The FuturIcT Knowledge Accelerator -
Unleashing the Power of Information for a Sustainable Future

Dirk Helbing, with the support of >200 scientists from all over Europe

We have explored the microcosmos and the universe, and have sent men to the moon. It turns out, however, that our knowledge of society is too limited to efficiently tackle the global challenges of humanity in the 21\textsuperscript{st} century. Thus, it is timely to create an ICT Flagship to explore social life on Earth and everything it relates to.

The greatest bottleneck of ICT systems today is the difficulty in making sense and efficiently use the large amounts of data we generate.
Challenges Humanity is Facing in the 21st Century

Lee C. Bollinger, president of Columbia University, formulated the issue as follows: “The forces affecting societies around the world ... are powerful and novel. The spread of global market systems ... are ... reshaping our world ..., raising profound questions. These questions call for the kinds of analyses and understandings that academic institutions are uniquely capable of providing. Too many policy failures are fundamentally failures of knowledge.”

1. Financial and economic crisis
2. Debts and inflation
3. Stability of the European Union
4. Corruption
5. Organized crime, hooliganism
6. Extremism, terrorism, war
7. Epidemics (SARS, H1N1 pandemic)
8. Security and cyber risks
9. Migration and integration
10. Environmental change
The Top 10 Socio-Economic Problems and their Reasons

Problems:
1. Demographic change
2. Financial and economic stability
3. Social, economic and political inclusion
4. Public health
5. Balance of power and conflict
6. Corruption and crime
7. Collective social behavior
8. Institutional design
9. Sustainable use of resources
10. Reliability of critical infrastructures

Reasons:
1. Interdependency, interconnectivity
2. Socio-economic, ecological, and technological complexity
3. Self-organization, emergence, chaos
4. Limits of predictability and control

Cascade failures/avalanche effects:
- Epidemic spreading
- Congestion spreading
- Failure of interbank market
- Breakdown of former GDR

5. Lack of quantitative models
6. (Due to) Lack of data
7. Lack of computational power
8. Lack of systemic predictions
9. Lack of tested alternatives
10. Systemic risks

This is about to change!
Techno-Social-Economic-Environmental Systems Are Complex

- Elements mutually adapt to each other
- They are influenced by their environment, but at the same time, they influence their environment
- Causes and effects not proportional to each other
- Unresponsive system or regime shifts
- Example: Sudden public opinion changes (collapse of GDR; pro vs. anti-war mood; public smoking ban; swiss banking secrecy; car sales)
- Network interactions are ubiquitous
  - Feedback loops, circuli vitiosi
  - Cascade spreading
  - Unwanted side effects

Limits of predictability: Chaos, turbulence, “butterfly effect”
Cascade Spreading and Systemic Crises

- Network interactions are ubiquitous
  - Feedback loops, circuli vitiosi
  - Unwanted side effects
- Systemic malfunctions, whenever the system state changes beyond a critical threshold („tipping point“)
- Often caused by massive cascading effects („domino effects“, „avalanche effects“)
- Triggered by overcritical perturbation or coincidence of failures
- Examples: Epidemic spreading, failure of interbank market, congestion spreading, blackout of electrical power system
The Need of A Knowledge Accelerator

We need to create a techno-socio-economic-ecological knowledge accelerator - a kind of multidisciplinary Apollo project that uses current and future ICT developments to address the challenges of humanity, involving natural scientists and engineers.
Ambitions of FuturICT

Requires to solve difficult

Fundamental ICT Challenges

- Exascale Computing
- Highly Decentralized and Peer-to-Peer Systems
- Zero-Delay Reality Mining
- Swarm Computing
- Social Computing
- Social Information Theory

Applied ICT Challenges

- User-Oriented ICT Systems
- Data Collectors
- ICT-Empowered Systems Modeling
- Evaluating ICT Systems
- Reasoning ICT Systems
- Creative ICT Systems

Living Earth Visualator to simulate life on Earth and everything it relates to
New ICT for Socio-Economic-Ecological Reality Mining + Simulation

