The emergent future of engineering

a personal vision

Theo Toonen

Dean, Faculty Technology Policy Management (TPM)
Chair in Institutional Governance
Delft University of Technology
(DUT)

Technology, Policy, Management (TPM/TBM)

Multiple methods to analyse and design the dynamics of complex, emerging systems of technology, policy and management for responsible innovation

TU Delft

Faculty of Technology, Policy, Management Introduction

Facts & Figures:

TPM staff year-end 2011

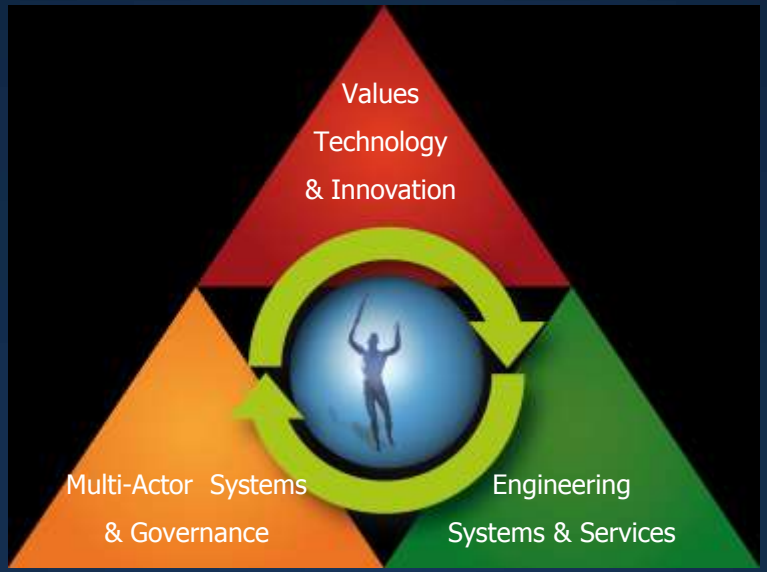
Academic staff	307
Support staff	55
Total number of employees (fte)	362

Student Intake 2011-2012

Bachelor SEPAM (TB)	199
Master EPA, MoT, SEPAM, TIL	141
Total new intake	340

Total active students:	approx. 1.200
Total PhD students:	148

TPM



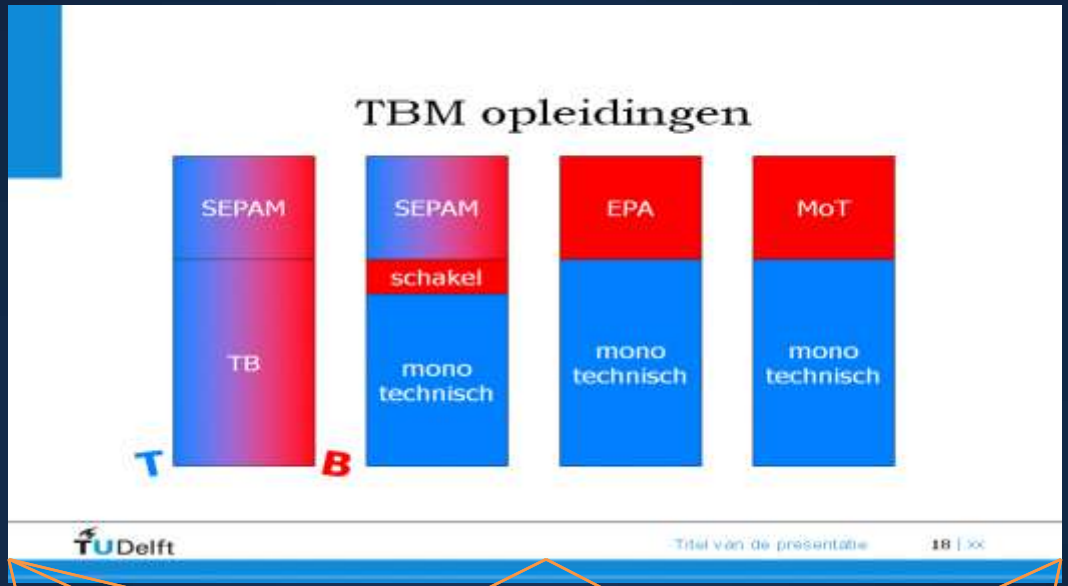
Graduate School

The perspective of the dean

ESS	MAS	VTI
ICT Mobility Energy&Industry	Participation Governance Policy	Ethics EcoTec Safety&Security
Emerging Technology, Infrastructure Development	Technology, agents & actors, Decision-making	Technology, Value, Responsible innovation

Teaching

TPM



Graduate School

The perspective of the dean

ESS	MAS	VTI
ICT Mobility InfraS&S	Systems Governance Policy	Ethics EcoTec Safety
Emerging Technology and Infrastructure Development	Technology and Decision-making	Technology and Quality of Life

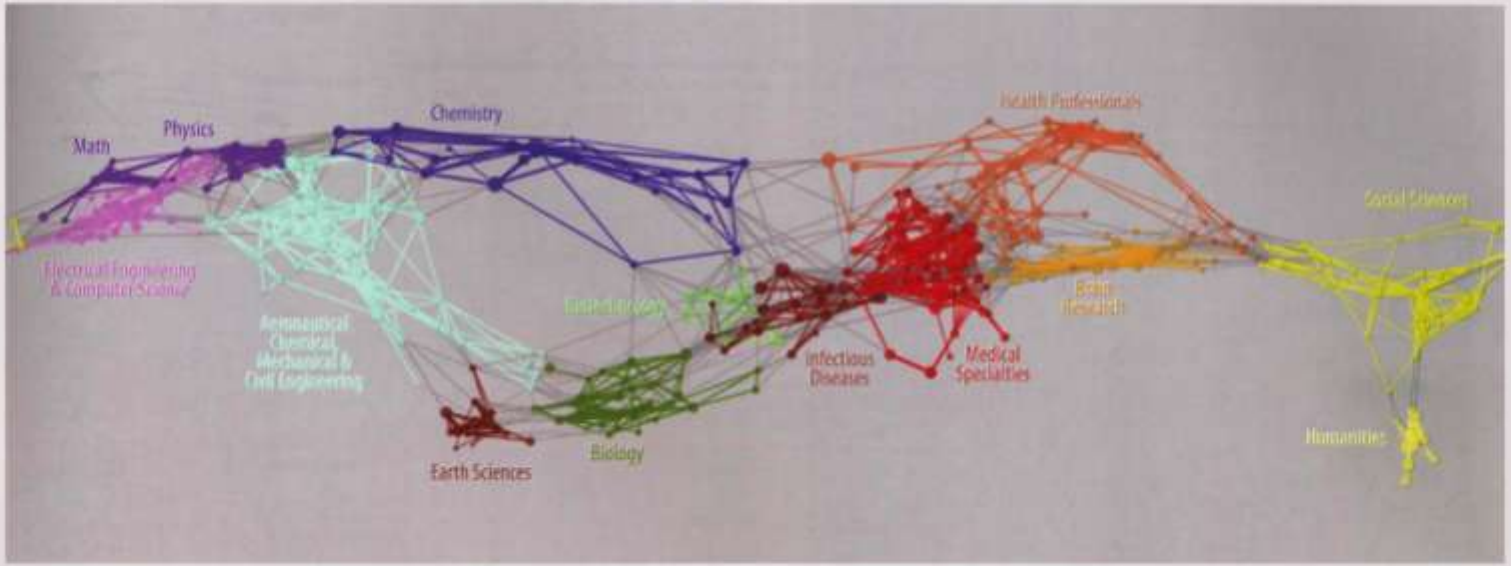
Research

Fall 2013: Re-evaluation Strategy and Portfolio

Policy, Management and Technology?

