

# **The future of Science and the Science of the Future**

**Outline of a Symposium organized by Academia Europaea**



**Brussels, March 3- 5, 2015**

**The future of Science and the Science of the Future**



## Session : "Energy and Computing in the Future"

**Talk 1: Sierd Cloetingh, President of AE, Professor of Tectonics, VU University Amsterdam.**



### "Geothermal energy and the underlying geoscience base"

Abstract:

At the beginning I will report on some major aspects of Academia Europaea. I will then talk about future developments in my area, Earth and Cosmic Sciences and more specifically about solid earth geophysics. In agreement with the title of this session I will then discuss the importance of geo-thermal energy.

Today, the tremendous energy in the 30 km thick crust of our planet (enough energy for humanity for thousands of years if we could tap into it!) is only used and is useable to a very small degree for either heating and cooling of buildings, usually by not going deeper than 100 m, or by using access to hot water, particularly near tectonic fault lines and in some sediment basins for geo-thermal power generating stations, like in Iceland or New Zealand.

Worldwide, some 14 Gigawatts of geothermal power is online in 24 countries.

An additional 30 gigawatts of direct geothermal heating capacity is installed for district heating, space heating, spas, industrial processes, desalination and agricultural applications. Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. And at the moment is negligible in the global energy mix.

Note, however, that heat difference can also be directly converted into electric energy. Thermoelectric generators (also called Seebeck generators) are devices that convert heat directly into electrical energy, using a phenomenon called the Seebeck effect (a form of thermoelectric effect). Although such TEGs are now even found in car exhaust systems to produce electricity, thermoelectric generators serve mainly application niches where efficiency and cost are less important than reliability, light weight, and small size. It is unfortunately a long way to use them cost effectively in connection with Geothermal energy.

Full paper below!

The Future of Science and the Science of Future  
March 4 2015



The Academy of Europe

## Geothermal Energy: the underlying geosciences base

Sierd Cloetingh<sup>1</sup>  
Jan Diederik van Wees<sup>1,2</sup>  
Fred Beekman<sup>1</sup>

<sup>1</sup> Tectonics Group  
Dept. of Earth Sciences  
Utrecht University  
<sup>2</sup> TNO  
Utrecht, The Netherlands



ISES  
Netherlands Research Centre for  
Integrated Solid Earth Sciences



Universiteit Utrecht



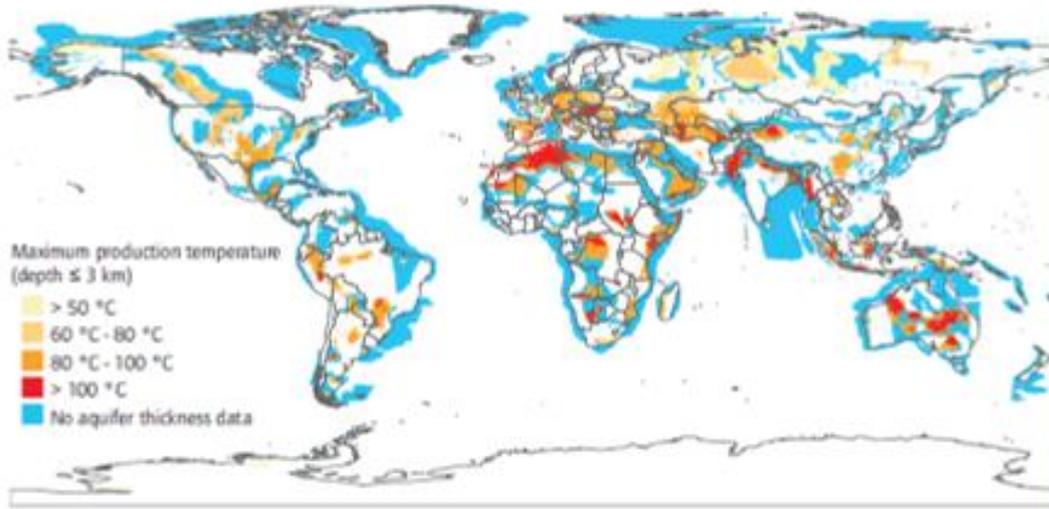
TNO innovation  
for life

Today we are in an energy transition. The earth itself has much to offer here, especially in view of rapid advances made in the last decades in better process understanding in how the earth works. Apart from hosting geo-resources such as hydrocarbons and fresh water, the system Earth provides us also with a formidable heat engine.



Like everything in the Earth subsurface, the geothermal resources are unevenly spread. Some countries like Iceland and Indonesia -places where abundant volcanic activity already points to ascend of hot material from the deep earth to the earth's surface- possess large resources and many potential for future growth. Other areas, in particular geologically older interiors and no longer tectonically active parts of the continents have less to offer.

World map of deep aquifer systems



Who speaks about geothermal energy also speaks about water. This map shows the world's deep aquifer systems, revealing the existence, in some areas, of very high temperatures in aquifer systems. Reaching more than 100° C at less than 3 km depth.

**Blue Lagoon (Iceland)**

**Ridge - Iceland**

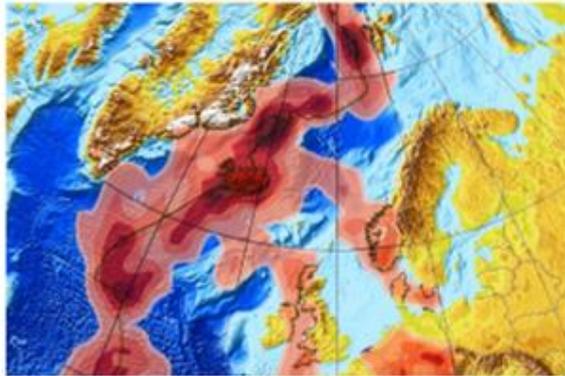
Labels in diagrams: NORTH AMERICAN PLATE, EURASIAN PLATE, ICELAND, ATLANTIC OCEAN, Ridge, Lithosphere, Trench, "SLAB PULL", Mantle, Outer Core, Inner Core, Lithosphere, Trench, 700 km, Outer Core, Inner Core, Lithosphere, Trench.

Iceland, located on top of the north-Atlantic ridge, is the site where hot mantle is ascending up to the surface with spectacular expressions, sometimes also with less positive impact on for example air traffic.

## Intraplate deformation: plumes



Plumes in the upper mantle resolved from seismic tomography  
(in the Northern Atlantic, depth slice between 100 – 200 km)



Rickers et al., 2013.  
EPSL.



Recent advances in seismic tomography have revealed that these plume systems have side lobes extending from Iceland all the way into the uplifting area of southern Norway, the areas of recent volcanic activity in western Scotland and into the mainland of Central Europe, explaining the recent volcanic activity in the Eifel region of Germany. This research conducted by Prof. Trampert and this ERC funded team has mapped the upper mantle structure in great resolution, detecting seismic velocities a few percent lower (in red) than predicted by a standard model, interpreted as areas of elevated temperatures.

**Sierd Cloetingh, Sean Willett & TOPO-EUROPE team**

## TOPO-EUROPE

**Fundamental Premise**

Continental topography is the product of the interaction between processes operating deep in the Earth, on its surface and in the atmosphere

It's understanding requires a multidisciplinary approach

- > 23 participating countries
- > 14.5 M Euro funding
- > 60 new positions for young researchers

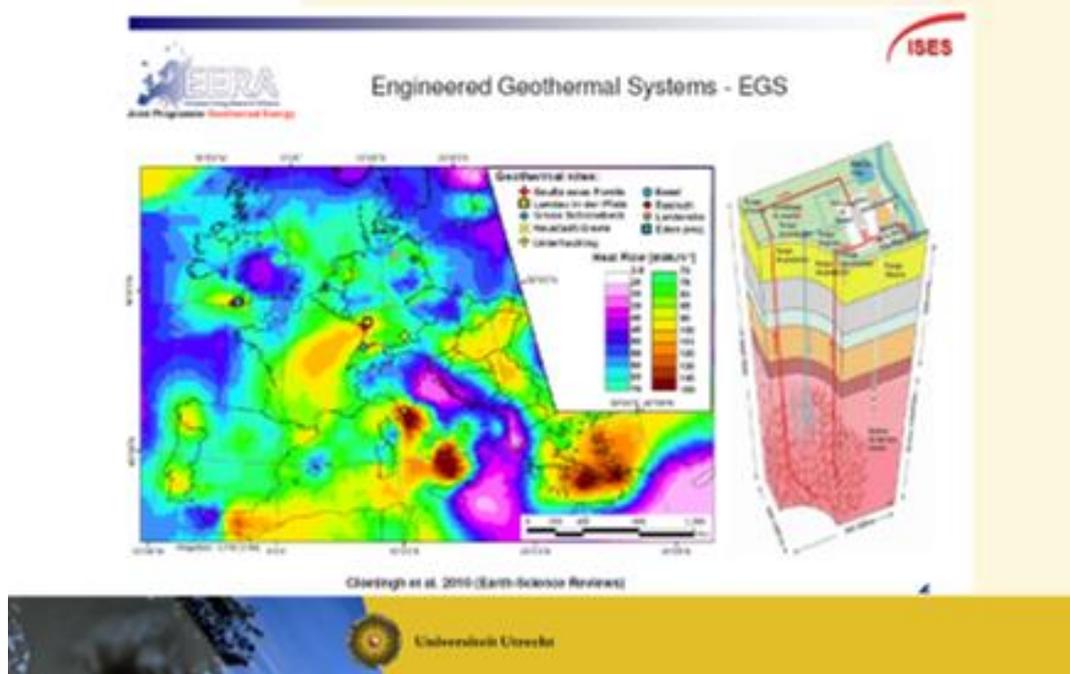
INTERNATIONAL LITHOSPHERE PROGRAM

EUROPEAN SCIENCE FOUNDATION

TOPO-EUROPE  
A EUROCORES PROGRAMME  
EUROPEAN COLLABORATIVE RESEARCH

This is another set of tomographic images, to a depth of 600km, this time from Prof. Wim Spakman, also from Utrecht University. Showing slabs going down (in blue) at the subduction zones in the Mediterranean region and under the Carpathian Mountains of Romania, overlain by hot areas (in red) like the Hungarian great plain, with great potential for geothermal energy. Better understanding of the coupling between deep earth processes and the processes operating at the earth surface represent a great challenge for modern Earth-sciences, tackled by the TOPO-EUROPE program.

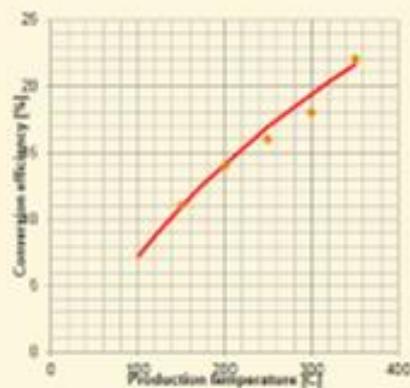
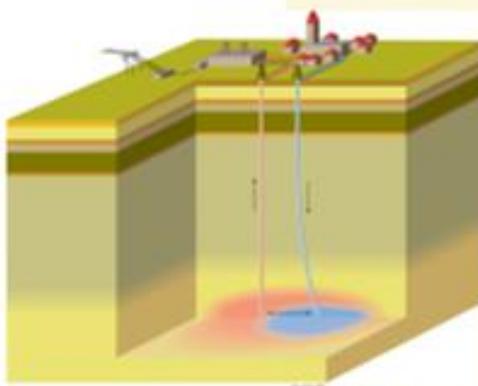
## Cross border nature of geothermal energy



Fundamental studies carried out in the framework of projects such as TOPO-EUROPE have generated insights into the presence or absence of geothermal energy potential. Key, for Enhanced Geothermal Systems (EGS) where water is injected in deep wells to be heated in fractured reservoirs.

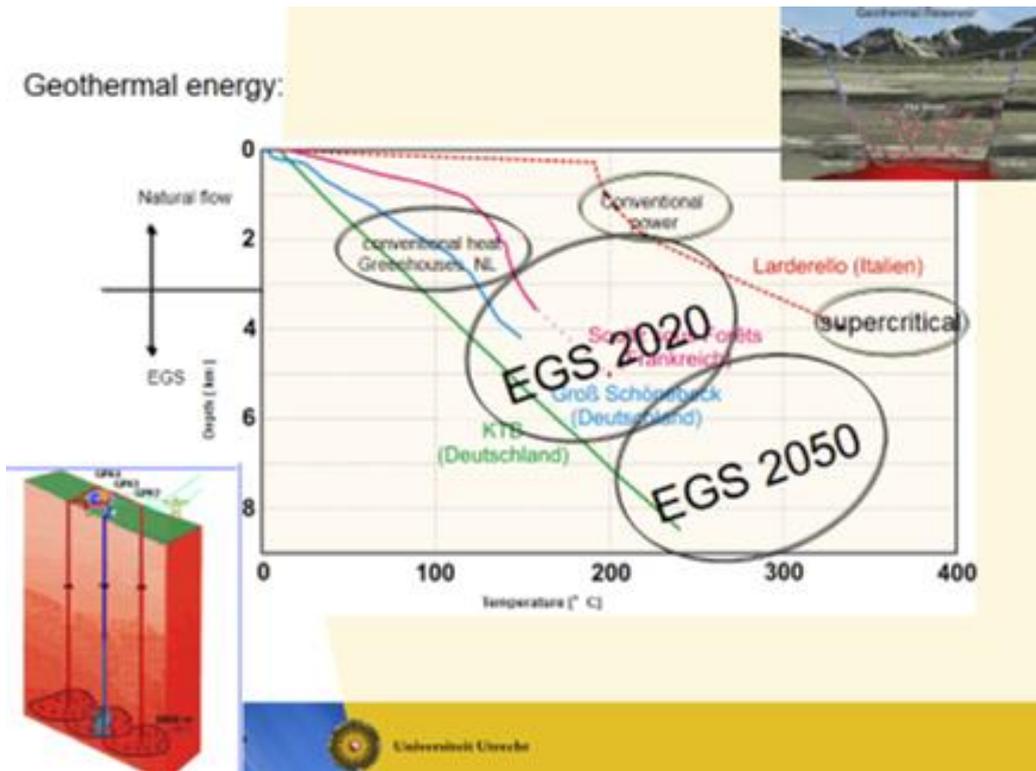
## Geothermal power:

MIT report, 2007: Future of geothermal energy

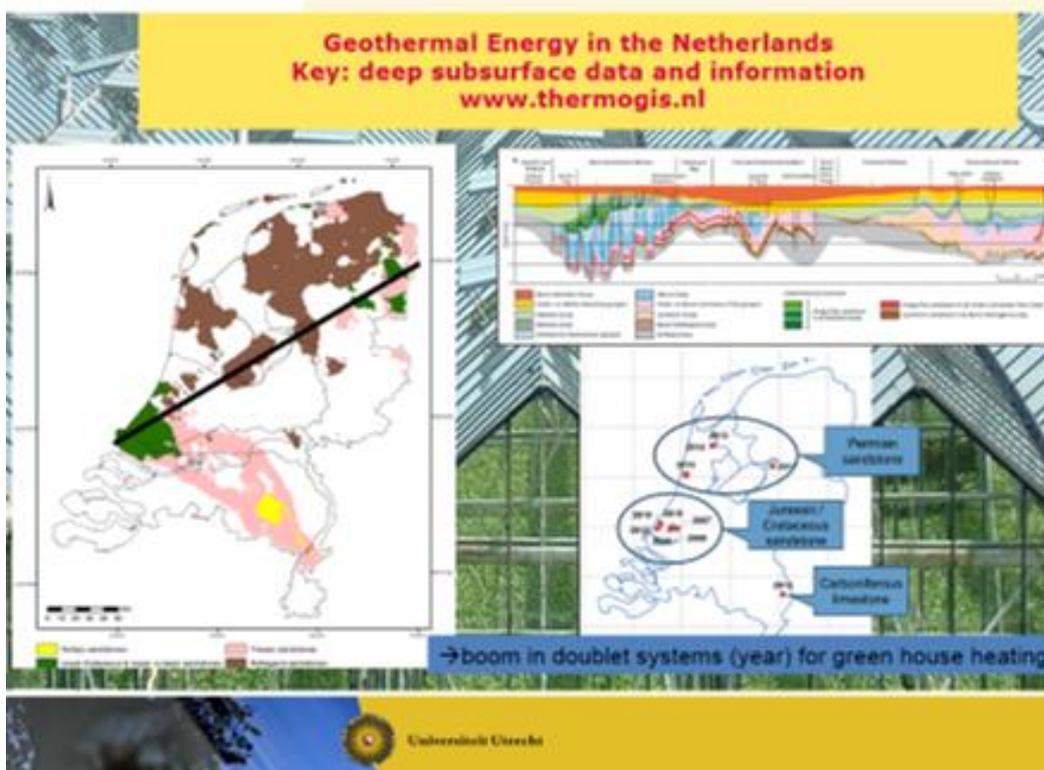


The energy efficiency is directly coupled to production temperatures implying the need for deep drilling.

## Geothermal energy:



For enhanced geothermal energy systems this means that with increased ability to drill deeper, its impact as a main contributor to energy supply will substantially increase in the coming decades.