- Remote sensing
- Internet
- Satellites
- Telecommunication
- Prediction markets
- Web2.0
- Sensor networks
- Second life
- GPS
- Social networks

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Global-Scale Simulation of Socio-Economic-Environmental Systems

Data
- demographic data
- transport data
- geographic data

Models
- contact network models
- multi-scale models
- agent-based models

Forecasts
- infection

Validation
- scenario analysis
- predictions
- priorities
- policies

(thanks to Alex Vespignani)

...complexity...
What’s the Right Model? Multiple World Views and Parallel Worlds

Social systems are so “noisy” that it is usually not possible to verify a unique model. What constitutes the best model or theory often appears to be a matter of belief. A superposition of inconsistent models may give the best results!

Examples: Hurricane prediction, climate science, car safety simulation, airplane control

(Thanks to Alex Vespignani)
Second Life for Policy Testing?
Decision Making Considering Priorities and Normative Issues

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Crisis Observatory for Conflicts
Crisis Observatory for Epidemic Spreading and Health Risks

HIV prevalence in adults, end 2001

Malaria

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Crisis Observatory for Environmental Change

Estimated Deaths Attributed to Climate Change in the Year 2000, by Subregion

- Mortality per Million Population
- 0 - 2
- 2 - 4
- 4 - 70
- 70 - 120
- No data

*Change in climate compared to baseline 1961-1990 climate

Data Source:

Maps produced by the Center for Sustainability and the Global Environment (SAGE)
Crisis Observatory for Financial Instabilities


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Large-Scale Evacuation and Contingency Plans

Node in the evacuated area
Secure node next to the evacuated area
Node in the secure area
Link that is evacueed

Source: Kay Axhausen, Christoph Dobler
Policy Decision Support through FuturICT: Case of Financial System

- Data collector
- Testing of alternative solutions
- Decision theater
- Meltdown modelling
- Crisis observatory
- European-scale, multi-disciplinary effort is needed!
- Political decision-making

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Innovation Accelerator

- Analysis of scientific productivity
- New indices to discover high-quality work
- Identification of innovations and trends early one
- Co-creation tools for large-scale projects
- New science forum and publication platform
- Customized recommender and reputation platforms
- New institutional designs to stimulate and spread innovations

Living Science (www.livingscience.eu)
How Knowledge Spreads Geographically

Data source: ISI WoS (Transportation Science and Technology)
Conformity versus Diversity in Recommender Systems

Collaboration with Jan Lorenz, Heiko Rauhut, and Frank Schweitzer

Source: Yi-Cheng Zhang et al.
Impact on Science, Industry, Business, Administration, Governance

- **Science and Education:**
  - Innovation accelerator
  - Personalized education

- **Public Sector:**
  - Smart, sustainable cities
  - Healthcare (e.g. epidemics)
  - Crisis observatories, risk management

- **Business and Industry:**
  - Financial sector
  - Managing complexity
  - Transport, traffic, logistics
  - Electrical micro-generation

- **Administration and Governance:**
  - eGovernance
  - Institutional design

- **Consultancy:**
  - Customized information services
Plausibility of FuturICT

- Europe has reached leadership in social modeling and simulation, but strong competitors are trying to take over. The project is in the best public interest, meets Europe’s Vision 2020.

- Many preparatory Networks of Excellence and Coordination Actions: Exystence, Giacs, Once-CS, ASSYST, PANORAMA/PerAda, ...

- EU projects on techno-social systems: QLectives, Cyberemotions, Epiwork, Socionical

- Various Integrated Projects and STREPS: EURACE, EMIL, PERPLEXUS, PATRES, MMCOMNET, EVERGROW, DELIS, EC-AGENTS, PACE, CREEN, IRRIS...

- Information Science: HITIME, VIVO, GAPMINDER, GLOBALHUBS, CREEN...
March 30, 2010

To Whom It May Concern,

On behalf of the Institute for New Economic Thinking and Central European University I am writing to express strong interest in this scientific endeavor and in collaborating with the initiative Flagship FuturICT and the team Professor Helbing is building.