Maps of Science

A visualization of 7.2 million scholarly documents
appearing in over 16,000 journals, proceedings or symposia
between Jan, 2001 and Dec, 2005



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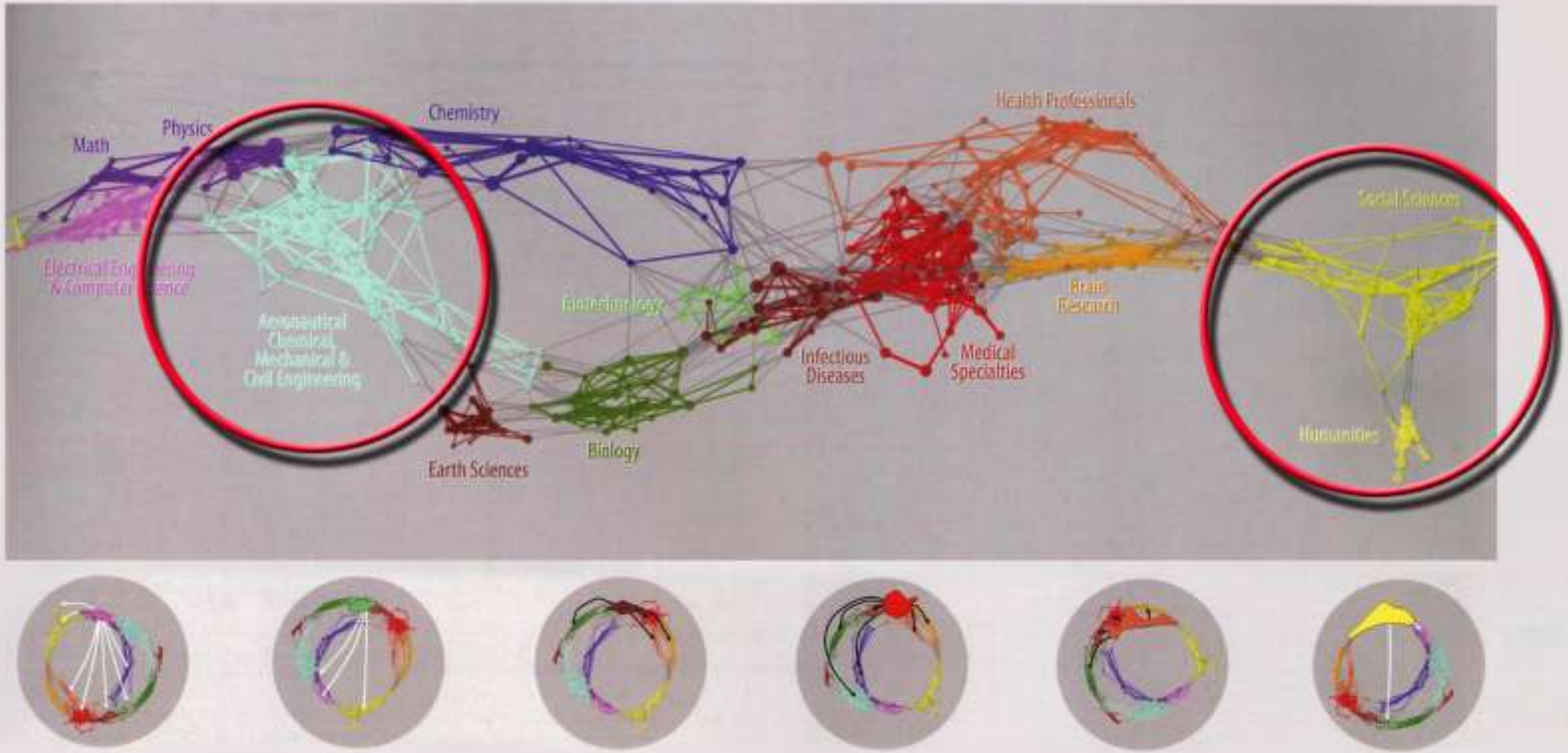
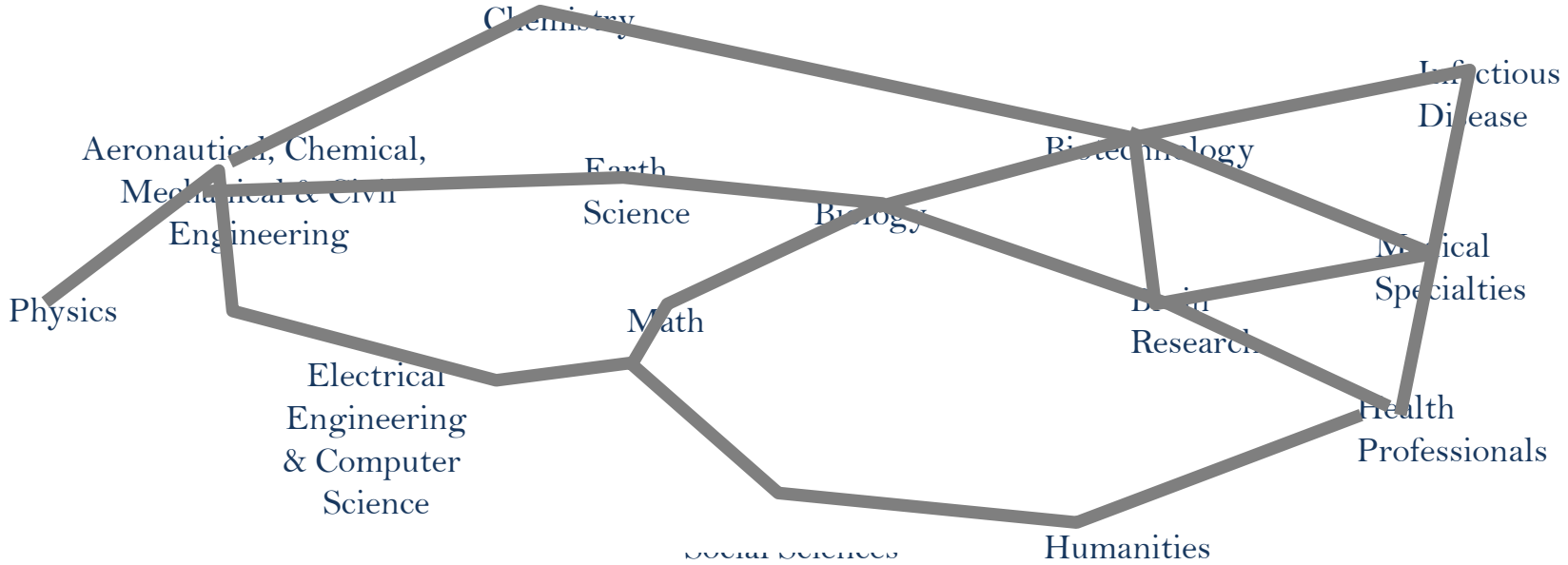
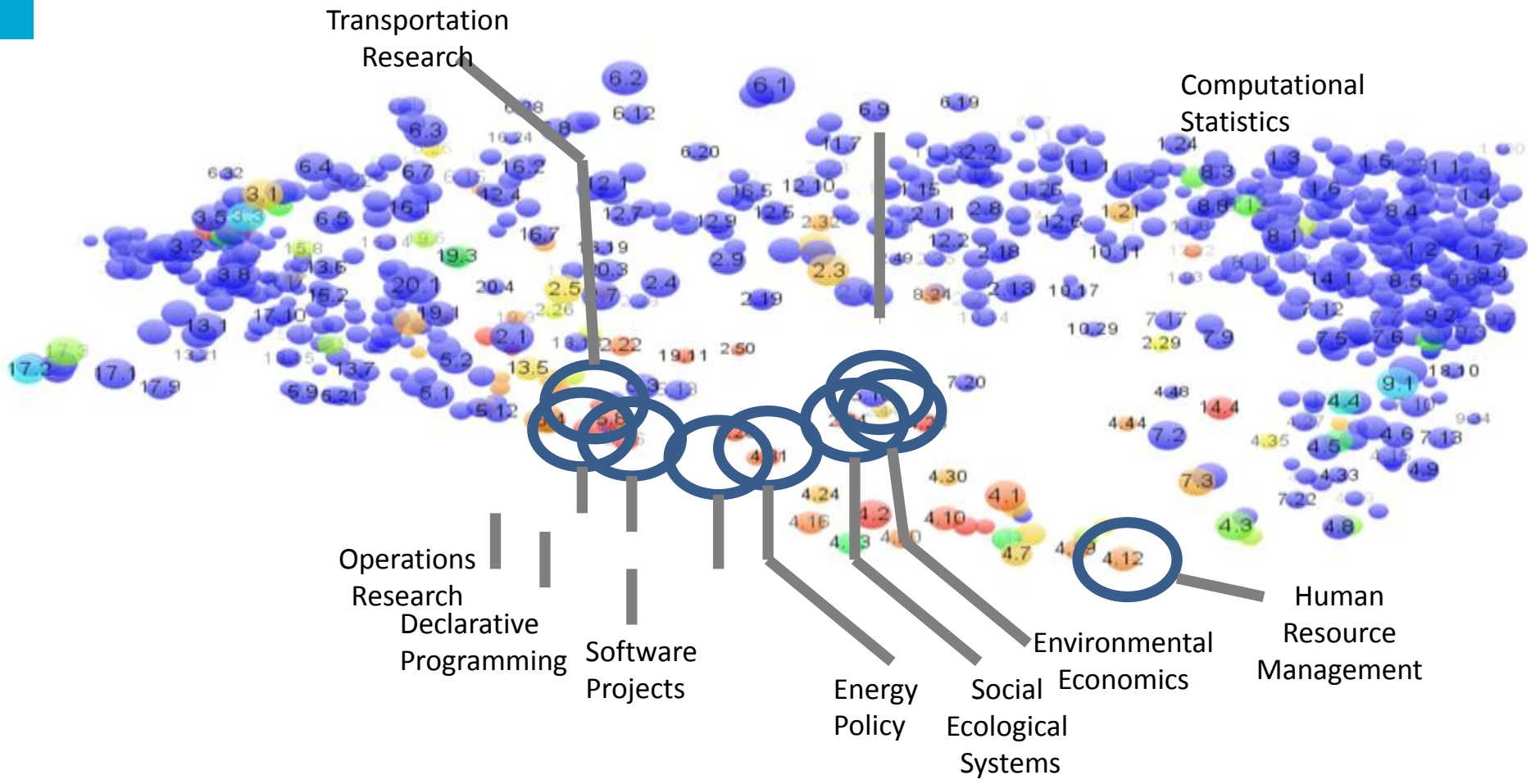
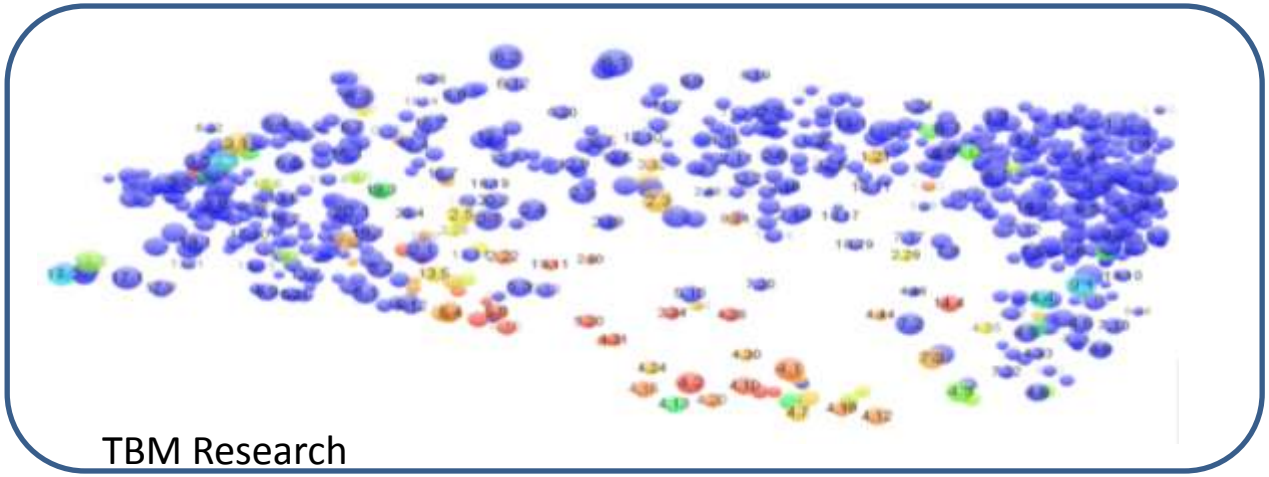