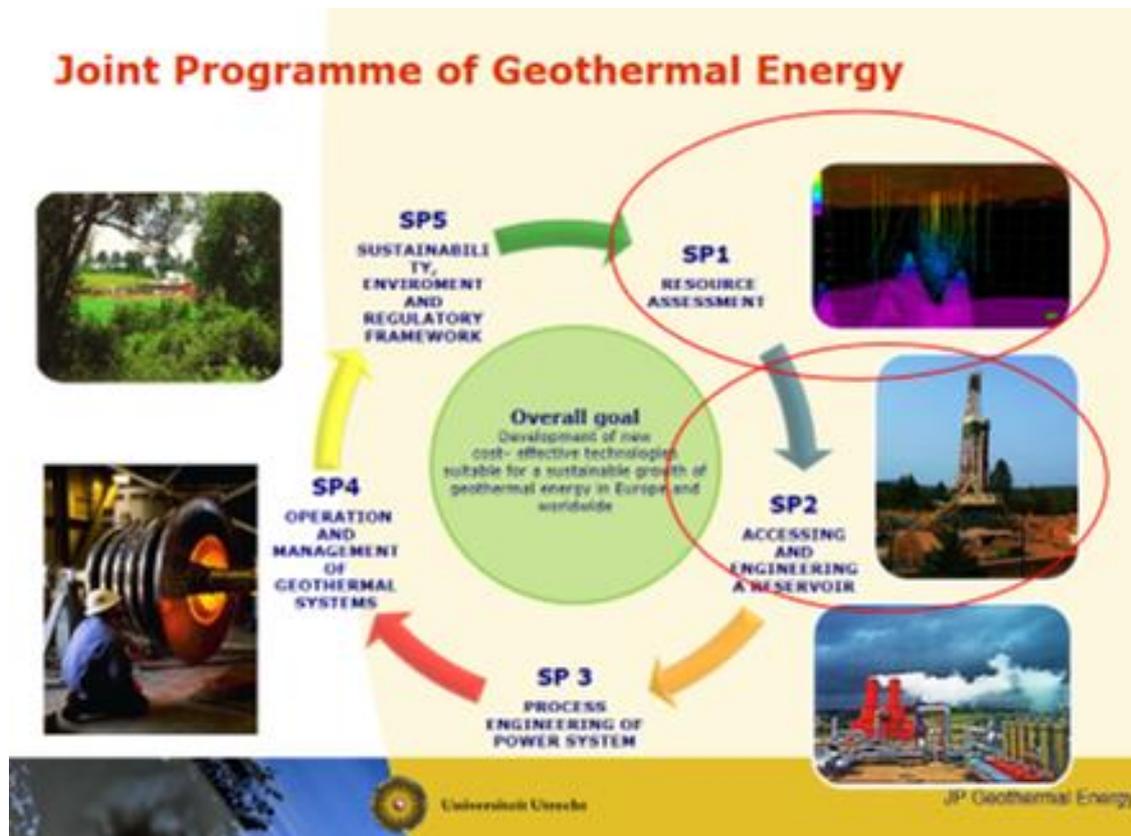
Knowledge of the subsurface structure is key in this respect. The Netherlands, explored in great detail for its oil and gas reservoirs, has a subsurface mapped in great resolution. It is this knowledge base that has been vital in the technology transfer for use in geothermal energy production such as here for the heating of greenhouses in the western part of the Netherlands.

## Nonlinear innovation



[www.eera-set.eu](http://www.eera-set.eu)

The European Energy Research Alliance (EERA), in which TNO and Utrecht University participate with other European partners, is deeply involved in this non-linear innovation.



As you can see here this joint program of geothermal energy has a very integrated nature.



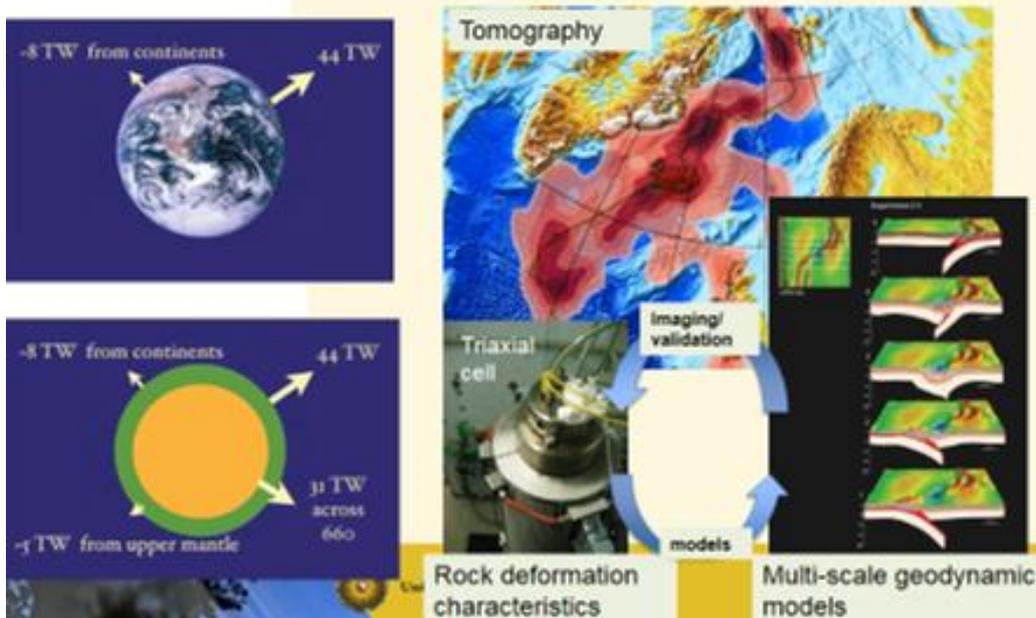
# IMAGE

Integrated Methods for Advanced Geothermal Exploration



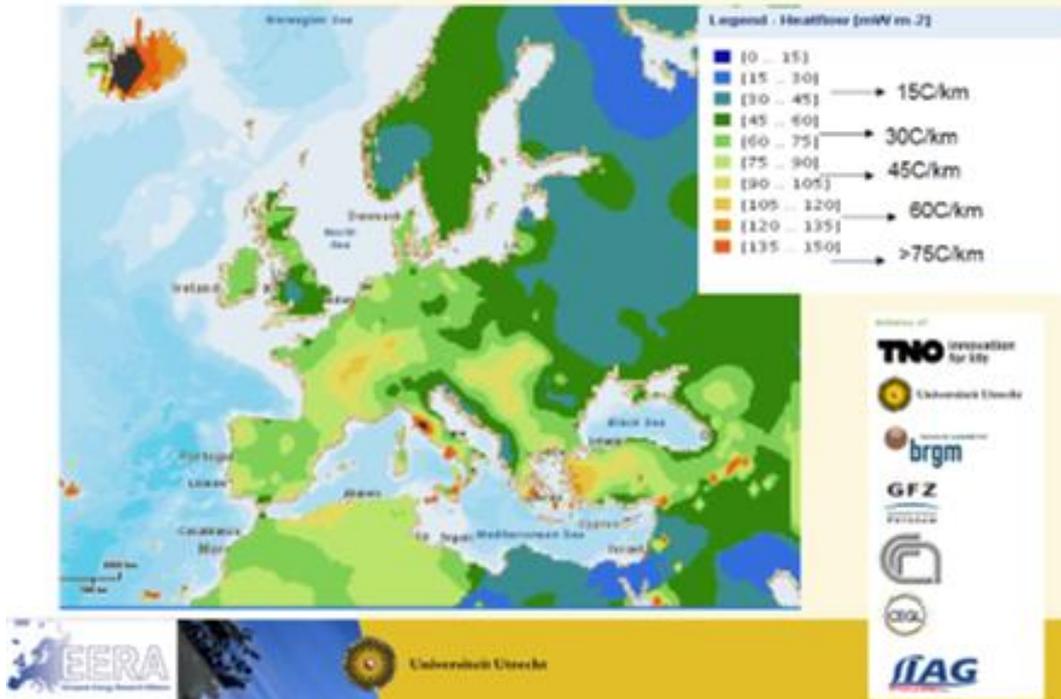
The same is true for this IMAGE project on Integrated Methods for Advanced Geothermal Exploration, part of EU FP-7 program.

## World class fundamental research to understand the heat engine → Linking small to large scales

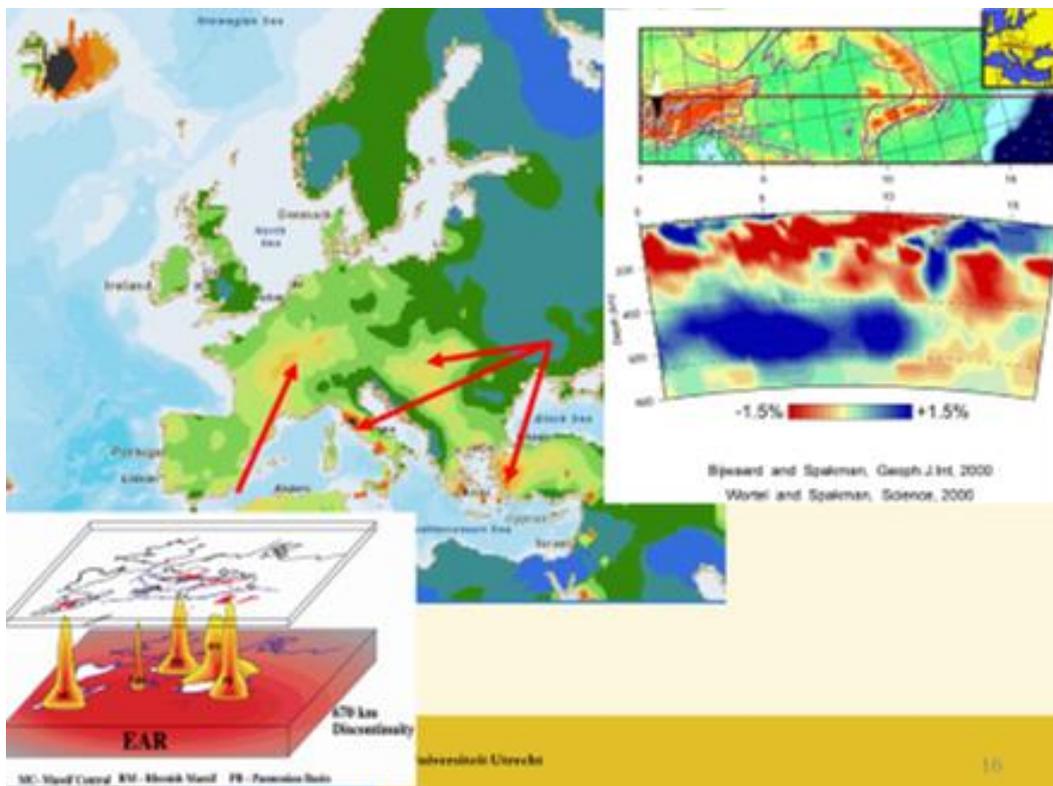


World-class fundamental research is a must to unlock the great potential for geothermal energy. By nature this research should be multi-scale linking seismic imaging, monitoring earth processes, experimental modeling of tectonic processes, numerical modeling and rock physics experiments.

## Surface heat flow as indicator for deep temperature

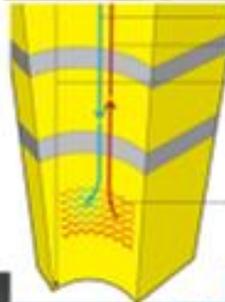


This surface heat flow is a direct indicator for deep temperature. Note the sharp NW-SE trending boundary between relatively hot western and central Europe and the eastern European platform with low temperatures.



Here we see that the areas with high temperatures at depth of a few kilometers are underlain by areas of mantle upwelling from depths up to 600-700 km. Like under the Massif Central of France, the volcanic areas of Tuscany, the Hungarian plain and the Aegean area.

## BASEL: Enhanced Geothermal System



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News > World news > Switzerland

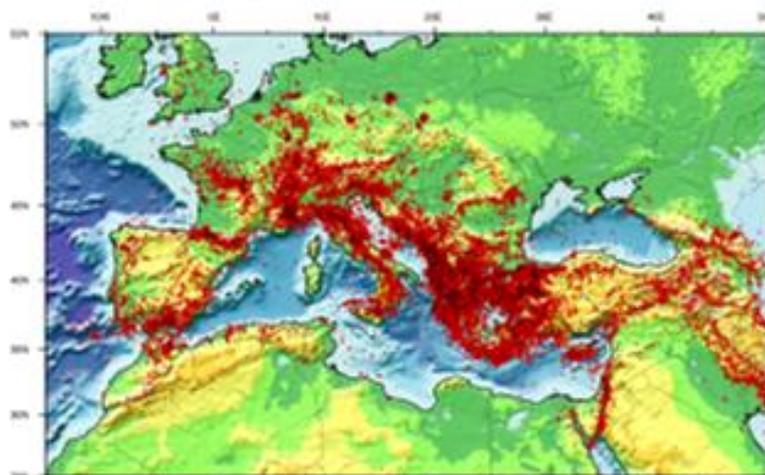
### Swiss geothermal power plan abandoned after quakes hit Basel

Designer of 'hot rocks' scheme under city on a fault line could face jail over damage to property

Like everything we do as humans in the subsurface, we operate in a system which has its own natural dynamics. In deep geothermal energy production, drilling can lead to induced seismicity and in the case of Basel it actually did, leading to abandonment of the geothermal power plan.

## Cross-border nature of earth sciences

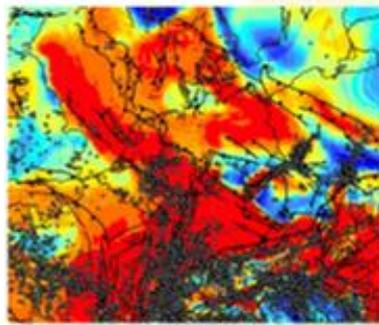
Natural hazards occur everywhere and do not respect national borders



Natural hazards, including earthquakes (in red) occur everywhere and do not respect national borders. They are not limited to plate boundaries but also occur in the plate interiors.



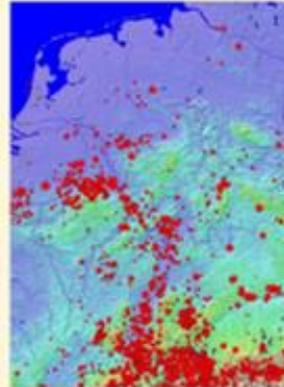
Neotectonics and crustal strength: The NW European foreland



Correlation between seismicity and crustal strength (Cloetingh et al., 2006, ESR)



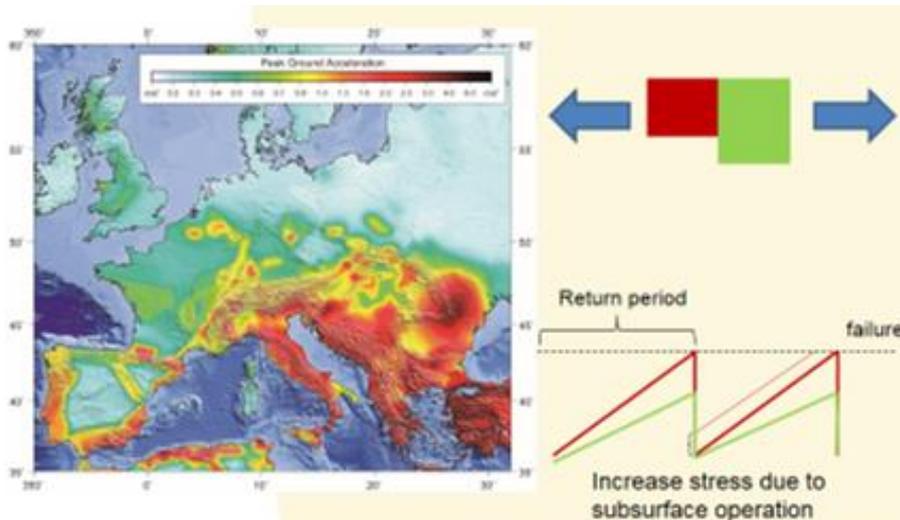
Neotectonics and geomorphology (Peters et al., 2005)



Seismicity of the North-European Platform



They do not occur random but are localized in weak areas (in red) or even more in areas where a contrast occurs in crustal strength between weak crust (in red) and strong crust (in blue) such as here in the NW European foreland of the Alps (left). The seismicity here is concentrated in the Rhine Rift, the major traffic corridor between the Netherlands and Switzerland (right). Deep-seated earthquakes (with depths up to 25km) occur primarily at the master faults bounding the Rhine rift with a steep geomorphic expression (center).



Seismic Hazard Map of Europe as part of the Global Seismic Hazard Map (Giardini et al., 2003; Grünthal et al., 1999). The map depicts the seismic hazard as Peak Ground Acceleration (PGA,  $ms^{-2}$ ) with 10% probability of exceedence (or a 90% chance of non-exceedence) in 50 years, corresponding to a return period of 475 years (source GFZ, Oliver Heubach)

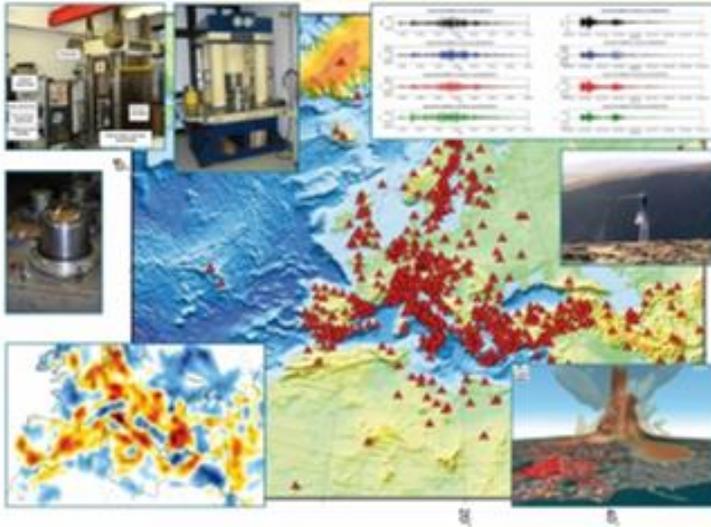


This seismic hazard map of Europe identifies the areas with enhanced seismic hazard in terms of peak ground acceleration. The return period for intraplate earthquakes is much longer than for earthquakes at the plate boundaries, with a much longer time for stress build up prior to release by an earthquake.

