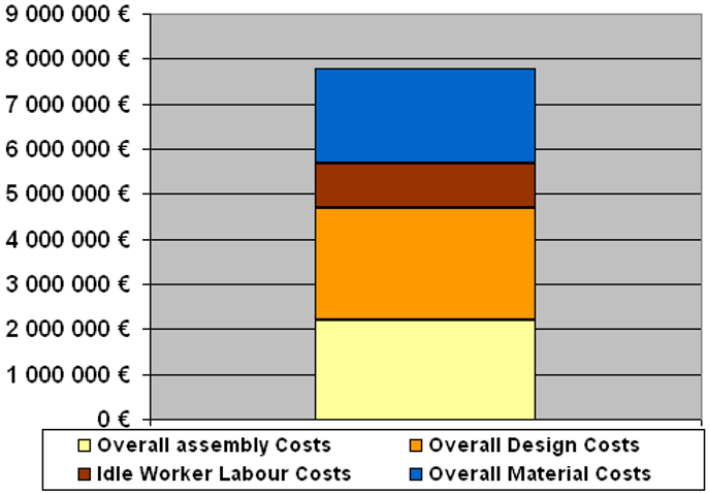
- Projects are scheduled
- Level of authority over design is tuned according to customer competences

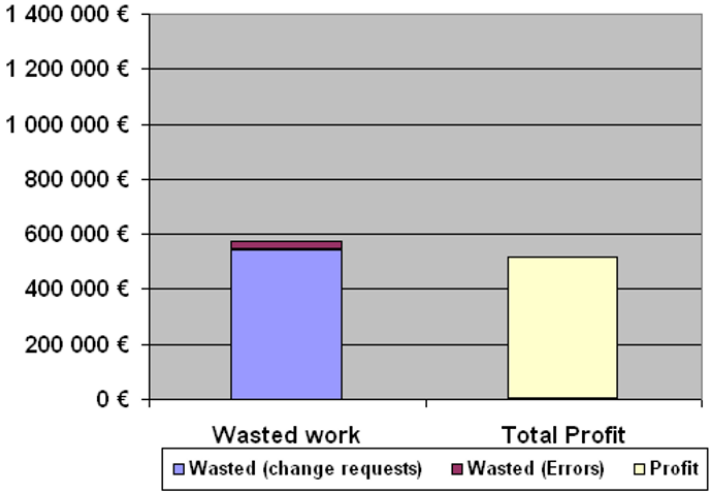


12 special product projects are simulated



The amount of wasted work due to change requests is significant



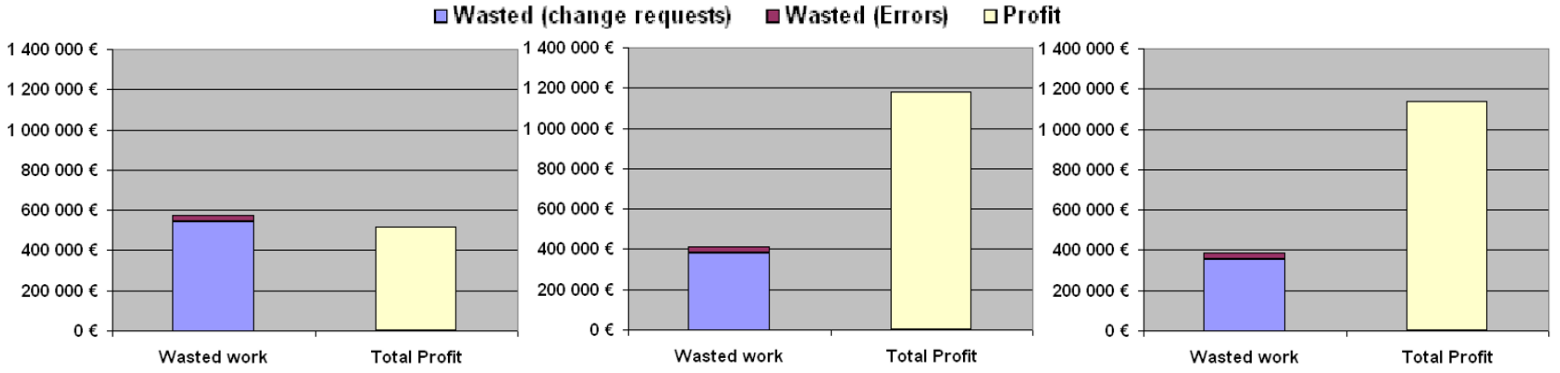


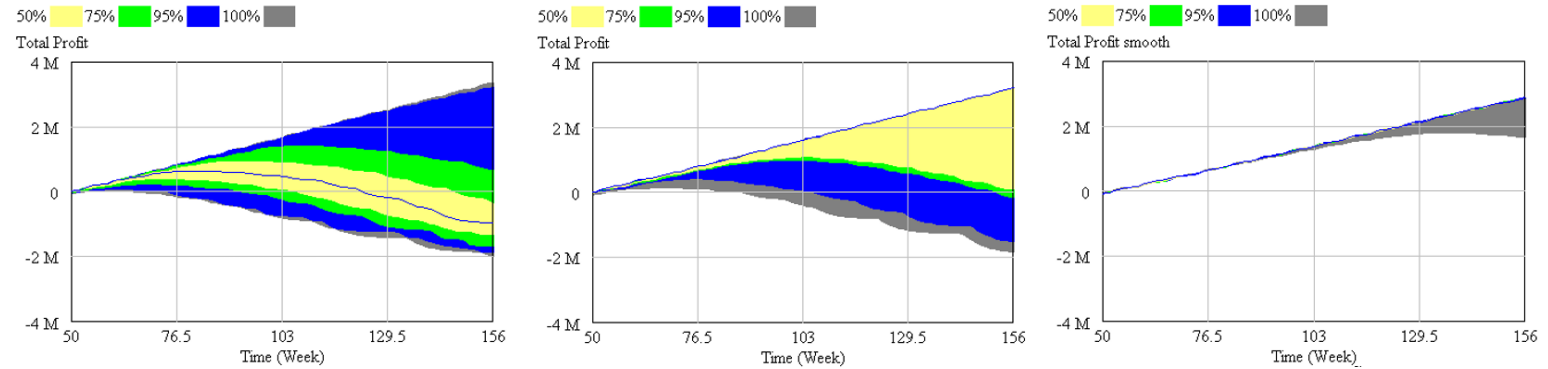
Different strategies are simulated and analysed

Every special product is manufactured individually (no portfolio)

Portfolio is planned and buffers are removed (no room for uncertainties)

Portfolio is planned and uncertainties taken into account in robust optimization



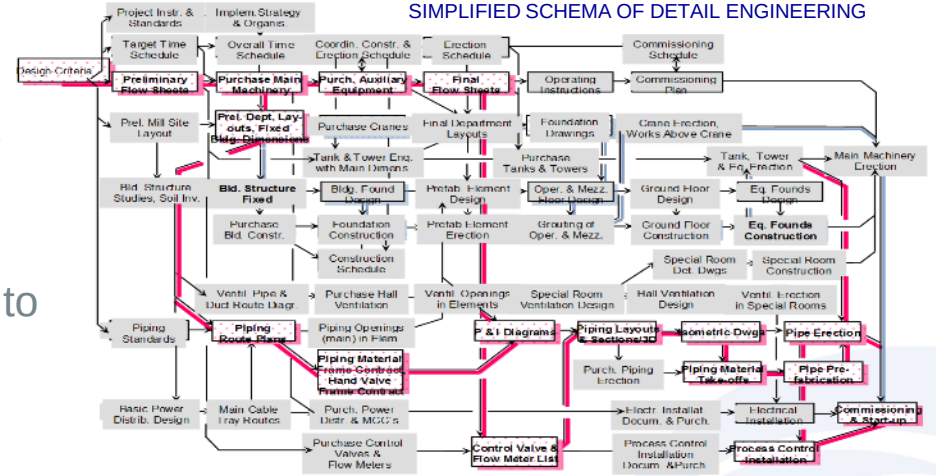


Case Pöyry: Orchestrating Large Investment Projects

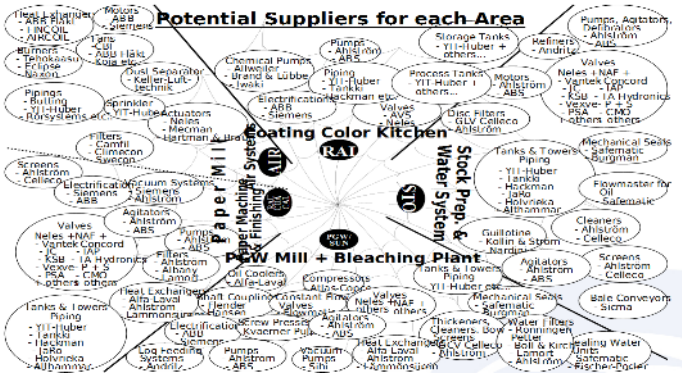
Why Pöyry needs simulation?