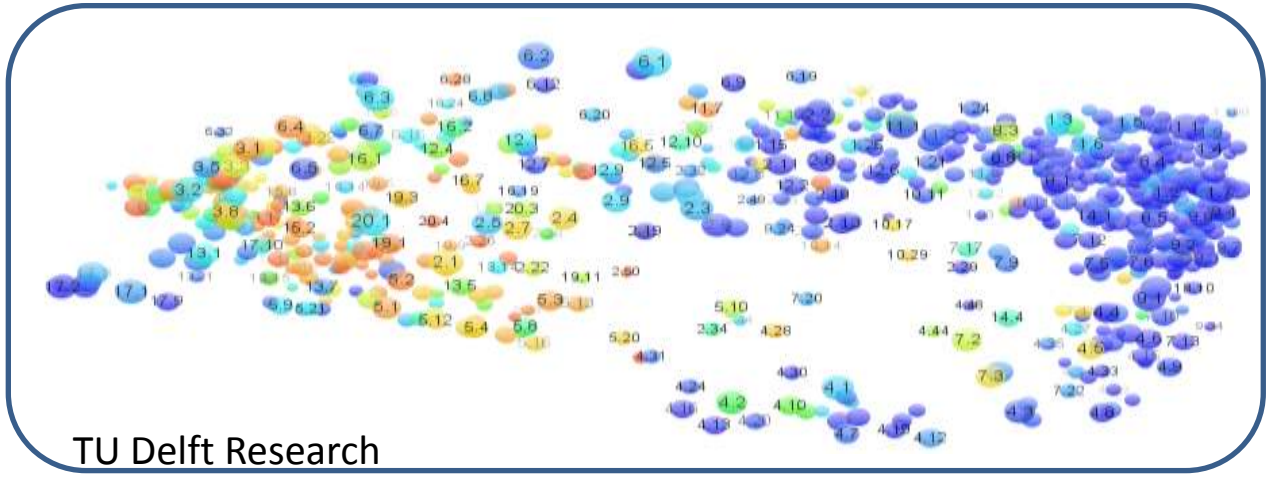
Science map of TPM




Transportation Research
Computational Statistics
Operations Research
Declarative Programming
Software Projects
Energy Policy
Social Ecological Systems
Environmental Economics
Human Resource Management



TBM Research



TU Delft Research

TPM research profile

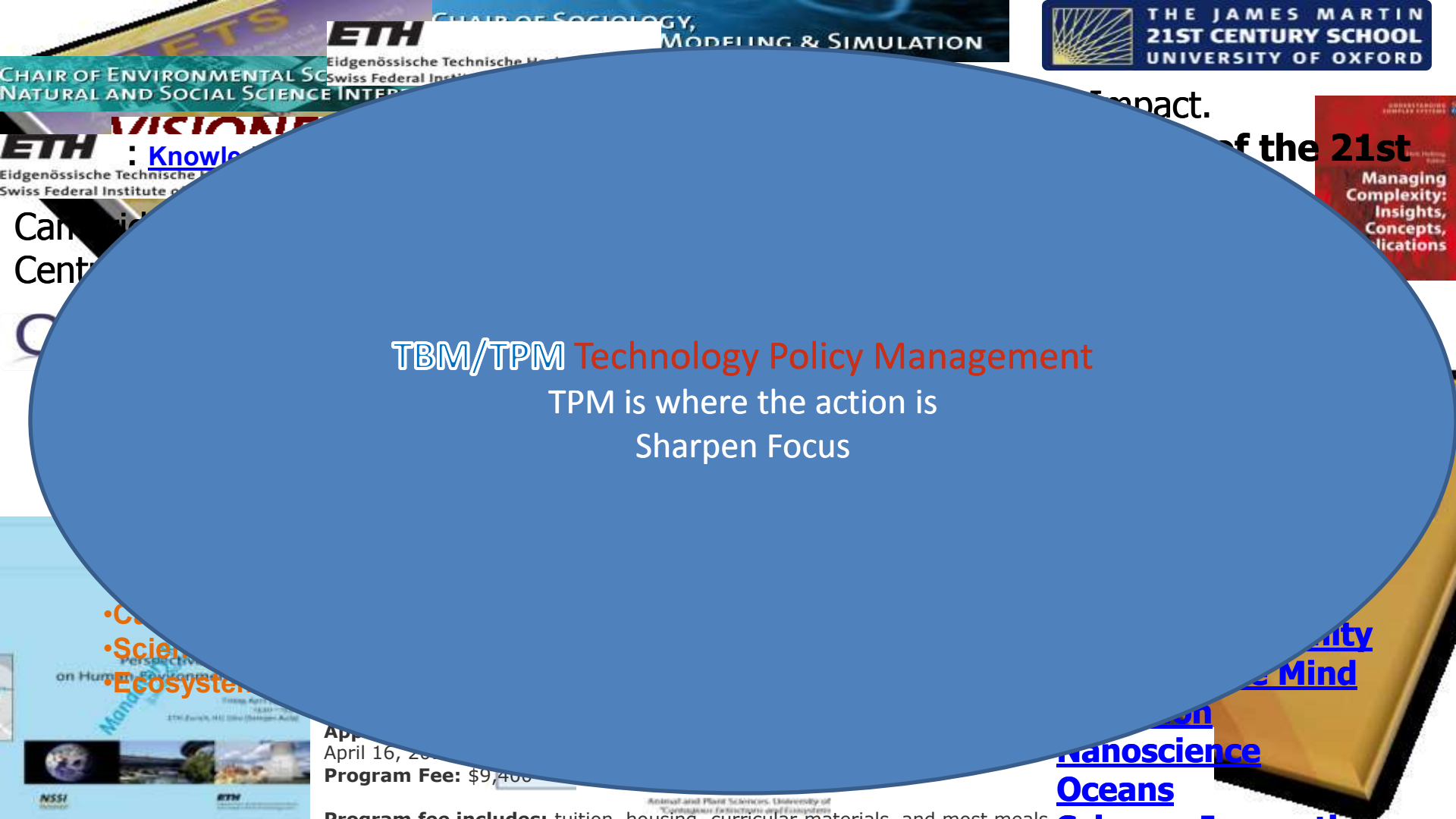
NSF Panel on Systems Engineering (March, 2013):
“Important Faculty in one of the largest Universities of Technology in the world”)

What are others saying about TPM?

It's nice to know that there is a next generation to build on what has already been accomplished. The Symposium was a major turning point for CESUN to go on to bigger and better undertakings. (Roos, MIT)

Experiences like this symposium will help CESUN to thrive, bringing the intellectual community -- younger and older -- together to explore complex socio-technical systems and contribute to their betterment. I greatly appreciate your leadership. The visit to Delft was wonderful! (Rouse, GATech)

What's happening at TPM in Delft "is the closest thing I came to a systems engineering department in this trip"; "we should do more co-publishing with them" "it is really good stuff" (Paul Collopy, NSF)


TBM/TPM Technology Policy Management
TPM is where the action is
Sharpen Focus
THE JAMES MARTIN
21ST CENTURY SCHOOL
UNIVERSITY OF OXFORD
ETH
Eidgenössische Technische
Swiss Federal
CHAIR OF ENVIRONMENTAL SC
NATURAL AND SOCIAL SCIENCE INTER
MODELING & SIMULATION
Managing
Complexity:
Insights,
Concepts,
Nanoscience
Oceans
April 16,
Program Fee:

EUROPE 2020


THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION
HORIZON 2020

EUROPE 2020

Excellent Science Base	Industrial Leadership	Societal Challenges
• **ERC:** Excellent basic research • **Marie Curie:** Excellent training and mobility • **Future Emerging Technologies** • **Research Infrastructure**	• ICT • Nanotechnologies • Biotechnologies • Space • Advanced manufacturing and processing • Advanced materials	• Health and demographic change • Sustainable agriculture and bio-economy • Clean energy • Transport • Climate Action & Ressource efficiency • Inklusive, innovative und reflective societies • Secure societies

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3 Departments: Multiple Methods Working together on the ‘Grand challenges of the urbanizing world’