The weaker and thinner the lithosphere, the higher the stresses induced by tectonic forces will be. Subsurface operations due to engineered geothermal energy production will increase the natural stress field and can shorten the return period.



Research Infrastructure and E-science for Data and Observatories on Earthquakes, Volcanoes, Surface Dynamics And Tectonics

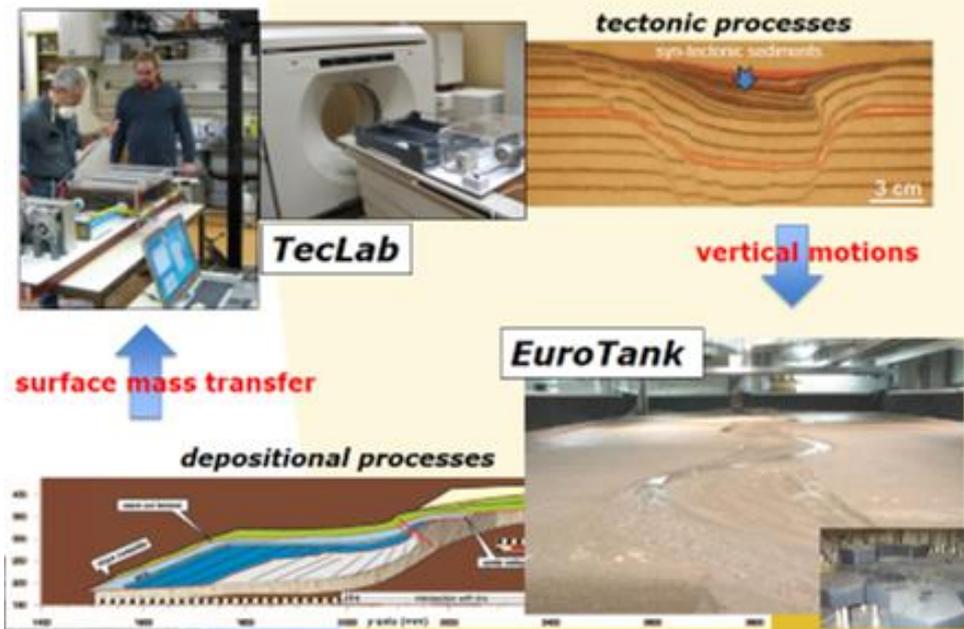


ESFRI



The research community in solid earth sciences in Europe has set up a European Plate Observing System (EPOS) to monitor earthquakes, volcanoes, surface dynamics and tectonics for the whole of western and central Europe. EPOS is part of the European large-scale scientific infrastructure initiative (ESFRI), and its establishment is an important development for monitoring induced seismicity in the context of geothermal energy production.

### Integrated multiscale experimental facilities



The multi-scale experimental facilities of the earth simulation lab (ESL) in Utrecht are part of EPOS. ESL includes the experimental tectonic modeling laboratory (TecLab) (top) where faulting and rift formation processes are modeled leading to vertical motion, affecting sedimentary processes in delta systems, modeled in the EuroTank (bottom).

The results of these European research efforts now also relevant for countries outside Europe. An example is the Geothermal Capacity Building Program (GEOCAP) where Dutch institutions share their expertise in geothermal energy research and education with Indonesia for unlocking the great potential of geothermal energy in Indonesia.

Important is the further development of the science base for future applications, requiring a long-term perspective such as developed in the TOPO-EUROPE program. TOPO-EUROPE was initiated through a joint effort of Academia Europaea, the International Lithosphere Program and the European Science Foundation.

## 10th TOPO-EUROPE workshop 2014

### Interplay between surface, lithospheric, and mantle processes

Barcelona, September 17-19, 2014

Venue: [CosmoCaixa](#), Science Museum [Barcelona](#).



ICTJA

Institute of Earth Science Jaume Almera, Barcelona



CSIC



Academia Europaea  
Barcelona Knowledge Hub

Last year TOPO-EUROPE had its 10<sup>th</sup> annual workshop in Barcelona it continues to serve as a platform for integrated solid earth science with a strong involvement of members of Academia Europaea.



## Origins & Mission

**Formed in 1988** as an international not-for-profit charitable organisation headquartered in London, and now with new regional hubs (Wroclaw 2011, Barcelona 2012, Bergen 2014). The AE covers all disciplines and fields of the Applied and Natural Sciences; Social Sciences, Humanities and Letters.

### Mission

- Encourage interdisciplinary and international research in all areas of learning, particularly in relation to European issues.
- Identify topics of trans-European importance to science and scholarship, and propose appropriate action to ensure that these issues are adequately studied.
- Pro-active role as voice for science in Europe, in close partnership with e.g. EASAC, ALLEA, ERC, and national academies
- Promoting synergy between Academia Europaea and the Young Academy of Europe

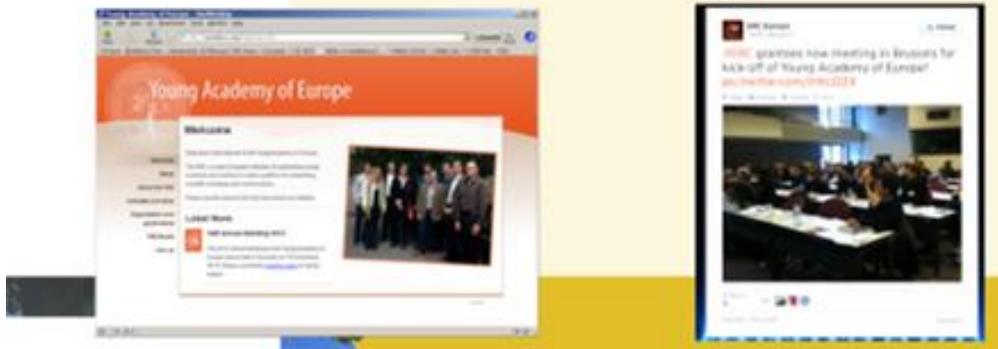
Academia Europaea was formed in 1988 and with its broad mission covers all fields of science, including social sciences and humanities.

# Young Academy of Europe

<http://yacadeuro.org>



*A pan-European initiative of young scientists and scholars with outspoken views about science and science policy*



A recent development has been the establishment of the Young Academy of Europe also formed in a bottom-up spirit.



Academia Europaea and the Young Academy of Europe meet this year in Darmstadt (Germany). For their annual conference with the theme 'Symbioses – synergy of humans & technology', a theme multidisciplinary by its nature.

## Conclusions

- Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but historically has been limited to areas near tectonic plate boundaries.
- The science base is now rapidly developing to bring geothermal energy into power in plate interiors.
- The Future of Scientific drilling for geothermal energy holds the prospect for significantly enhancing its contribution to the global energy transition.
- Europe through its excellent natural laboratories, its high level of integrated solid earth science and its links to other science fields fostered by Academia Europaea has a strong potential to be at the forefront of this endeavour.



### Profile:

Sierd Cloetingh is Royal Netherlands Academy Professor of Earth Sciences at Utrecht University.

He published more than 300 papers in international peer-reviewed journals and has been promotor of more than 70 PhD students of 18 different nationalities. He served the Earth Science community in various functions, including Presidency of the European Geophysical Society.

He is currently the President of the International Lithosphere Programme, Editor-in-Chief of the International Journal “Global and Planetary Change” and Chairman of the Scientific Committee of the ESF Large Scale Collaborative Research Programme (EUROCORES) TOPO-EUROPE.

He received honorary doctorates from five European universities and numerous honours and awards, including the Stephan Mueller Medal, Arthur Holmes Medal and honorary membership of the European Geosciences Union, Fellow and Honorary Fellow of the American Geophysical Union and the Geological Society of America, the Leopold von Buch Medal of the German Geological Society and the Alexander von Humboldt Research Award.

He is member of the Royal Netherlands Academy of Arts and Sciences and Foreign member of the Royal Norwegian Academy of Sciences, the Royal Danish Academy of Sciences, the Heidelberg Academy, the Bavarian Academy and the German Academy for Technical Sciences, Acatech. He was distinguished in 2006 as Chevalier de Legion d'Honneur and in 2014 as Knight of the Royal Order of the Netherlands Lion for his contributions to science and European scientific cooperation in research and education.

He was elected member of Academia Europaea in 1994 and served Academia Europaea as Chair of the Earth and Marine and Earth and Cosmic Sciences Sections and as Vice-President. In 2014 he was elected as President of Academia Europaea. He is a member of the Scientific Council of the ERC since 2009. In 2015 he was appointed as Vice-President of the ERC and coordinator of the ERC domain Physical Sciences and Engineering (PE).

### Present and Previous Positions

- 2014 - present: President of Academia Europaea
- 1988-present: Professor of Tectonics, VU University Amsterdam
- 1986-1988: Associate Professor of Tectonophysics, department of Geophysics, Utrecht
- 1983-1986: Senior lecturer Geophysics, department of Geophysics, University of Utrecht
- 1977-1982: Junior lecturer Geophysics, department of Geophysics, University of Utrecht
- December 1982 PhD degree geophysics University of Utrecht (Thesis: Evolution of passive margins and initiation of subduction zones; Promotor: Prof. dr. N.J. Vlaar)
- January 1977 MSc degree geophysics with minors in structural geology and numerical mathematics (cum laude; supervisor Prof. dr. N.J. Vlaar), University of Utrecht
- March 1972 BSc degree geology with physics and mathematics, University of Groningen (supervisors Professors Ph.Kuennen and L.M.J.U. van Straaten)

### Fields of Scholarship

- Solid earth geophysics
- Tectonics
- Intraplate deformation
- Lithospheric dynamics
- Sedimentary basin evolution
- Sea level change

### Honours and Awards

- 1993 Member Academia Europaea
- 1993 Distinguished Lecturer American Association of Petroleum Geologists
- 1995 Foreign Member of the Russian Academy of Natural Sciences
- 1995 Leopold von Buch Medal, German Geological Society
- 1996 Golden Badge Award European Geophysical Society
- 1996 Professor Honoris Causa of Bucharest University, Romania
- 1997 Member Netherlands Society for Sciences

- 1997 Sackler Professor at the Institute of Geophysics and Planetary Sciences, Tel Aviv, University, Israel
- 1998 Member Royal Netherlands Academy of Arts and Sciences
- 1999 Doctor Honoris Causa of University of Rennes, France
- Honorary Member of the Hungarian Geophysical Society
- 2001 Professor and Doctor Honoris Causa, Eötvös University of Budapest, Hungary
- 2002 Fellow American Geophysical Union
- 2002 Doctor Honoris Causa of University of Salzburg, Austria
- 2005 Foreign Member Royal Norwegian Academy of Sciences
- 2005 Corresponding Member Heidelberg Academy of Sciences
- 2005 Chevalier dans l'Ordre national de la Légion d'Honneur
- 2006 Stephan Mueller Medal, European Geosciences Union
- 2006 Foreign Member Royal Danish Academy of Sciences
- 2006 Royal Netherlands Academy of Sciences Distinguished Professor
- 2006 Honorary Fellow, Geological Society of America
- 2007 Van Waterschot van der Gracht Medal, Royal Netherlands Geological and Mining Society
- 2007 Honorary Professor, Dublin Institute for Advanced Studies
- 2007 Visiting Professor, University Pierre et Marie Curie, Paris
- 2007 Blaustein Professor, Stanford University
- 2008 Foreign member Bavarian Academy of Sciences
- 2008 Visiting Professor, University Pierre et Marie Curie
- 2009 Visiting Professor, ETH Zürich
- 2009 Visiting Professor, IFP Rueil-Malmaison
- 2014 Order of the Netherlands Lion (Knight)
- 2014 President of Academia Europaea

More see [http://www.ae-info.org/ae/User/Cloetingh\\_Sierd](http://www.ae-info.org/ae/User/Cloetingh_Sierd)

**Talk 2: Sibylle Günter, Director, Max Planck Institute for Plasmaphysics, Garching/Greifswald**



**“Fusion Energy - base load electricity for the second half of the century”**

Abstract:

In a future fusion power plant, two hydrogen isotopes – deuterium ( $2\text{H}$ ) and tritium ( $3\text{H}$ ) – will combine to form a He atom and set free a neutron, releasing in this process 17.6 MeV of energy. The reaction is an analogue to combustion, but the burn temperature is in the 100 Million  $^{\circ}\text{C}$  rather than the several 100  $^{\circ}\text{C}$  range, and the energy set free in a single reaction is correspondingly some Million times larger. Thus, like in combustion we face the need to obtain a sufficiently high temperature and to keep the reactants from cooling too much by contact to the cold surroundings.

There are in principle two ways to a fusion reactor, the so-called inertial fusion and the magnetic fusion. In inertial fusion, a small pellet with frozen deuterium and tritium is heated up so fast that a sufficient number of fusion reactions can occur before the pellet disintegrates. Research in inertial fusion energy will not be reported here as it is mainly performed outside the EURATOM framework and to a large extend driven by military applications.

At the required temperatures of about 100 Mio degrees, a gas is fully ionized, and the motion of the particles of this so-called plasma can be influenced by electromagnetic fields. Only a strong and properly shaped magnetic field, in combination with a very low plasma density can provide this exceptional insulation, but even in that case a large volume is required for self-sustaining burn. As a stationary fusion power plant has to be a system with inherently low power density – only about one hundredth of that of a fission plant – the thermal insulation has to be very good.

As opposed to fission the safety of a fusion reactor is inherent. Even in the event of external catastrophes, consequences would remain limited to the immediate power-plant vicinity. The product of the fusion reaction is helium, which is not radioactive and does not produce any afterheat. As the fusion reaction is not a chain reaction, there is no possibility of loss of control. The only volatile, radioactive element in the fuel cycle is tritium, which is produced and also

consumed in the reactor itself, and the needed inventory can therefore be kept very low. Radioactive isotopes are also produced due to the neutron bombardment of components in the reactor core, but the consequences strongly depend on the choice of materials used. For example, steels have been developed which could be fully recycled within a hundred years period.

The inherent safety properties, the crisis-proof availability of the fuel, and the promise of small environmental impact make fusion an attractive candidate for a source of CO<sub>2</sub>-free electricity production, suited in particular to cover base-line loads. Its development had to clarify and overcome first a set of novel physics challenges: identification of magnetic configurations that can stably confine plasmas, heating of a plasma to 10 times the temperature in the solar interior, and control of the interaction with materials at energy fluxes locally comparable to those at the surface of the sun.

After more than 50 years of research, fusion has advanced to the decisive step on the way to a power plant: the international tokamak experiment ITER is designed to demonstrate the feasibility of net energy production from nuclear fusion reactions. In a joint enterprise by 7 partners (the EU, Japan, Russia, USA, China, the Korean Republic and India) - ITER - will for the first time show energy production exceeding the heat input to the plasma by an order of magnitude.

While magnetic confinement fusion research has converged to one experiment for the demonstration of sustained thermonuclear burn, there exist, at present, still two options for the ultimate, electricity producing power plant. They differ essentially on how stationarity of power production is to be achieved. By far the most advanced confinement configuration – the tokamak – requires the continuous flow of an electric current in a donut-shaped plasma. In present devices this plasma current is driven by a transformer, and can therefore be maintained only over a certain time, which – in a reactor – could amount to some hours. A thermal storage would provide for continuity of the electric power production during the short time interval needed to recharge the transformer. There exist, however, also ways to drive the plasma current continuously, but to do this in an economic way is a subject of current R&D. Both of these distinct operating modes of a tokamak are being prepared at present day experiments such as JET (Culham, UK) and ASDEX Upgrade (Garching, Germany), and will be tested extensively in ITER.

An alternative to the tokamak is the stellarator, which has a considerably more complex magnetic configuration, but is intrinsically stationary without any need of external current drive. The complex magnetic field of a stellarator requires careful optimization to ensure sufficiently good confinement properties. The first optimized stellarator of sufficient size to prove that the stellarator concept has the potential for a power plant, Wendelstein 7-X, has recently been built up in Greifswald, Germany. It will start plasma operation still in 2015.

Given the still open physics and technology issues and also the need to further develop and characterize materials, fusion can make a significant impact on the electric energy supply only in the second half of this century. However, even after 2050, electricity needs are still expected to further rise (about by a factor of 3 till 2100) and some of the shorter-term solutions to the CO<sub>2</sub> problem, like the enhanced usages of gas or CO<sub>2</sub>-sequestration, will run out of resources or face a shortage of suitable repositories by that time. Fusion has the promise to offer a complement to renewables, being available continuously and independently of location.

The European fusion community has recently elaborated a roadmap to fusion electricity by 2050, pointing out the main missions and the milestones to be met on that way. All European fusion laboratories are working jointly to implement this roadmap. The collaboration is organized within the consortium EUROfusion, involving fusion laboratories from 26 EU member states and Switzerland.