- Complex project behaviour is not easy to understand
- Understanding and training internally
- Making a tool for clients and suppliers to understand project behaviour

COMPLEXITY OF INFORMATION FLOW
SIMPLIFIED SCHEMA OF DETAIL ENGINEERING



- Goal: To build a simulation model to study:
  - Effects of delays in customer and supplier data
  - Effects of client and supplier know how
  - Distributed design work in multiple offices around the world



Pöyry -model

Microsoft Excel - poyry_ui.xls

File Edit View Insert Format Tools Chart Window Help Adobe PDF

Chart 78

Simulation parameters

Selected office for subdiscipline

P10-15	P20	P30	P40	B20	B30	M20	M30	M40	M50	T10-12	T20	T30	T40	T50	E10	E30	E40	E70	I10	I20	I40
FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN	FI PL CN

Purchase process

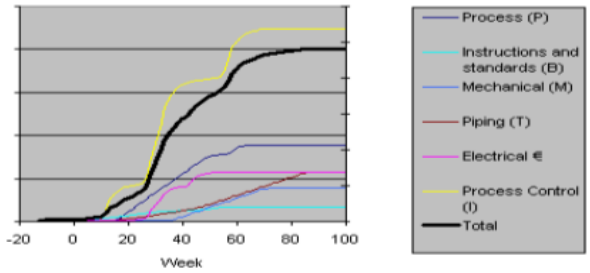
Client knowhow	4 (1=Poor, 5=Good)
Client timeliness (additional delay)	0 Weeks
Supplier know how	4 (1=Poor, 5=Good)
Preliminary supplier data delay	8 Weeks
Final supplier data delay	20 Weeks

Prerequisite limits: Low — High

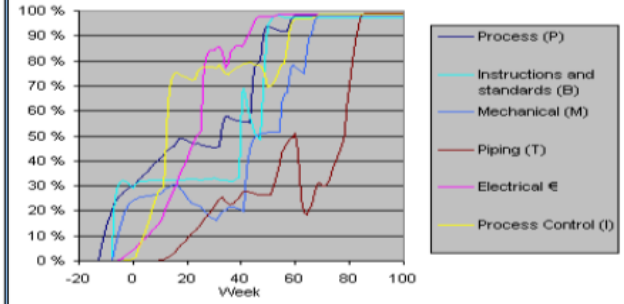
Heuristic accuracy: Low — High

Reset parameters | Run simulation

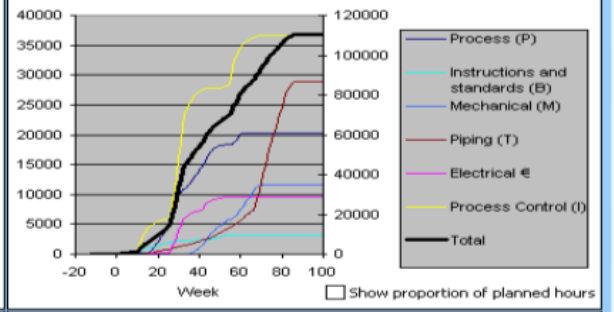
Costs

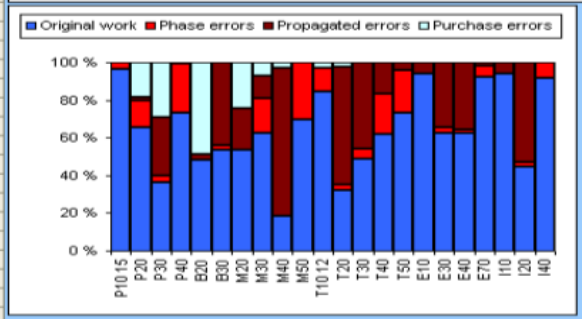


Discipline stage

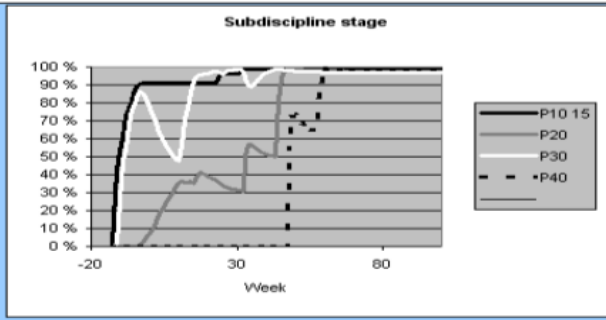


Discipline work hours

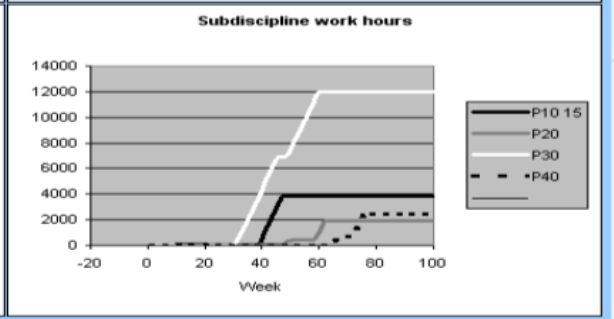




Subdiscipline stage



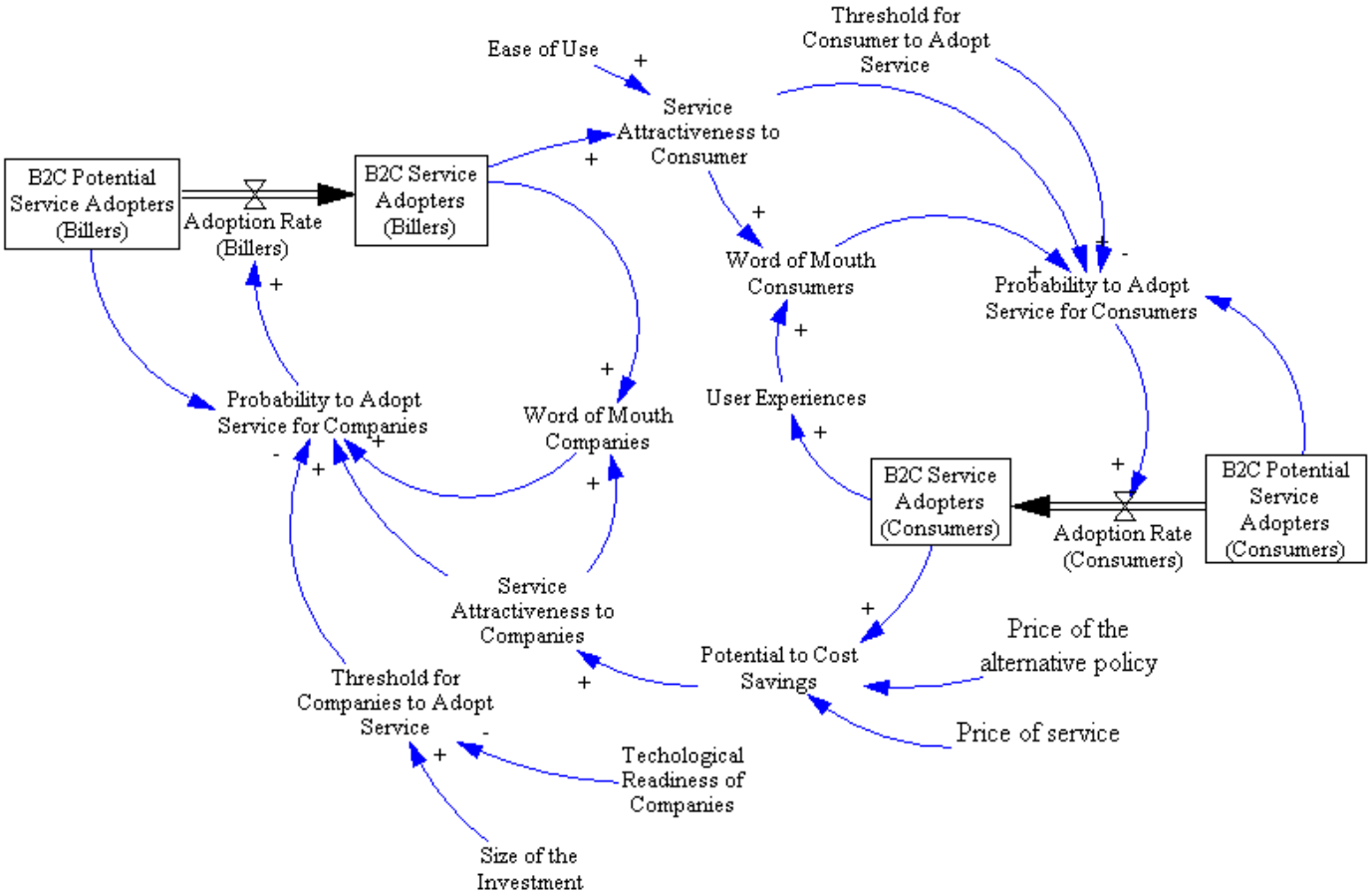
Subdiscipline work hours



Sheet1 | Sheet2 | data | Scope | Prerequisites | Purchasing | Offices and employees