Energy, resources, distributed infrastructures

Mobility, logistics, supply chains

Climate, water, urbanised delta’s

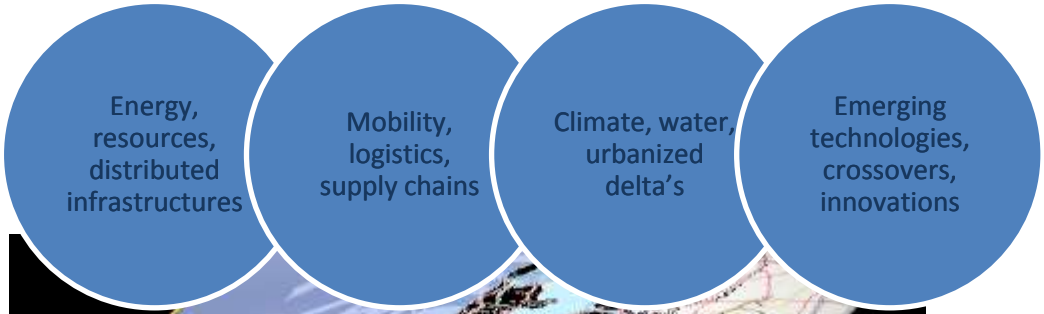
Emerging technologies, crossovers, innovations

From a perspective of

(Engineering) Systems, Values, Governance

Focus:

Locus:



Engineering Systems & Services

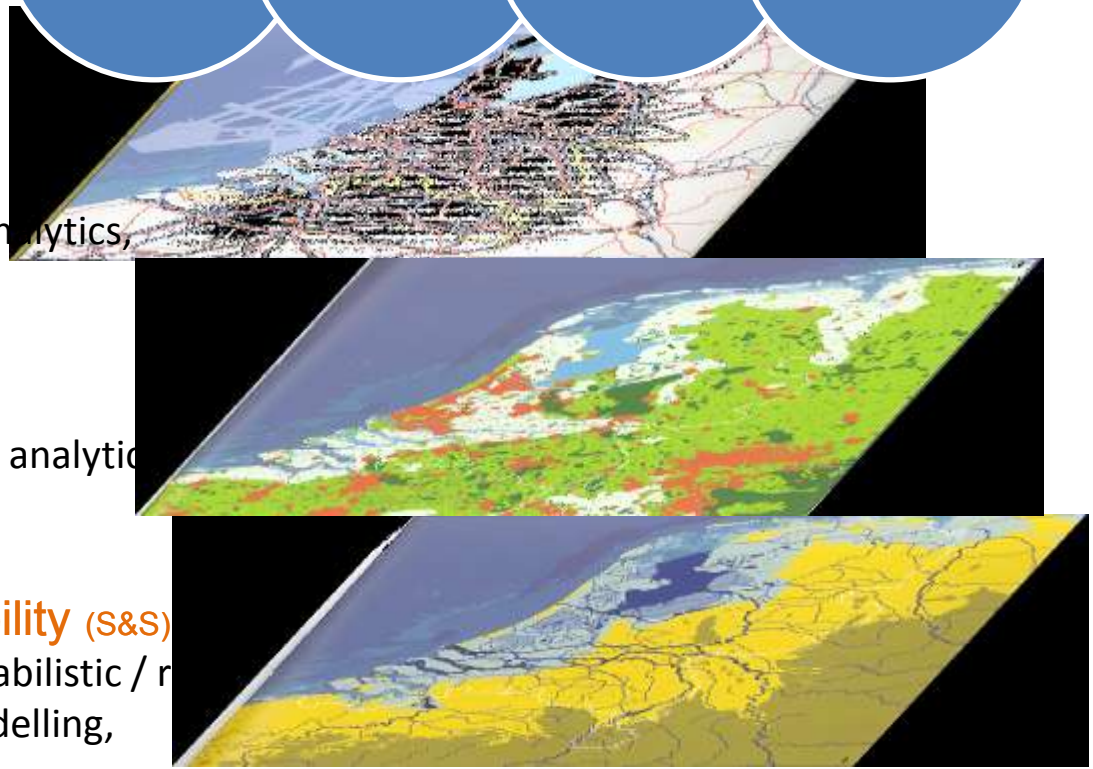
Methods: agent-based simulation and modelling, choice modelling, big data an lytics,

Governance: policy, networks, actors & agents

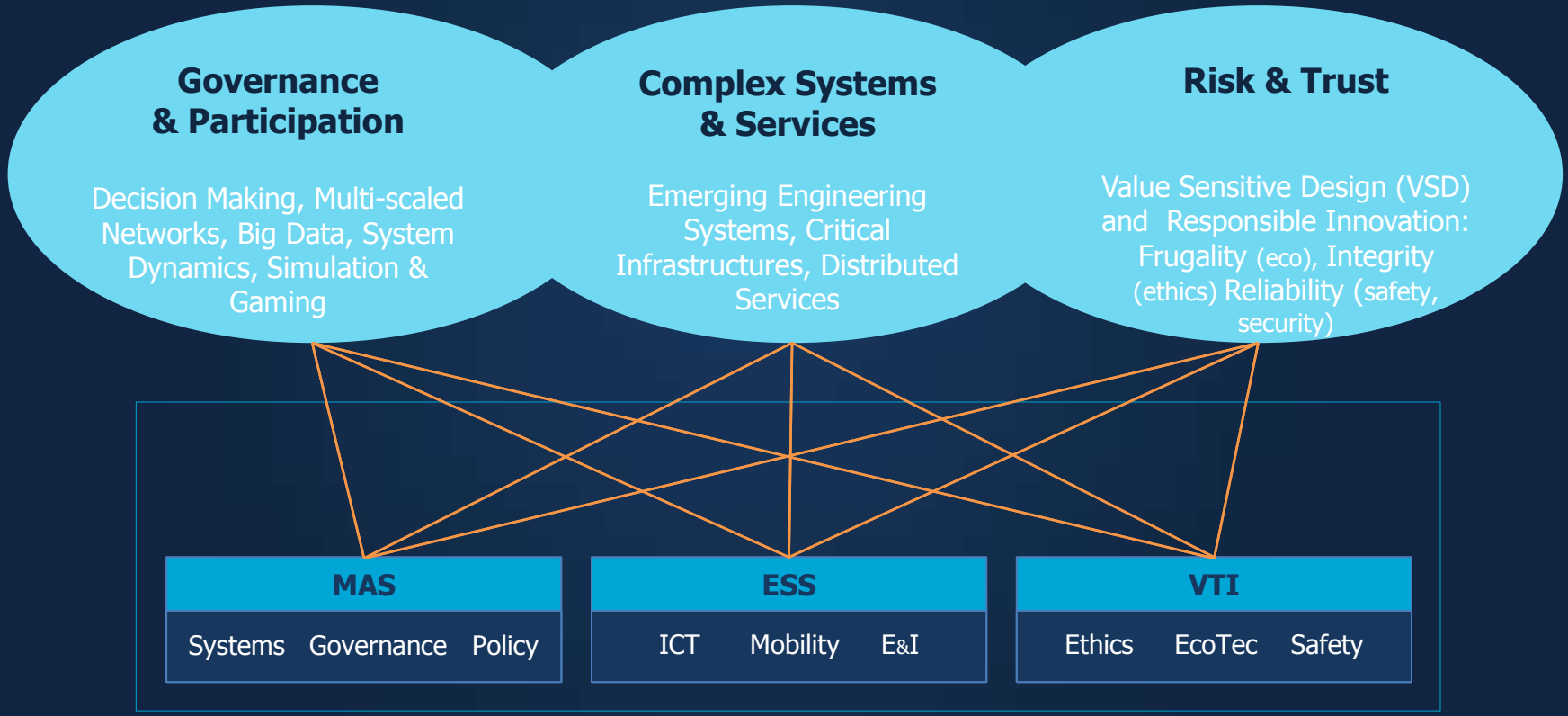
Methods: exploratory modelling, big data analytic serious gaming, multi-agent modelling