#### Further Reading:

--- Fusion Electricity. A roadmap to the realization of fusion energy

<https://www.euro-fusion.org/wpcms/wp-content/uploads/2013/01/JG12.356-web.pdf>

--- CM Braams and P.E. Stott: "Nuclear Fusion - Half a century of magnetic confinement fusion research" IOP 2002

--- Fusion Physics, International Atomic Agency, Wien, 2012 (ISBN: 978-92-0-130410-0)  
Wesson Tokamaks, Oxford University Press; 2nd edition 1997

#### Profile:

Prof. Dr. Sibylle Günter is scientific director of the Max Planck Institute for Plasmaphysics in Garching

1982	High school diploma in Rostock
1982-1987	Study of physics, Rostock University
1990	PhD in theoretical physics, Rostock University
1990-1996	Scientific staff member, theoretical physics Rostock University
1994	University of Maryland and National Institute for Standards and Technology (NIST), USA
1996	Habilitation in Rostock, <i>venia legendi</i> in theoretical physics
1996 - 1998	Scientific staff member, Max-Planck Institute for Plasma Physics
1998	Appointment to group leader position (C3)
2000	Appointment as scientific member of the Max-Planck Society and Director at Max-Planck Institute for Plasma Physics
2001	Appointment as adjunct professor at Rostock University
2005	Appointment as honorary professor at Technical University of Munich (TUM)
2007 - 2011	Member of the directorate of the Max-Planck Institute for Plasma Physics
2009 -	Head of Research Unit of the EURATOM Association IPP

2010 - 2011	Deputy Chair of the Board of Scientific Directors of IPP
2011-	Scientific director of the Max-Planck Institute for Plasma Physics, Chair of directorate and of the Board of Scientific Directors of IPP
2013	Federal Cross of Merit of the Federal Republic of Germany on the Ribbon

#### Collaborations

:

- Chair of the General Assembly of the EUROfusion consortium (2014), vice chair since 2015
- Chair of the Steering Committee of the European Fusion Development Agreement 2011-13
- Scientific Leader of the Max-Planck/Princeton Research Center on Plasma Physics since 2012
- Member of the Consultative Committee for the EURATOM Specific Research and Training Programme in the Field of Nuclear Energy (Fusion) 2011-2013
- Leader of the “International Tokamak Physics Advisory Committee on Energetic Particle Physics” (2008-2010)
- Deputy Task force leader MHD on JET (1999-2001)

#### Organisations/Editorial Boards

- Member of the National Academy of Science and Engineering of Germany since 2015
- Member of the Senate of the Max-Planck society
- Member of the Editorial Boards of New Journal of Physics since 2011
- Member of the Vorstandsrat of the German Physical Society since 2009
- Member of the board of trustees of the Max-Planck Institute for Quantum Optics since 2011
- Member of the board of trustees of the Wissenschaftspressekonferenz (WPK) since 2011
- Member of the board of trustees of the Karl Heinz Beckurts-Stiftung since 2011
- Member of the board of trustees of the Deutsche Museum since 2014
- Member of the International Fusion Research Council (IFRC) of the International Atomic Energy Agency (IAEA) since 2004
- Member (2004-2006) and Chair of the Plasma Physics Division of the German Physical Society (2006-2008)

#### Advisory Committees/Evaluations/Prize Committees

- Co-Chair of the Scientific Advisory Committee of the Princeton Plasma Physics Laboratory (USA) since 2013, Member since 2010
- European Research Council: Member of “starting grants panel” (2009-2011)
- Member of the Robert-Pohl Prize Committee of the German Physical Society (2009-2012)
- Chair of the “Board for high-performance computing of the European fusion community (HPC board)” (2008-2010)
- Member of the Advisory Committee of the Computer Center of the Max-Planck Society (2007-2011), Chair: 2007, 2009
- Member of the FOM Rijnhuizen Evaluation Committee 2011
- Member of the DIII-D Programme Committee (2006-2008)

### Programme Committees:

- Member (2006) and Chair (2007) of the Programme Committee of the European Plasma Physics Conference (EPS)
- Member (2007-2011) and Chair (2007) of the Programme Committee of the IAEA Technical meeting on “Energetic particle physics”
- Member of the Programme Committee of the IAEA Technical meeting on “Theory of plasma instabilities” (2002-2011)
- Member of the Programme Committee of the European Fusion Theory Conference (2000-2005)
- Director Committee of the Festival de Theorie, Aix-en-Provence, France (2011-)

### Research Interests:

- Theory of Magnetized Plasmas:
  - Magneto-Hydrodynamics
  - turbulent transport
  - kinetic theory
  - supra-thermal particles
- Experimental tokamak physics:
  - Performance limiting instabilities
  - Heating and current drive
  - “Advanced Tokamak Scenarios”
- Numerical Methods to describe transport in strongly anisotropy systems

### Talk 3: Oskar Mencer, CEO, Maxeler Supercomputer Technologies, UK



#### “From Big Data to Dataflow Computing”

##### Abstract:

Von Neuman computers were invented at a time when 1 KB was a lot of data. As we move to processing Petabytes without microprocessor frequencies increasing further, the movement of data becomes the bottleneck. Maxeler has shown how multiscale dataflow computing addresses the energy, cost and speed challenges of the modern era of computing, in application areas ranging from HighEnergy/Weather, Oil&Gas, Finance, Media, and most recently, networking.

##### Profile:

Oskar Mencer was born in Vienna, Austria, and holds a BSc degree in Computer Engineering from the Technion, and an MS and PhD degree in Electrical Engineering from Stanford University. Oskar is a member of academic staff in the Computing Department, Imperial College London, and was Member of Technical Staff at the Computing Sciences Center (1127) at Bell Labs in Murray Hill, the cradle of Unix, C, C++, the first transistor, and information theory.

Besides driving the development of Multiscale Dataflow Computing as Founder, CEO and CTO of Maxeler Technologies, Oskar is a member of the steering committee for the Centre for Nature Inspired Engineering at UCL, and was Consulting Professor in Geophysics at Stanford University.

In 2013, Oskar started OpenSPL ([www.openspl.org](http://www.openspl.org)), an open standard for a spatial programming eco-system, supported by Chevron, Juniper and CME Group in Chicago.

Recently, Maxeler installed a large Dataflow computer at the UK government laboratory in Daresbury (and a smaller version in a Chinese government laboratory in Jinan), and Oskar was invited to join a UK government committee developing a recommendation for future investment into software infrastructure for High Performance Computing.

Over the years, Oskar gave a series of keynotes on three continents, served on numerous program committees, received two Best Paper Awards, a diploma as an entry level Austrian skiing instructor, an Imperial College Research Excellence Award in 2007 and a Special Award from Com.sult in 2012 for "revolutionising the world of computers".

**Talk 4: Rainer Blatt, Professor, Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences**



**"The Quantum Way of Doing Computations"**

**Abstract:**

Since the mid nineties of the 20th century it became apparent that one of the centuries' most important technological inventions, computers in general and many of their applications could possibly be further enormously enhanced by using operations based on quantum physics.

This is timely since the classical roadmaps for the development of computational devices, commonly known as Moore's law, will cease to be applicable within the next decade due to the ever smaller sizes of the electronic components that soon will enter the quantum physics realm. Computations, whether they happen in our heads or with any computational device, always rely on real physical processes, which are data input, data representation in a memory, data manipulation using algorithms and finally, the data output.

Building a quantum computer then requires the implementation of quantum bits (qubits) as storage sites for quantum information, quantum registers and quantum gates for data handling and processing and the development of quantum algorithms.

In this talk, the basic functional principle of a quantum computer will be briefly reviewed. It will be shown how strings of trapped ions can be used to build a quantum information processor and how basic computations can be performed using quantum techniques. In particular, the quantum way of doing computations will be illustrated by quantum simulations and it will be shown how the current small devices can possibly be scaled to larger systems.

**Profile:**

Rainer Blatt is Professor at the Institute for Experimental Physics, University of Innsbruck, Rainer.Blatt@uibk.ac.at, [www.quantumoptics.at](http://www.quantumoptics.at) and Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences, Otto-Rainer.Blatt@oeaw.ac.at, [www.iqoqi.at](http://www.iqoqi.at)

He was born in Idar-Oberstein/Germany.

He studied physics at the University of Mainz. He finished his doctorate in 1981 and worked as a research assistant.

In 1982, he went to the Joint Institute for Laboratory Astrophysics (JILA), Boulder, USA, and worked with John Hall for a year.

In 1983, he joined the FU Berlin, and in the following year went to the University of Hamburg.

After another stay in the US, he qualified as a professor by receiving the “venia docendi” in 1988. In 1989 to 1994 he worked as a Heisenberg research fellow in Hamburg and returned several times to JILA in Boulder.

In 1994 he was appointed to a chair at the University of Göttingen and in the following year accepted a chair at the University of Innsbruck.

Since 2003 Blatt has also held the position of Scientific Director at the Institute for Quantum Optics and Quantum Information.

Blatt is known for his support of young scientists and has been awarded numerous scientific prizes nationally and internationally.

## Session : “Medicine of the Future”

**Talk 1: George Church, Professor of Genetics at Harvard Medical School and Director of PersonalGenomes.org**



### **"Big data driven medicine: Next generation sequencing and genome engineering"**

Abstract:

Next generation sequencing and genome engineering using techniques from Big Data

Information on The personal Genome Project

#### Our Mission

Our mission is to make a wide spectrum of data about humans accessible to increase biological literacy and improve human health. PersonalGenomes.org is a nonprofit organization working to generate, aggregate and interpret human biological and trait data on an unprecedented scale using open-source, open-access and open-consent frameworks. Our efforts are informed by values encouraging greater transparency and collaboration between researchers and participants.

#### Our Vision

We believe obtaining a personal genome sequence is an activity that soon will be shared by millions of individuals around the world. To improve our understanding of how human traits are formed through the interactions between genomes and their environments, a much more holistic picture of the human experience is needed. The ideal scientific resource would be to create a collection of many human genomes that remain connected to their owners who contribute additional information over their lifetime, such as longitudinal health status, medical and social history, environmental exposures, nutrition, lifestyle, physical measurements, blood chemistry, presence or absence of microbes and viruses, and many other kinds of data.

#### The Dilemma

Even if a person's name, home address or facial photograph is specifically excluded, a dataset like the one we are building is far from anonymous. It is simply too easy for someone to connect the dots and reveal a person's identity. Moreover, data breaches are not uncommon even in the most highly regulated arenas like national intelligence where secrets are heavily

guarded with extensive security clearance protocols and background checks. We think it is very important to be honest about how difficult it is to simultaneously share and protect data.

Sharing data is critical for enabling discovery. Assembling under one roof a research team with the requisite expertise to generate, aggregate and interpret this dream dataset is unrealistic. Expertise is too diffuse. Major contributions might come from unconventional actors residing in far flung corners of the globe. Einstein started off as a patent clerk after all. Citizen scientists, hobbyists, amateurs and the participants themselves will undoubtedly make significant contributions.

## Our Model

We feel the most ethical and practical solution to this dilemma is to turn the privacy problem on its head and collaborate with individuals who are willing to share their data publicly with the understanding that re-identification is possible. We also will reduce potential misunderstandings by requiring prospective participants to demonstrate that they comprehend the public, non-anonymous nature of this endeavor as part of our unique consent process.

We will grow this exceptional public resource by seeding a cohort of well-consented individuals with extensive genomic data and then invite a network of researchers to recruit from this cohort for additional phenotyping and molecular profiling, under the condition that they return computable datasets to the research participants. These participants, in turn, may donate their data to the public domain for others to use, thereby reinforcing the virtuous circle of sharing.

We will encourage widespread use of this public data resource as a platform for scientific research, education, improvement of the public health, public- and private-sector innovation, benchmarking and standardization, and personal exploration.

## Profile:

George Church is Professor of Genetics at Harvard Medical School and Director of PersonalGenomes.org, which provides the world's only open-access information on human Genomic, Environmental & Trait data (GET).

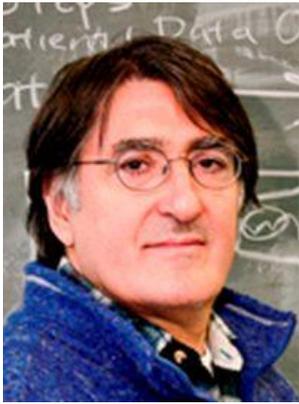
His 1984 Harvard PhD included the first methods for direct genome sequencing, molecular multiplexing & barcoding. These led to the first genome sequence (pathogen, *Helicobacter pylori*) in 1994.

His innovations have contributed to nearly all "next generation" genome sequencing methods and companies (CGI, Life, Illumina, nanopore). This plus chip-based DNA synthesis and stem cell engineering resulted in founding additional application-based companies spanning fields of medical diagnostics ( Knome, Alacris, AbVitro, Pathogenica ) & synthetic biology / therapeutics ( Joule, Gen9, Editas, Egenesis, enEvolv, WarpDrive ).

He has also pioneered new privacy, biosafety , environmental & biosecurity policies. He is director of NIH Center for Excellence in Genomic Science.

His honors include election to NAS & NAE & Franklin Bower Laureate for Achievement in Science. He has coauthored 370 papers, 60 patents & one book (Regenesis).

## Talk 2: Hans Lehrach, Professor for molecular genetics at Max Planck Institute, Berlin



### "The virtual patient"

Abstract:

This talk will discuss how the notion of virtual patient has developed and is going to influence medicine more and more in the future.

Research at the Max-Planck-Institute for Molecular Genetic:

Research at the Max Planck Institute for Molecular Genetics concentrates on genome analysis of man and other organisms to contribute to a global understanding of many of the biological processes in the organism, and to elucidate the mechanism behind many human diseases. It is the overall goal of the combined efforts of all MPIMG's groups to gain new insights into the development of diseases on a molecular level, thus contributing to the development of cause-related new medical treatments.

Genome research, the systematic study of genes and genomes, has changed the way in which research in molecular genetics is pursued. The focus and composition of the MPI for Molecular Genetics reflects this development. The Dept. of Vertebrate Genomics (Lehrach) generates the tools and information to understand the function of most or all genes of man and other organisms. The Human Molecular Genetics Dept. (Ropers) searches for disease genes and their biological function. The Dept. of Computational Molecular Biology (Vingron) exploits the generated data to better understanding of biological and disease processes. The Dept. of Developmental Genetics (Herrmann) uses the systematic functional analysis for understanding developmental mechanisms.

The institute pursues a number of large scale projects. Probably the most prominent national project is the German National Genome Network (NGFN), where all departments of the institute participate and collaborate with each other. Other prominent projects include a number of EU projects, participation in several projects of the German Ministry of Science as well DFG "Sonderforschungsbereiche".

Profile:

Hans Lehrach is Professor for Molecular Genetics at the Max Planck Institute, Berlin

## University Education

1970 Diploma in chemistry, Technische Universität Braunschweig

- 1974 Ph.D., MPI for Experimental Medicine, Göttingen

## Professional Experience (selection)

- 1974-1976 Research fellow, Department of Biochemistry and Molecular Biology, Harvard University, USA
- 1978-1987 Head of a research group at the EMBL, Heidelberg
- 1987-1994 Head of Department Genome Analysis, Imperial Cancer Research Fund, UK
- 1994- Director of the Max Planck Institute of Molecular Genetics (MPI-MG)

## Research Fields

- Main field: Technology development in genomics
- Other fields: Automation, sequencing, proteomics, transcriptomics
- Current research interest: Systems biology of cancer

## Most important Awards, Grants or Scientific Achievements

- 2003 The Ján Jessenius SAS Medal of Honour for outstanding achievements in medical sciences, Slovak Academy of Sciences
- 2004 Karl Heinz Beckurts Award for achievements in genome research, Munich

## 3 most relevant Publications

- Ralser, M., Wamelink, M. M., Struys, E. A., Joppich, C., Krobitsch, S., Jakobs, C., and Lehrach, H. (2008). A catabolic block does not sufficiently explain how 2-deoxy-D-glucose inhibits cell growth. *Proc Natl Acad Sci USA* 105, 17807.
- Sultan, M., Schulz, M. H., Richard, H., Magen, A., Klingenhoff, A., ..., Lehrach, H., and Yaspo, M.L. (2008). A global view of gene activity and alternative splicing by deep sequencing of the human transcriptome. *Science* 321, 956.
- International Human Genome Sequencing Consortium (2004). Finishing the euchromatic sequence of the human genome. *Nature* 431, 931

### Talk 3: Claudio Luchinat, Center of Magnetic Resonance, University of Florence



#### " Metabolomics for preventive and personalized medicine"

##### Abstract:

Metabolomics is the "systematic study of the unique chemical fingerprints that specific cellular processes leave behind", the study of their small-molecule metabolite profiles. The metabolome represents the collection of all metabolites in a biological cell, tissue, organ or organism, which are the end products of cellular processes. mRNA gene expression data and proteomic analyses reveal the set of gene products being produced in the cell, data that represents one aspect of cellular function. Conversely, metabolic profiling can give an instantaneous snapshot of the physio-pathology of that cell. One of the challenges of systems biology and functional genomics is to integrate proteomic, transcriptomic, and metabolomic information to provide a better understanding of cellular biology and to apply it to preventive and personalized medicine.