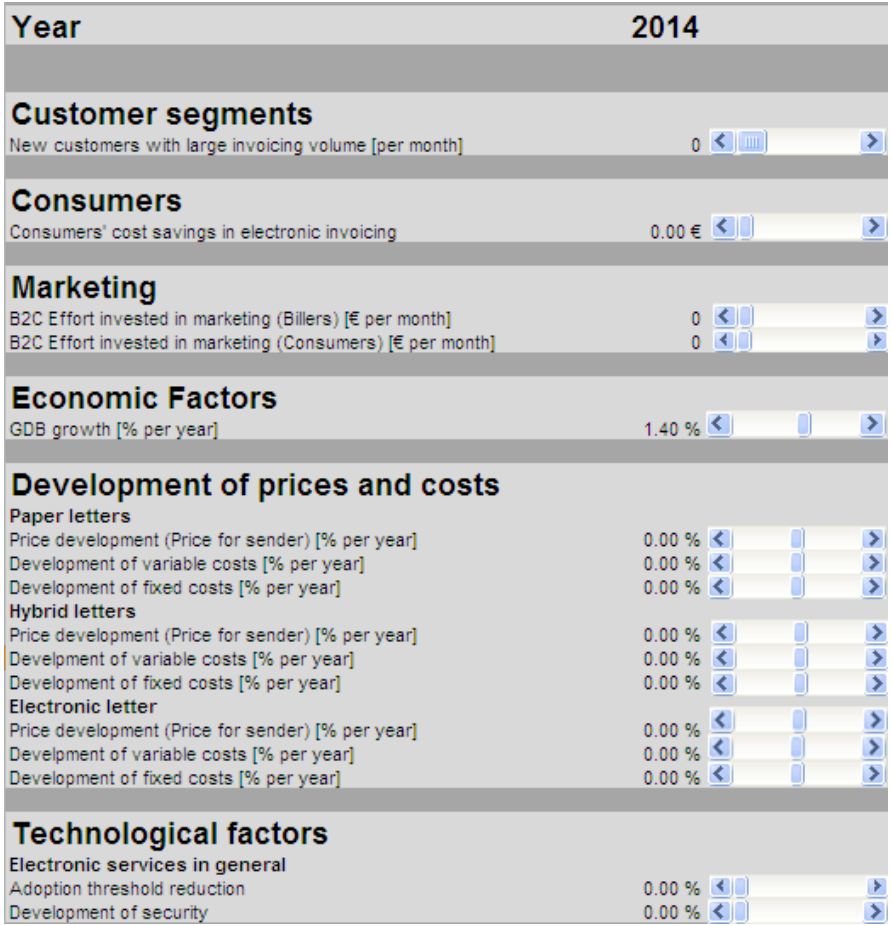
Case Itella – electric billing

Simplified system dynamics model of B2C sector



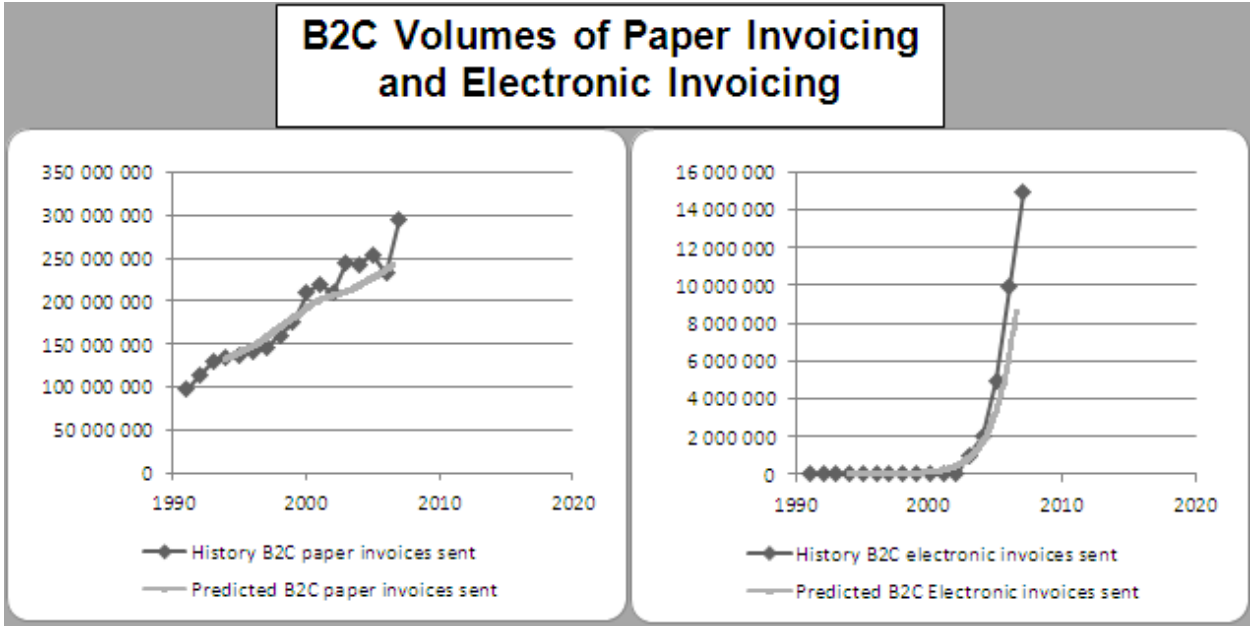
Excel user interface

Excel UI makes it possible to generate scenarios with different policies and assumptions



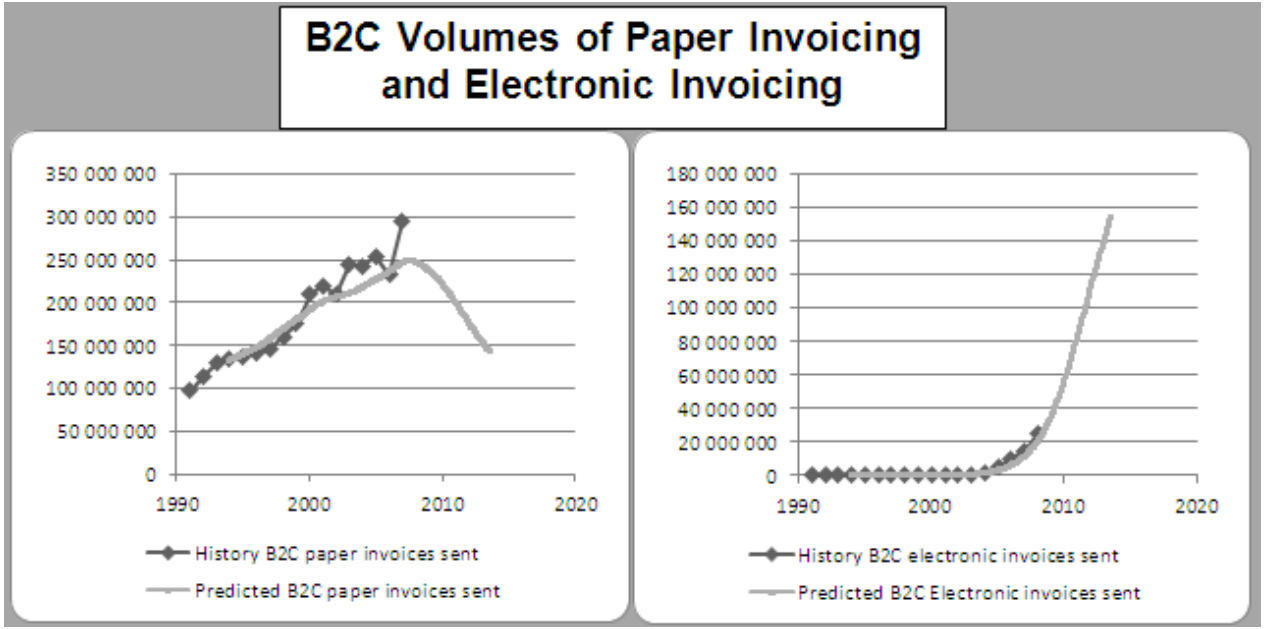
Year	2014
Customer segments	
New customers with large invoicing volume [per month]	0
Consumers	
Consumers' cost savings in electronic invoicing	0.00 €
Marketing	
B2C Effort invested in marketing (Billers) [€ per month]	0
B2C Effort invested in marketing (Consumers) [€ per month]	0
Economic Factors	
GDB growth [% per year]	1.40 %
Development of prices and costs	
Paper letters	
Price development (Price for sender) [% per year]	0.00 %
Development of variable costs [% per year]	0.00 %
Development of fixed costs [% per year]	0.00 %
Hybrid letters	
Price development (Price for sender) [% per year]	0.00 %
Develpment of variable costs [% per year]	0.00 %
Development of fixed costs [% per year]	0.00 %
Electronic letter	
Price development (Price for sender) [% per year]	0.00 %
Develpment of variable costs [% per year]	0.00 %
Development of fixed costs [% per year]	0.00 %
Technological factors	
Electronic services in general	
Adoption threshold reduction	0.00 %
Development of security	0.00 %

Calibration



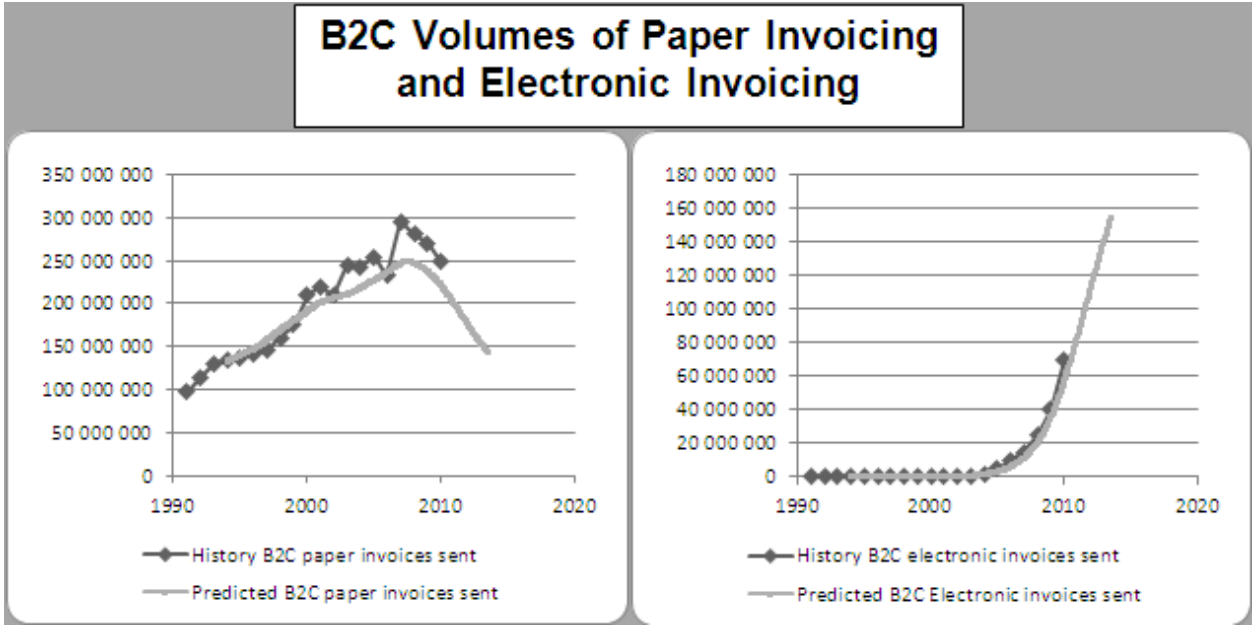
- B2C sector

Prediction



- B2C sector

Validation



- B2C sector

Case ABB Managing Project Competences

Flexible, global, and cost efficient – A new approach to developing a dynamic service competence base

Case ABB Marine

How to serve customers efficiently and sustainably in a complex business environment?