Values: ethics, economics, reliability (S&S)

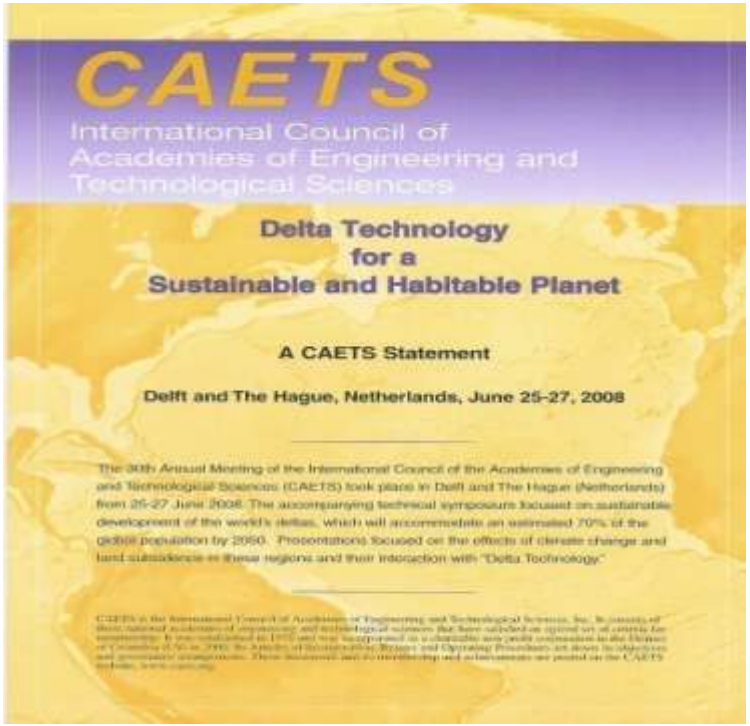
Methods: Bayesian belief networks, probabilistic / r modelling, socio-technological logic modelling,

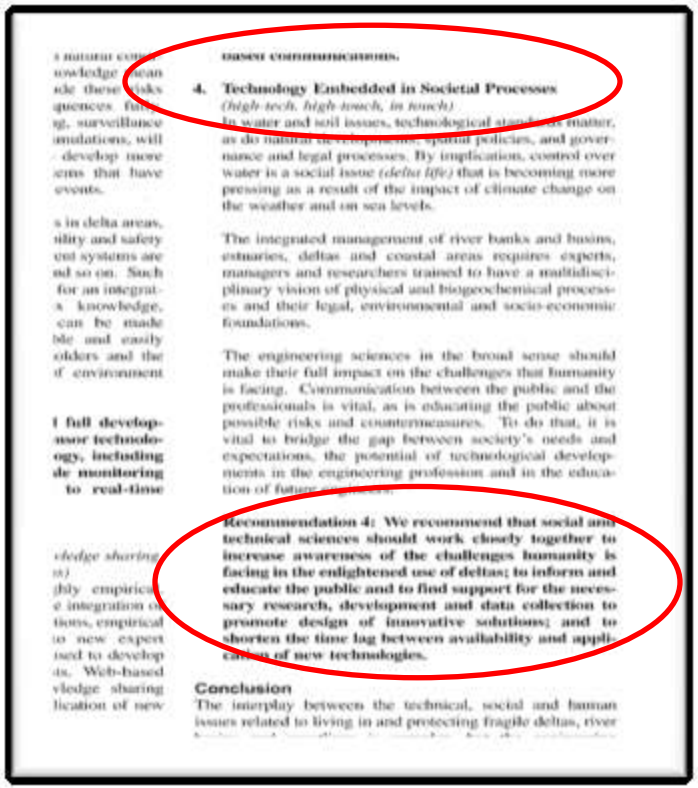


Research Development platforms



The world around us is changing





...based communications.

4. Technology Embedded in Societal Processes
(high-tech, high-touch, in touch)

In water and soil issues, technological standards matter, as do natural developments, spatial policies, and governance and legal processes. By implication, control over water is a social issue *(delta life)* that is becoming more pressing as a result of the impact of climate change on the weather and on sea levels.

The integrated management of river banks and basins, estuaries, deltas and coastal areas requires experts, managers and researchers trained to have a multidisciplinary vision of physical and biogeochemical processes and their legal, environmental and socio-economic foundations.

The engineering sciences in the broad sense should make their full impact on the challenges that humanity is facing. Communication between the public and the professionals is vital, as is educating the public about possible risks and countermeasures. To do that, it is vital to bridge the gap between society's needs and expectations, the potential of technological developments in the engineering profession and in the education of future engineers.

Recommendation 4: We recommend that social and technical sciences should work closely together to increase awareness of the challenges humanity is facing in the enlightened use of deltas; to inform and educate the public and to find support for the necessary research, development and data collection to promote design of innovative solutions; and to shorten the time lag between availability and application of new technologies.

Conclusion

The interplay between the technical, social and human issues related to living in and protecting fragile deltas, river

The ‘Societal’ Engineer

Foundations
Development
Future

TPM@ TU Delft

Foundations

- Engineering: human needs, practical solutions
- Engineering: Design and Development rather than Exploration and Understanding (fundamentally applied)
- Engineering: Metrics, Math, Models (& Simulation)
- Engineering: Variety (of prototypes) & (practical) Selection, rather than Grand Design