In the last few years, metabolomic studies at the systemic level (blood and/or urine) have shown that a clear fingerprint exists for several pathologies, in some cases emerging at a very early stage. Although obviously limited in the number of patients and controls, these studies have enough statistical power to at least warrant further investigations on larger cohorts. I am personally convinced that we are right now only looking at the tip of the iceberg, and that metabolomic fingerprinting, if pursued at a one-to-two orders of magnitude higher scale, may have a dramatic impact on our way of conceiving preventive and personalized medicine.

##### Profile:

Claudio Luchinat is Professor at the Center of Magnetic Resonance, University of Florence.

Born in 1952, he received his Doctorate in Chemistry cum laude March 1976

##### Positions held

- University of Florence: Post-doc, 1976-1978; recipient of a CNR research grant, 1978-1981; tenure researcher, 1981-1986 (Faculty of Pharmacy and Faculty of Sciences).
- University of Bologna: Full professor of General and Inorganic Chemistry, Faculty of Agricultural Sciences, 1986-1996.

- University of Florence: Faculty of Agricultural Sciences, 1996-2012 and Faculty of Sciences, 2012 to present.

## Honors

- IBM visiting scientist, T.J. Watson Research Center, Yorktown Heights, N.Y., 1981, 1983, 1984, 1986; visiting professor, State University of New York, Plattsburgh, 1982; recipient of a J.S.P.S. (Japanese Society for the Promotion of Science) fellowship as visiting professor, 1987; visiting scientist at the California Institute of Technology, 1988; visiting Professor at the University of Ioannina, 1993; visiting Professor for the "Troisième Cycle" at the Universities of Genève and Lausanne, 1988 and 1999;
- Regional representative of the Italian Association of Inorganic Chemistry, 1983-1985; member of the National Committee of the Magnetic Resonance Discussion Group, 1987-1989 and 1989-1991; Member of CNR committees for the selection of CNR Research Directors, 1992, 2009 and 2013; member of Progetto Finalizzato CNR Committee, 1995; member of the Board of Directors for the Interuniversity Consortia INCA (1994-1998) and CIRMMP (1995 to present).
- Coordinator of the International Doctorate School in Structural Biology in collaboration with the Universities of Frankfurt and Utrecht (2001-2009, and 2013 to present).
- Scientific Coordinator or Principal Investigator in European research projects since Framework Programme III.
- Co-founder of the Magnetic Resonance Center of the University of Florence (CERM), of the Interuniversity Consortium on Magnetic Resonance of Metalloproteins (CIRMMP), of the spin-off Giotto Biotech Srl, and of the not-for-profit biomedical research organization Fiorgen.
- President of the Interuniversity Consortium on Magnetic Resonance of Metalloproteins (CIRMMP) since 2011.
- "Raffaello Nasini" gold medal award for Inorganic Chemistry of the Italian Chemical Society, 1989; Federchimica Award "For an Intelligent Future", 1994; European Medal for Biological Inorganic Chemistry, awarded by the Society of Biological Inorganic Chemistry, 1996; "GDRM gold medal for magnetic resonance", 2001.
- Member of the Supervisory Board of the Paramagnetic NMR Facility of the University of Leiden, 2013 to present; member of the Scientific Advisory Board of the French High Field NMR Research Infrastructure, IT-RMN-THC, 2014 to present;
- Member of several scientific societies, editor of several journals, organizer of large conferences and many symposia and workshops.

## Scientific Activity

His research interests include bioinorganic chemistry, structural biology, Development of NMR-based structural methodologies in solution and in the solid state, metalloproteins and metalloenzymes, enzyme-inhibitor interactions, structure-function relationships, spectroscopy, theory of electron and nuclear relaxation, NMR of paramagnetic species, relaxometry, contrast agents.

In the last decade, he has also provided many scientific contributions on metabolomics and NMR-based analytical methods.

He is the author of more than 540 research articles, written in English, published in internationally renowned scientific journals. His h-index is 66, and his publications have been quoted more than 18000 times.

He is the author of the following books: C. Luchinat, S. Aime and G. Valensin "NMR Spectroscopy: Applications in Inorganic and Bioinorganic Chemistry", AICI, 1984; I. Bertini, C. Luchinat, "NMR of Paramagnetic Molecules in Biological Systems", Benjamin-Cummings, 1986; I. Bertini, L. Banci, C. Luchinat " Nuclear and Electron Relaxation", VCH, 1991; I. Bertini, C. Luchinat, "NMR of Paramagnetic Substances", Elsevier, 1996; I. Bertini, C. Luchinat and G. Parigi "Solution NMR of Paramagnetic Molecules" Elsevier, 2001.

More at <http://www.cerm.unifi.it/people/claudio-luchinat>

## Talk 4: Christine Moissl-Eichinger, Professor at Graz Medical University



### "The microbiome ecosystem"

#### Abstract:

Approximately ninety percent of all cells in the human body are microorganisms. They reside on our skin, in mouth, nose, ears, intestinal tract and genitals. The microbial material living in our gut weighs about 1-2 kg, and there are more bacteria on our skin than human beings on the Earth. Regarding these numbers, it is not surprising that the human microbiome (the entity of all microorganisms living with us) has an enormous power: Most species (out of approximately ten thousands of them) are essential for our survival, health and well-being.

Health problems such as inflammatory bowel diseases, obesity, diabetes and even autism and depression have been linked to altered composition and diversity in human-associated microbial community. The human microbiome interacts closely with the environmental microbiome - from our indoor homes, animals or plants, which are an important source of healthy microorganisms - as food and environmental component

We spend the majority of our lifetime in indoor environments and the impact of a healthy environment on the human microbiome has been shown in previous studies. Normal indoor environments are strongly influenced by ventilation (outdoor air), the natural outside-environment and the (human) activity- and thus ensure the interaction with beneficial microorganisms. Restricted areas, such as clean rooms, intensive care units or the international space station are special indoor environments, which provide are very limited or no exchange with the surroundings. In our research, we want to understand the interaction and influence of maintenance of such special living environments with low microbial diversity on the health and well-being of inhabitants. In particular, analogue space missions and studies of the international space station are experimental environments which provide critical insight in the (resistant) microbiome that might have to be controlled during long-term spaceflight or human isolation. Requirements for spaceflight are a general driver for technical innovations and could thus push the improvement of microbial detection and the analysis of their activity. Both, the spaceflight models and novel technical innovations can have direct impact on the maintenance of medical environments on Earth and novel applications in microbiome research, control and diagnostics.

## Profile:

C. Moissl-Eichinger is Professor for “Interactive Microbiome Research” at the Medical University Graz, Austria. She is PI of numerous microbiome-, microbial ecology- and astrobiology-related projects from national up to European level, including the upcoming International Space Station-ARBEX project. She is member of the European BIOSIS consortium (“Biosafety in space”), the ESA ECSS group “Microbiological examination of flight hardware and cleanrooms” and MC member of the COST activity “Origins” (Origins and evolution of life on Earth and in the Universe; TD1308). She is reviewer for the Planetary Protection panel of NASA.

Within the last years, she has received several prizes and grants, including the NASA Certificate of Recognition for the creative development of technical innovation (2008) and the ESF TOP 10 New Species Award (2014). She has published more than 40 articles in high-impact Journals, such as Nature Communications and Nature ISME Journal. She has collaborations all over the world, including Caltech/ NASA JPL (Pasadena, USA), Moscow State University, University of Edinburgh and DLR Cologne (Germany).

## Career

- Since Sep 2014 Professor for „Interactive Microbiome research“ at the Medical University of Graz (BioTechMed Professorship)
- 2007 – 2014 Project- and group leader at the Department for Microbiology and Archaea Center at the University of Regensburg, Germany
- 2005 – 2006 PostDoc at the NASA Jet Propulsion Laboratory/California Institute of Technology (Caltech) in Pasadena, USA
- 2004 – 2005 PostDoc at the University hospital Regensburg (Internal Medicine/Rheumatology), Germany

## Academic background

- 2014 Habilitation (Dr. habil) and Venia Legendi in Microbiology (Privatdozentin)
- 2000 – 2004 Dissertation (Dr. rer. nat.)
- 1995 – 2000 Study of Biology at the University of Regensburg, Germany

## Areas of expertise and contribution to BioTechMed-Graz

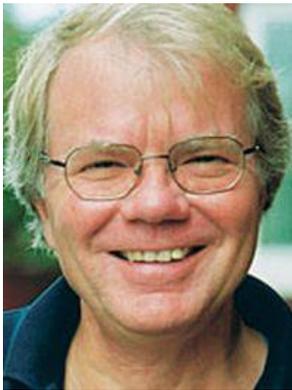
Every human being carries more than 10-100 times more microorganisms than own body cells and we interact closely with about 10.000 different microbes. The interaction with this so-called microbiome is highly relevant for us: Some of these microbes are essential, others can have negative effects on our body, but due to the complexity of the microbiome, we are just at the beginning to understand the function and importance of these microbes. In my group, we

are highly interested in the human gut- and skin microbiome, but also in the interaction of the human microbiome with plants and our direct, biotic and abiotic environment – also to culture and characterize novel, beneficial microorganisms. Besides Bacteria, we will also look into the fungal and archaeal diversity: Archaea are special microorganisms with unusual characteristics, often overlooked in diagnostic analyses. They, however, play a crucial role in the natural environment (e.g. spring water, soil), but also in the human body, which we would like to elucidate further. Besides unusual microbes we will also look into unusual working areas, such as the International Space Station, which will be sampled for us by an astronaut during an ESA space project. In all these projects, colleagues from the three universities will be involved, in order to emphasize the cooperative aspect and to position our research optimally in the Graz network and beyond.

Modern research is driven and shaped by cooperation, exchange, discussion and networking, the application and combination of state-of-the-art analysis methods and techniques, as well as by unusual and brilliant ideas. BioTechMed creates a novel, extraordinary basis for all this and allows us, the BioTechMed professors and associated teams, to perform highly efficient research for human health.

Her statement: “I am full of enthusiasm and energy, I am looking forward to my Interactive role in the frame of the unique BioTechMed cooperation project, to novel insights into the Microbiome of the human body and the environment, and to join Research for the human health in an excellent environment!”

**Talk 5: Jan-Eric Litton, Professor at Karolinska Institute and Director General of DG BBMRI-ERIC:**



**" Life Sciences Research Infrastructures"**

Abstract:

Europe made a big leap forward in the last decade with the ESFRI process for establishing urgently required large-scale research infrastructures to support frontier research and innovation. These research infrastructures should work in synergy to support the process from research up to clinical development for the benefit of the patients and the improvement of health care for the European citizens, generating value for society through collaboration. Essential for the understanding of the diversity of human diseases, biological samples and corresponding data are required for the development of any new drug or diagnostic assay and are therefore critical for the advancement in health research, ultimately leading to personalized medicine. Biobanks also will provide key information on the influence of environment and lifestyle on health, constituting a basis for disease prevention programs and the improvement of public health.

Hence, a close collaboration between researchers, biobankers, patient advocacy groups, and the biotech and pharma industry is essential in addressing both common and rare diseases. Retrieving high quality data on clinically annotated human samples is a time-consuming bottleneck for biomedical research in Europe as well as globally. Absent a proper infrastructure, for connecting biobanks across the EU, new discoveries, research on rare diseases identification of new targets for therapy and drug discovery and development continue to suffer from attrition and may be delayed, frustrated or even blocked from happening. Compounding the problem is the fact that biobanks contain sensitive data from human donors, of sometimes-vulnerable patients groups. To protect their interests, the use of biobanks, both internal and external use, is subject to laws and regulations which have proliferated into a patchwork of EU, national, institutional and data subject requirements and restrictions on access and exchange of information.

Keeping in mind the need for better prevention, diagnostics, and therapy for all, we are aware that every single sample impacts our ability to comprehend disease and, thus, achieve our goal for a healthier life. Sixteen Member States and one International Organization have thus joined forces in establishing BBMRI-ERIC, which is one of the largest health Research Infrastructure in Europe today. BBMRI-ERIC primarily aims at establishing, operating, and developing a pan-

European distributed research infrastructure of biobanks and biomolecular resources. This will facilitate the access to biological resources as well as biomedical facilities and support high-quality biomolecular and medical research.

Profile:

Director General Jan-Eric Litton is Professor of Biomedical Computing Technology at the Karolinska Institutet, Stockholm, Sweden. He was appointed BBMRI-ERIC's first Director General on 22 January 2014 in Graz, Austria.

Prof. Litton acts as the chief executive officer and legal representative of BBMRI-ERIC and he is responsible to the Assembly of Members. Prof. Litton was Executive Director and head of one of the largest medical infrastructure in Sweden – BBMRI.se (The Biobanking and Molecular Resource Infrastructure of Sweden). He also coordinated the Nordic BBMRI (Denmark, Sweden, Norway, Finland, Island, Faroe Island and Estonia).

Litton is renowned for his expertise in biobanking and leadership in large-scale projects. He is also heading the development of e-epidemiology by using Internet, cell-phones, digital paper and digital TV for collecting epidemiology data. Litton is involved in many large EU project in medicine, including the: BiobankCloud – Scalable, Secure Storage of Biobank Data. He was one of the driving forces in the FP5 project GenomEUtwin, where an infrastructure was built to link information between the 600 000 twins in seven European Countries and Australia between 2002–2007.

He led an infrastructure group in the "EU Coordination Action; Harmonising population-based biobanks and cohort studies to strengthen the foundation of European biomedical science in the post-genome era" 2006, and has been involved in P3G since 2004, he led IWG2 (Information Curation and Information Technology) in P3G during 2004–2008.

He was the co-director for the Swedish LifeGene initiative, a prospective cohort based biobank with the aim of 500,000 participants until 2010. Since 2012, Prof. Litton is part of the e-science initiative in Sweden with a yearly budget from the Swedish government. Jan-Eric Litton has also made major contributions to the current knowledge in Positron Emission Tomography (PET) and was one of the first researchers showing receptor binding with PET technique.

He did his post doc at The Research Medicine Department of Lawrence Berkeley Laboratory and Donner Laboratory of the University of California, USA, 1986–1987.

## Research description

BBMRI.se, established by The Swedish Research Council (Vetenskapsrådet), is a national large-scale research infrastructure whose purpose is to build and develop effective systems for saving and analyzing biological samples.

Biobanking: The general aim is to develop an infrastructure for a Biobank Information Management System - BIMS, connecting large hospital and research databases in Sweden with the possibility of linking information about phenotypes and genotypes.

## EU-biobanking

The role of ESFRI (European Strategy Forum on Research Infrastructures) is to support a coherent approach to policy-making on research infrastructures in Europe, and to act as an incubator for international negotiations about concrete initiatives. ESFRI brings together representatives of EU Member States and Associated States, appointed by Ministers in charge of Research, and one representative of the European Commission.

## LifeGene

Half a million Swedes will be contacted for information concerning their health, lifestyle and exposures, and for donation of blood samples. At project start (baseline), individuals will be contacted for assessments by age groups. Sampling for blood will be done by LifeGene staff at hospital laboratories and/or in mobile units.

e-epidemiology: web-based questionnaires

The aim is to implement and evaluate the use of web-based questionnaires as opposed to paper-based questionnaires in otherwise standard epidemiological study design.

e-epidemiology: mobile phones

The aim is to evaluate the use of mobile phones (SMS) and stationary telephones (IVR) as a tool in e-epidemiology.

e-epidemiology: computerized programs

The aim is to evaluate the possibilities of using computerized programs over the Internet for testing physical functions connected to epidemiological trails.

## Textmining

Creation of an extensive healthcare information discovery platform which will act as the underlying research platform on which we develop our text analysis capabilities in Swedish.

**Talk 6: Kurt Zatloukal, MAE, Professor for Medicine, Graz Medical University**



**"Disruptive innovation in health care"**

Abstract:

Diseases associated with ageing societies, reemerging infectious diseases and pandemics pose major challenges on future healthcare systems. Furthermore, these challenges are superimposed by increasing costs of healthcare which exceed annual growth of GDP in most countries. The enormous costs of improving disease outcomes by the current innovation system is well exemplified by the investment needed to bring one new drug to market and the therapy costs per patient with modern drugs of personalized medicine. This situation cannot be improved by incremental developments but require substantial new solutions.

Such substantial new solutions might emerge from efficient utilization of massive data generated by modern technologies. These technologies allow characterizing the multitude of parameters, such as the genetic makeup of individuals, their environmental exposure and life style factors as well as composition of the metagenome, all of which contributing to the individual's metabolic and functional status and finally determining the health or disease status. The integration and computational modelling of these data will open the door to understanding the complexity of the biological systems affected in human diseases, thereby laying the foundation for a new type of healthcare.

Such a development would require several changes, such as: I) Improvement of data interoperability by better characterization of data sources (e.g., quality of biobanks) and implementation of data quality standards; II) Reduction of the current knowledge bias towards oversimplification; III) Establishment of new infrastructures for open and free knowledge sharing; IV) Improvement of the knowledge gaps of complex systems and their components; V) Co-development of biomedical and computer sciences; VI) New culture of interdisciplinary and collaborative research; VII) Pro-active engagement of individuals in tailored disease prevention throughout their lifespan.

The consequences of these developments would result in several fundamental changes in healthcare ranging from the current organ-driven to mechanism-based disease taxonomy, new teaching curricula and organization of hospitals to a disease prevention focused healthcare and reimbursement systems. However there are several roadblocks for such disruptive innovation in healthcare. First, healthcare itself is a highly complex system and there is reluctance to adoption of new procedures as long as their utility is not proven. Second,

healthcare is – for good reasons - a highly regulated field and regulatory requirements are not fit-for-purpose in case of substantial new procedures. Therefore, there is need for an experimental environment in which new healthcare concepts can be developed and tested before translation into general healthcare innovation may occur. In this context healthcare requirements under extreme conditions, such as remote and closed containments or long-term space flights might create an incubator for disruptive healthcare innovation.