The approach turns a snapshot view into a management flight simulator to test what if without the risk of wrong decisions

First, the approach involves competence mapping.

-5 different competence systems
-2900 marine-specific skills
-200 service engineers mapped and total of 50 000 skills recorded

Second, the approach involves business analysis.

-competence charts
-resource utilizations
-customer needs and drivers

Thirdly, the approach involves dynamic modelling of the global competence base

Combined with other managerial and IT related factors, the approach supports better planning of competence development and manning policies.

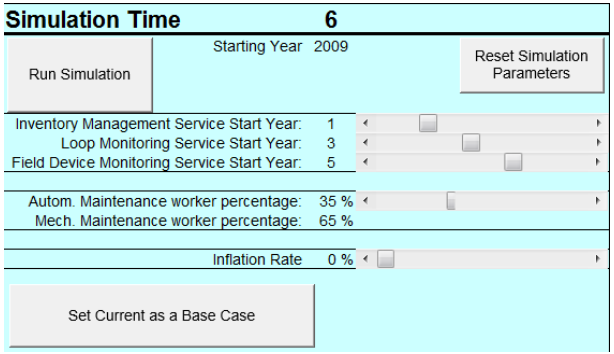
- More flexible service competence base
- More cost efficient service operations
- Right skills in the right place for the customer

"We got a better view of our business, the mobility of service engineers, where service centers can ask for help, and a lot of information on what was previously unknown"

Jukka-Pekka Hellgren, ABB Global Competence Manager

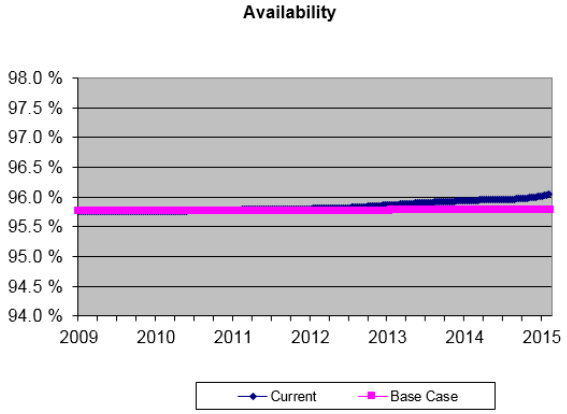
Case Metso Service Product development

Metso: Tools for Selling Outcome

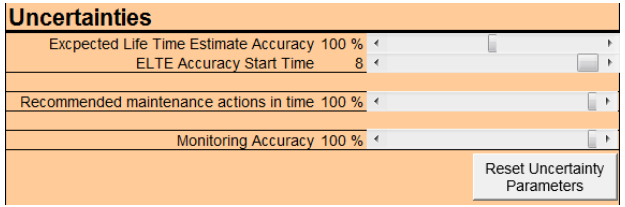


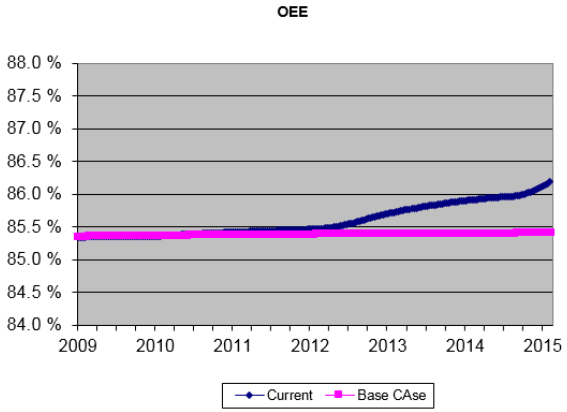
Visualising the impact of different offerings:

- Inventory management
- Loop monitoring
- Field device monitoring



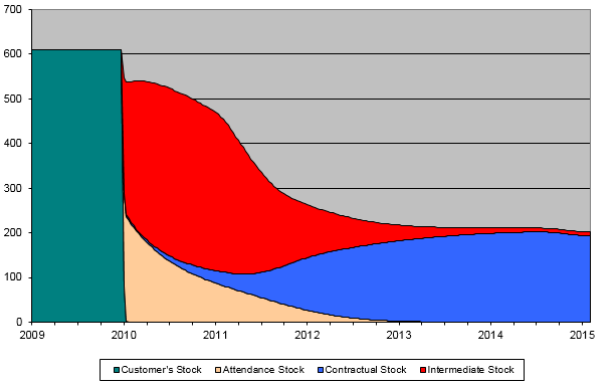
…under various uncertainties…





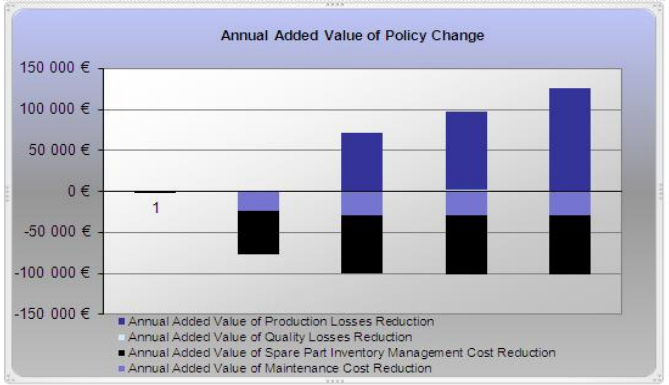
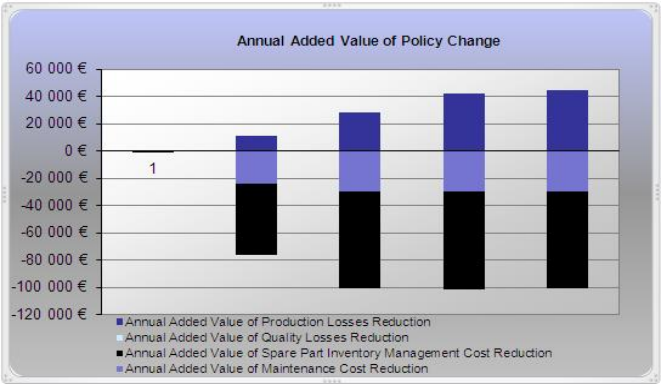
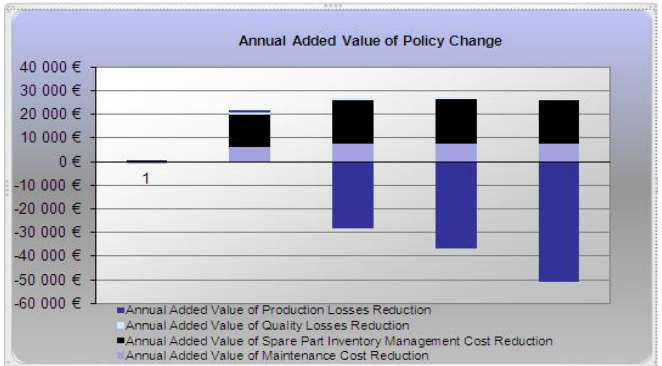
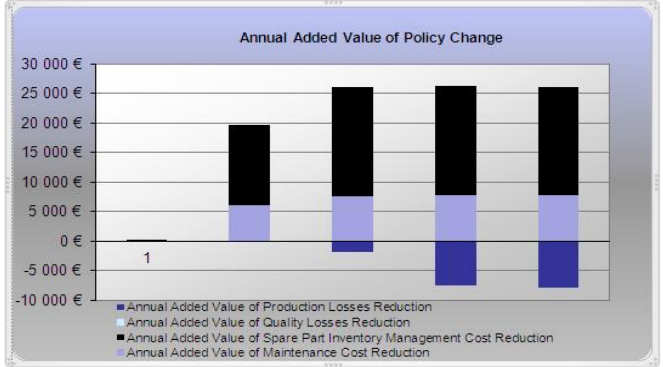
…and operative (maintenance) outcomes