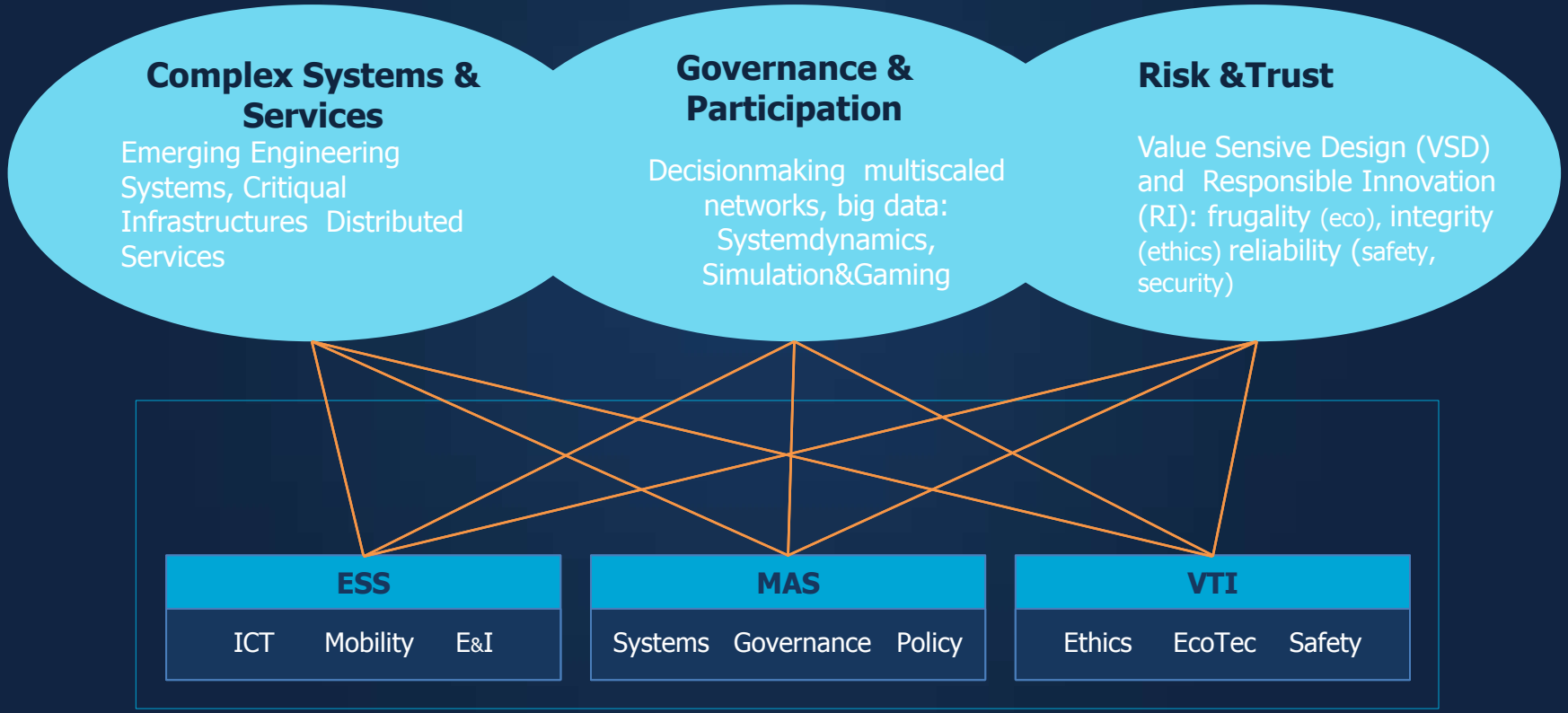
Development

- From Science-based Engineering, to **Engineering-based Science** (e.g. new materials)
- From artifacts to **services** e.g. roadsystems/traffic versus mobility: ‘from moving cars to moving people’
- From Sectors & Silo’s to (Life)Cycles and Societies **(“Systems of Systems”**)
- From Complicated to **Complex Systems**
- From Functional Requirements to Organizational structures and Incentive Systems (‘management’ of technology)

Future

- **Grand challenges**: from ‘Engineering Science’ to ‘Translational Research’
- From Project Management to (engineering) **Systems Integration**
- From Optimalisation of Functional Requirements to **Balancing** Normative (technological/societal/cultural/political) **Trade-Offs** - Value Sensitive Design and Responsible Innovation
- From Bridging the Divides to **Integrating Teams and Disciplines**
- From Technology Transfer to Leadership in Creating **Technology Based Added Value**

Research programme development and innovation: TPM Research Initiatives – Dean's interpretation (september 2013)



ESS	MAS	VTI
ICT Mobility E&I	Systems Governance Policy	Ethics EcoTec Safety

Working together:

Multiple methods analyzing the dynamics of complex, emerging systems of technology, policy, management and the value sensitive design of responsible innovation

The Civilized Engineer

Foundations

Engineering: human needs, practical solutions

Engineering: Design and Development rather than Exploration and Understanding (apllied/fundamental)

Engineering: Metrics, Math, Models (& Simulation)

Engineering: Variety (of design) & (practical) Selection, rather than Grand Design

Development

From Science-based Engineering, to Engineering-based Science (new materials)

From artifacts to services (roadsystems/traffic versus mobility: 'from moving cars to moving people'

From Sectors & Silo's to (Life)Cycles and Societies ("Systems of Systems")

From Complicated to Complex Systems

From Functional Requirements to Organisational structures and incentive systems

Future

From Engineering Science to Translational Research: Grand (Societal and Engineering) Challenges

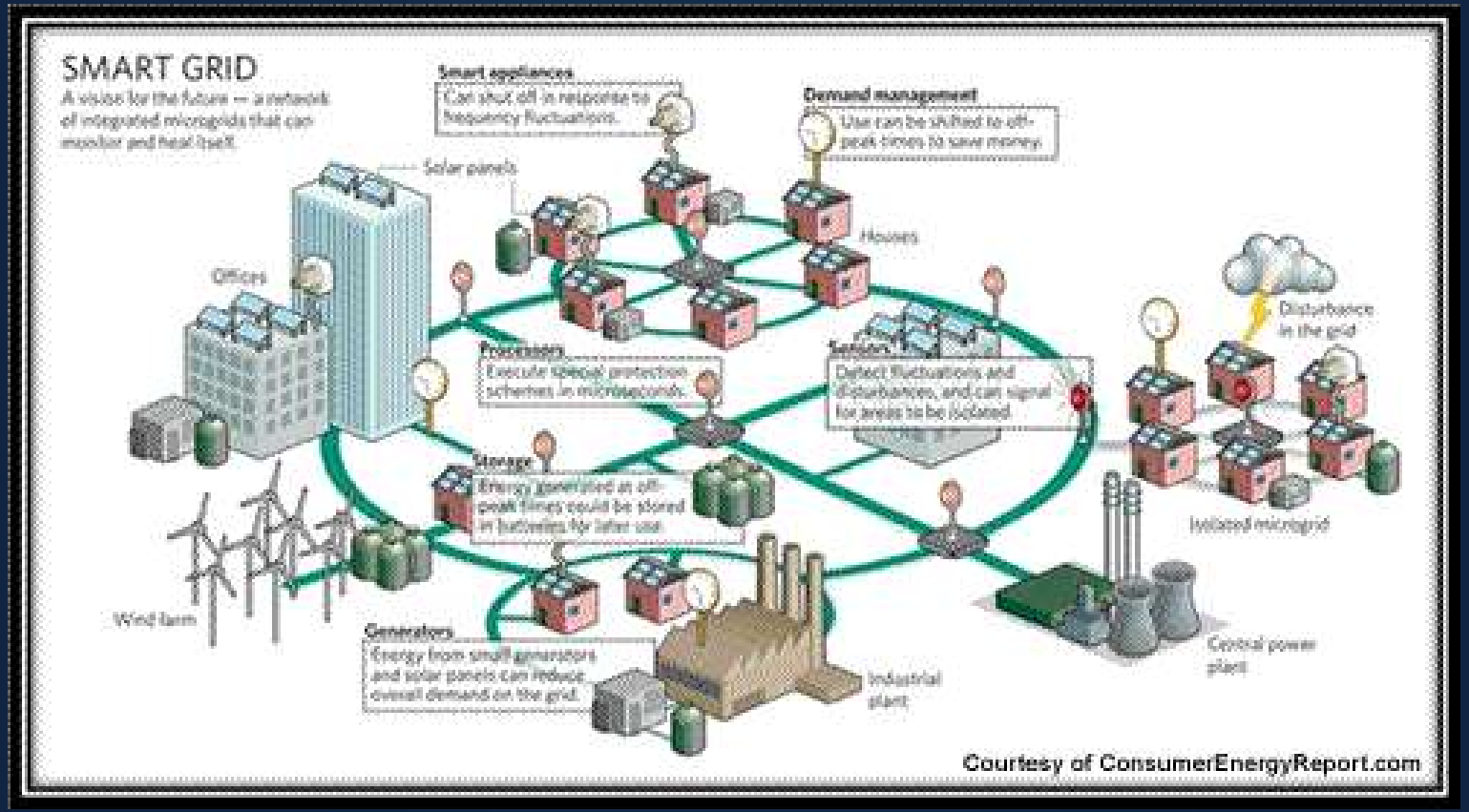
From Project Management to (engineering) Systems Integration