The Institute for New Economic Thinking (INET) www.neweconomicthink.org has been founded to foster and create new interdisciplinary paths to address social and economic problems. Applications of network theories to systemic evaluation, political-economic interactions and psychologically-inspired approaches to understanding system dynamics are just a few dimensions of exciting new research that our follow will be working to develop.

Central European University, INET and a number of leading universities are working to establish a network of campus based joint venture institutes around the world to foster innovative research. The first of which, in conjunction with the Oxford University’s 21 Century School will begin in earnest shortly. This interdisciplinary network will add further strength and depth of scholarship in the pursuit of new and deeper understanding of a myriad of social issues.

The team of scientists that Prof. Helbing has gathered together one, I believe, make a significant contribution to the understanding of the evolution and change in societies as well as the formidable issues of governance, climate change, sustainable economic balance that we are all faced with in the coming decades. I look forward to INET and Flagship joining with FuturICT to address these daunting challenges in the coming years.

Sincerely yours,

George Soros

Lord Robert May of Oxford: “Your letter to Soros puts the case admirably well, and I believe he may well be interested in such an initiative.”
Dear Wolfgang,

As you know, GSD is very much concerned with identifying new techniques of ICT facilitated mathematics that we require in order to assist policy makers with their decision making, particularly in the area of sustainability. GSD Partners have been informed, and indeed are informing, the proposal being put forward by Professor Helbing for his idea of a flagship. Although GSD is approaching its end, new ideas are now being fed into many different projects. It is necessary that despite all the advanced mathematics available to us we are still not able to successfully model social interactions. It is this inability which lets scientific advisors down in their efforts to provide advice to politicians and others on the best way forward.

As Coordinator of the GSD project I firmly support this notion for a flagship and I know that my colleagues are also supportive. We feel that we have only just begun how modelling and simulation can be brought together to inform an making both for governance and in business. Furthermore we have instigated and collect data that will hopefully form the basis for new actions much interested in this project.

Furthermore we recognise that the ideas being proposed go well beyond the FuturICT programme is truly both adventurous and challenging.

Finally, the goals of FuturICT very much match not only my own but also many of my colleagues here at UCL.

I am therefore very keen to work with Professor Helbing and with this important project. I know that this attitude is already mirrored by many of our GSD database and I am sure that the others will be more aware of the particulars.

Yours sincerely,

Steven Bishop
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To:

Prof. Dr. Carlo C. Jäger
Department of Geosciences
Earth Sciences Building
University of Cologne
Cologne, Germany

From:

Prof. Peter Reichenbach
Tel: +49 228-73 74 74
Email: Peter.Reichenbach@Geo.Uni-Cologne.DE

Subject: Support for the FutureICT Project

Date: 24 March 2010

Dear Professor Jäger,

Your kind invitation to the FutureICT Conference 2010 in Cologne is most appreciated. Unfortunately, I am not able to attend the conference due to a prior commitment in that period. I regret any inconvenience this may cause and extend my sincerest apologies.

Best regards,

Peter Reichenbach

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The Complex Systems Society

Support for the FutureICT Project

Dear Professor Jäger,

I am pleased to support your invitation to the FutureICT Conference 2010 in Cologne. The conference seems to be a timely and important event, and I look forward to hearing about the latest developments in complex systems research.

Sincerely,

[Signature]

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Edinburgh Napier University

[Signature]
Completed Steps and On-Going Preparations for FuturICT

- Build-up of networked multidisciplinary community
- Identification of Grand Challenges, Hilbert Program for the socio-economic sciences
- Elaboration of suitable institutional settings (Visioneer):
  - Social data-mining and crises forecasting capacities
  - Data security and privacy
  - Innovation accelerator
  - Social simulation capacities
  - Integrative systems design centers
  - Organization and institutional design of large-scale, goal-driven projects (GSDP)

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Coping with Crises in Complex Socio-Economic Systems

Kay Axhausen, Lars-Erik Cederman,
Dirk Helbing, Hans Herrmann,
Frank Schweitzer, Didier Sornette