for instance – Inventory management costs



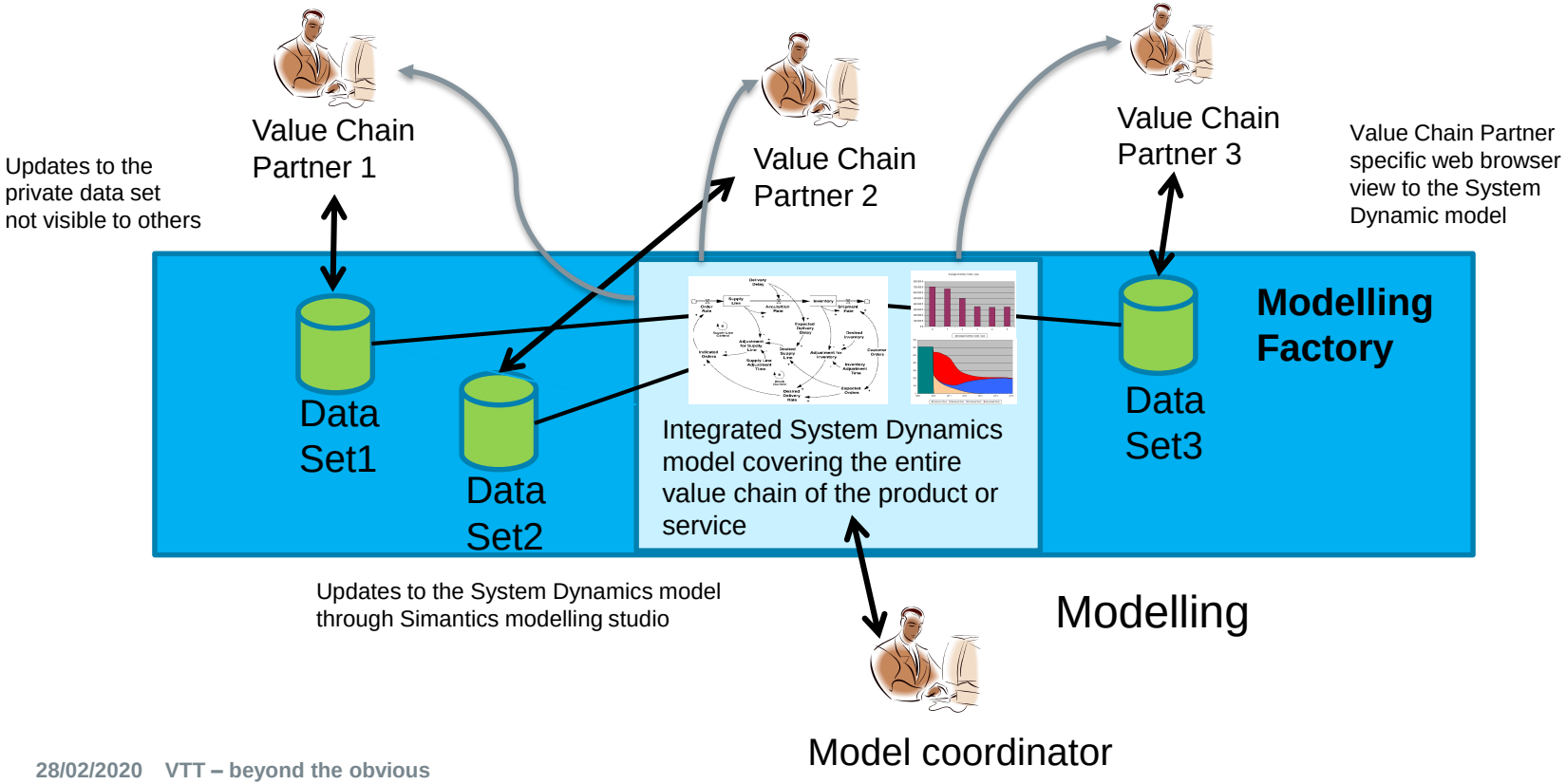
Scheduled maintenance interval & end product market price

Added value of policy change at year 2 (length of maintenance interval). 5 year simulation.

	Market price of end product unit 900$	Market price of end product unit 500$
Policy change: Shorter scheduled maintenance interval (after 1st year)		
Policy change: Longer scheduled maintenance interval (after 1st year)		

Challenges

Modelling Factory approach – For sharing confidential data



Some applications

- Digital platform ecosystem orchestration
- Digital twin of business
- Computational metrics
- Optimization under uncertainties
- Development of complex ecosystems
- Planning of future city
- Regulation and service development
- Business and agreement disputes
- Decision support for strategy and large investments

Thank you for interest

Peter Ylen
Peter.ylen@vtt.fi
+358 40 507 7474

Systemic approach requires understanding of complex systems, diverse factors and their interlinkages

Business related factors

- VALUE NETWORKS
  Customers, stakeholders, suppliers partners
- MARKET/EXCHANGE CONDITIONS:
  Customer problem; need
  Price level
- MARKET STRUCTURE:
  Competition, turbulence,
  Emergent vs. established

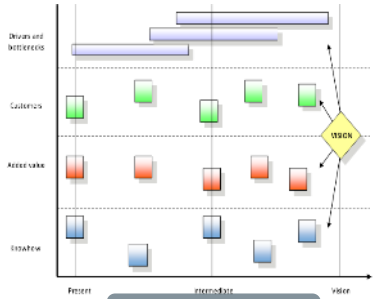
Socio-cultural-regulation related factors

- POLITICAL AND REGULATIVE FEATURES:
  National vs. municipal-level
- MINDSET
  Awareness on outcomes, attitudes
- SYSTEM IOF INFORMAL CONNECTIONS
  Interpersonal and organizational relations, trust, quality of relationships
- RESPONSIBILITY
  Social and environmental sustainability, equal treatment
- REPUTATION
  Brand image

Technology related factors

- TECHNOLOGY DEVELOPMENT MODE/PACE
  Maturity; speed; alternatives
- CURRENT INFRASTRUCTURE
  Manufacturing, logistics, energy etc.
- TECHNOLOGY COMPETENCES
  Education, R&D mindset, know-how
- DATA AND SENSORS
  Data, analytics, KPI metrics

From foresight to strategies



Internal choices

Horizon scanning

- What are the main trends and weak signals in the ecosystem?
- Technology horizon

Network mapping

- Who are our key stakeholders and partners?
- Stakeholder segments and future needs

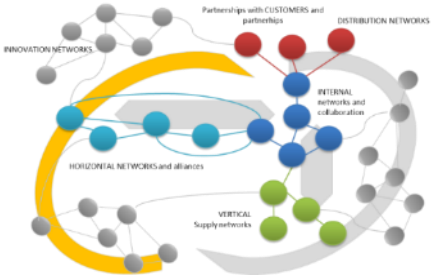
Risk analysis

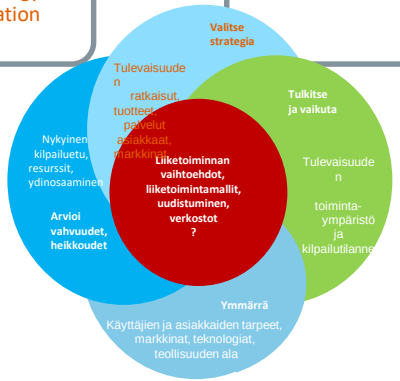
- What are your weak spots?
- What are the emerging opportunities?
- Key technology and application areas

Strategy radar
Vision

- What are our choices, new operation models?
- Action plans, implementation paths, capabilities

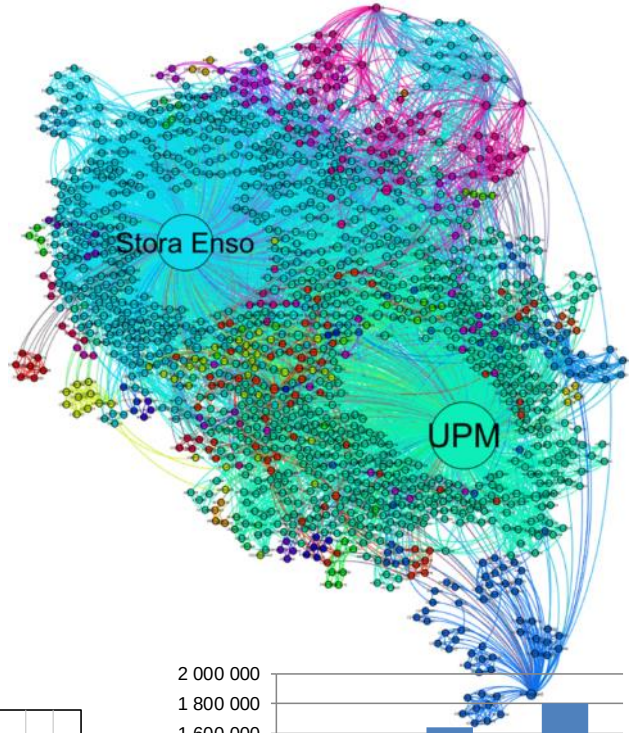
External trends

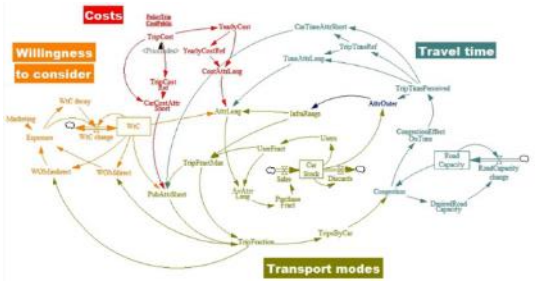


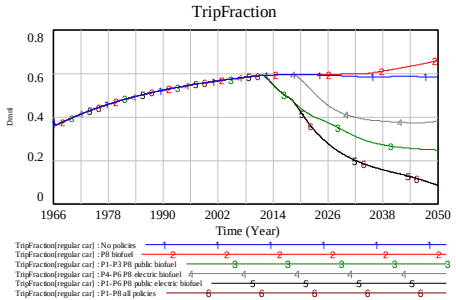


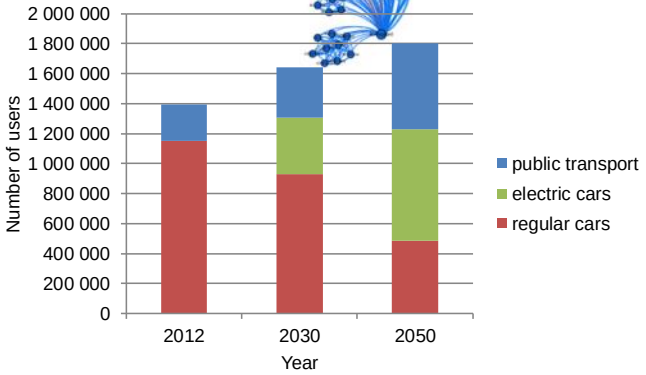
Quantitative methods

- Data mining
- Econometrics
- System dynamic simulations
- Organizational culture evaluation
- …