#### Profile:

Kurt Zatloukal, M.D. is professor of pathology at the Medical University of Graz, Austria and is director of the Christian Doppler Laboratory for Biospecimen Research and Biobanking Technologies. His research focusses on molecular pathology of diseases as well as biobanking and related technologies. He coordinated the preparatory phase of the European biobanking and biomolecular research infrastructure (BBMRI) within the 7th EU framework programme and is now director of the Austrian national node of BBMRI-ERIC.

He led in the FP7-funded large integrated project SPIDIA the development of new European standards and norms for pre-analytical processing of tissue samples for molecular diagnostics.

He is and has been involved in developing the ethical and legal framework for medical research and health care in Austria. He is member of the Austrian Arzneimittelbeirat and the scientific board for genetic testing and human gene therapy at the Austrian Ministry of Health, and member of the Austrian Standards Institute. He has published 189 scientific papers and was co-inventor of 15 patents.

#### Present and Previous Positions

- 1997- present Professor of Pathology, Medical University of Graz, Austria
- 1991 - 1993 Postdoc at the Research Institute of Molecular Pathology (I.M.P), Vienna, Austria, in the group of Prof. Max L. Birnstiel (development of gene therapies for cancer)
- 1985 - 1991 Residence for pathologist at the Institute of Pathology, University of Graz, Austria (Head: Prof. Helmut Denk), with specialization in Molecular Pathology

#### Fields of Scholarship

- Molecular pathology
- Metabolic liver diseases
- Cancer
- Biobanking
- Research infrastructures

#### Honours and Awards

- 2000 –2003 Member of the board of the Austrian Science Fund
- 2001 - 2009 Member of the Bioethics Commission at the Federal Chancellery
- 2001 Founder of Oridis-Biomed (CEO 2001-2005)
- 2002 - 2005 President of the Austrian Society of Genetics and Gene Technology
- 2002 Corresponding member of the Austrian Academy of Sciences
- 2002 - 2007 Member of the OECD task force on biological resource centres

- 2004 - 2011 Member of the Roadmap (thematic) Working Group of the European Strategy Forum on Research Infrastructure (ESFRI)
- 2009 Member of the Austrian “Arzneimittelbeirat”
- 2009 Santa Chiara Chair at the University of Siena
- 2009 -2012 Honorary Professor of the University of Dundee
- 2010 Director of the Christian Doppler Laboratory “ Biospecimen Research and Biobanking Technologies”
- 2013 Member of Academia Europaea

More see [http://www.ae-info.org/ae/User/Zatloukal\\_Kurt](http://www.ae-info.org/ae/User/Zatloukal_Kurt)

## Session: “How Research and Science are going to change with new Technologies”

### Talk 1: Viktor Mayer-Schönberger, Professor at Oxford University



#### "Big Data and how it changes research"

##### Abstract:

In this talk I will show how Big Data is changing how we do research, in many ways replacing traditional causality. This trend will be more and more important in almost all areas of research. A number of startling results of this new approach will be given.

##### Profile:

Viktor Mayer-Schönberger is the OII's Professor of Internet Governance and Regulation. His research focuses on the role of information in a networked economy. Earlier he spent ten years on the faculty of Harvard's Kennedy School of Government.

Professor Mayer-Schönberger has published seven books, as well as over a hundred articles (including in Science) and book chapters. His most recent book, the awards-winning 'Delete: The Virtue of Forgetting in the Digital Age' (Princeton University Press 2009) has received favorable reviews by academic (Nature, Science, New Scientist) and mainstream media (New York Times, Guardian, Le Monde, NPR, BBC, Wired) and has been published in four languages. Ideas proposed in the book have now become official policy, e.g. of the European Union.

A native Austrian, Professor Mayer-Schönberger founded Ikarus Software in 1986, a company focusing on data security, and developed Virus Utilities, which became the best-selling Austrian software product. He was voted Top-5 Software Entrepreneur in Austria in 1991 and Person-of-the-Year for the State of Salzburg in 2000.

He chaired the Rueschlikon Conference on Information Policy, is the cofounder of the SubTech conference series, and served on the ABA/AAAS National Conference of Lawyers and Scientists. He is on the advisory boards of corporations and organizations around the

world, including Microsoft and the World Economic Forum. He is a personal adviser to the Austrian Finance Minister on innovation policy.

He holds a number of law degrees, including one from Harvard and an MS(Econ) from the London School of Economics, and while in high school won national awards for his programming and the Physics Olympics of his home state.

In his spare time, he likes to travel, go to the movies, and learn about architecture.

Research interests

Internet governance

Positions held at the OII

- Professor of Internet Governance and Regulation, October 2010 -
- Director of Advancement of the OII, February 2012 - February 2013
- Visiting Fellow, - November 2009

## Talk 2: Hans Sünkel, MAE, Past president and Professor, Graz University of Technology



### **“The Future of Research”**

Abstract:

Research has always been driven by curiosity and necessity. And contemporary research is increasingly characterized by two attributes: complexity and globality. The solution of complex and global problems, in turn, requires a systemic approach, intra-disciplinary excellence, interdisciplinary approaches and international collaboration alike.

Fundamental progress in research has never been made by incremental steps only, but almost exclusively by completely new approaches which disregard any beaten track. A strict differentiation between basic and applied research is becoming increasingly obsolete. A substantial progress in Natural and Technical Sciences requires a direct access to technology at the latest state of the art, and the often perceived call for a quick return-on-investment is inappropriate.

For collaborative research stone-carved organizational charts and structures are irrelevant. Research groups are being rather dynamically formed and follow as such the philosophy of cloud computing. An excellent command of mathematics, physics and informatics as a strong intellectual platform is a fundamental and indispensable prerequisite for interdisciplinary activities.

Modern Geosciences in general and Space Geodesy in particular are good examples of future trends of research and related requirements for academic teaching and follow closely the recommendation of Albert Einstein: “Progress comes from the exchange of knowledge”.

Profile:

Hans Sünkel is Professor at Graz University of Technology.

Present and Previous Positions

- 2010 - 2011 President, Universities Austria

- 2003 – 2011 Rector, TU Graz
- 2001 – 2004 Director, Space Research Institute, Austrian Academy of Sciences (AAS)
- 2000 - 2003 Vice President (Research) of TU Graz
- 1990 – 2014 Head of the Division for Satellite Geodesy, AAS
- 1987 – 2003 Head of the Institute of Theoretical Geodesy, TU Graz
- 1983 - Full Professor for Math. and Numerical Geodesy, TU Graz
- 1978 – 1979 Research Associate, Ohio State University, Columbus, Ohio, USA
- 1976 PhD, TU Graz

#### Fields of Scholarship

- Mathematical, numerical and statistical techniques in Geodesy
- Satellite based gravity field determination
- Geodynamics

#### Honours and Awards

- 1985 W.A. Heiskanen – Award, USA
- 1991 Fellow of the International Association of Geodesy, France
- 1992 Grand Medal for Distinguished Services for the Republic of Austria
- 1998 Distinguished International Research Fellow, Canada
- 2003 Wilhelm-Exner-Medal for Outstanding Science & Application, Austria
- 2006 UPV Prize for Outstanding University Organisation, Austria
- 2006 Int. Association of Astronomy: Planetoid 2992 RY named after “Sünkel”
- 2010 Grand Josef Krainer Prize, Austria
- 2011 Grand Gold Medal for Distinguished Services for the Republic of Austria
- 2011 Grand Gold Medal of the State of Styria, Austria
- 1998 Member, Austrian Academy of Sciences
- 2007 Member, International Academy of Astronautics
- 2007 Member, Engineering Academy of Georgia
- 2010 Member, European Academy of Sciences and Arts
- 2010 Member, Academia Europaea
- 2013 Member, Leibniz Society at Berlin

More see [http://www.ae-info.org/ae/User/Suenkel\\_Hans](http://www.ae-info.org/ae/User/Suenkel_Hans)

**Talk 3: Wolf-Tilo Balke, MAE, Professor at U. of Braunschweig and Director, L3S, Hannover**



**“Crowdsourcing, societal and research implications”**

Abstract:

Recent advances in digital technologies, data science/analytics, and the European knowledge society have brought severe changes to business processes in today’s economy. This is especially true for the basic question of what and where people work. On one hand there is a clear transition from traditional production of goods or processing of raw materials towards the provisioning of services. On the other hand the flexibility with respect to the place where such services are actually physically provided has dramatically increased.

Take for instance the area of customer relationship management, where everyday services like ordering procedures, customer data management, complaint handling, etc. have to be performed. Although such services do not produce anything in the traditional sense, they are critical for company goals like efficient sales handling, customer satisfaction and retention, etc. Whereas such tasks used to be done on-site, nowadays ‘call centers’ all over Europe centrally provide such services at considerably reduced costs for a large number of customers. These services are quite basic and easy to provide in terms of education. On an educationally higher level, business intelligence services can serve as a good example: extracting relevant information from company data and using it to recognize or design value-adding areas like new products, promising customer segments, or better business processes for a company is a profitable business. Indeed ‘infopreneur’ is a term coined for the growing number of persons whose primary business is gathering and selling electronic information.

Still, although in both cases services could in principle be offered flexibly from virtually anywhere in Europe, typical constraints like the local cost of labor or easy access to an educated workforce, remain valid.

Impact Sourcing – Crowdsourcing as a Social Chance

One of the problems Europe is currently facing as a market, are the steadily improving, but still existing differences in location factors like infrastructure, costs of living, education and salary level, workforce availability, etc. The following diagram shows the development of unemployment rates in different European countries that to some degree are influenced by these location factors. As we can see in Figure 1 unemployment rates may differ quite drastically: whereas rates in France, Germany and the UK tend to move between 5 -10%

during the last 15 years, countries like Greece or Spain show a dramatic increase peaking between 25-30%.

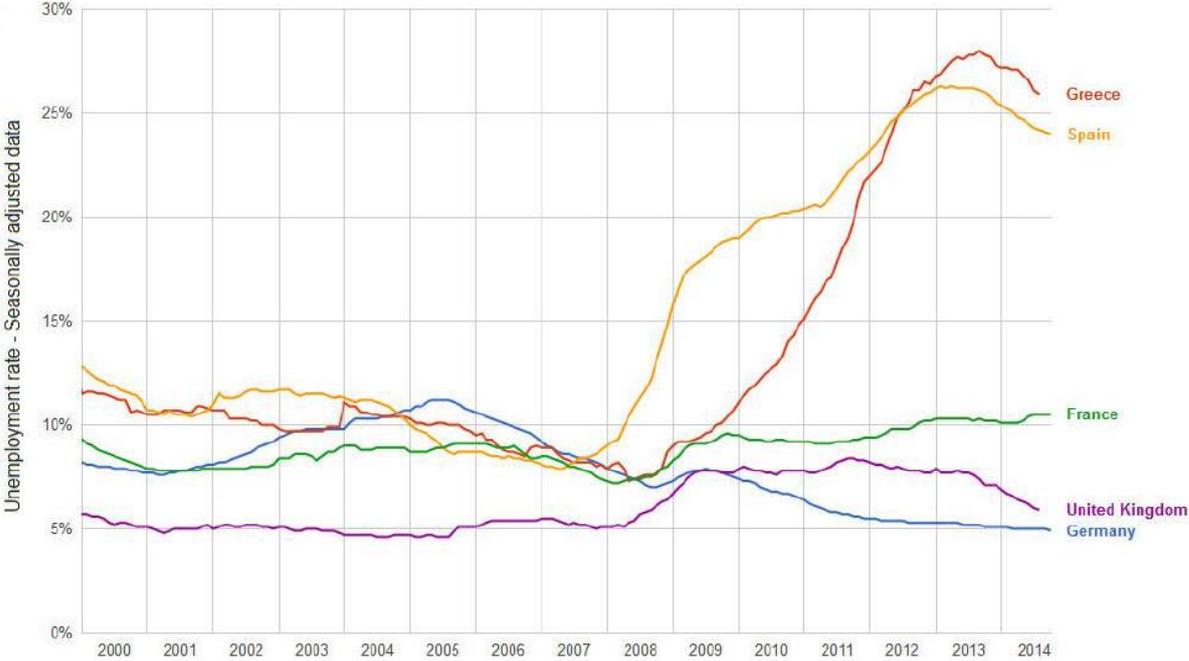


Figure 1: Seasonally adjusted unemployment rates for Greece, Spain, France and the United Kingdom, and German [Eurostat, 2015]

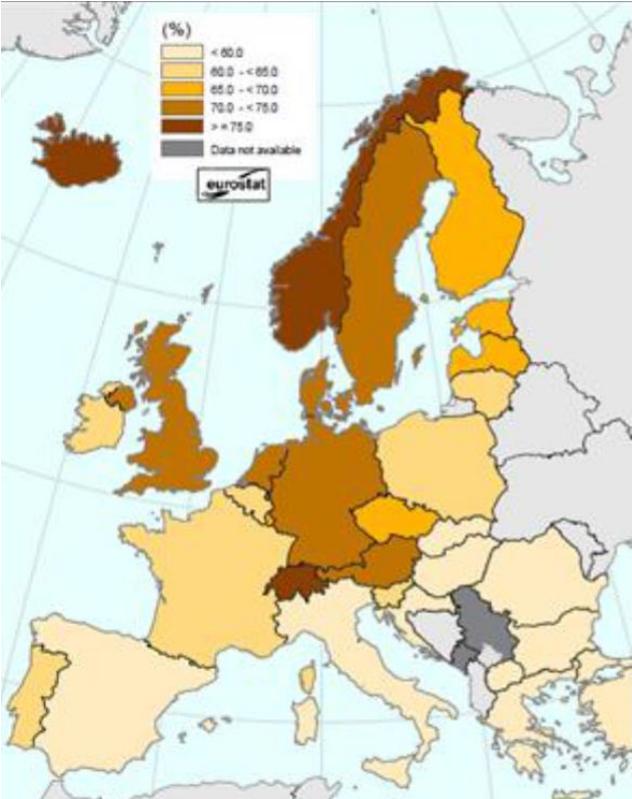


Figure 2: Distribution of Employment rate of persons aged 15-64 in Europe [Eurostat, 2013]

The problem of finding adequate workplaces today locally contributes to urbanization and rural depopulation. Moreover, bigger movements of the workforce are already taking place and an increase of mobility has to be expected in future (cf. figure 2).

But given the ubiquity of the Internet and recent developments in semantic applications and data analytics the chance of a fairer employment market independent of locations may become feasible. A key insight is what is often referred to as the ‘wisdom of the crowd’: instead of having sophisticated and complex tasks solved by experts with low-availability and high-cost, to some degree they can also be solved by an intelligent decomposition into smaller low-cost work packages that are distributed to highly-available non-experts, followed by a suitable subsequent aggregation. The result often even surpasses the individual expert’s solution in terms of quality.

The idea of tapping into the wisdom of the crowd by electronic distribution of small, easy to solve, and low-cost digital work packages is usually referred to as *crowdsourcing*. Of course such a work distribution also has to be facilitated over the Internet which gave rise to several platforms like Amazon’s Mechanical Turk, CrowdFlower or SamaSource. Some of these platforms already recognized the social dimensions and chances of their basic business model usually in conjunction with bringing employment to low- and middle-income countries (so-called *impact sourcing*), e.g. SamaSource claiming as mission statement: “*Samasource is an innovative social business that connects women and youth living in poverty to dignified work via the Internet.*” (cf. [www.samasource.org](http://www.samasource.org))

The Research Dimension – What can be done by Crowdsourcing?

Today crowdsourced tasks are mostly limited to simple cognitive tasks like data cleaning and verification, entity resolution and reconciliation, or image recognition and metadata annotation. But the generalized use of the Internet and social network platforms has already essentially changed the way human beings establish relations, collaborate and share resources. Recently, innovative – although still non-mature – methods to provide solutions to complex problems by automatically coordinating the potential of machines and human beings working hand-in-hand have been proposed. Several research challenges still separate crowdsourcing from being a real solution for real world problems. For instance, the reliability and quality delivered by workers in the crowd is crucial and depends on different aspects such as their skills, experience, commitment, etc. Ethical issues, the optimization of costs, the capacity to deliver on time, or issues of confidentiality are just some other possible obstacles to be removed. Finally, trusting individuals in a social network and their capacity to carry out the different tasks assigned to them becomes essential in speeding up the adoption of this new technology in industrial environments. Europe definitely has to catch up: platforms such as Amazon’s Mechanical Turk do not allow workers from outside USA and India, and there are no solutions at a European level that allow leveraging the potential of the crowd yet.

*Considering the variety of problems and the extremely promising potential of crowdsourcing, from an academic perspective it is clear that there will be increasing research efforts in European countries in the foreseeable future. From an ICT perspective the grand challenge is to find out what tasks can be solved effectively, as well as cost-efficiently by crowdsourcing and how exactly this can be done.*

But this tells only part of the story: the immanent social transformation of the European knowledge society by new models of work like crowdsourcing is bound to encourage also strong academic research in the social sciences, business and law. There is a large area for scientists and practitioners to explore: Are there limits in complexity? What algorithms benefit most from human input? How to control result quality? How to avoid misuse? Moreover, besides technical questions there are many legal, economical and ethical

implications: Who is responsible for the result correctness? How can liability be defined? What defines the price for any given task? What is a fair price in the sense of incentives?