From Optimalisation of Functional Requirements to Balancing Normative (societal/cultural/politcal) Trade-Offs - Value Sensitive Design and Responsible Innovation

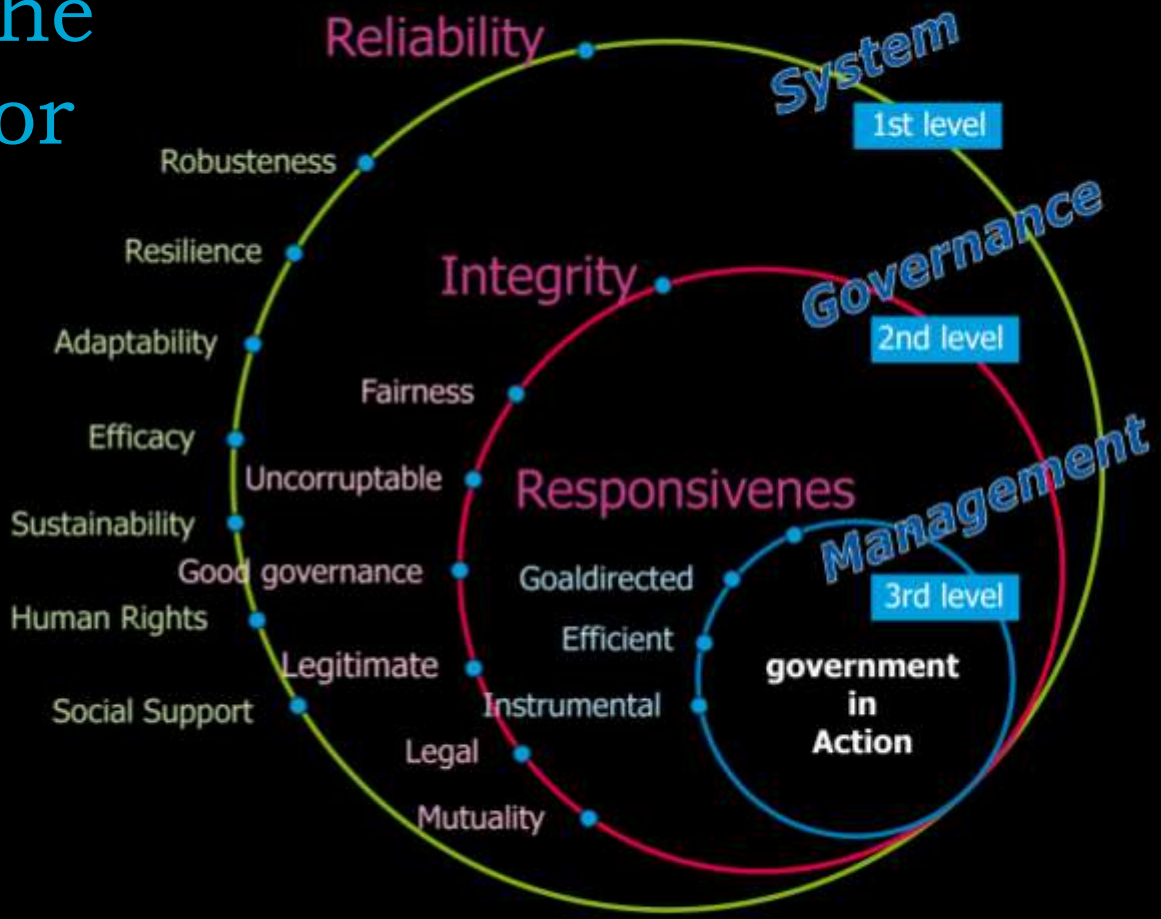
From Bridging the Divides to Integrating Teams

From Technology Transfer to Leadership in Creating Added Value

Discussion


SMART GRID
A vision for the future — a network of integrated microgrids that can monitor and heal itself.
Smart appliances
Can shut off in response to frequency fluctuations.
Demand management
Use can be shifted to off-peak times to save money.
Solar panels
Houses
Offices
Disturbance in the grid
Processors
Execute special protection schemes in microseconds.
Sensors
Detect fluctuations and disturbances, and can signal for areas to be isolated.
Storage
Energy generated at off-peak times could be stored in batteries for later use.
Isolated microgrid
Wind farm
Generators
Energy from small generators and solar panels can reduce overall demand on the grid.
Industrial plant
Central power plant
Courtesy of ConsumerEnergyReport.com

Quality in the Public Sector



Elinor Ostrom

1933 -2012

2009 Nobel Laureate in Economics

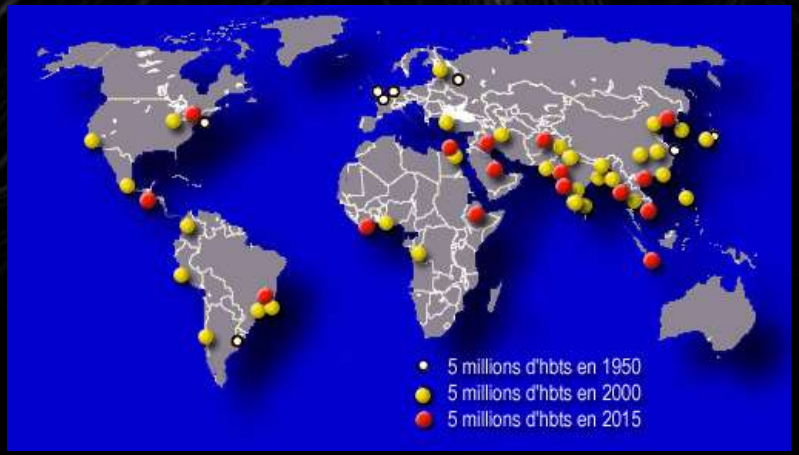
TU Delft Delft University of Technology

Actors and Agents

PARTICIPATORY SYSTEMS

Internet Map

city-to-city connections



ChrisHarrison.net

PhD-programme

Best Practices Cycle (2 blocks)

- Five day course TPM research methods and skills
- Deeper investigation of research methods relevant for the specific research programmes

Demand driven symposia

Peer groups

Coaching by experienced researchers (e.g. on writing a research proposal)