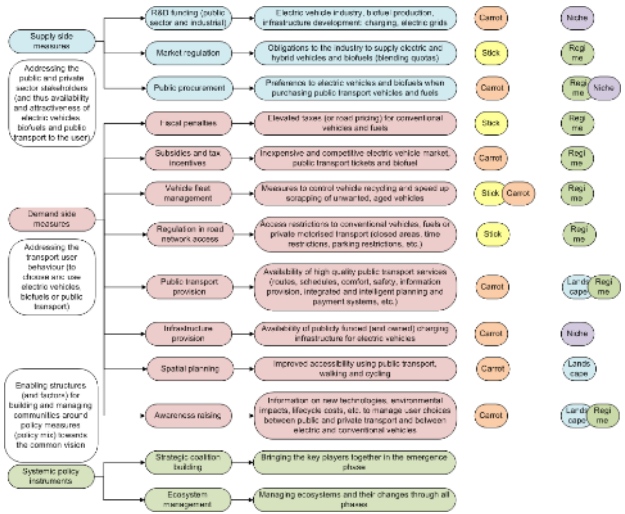


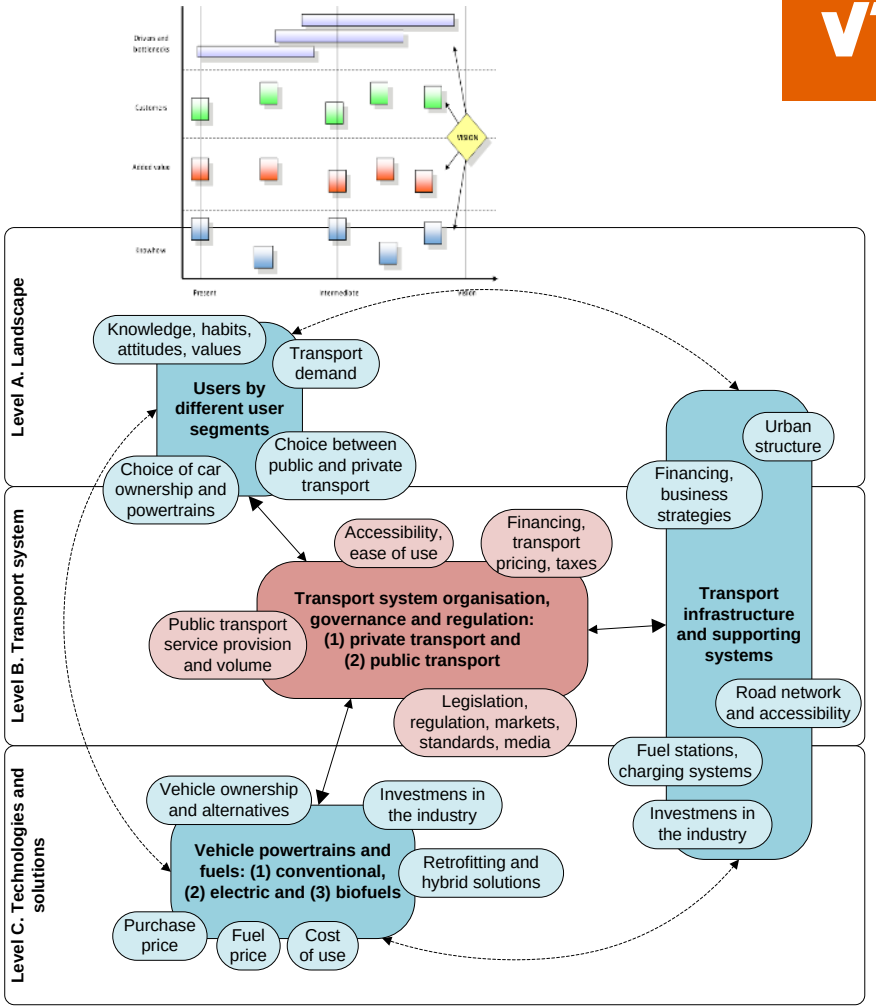




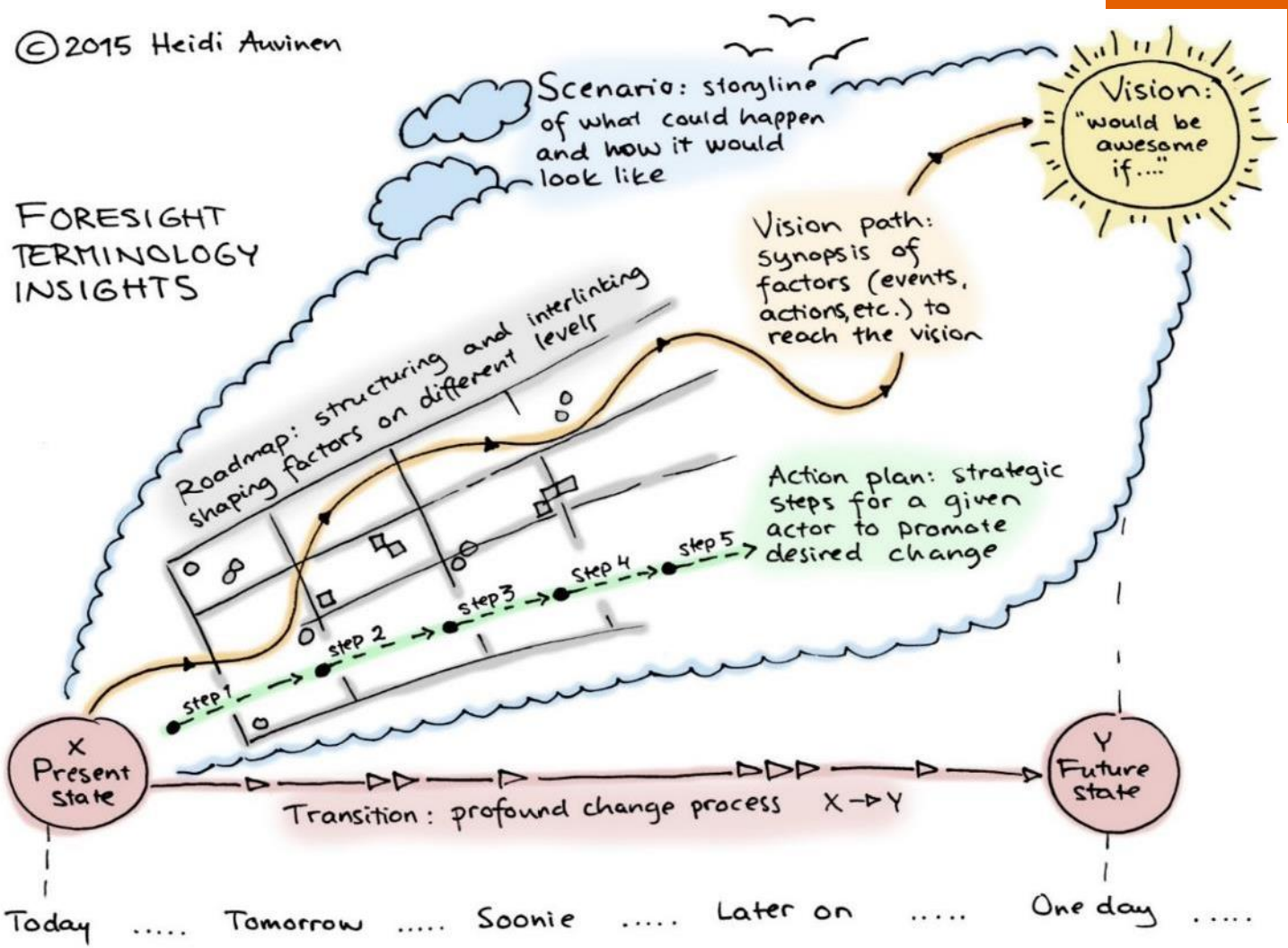
Qualitative methods

- Roadmaps
- Workshops
- structural assessment
- …

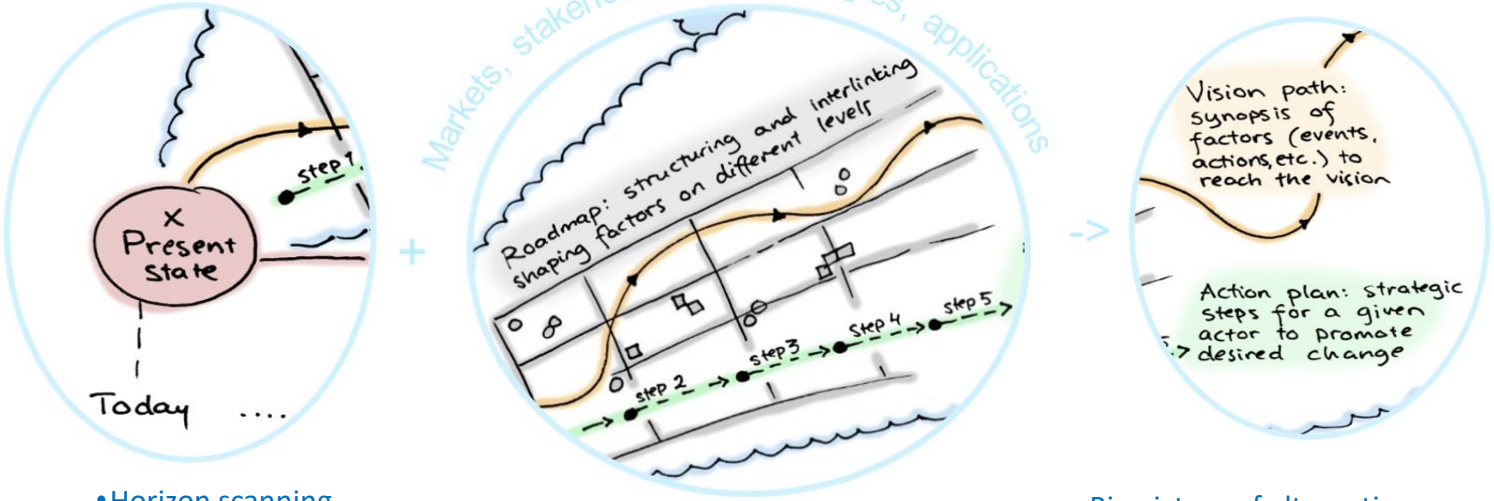




Foresight terminology



Creating understanding through foresight



- Horizon scanning
- Trend analysis
- Market insight
- Stakeholder mapping
- Value network analysis
- Expert assessment
- Innovation landscape
- Technology audit

- Interviews, vision and roadmap workshops, business modelling

- Big picture of alternative pathways
- Recommendation for policy actions
- Development steps and focus areas for technology commercialisation

Methodologies support the systematic and forward-looking analysis of following dimensions towards vision