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- [3] J. Surowiecki, "The Wisdom of Crowds," Doubleday, Anchor, 2004.
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- [6] F. Gino and B. R. Staats, "The Microwork Solution," in Harvard Business Review, Vol. 90(12), 2012.
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- [9] P. G. Ipeirotis, "Analyzing the Amazon Mechanical Turk Marketplace", ACM Crossroads (XRDS), Vol. 17(2), 2010.

## Profile:

Professor Wolf-Tilo Balke currently heads the Institute for Information Systems (IfIS) at Technische Universität Braunschweig, Germany, and serves as a director of L3S Research Center at Leibniz Universität Hannover, Germany.

Before, he was the associate research director of L3S and a research fellow at the University of California at Berkeley, USA. His research is in the area of databases and information service provisioning, including personalized query processing, retrieval algorithms, preference-based retrieval and ontology-based discovery and selection of services.

In 2013 Wolf-Tilo Balke has been elected as a member of the Academia Europaea. He is the recipient of several best paper awards (ECDL'05, RCIS'07, CEC'10) as well as two Emmy-Noether-Grants of Excellence by the German Research Foundation (DFG) and the Scientific Award of the University Foundation Augsburg, Germany.

He has received his B.A and M.Sc degree in mathematics and a PhD in computer science from University of Augsburg, Germany.

## Present and Previous Positions

- 2010 - 2013 appointed Head of Department for the Computer Science Department at Technische Universität Braunschweig, Germany
- Since 2008 appointed to a tenured Full Professorship (Chair for Databases and Information Systems) at Technische Universität Carolo-Wilhelmina zu Braunschweig, Germany

- Since 2008 appointed as director of the L3S Research Center at University of Hannover, Germany
- 2005 - 2008 lecturer at University of Hannover, Germany, in the field of databases and information systems
- 2004 - 2008 appointed as associate research director of the L3S Research Center at University of Hannover, Germany
- 2002 - 2004 appointed as research fellow at the Department of Electrical Engineering and Computer Science (EECS), University of California, Berkeley, CA, USA
- 2001 - 2002 lecturer at University of Augsburg, Germany, in the field of databases and information systems

#### Fields of Scholarship

- Query processing in databases and information systems
- User preferences and personalization
- Digital libraries and content syndication
- Cognitive user modeling and conceptualization
- Peer-to-peer networks and distributed retrieval

#### Honours and Awards

- 2010 "Best Paper Award" awarded at IEEE Conference on Commerce and Enterprise Computing (CEC'10), Shanghai, China
- 2007 "Best Paper Award" awarded at IEEE Conference on Research Challenges in Information Systems (RCIS'07), Ouarzazate, Morocco
- 2005 "Best Paper Award" awarded by the IEEE Technical Committee on Digital Libraries at European Conference on Advances in Digital Libraries (ECDL'05), Vienna, Austria
- 2002 admitted to "Emmy Noether Program of Excellence" by the German Research Foundation (DFG)
- 2001 "Science Award" awarded for best Ph.D. thesis 2001 by the University Foundation, University of Augsburg

More on [http://www.ae-info.org/ae/User/Balke\\_Wolf-Tilo](http://www.ae-info.org/ae/User/Balke_Wolf-Tilo)

## Talk 4: Nara Kulathuramaiyer, Dean, Computer Science, UNIMAS, Malaysia



### “How social networks will change research”

Extended abstract:

#### Introduction

Social networks are growing in terms of reach and content at an extremely rapid pace. Even the question of what constitutes a social networking site tends to change over time. We have therefore taken an encompassing view<sup>1</sup> (expanding from [1]) representing the current state of things. As we now are in the midst of an information deluge with several life-times of information coming fast at us like an avalanche; there is a need a shift in the way we deal with information. Users can no longer remain as passive receivers of information totally oblivious of the inner workings of social network tools. One cannot afford to treat the Web as a black box, relying entirely on its algorithmic measures of information supply. Instead there is a need to tap into the rich resources without becoming totally overwhelmed by shallow information (trending media), or becoming victims of ‘group think’<sup>2</sup> [2], filter bubbles<sup>3</sup> [3] [4] or ‘Facebook fatigue’<sup>4</sup> [5] [6].

The focus of this talk will be on the evolving social network landscape and its influence on the way we do research. Aspects of research seen to be significantly changing as a result of social network landscape includes: I) how we acquire and test new knowledge & ideas II) how we connect with peers and experts III) how we collaborate and share results IV) how we manage knowledge and expertise for better decision making V) how we profile and promote ourselves VI) how we assess our research contributions and VII) how we manage research.

Beyond these, we are also concerned with how Social Networks (SN) can help in shaping the future of research. In this respect, we raise the following questions: I) is it possible to efficiently

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<sup>1</sup> Social networks then includes typical Social Networking services ( e.g. Facebook, Twitter, Google+, LinkedIn), Social Bookmarking/Curation services (e.g. Del.icio.us, Pinterest, Tumblr), Content Creation services (e.g. Blogger) Mobile Messenger services (e.g. Whatsapp, Skype, SnapChat), media sharing services (e.g. YouTube, Instagram), document sharing services (e.g. Google Drive, Dropbox), Community Question Answering systems (e.g. Quora, StackExchange) and scientific Social Networks (e.g. ResearchGate, Academia.edu).

<sup>2</sup>Group-think refers to user being influenced by collective group deliberations on issues.

<sup>3</sup> Filter Bubbles refers to the personalization of user’s access to information based on past behavior of using the Web.

<sup>4</sup> Social networking fatigue (and in particular Facebook fatigue) refers to the situation where users become tired of the compelling need to stay connected, in touch with innumerable friends while engaging in insurmountable transactions.

access relevant information and expertise even if these are not currently available II) is it possible to come up with a meaningful strategy for harnessing the emerging landscape fully III) is the emerging social networking landscape actually supporting creative expressions and knowledge discovery, or is it instead inhibiting our creative expressions.

This talk then aims to put things into perspective by connecting and linking to an insightful understanding of the emerging SN landscape. We will first present two key developments of the emerging landscape, namely the small world phenomenon<sup>5</sup> and social curation. We will then look at future implications describing the projected influence of SNs and the responses needed need to manage research in future.

## 1. Small World Phenomenon

The small world phenomenon [7] describes the connected nature of researchers linked to scholarly networks and stakeholders across the world according to their interest and capacity to mutually cooperate. In principle, we anticipate an access to all knowledge and resources beyond all traditional inhibitions or boundaries.

### Emerging Landscape of ‘Research eCommunities’

In order to overcome situations of SN fatigue and group think, ‘the right tool has to be used for the right purpose with the right audience in mind’. This will however not work without a proper understanding of how each SN service functions as a component within a cooperative ecosystem of services.

The SN landscape will need to be harnessed by assimilating an appropriate series of social networking services in an orchestrated manner. Each SN tool has its own strengths and weaknesses that make it suitable for a particular task based on some known constraints. Figure 1 illustrates the segments of the emerging eCommunity that has been mapped to SN tools according to the ability to address a research function.

The engagement with different groups of users with the help of selected tools has to consider the community’s characteristics. In this way a sample strategy could employ one or more of the following:

- Regional or Focus group discussions to facilitate discourses on localized or specialized themes with a closely knit core user community. This core group will serve as a support group for linking with outer layers.
- Scientific research communities will serve a community of researchers and their partners and collaborators in focused research fields.
- Community Question Answer tools serves as a means of acquiring information and knowledge discovery through a targeted deliberation on specific topics. This then provides links to experts who become acknowledged by their contributions who are not only concerned with answering questions but also guiding along problem solving steps.
- Professional networks serve as means of identifying people suited for a task and has been widely used in recruitment tasks.

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<sup>5</sup> The Small World phenomenon refers to the surprising close links between any two users on the Web. Studies have shown that there are at most 5 persons in between any two arbitrary individuals on networks such as Facebook..

- Global social network sites help in engaging in transactional and content creation and dissemination activities for generalized but useful content and as a platform for promoted individuals and their expertise.
- MOOCs will serve as identifying experts known for delivering specialized knowledge delivery on specific areas of gap.

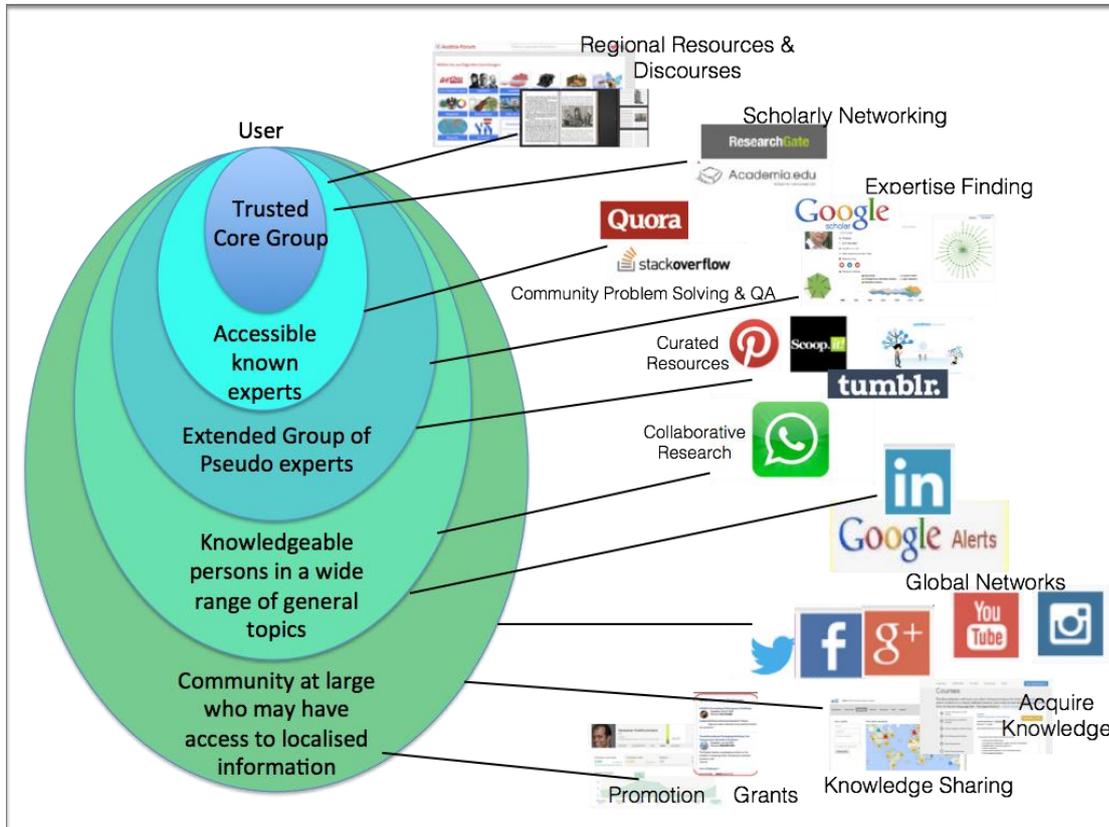


Figure 1: SN tools should be according to purpose and target audience

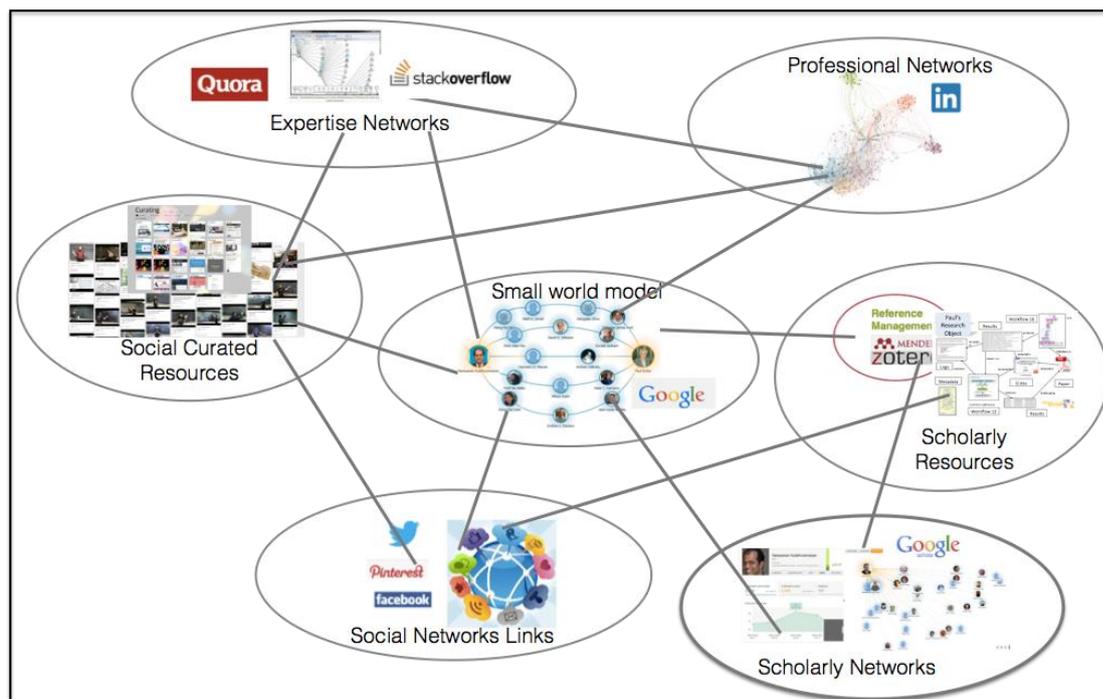


Figure 2: An illustration of a sample strategy

This then calls for a careful, well-planned knowledge navigation strategy to suit a particular need. An arbitrary strategy will obviously not be adequate for all purposes and needs. A sample strategy for rapidly gaining insights into a new area is shown in Figure 2. Here a small world model is used as a basis for performing directed search across a number of related SN tools.

## Exploiting the Small World for Research

As 2 billion users use the Web with over 5 billion mobile users and having 1 billion online networked users, the small world phenomenon is real and multi-faceted in its influence on all of us. With regards to research, the small world phenomenon will thus:

- I. Empower users with the power of manipulating and participating in mass-collaboration systems that will benefit from the network effect and the collective intelligence.
- II. Enable users to access any research element including rare artifacts and interesting findings through the closely-knit interconnected web
- III. Orchestrate content re-purposing and packaging of collections of resources tailored to suit user's specific needs
- IV. Enable access to expertise and knowledge from the best sources made directly available where and when needed
- V. Enable access to emerging learning modes (e.g. Massive Open Online Courses or MOOCs) that will breakdown barriers and access to learning particularly in bridging divides for marginalized nations.
- VI. Acknowledge users as experts through crowd endorsement of reputation based on new measures for evaluating competence.

## 2. Social Curation

The role of social curation<sup>6</sup> [8] will now be discussed in terms of how it influences research. Here we see first its role in promoting creative expressions and subsequently it serving as the basis for future organization of web resources. It will thus play an important role in enabling users' creativity in collaboratively managing the radical information surge.

### Social Curation Tools as a means of supporting creative expressions

In this respect, social curation sites are enabling apparent 'just-for-me-spaces' where users are able to creatively generate ideas and collaborate. User activities in searching and organizing of resources is enriched by other users who provide insights for discovering additional content relevant to the same user interest (and in many cases providing a fresh perspective). These collections are seen by many users as personalized spaces for organizing ideas and reflection on the associated themes.

The potential of social curation is manifested mainly due to the innumerable hours put in by users in their carefully collecting, categorizing and labeling, reflecting on content match to

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<sup>6</sup> Content seen to be useful by users as curators are collected from a variety of sources (e.g. Facebook, Twitter, Blogs, Websites) by using one of the many emerging social curation tools (e.g. Pinterest, Tumblr, Pearltrees, Scoop.it).. Social curation happens in a layered fashion; at the lowest level, content as media items are curated by users who then add meta-level information for re-purposing these objects within their own context. At a subsequent step, objects deemed useful are then organized into labeled collections, which in a way relates these objects to a user's task or role.

collection, engaging in communities to broaden perspectives and exploring new ideas in cooperatively organizing the Web.

### Managing Information Explosion with Multi-tiered Social Curation

Layered content curation serves as the way to organize the explosive content, with users helping to hand-pick and craft useful relevant content. Multi-tiered social curation will allow a meaningful way of dealing with the small world.