Markets and business ecosystem

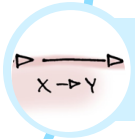
Trends, customer needs, business insight, key players in research and industry

Technologies

Technology readiness level, technology opportunities, rival technologies, applications

Competences and capabilities

Technology knowledge, customer understanding, networking, solution providing, management & leadership, international sales skills



Transformation process and resources

Practices, funding sources, innovation system

Impacts

Economic growth, new business, socio-cultural changes, new jobs & entrepreneurship, knowledge sharing, new competences

Case example: Sustainable urban traffic

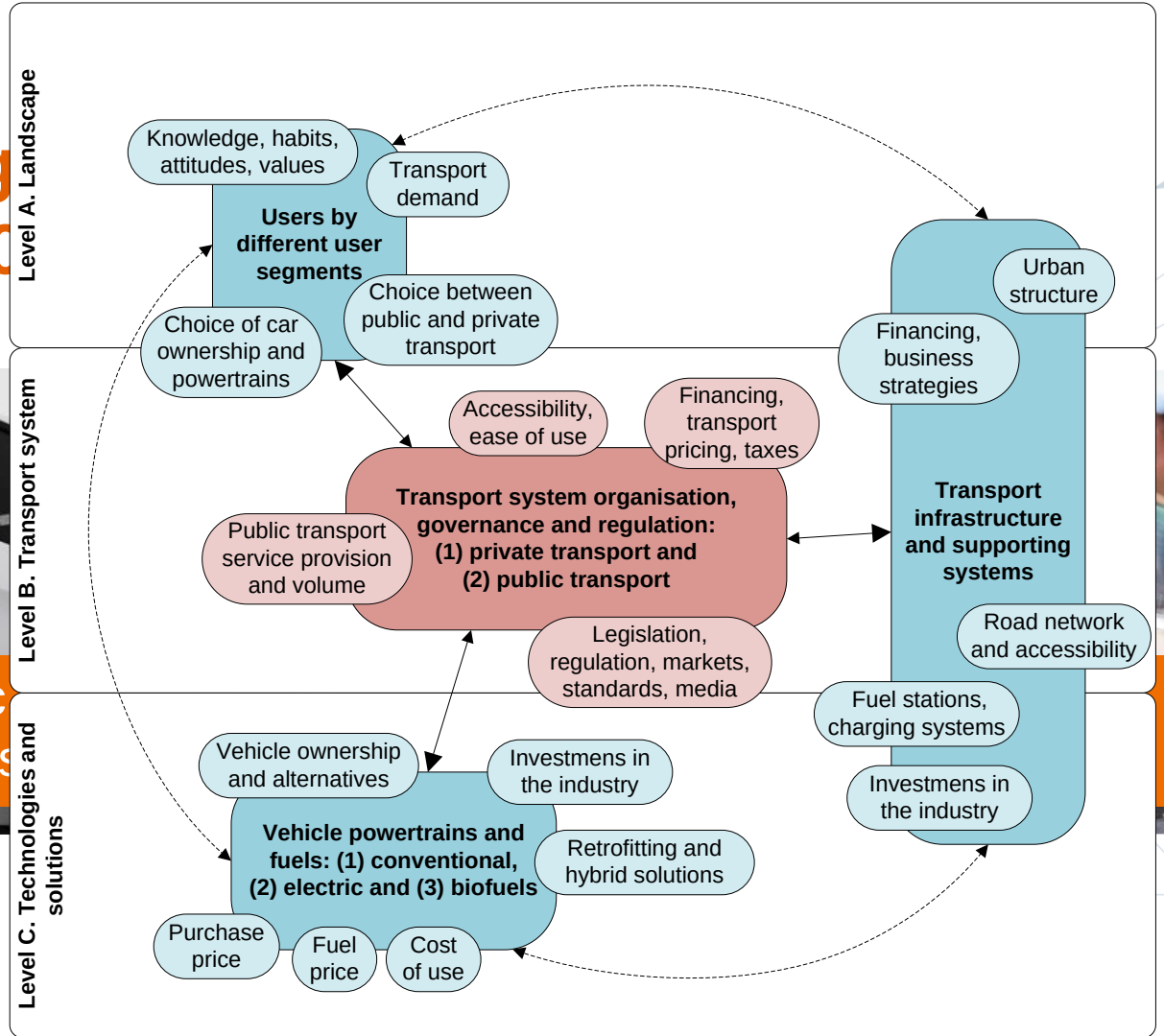
Target: Emission free urban transport 2050

Target: Emission free urban transport 2050

Targ
2050

Electric vehicles

Public transport



BIOFUELS VISIONPATH

Emission free transport in cities 2050 enabled by biofuels

	Phase 1. Emergence	Phase 2. Diffusion	Phase 3. Consolidation
Landscape	Congested traffic Noise Dependency on fossil fuels Climate change Air quality	Changes in energy and electricity production Development of electric grids Development of urban and societal structures Production of fuels, local and global directions European Strategic Energy Technology Plan (SET)	Changes in the structures and operations of governance User population electric vehicles User-driven policy practices in biofuels at the local scale Realisation of Europe-level bioeconomy strategy
Transport system	Transport white paper Changing transport policies Emission trading Market and price mechanisms	Constructing specific legal frameworks for biofuels Public procurement I Public procurement II Public procurement III Subsidies and tax incentives Policies building on comparative and absolute advantages Seven axes of EC's biofuel policy (see EU strategy on biofuels, 2006) Certification of fuels, standardisation Coalition building among energy providers and vehicle industry Building sustainable ad ethical land use policies for production of biofuel feedstock	Emission free transport in cities by biofuels
Technologies and services	Adapting and accessorising the existing infrastructure Hybrid and full electromobility technologies Catalysators, purification technologies Battery technologies	Systems and solutions based on biofuels Biofuels Development of second generation biofuels, e.g. lignocellulosic biofuels Development of conversion processes Technologies for thermo-chemical and bio-chemical conversion routes to biofuels production Development of biorefinery concepts Full electric vehicles	Embedded, intelligent infrastructures Hydrogen vehicles Specialised charging infrastructure and vehicle stock for electromobility

Urban structure

ansport
astructure
supporting
ystems

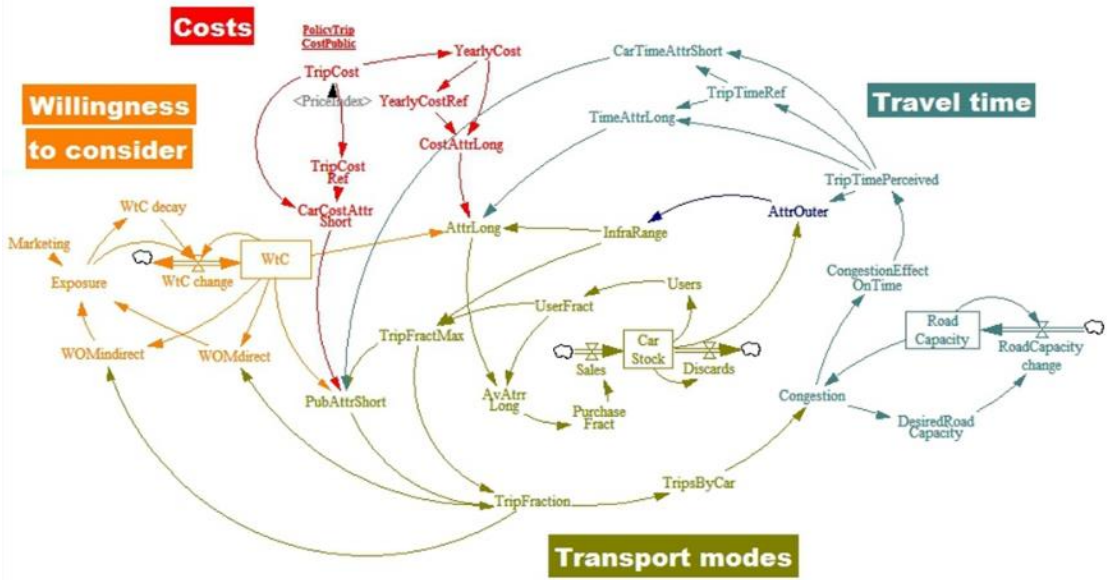
Road network and accessibility

ns,
tems

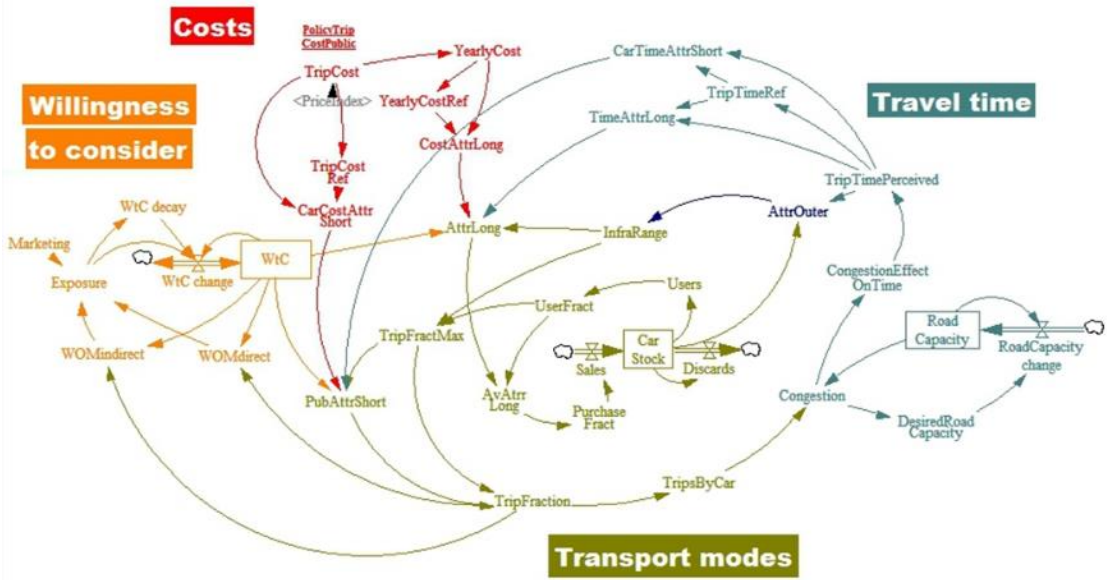
ns in
ustry

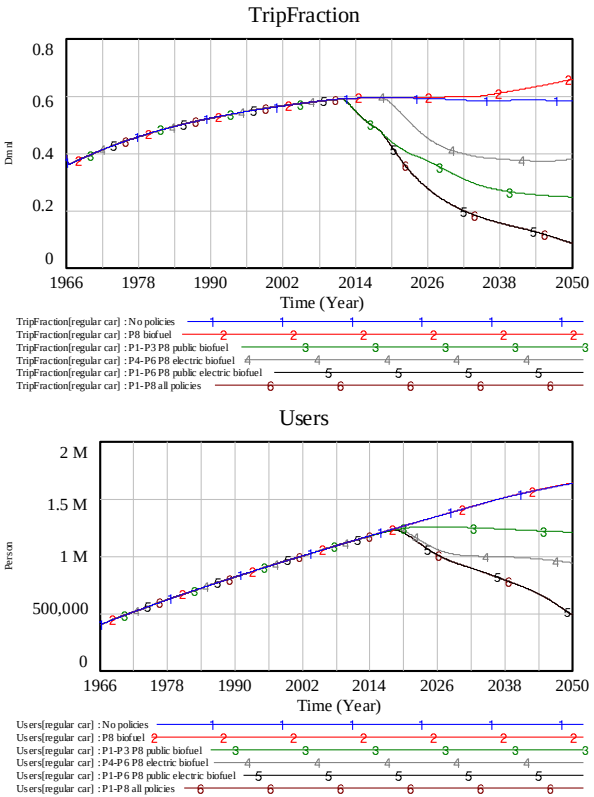
Public transport

Simulations

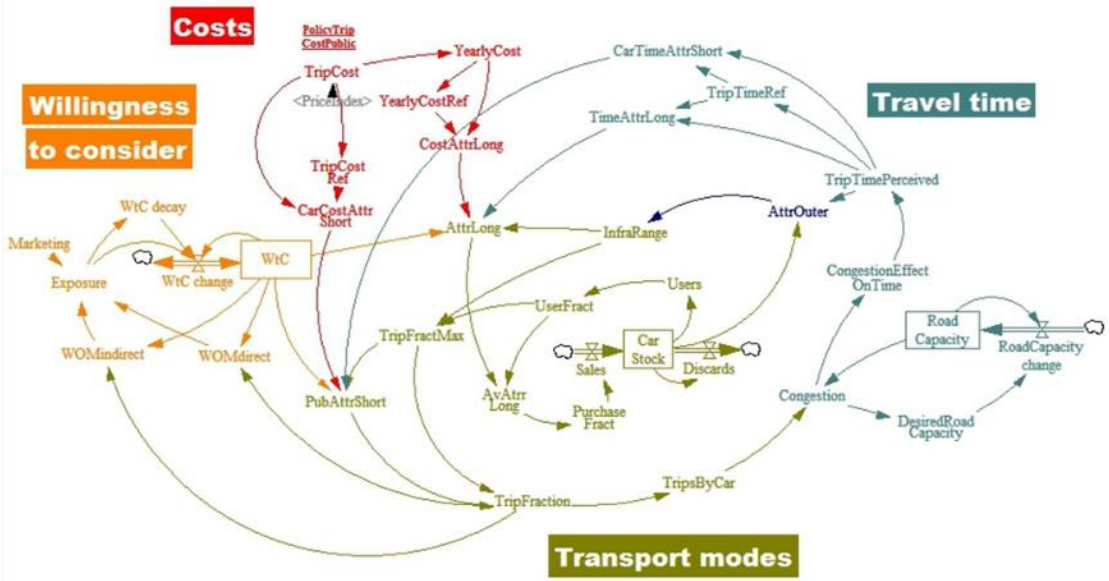


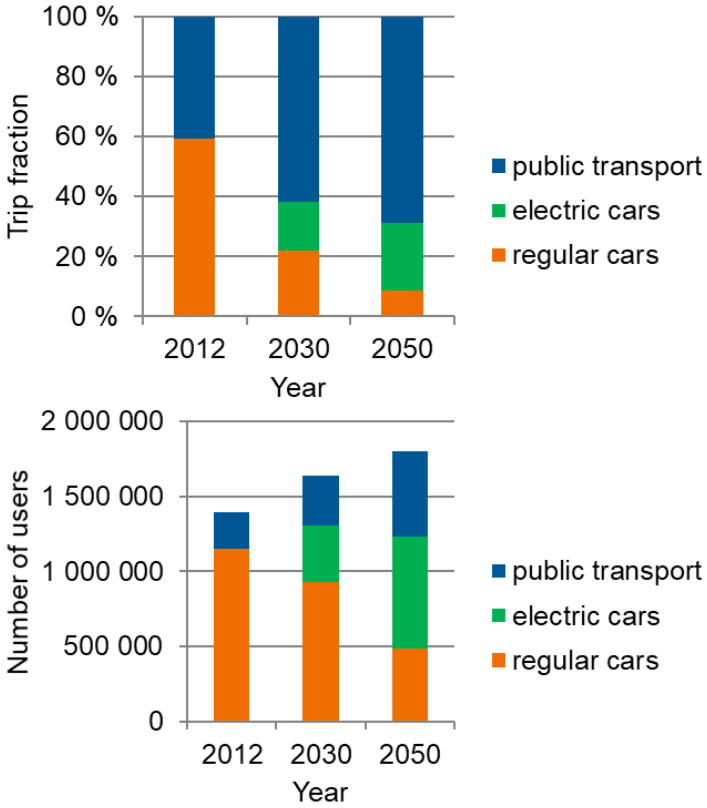
Simulations





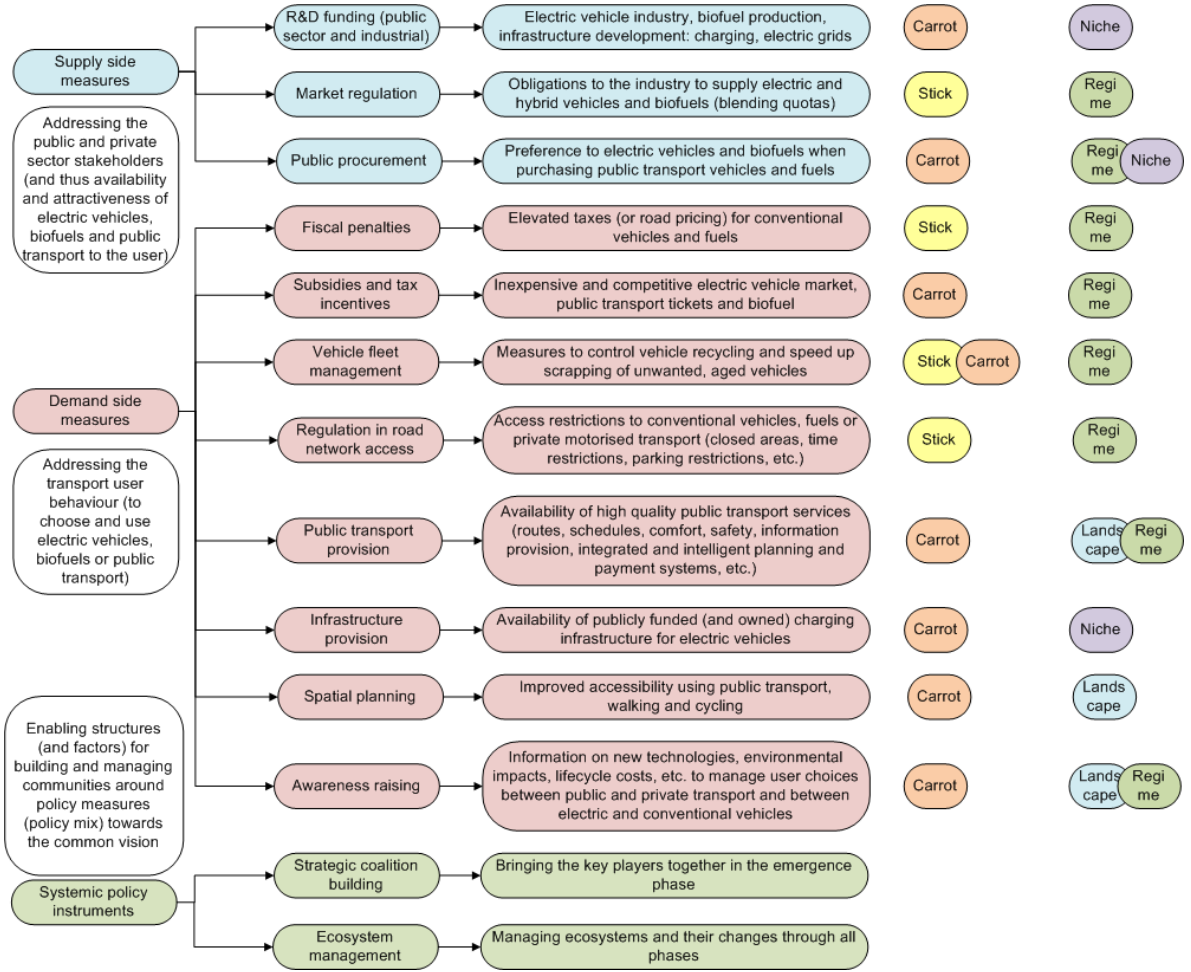
Simulations





Leverage points

Supply and demand measures for achieving the targets are analysed.



Thank you for interest

Peter Ylen
Peter.ylen@vtt.fi
+358 40 507 7474