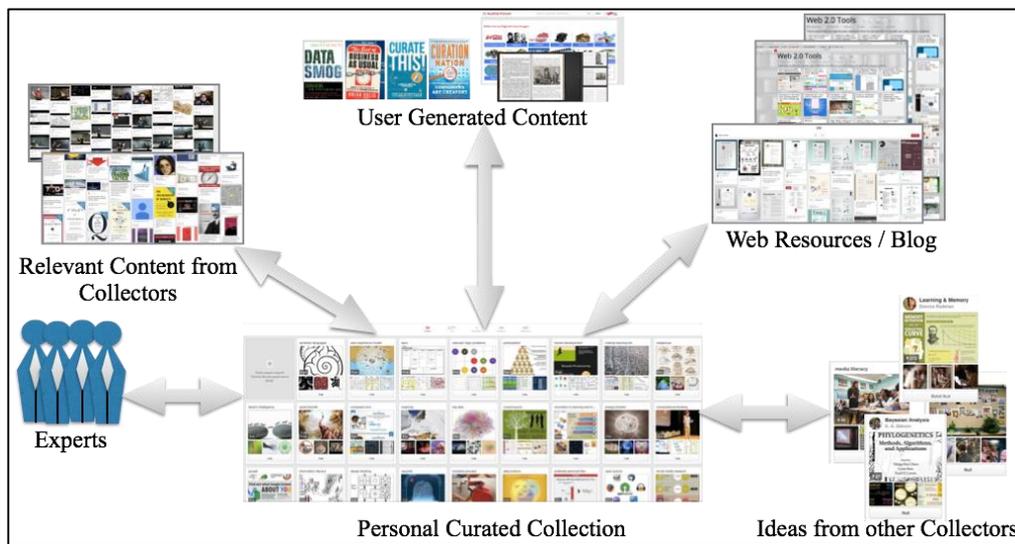


Figure 3: Social Curation in Action

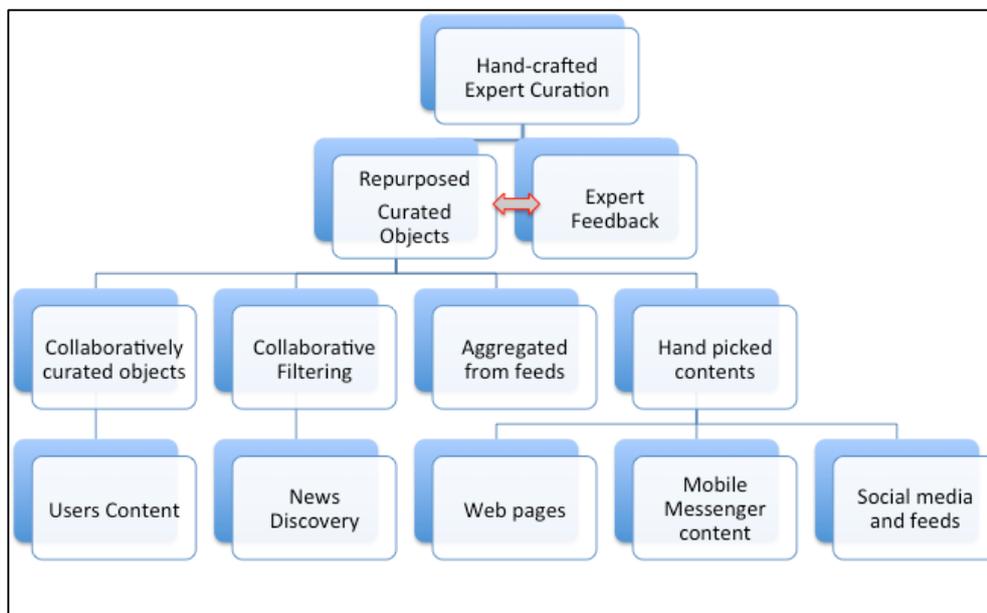


Figure 4: An illustration of multi-tiered information management

This will make use of user profiles based on interests, perspectives and inclinations (that can be evolving over time) to establish partnerships and collaborations. The idea of multi-tiered curation in helping researchers deal with the information explosion is illustrated in Figure 3.

The full potential of social curation is yet to be realized as these developments do not yet directly help us solve our day-to-day problems. For this to happen, the curation layers will need to blend in with users' context-specific (relates to what a user wants to do).

### 3. Implications to Research Management and Concluding Thoughts

By becoming aware of emerging developments and exploiting the changing landscape we will not only learn to cope with the emerging situation, but also to effectively contribute and make an impact.

This talk has identified gaps that need to be addressed by focused targeted research and strategic investments. As an illustration of gaps, the analysis using Google Trends demonstrates that only few countries are showing interest in terms of exploiting social curation as a content strategy (see Figure 5).

There is thus a need to catalyse the movement to invest in these emerging key developments. We need to take note of the emergence of over 50 new curation SN software. These tools either focus on regional themes or special offering or just work for specific applications. Further interdisciplinary research is needed in this respect as meta-level tools and workflow enabled multi-tiered curation system will be the next big-thing to come up.

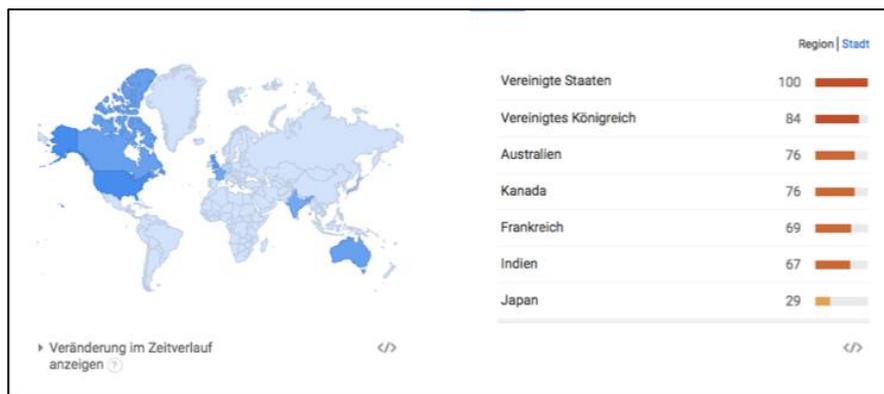


Figure 5: Google Trends indication of countries showing interest in Curation as Content Strategy

These tools can help businesses and at the same time help industries, research institutions and government agencies. An example of a workflow for connecting with research management is shown in Figure 6. Further research will be required in blending together with a multi-tiered information processing system as described earlier as either application-specific, targeted regional or as high-level tools.

In the evolving ecosystem, SN companies will have access to immense human resources to empower mass collaboration systems. The control of small world phenomenon will be instrumental as SN sites are already being used for recruitment (e.g. LinkedIn), expert finding (e.g. Quora), appraisal of researchers (e.g. Google Scholar ranks, ResearchGate scores). E.g. these companies are immediately expected to dominate policies and governance particularly in less-resourceful nations.

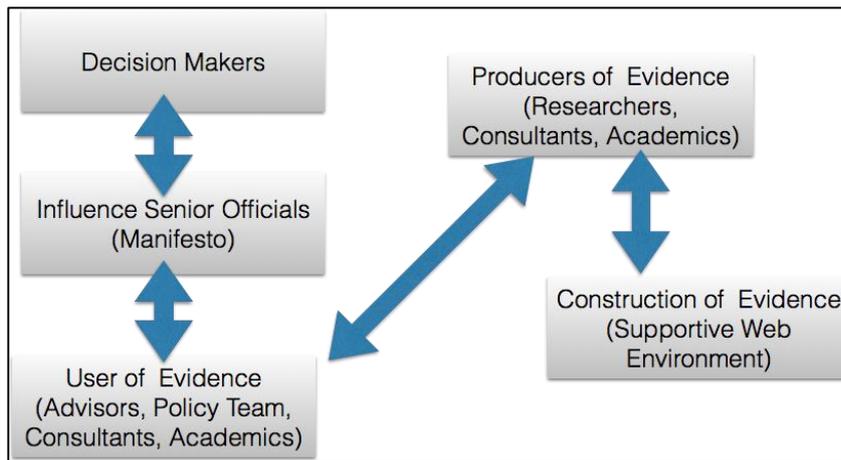


Figure 6: Linking of Research into a sample Decision Making Workflow.

There will thus be a shift in the governance and management of research: it would not be surprising in the future for researchers to seek grants from global companies who tend to know everything about everyone [13]. Companies that are already capable and playing this role include: Google, Microsoft, LinkedIn, ResearchGate, Academia.edu and Innocentive. We also notice that social networks such as LinkedIn are preferred ways of recruiting talents.

As such studies resulting in new blueprints, frameworks and policies will be need to be drawn out describing how governments will partner with SN companies in shaping future governance strategies.

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Profile:

Narayan Kulathuramaiyer is a Professor of Computer Science at the Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak (UNIMAS). He received his Ph.D. in Computer Science from Graz University of Technology, Austria. He has served the Dean of Faculty for over 10 years, and also previously headed the Centre for Applied Learning and Multimedia. He is now a visiting Professor at the Graz University of Technology, Austria and Braunschweig University of Technology, Germany.

He is the Director of the Web Intelligence Consortium (WIC), Malaysia Research Centre, Editor-in-Chief for the Journal of Universal Computer Science and the Senior Fellow of the Information Society Institute.

He has spearheaded the UNIMAS Virtual Campus project and has helped product blueprints on eLearning and the Framework for the ICT Human Capital the National IT Council. He has been involved in various key roles at the National level; these include his services as secretary of the National ICT Human Resource Taskforce, Chairman of the ICT Deans' Council (MADICT), Steering Committee Member of the Board of Computing Professionals, ICT Cluster Member of National Professors Council, Steering Committee member of the National Citation Centre.

He has been a Senior Fellow of the Centre of Excellence on Rural Informatics, Institute of Social Informatics and Technological Innovations, UNIMAS. He has won a number of National and International awards for his role in the eBario project and the e-Toro Indigenous Knowledge Management system, Semantic Clustering Toolkit and the e-Co Outcome-based profiling system.

He also sits on a number of Expert Panels which include National IT Council Human Resource Expert Panel, Technical Committee on Information Services, Malaysian Research and Education Network. He is currently an Assessor for Malaysian Qualification Agency, and on the Board of Studies for a number of universities.

In terms of research he has been a part of a number of Research and Commercialization projects which include European Commission projects, Japanese Human Resource grants and the National Language Technology Productisation project. He has also been working on a number of consultancy projects such as: UNIMAS Permanent Campus project and the SCORE Human Resource Portal.

His research interests include Semantics-Aware Systems, Technology Assimilated Learning and Future Web developments.

## Session: "The 100 Year Star Ship Project"

### Talk 1: Mae Jemison, M.D., Principal, 100 Year Starship



#### "The 100 Year Starship Project"

Abstract:

We exist to make the capability of human travel beyond our solar system a reality within the next 100 years. We unreservedly dedicate ourselves to identifying and pushing the radical leaps in knowledge and technology needed to achieve interstellar flight, while pioneering and transforming breakthrough applications that enhance the quality of life for all on Earth. We actively seek to include the broadest swath of people and human experience in understanding, shaping and implementing this global aspiration.

Taking up this task ignites not only our imagination, but the undeniable human need to push ourselves to accomplishments greater than any single individual.

The why

When we explore space, we garner the greatest benefits here at home. The challenge of traveling to another star system could generate transformative activities, knowledge, and technologies that would dramatically benefit every nation on Earth in the near term and years to come.

*We believe that pursuing an extraordinary tomorrow will build a better world today.*

Today, people take very much for granted (but would loath to surrender) the benefits space exploration has provided right here on Earth.

Global positioning satellites (GPS); remote sensing for water, minerals, and crop and land management; weather satellites, arms treaty verifications; high-temperature, light-weight materials; revolutionary medical procedures and equipment; pagers, beepers, and television and internet to remote areas of the world; geographic information systems (GIS) and algorithms used to handle huge, complex data sets; physiologic monitoring and miniaturization; atmospheric and ecological monitoring; and insight into our planet's geological history and future – the list goes on and on.

Also remarkable is the boom in other science and engineering fields - and the accompanying wave of social creativity, artistic expressions, and educational innovation - that followed the Apollo missions and each successive leap in space exploration.

*Technologies created for and made possible by space exploration permeate, shape and are an integral part of our world.*

Travel to the stars will require: the development of revolutionary non-chemical technologies to generate, harness, control and store enormous quantities of energy safely; radical advancements in closed-loop life-support systems and sustainable habitats; new insights into human development, health, behavior and training; quantum leaps in agriculture, communication and handling massive data sets; advances in robotics, automation, intelligent systems, and manufacturing techniques; as well as deeper, robust understanding and innovative approaches to social structures, education, economics and finance, legal frameworks, politics and international collaboration.

Programs to establish a human presence on the Moon, Mars, or elsewhere in our solar system will be stepping-stones to the stars.

*All the capabilities needed to accomplish human interstellar travel are the same ones required for successful human survival.*

### Reality check

The concept of humans traveling to other star systems may appear fantastical, but no more so than the fantasy of reaching the Moon was in the days of H. G. Wells. “The First Men in the Moon” was published considerably less than 100 years before humans landed on the Moon (1901 vs. 1969), and the rapidity of scientific and technological advances was not nearly as great as it is today. The truth is that the best ideas sound crazy at first. And then there comes a time when we can’t imagine a world without them.

### Profile:

Dr. Mae C. Jemison is leading 100 Year Starship (100YSS), a bold, far reaching new initiative to assure the capabilities exist for human interstellar space travel to another star within the next 100 years.

Jemison is building an international, multi-faceted organization to promote the broad global commitment, scientific, social and technical support and financial framework to accomplish the 100YSS vision—*An Inclusive, Audacious Journey (that) Transforms Life Here on Earth and Beyond.*

Her team won the competitive, single awardee grant from DARPA (Defense Advanced Research Projects Agency), the US Defense Department’s premiere research group responsible for the development of the internet and GPS (global positioning satellite systems). 100YSS held its inaugural Public Symposium in Houston September 13-16, 2012.

Jemison started The Jemison Group, Inc. a technology consulting firm integrating critical socio-cultural issues into the design of engineering and science projects, such as satellite technology for health care delivery and solar dish Stirling engine electricity in developing countries. The Jemison Group explores and develops stand-alone science and technology companies.

BioSentient Corporation, a medical devices and services company focused on improving health and human performance is such a company.

An Environmental Studies professor at Dartmouth College, Jemison worked on sustainable development and technology design.

Jemison, the first woman of color in the world to go into space, served six years as a NASA astronaut. Aboard the Space Shuttle Endeavour, STS-47 Spacelab J mission in September 1992, she performed experiments in material science, life sciences and human adaptation to weightlessness.

Before joining NASA she was the Area Peace Corps Medical Officer for Sierra Leona and Liberia and a general practice physician in Los Angeles.

In 1994 Jemison started the international science camp The Earth We Share™ (TEWS) for students 12-16 years old. TEWS, is a program of the Dorothy Jemison Foundation for Excellence non-profit which launched TEWS-Space Race in 2011 in collaboration with the Los Angeles Unified School District; over four years it will impact up to 10,000 middle school students and train 400 teachers.

Other foundation programs include *Reality Leads Fantasy—Celebrating Women of Color in Flight* that highlighted women in aviation and space from around the world.

Jemison is a member of the U.S. National Academy of Sciences' Institute of Medicine and is on the boards of Kimberly-Clark, Scholastic and Valspar.

She was the Founding Chair of the Texas State Product Development and Small Business Incubator Board, Chair the Texas State Biotechnology and Life Sciences Industry Cluster and the Greater Houston Partnership Disaster Planning and Recovery Task Force.

She is a member of the Morehouse Board of Trustees and the Board of the Texas Medical Center. She serves as Bayer Corporation USA's national science literacy advocate. Jemison is an inductee of the National Women's Hall of Fame, the National Medical Association Hall of Fame and Texas Science Hall of Fame as well as a recipient of the National Organization for Women's Intrepid Award and the Kilby Science Award among many honors.

September 2011 she was a featured panelist on the CNBC special "*The Business of Science*".

*B.S., Chemical Engineering; Fulfilled requirements A.B., African and Afro-American Studies—Stanford University Earned Doctorate in Medicine, Cornell University.*

For more see e.g. [http://en.wikipedia.org/wiki/Mae\\_Jemison](http://en.wikipedia.org/wiki/Mae_Jemison)

## **Talk 2: Roya Ayazi, Nereus, General secretary**



### **Profile:**

As Secretary General of the NEREUS-Secretariat in Brussels/Belgium Mrs. Roya Ayazi is the key interlocutor for the initiative at EU-level.

NEREUS is the Network of European Regions Using Space Technologies. Currently 22 European regions and 16 associated members are part of the platform. NEREUS aims at being a strong voice for the regional dimension of space policy and programmes.

Its key objective is to ensure the full exploitation of space technologies for the benefit of the Regions and their actors. Having a legal background Roya Ayazi made a professional career in European Affairs.

She studied law at the Free University of Berlin/Germany and started her working life as an independent lawyer.

Prior to this position Mrs. Ayazi worked for eight years in the EU-Liaison office of the Association of the German Engineers (VDI) in Brussels.

Being responsible for political interest representation and following up the development of EU-policies in research and innovation and positioning the VDI, she complemented the EU-activities of the national funding agencies in the area of nanotechnologies and optical/laser technologies.

For more information see <http://nereus.regions.edu/home>

### **Talk 3: Dan Hanson, Founder, Technology Innovation Group**



#### **Profile:**

Dan Hanson has over 30 years of experience in the management of innovation, finance and investment banking, governmental policy development, and public-private partnerships.

His professional experience has included technology venture creation, investment portfolio management and risk management, capital raising through the equity, bond, and securitization markets, and public policy development for various government agencies.

For the past fifteen years, he has focused on creating novel solutions to complex societal challenges, commercializing new technologies, and building research and development infrastructure in collaboration with centers of innovation. Mr. Hanson has a keen interest in leveraging art, science, and education infrastructure to promote economic development in regional economies.

He helps build economic engines by forging partnerships among business, government, and nongovernmental organizations. These partnerships often are a mix of organizations operating on a local, national, and international level.

Mr. Hanson's efforts are realized through a combination of business and volunteer activities. He participates in leadership roles on the board of directors of several state and local community organizations. These organizations include the North Texas Life Science Society, Big Thought: A Learning Partnership, and the State of Texas Product Development and Small Business Incubator Board.

Mr. Hanson is noted for his outstanding analytical and commercial skills, and for his commitment to achieving equitable outcomes of government policy and program initiatives across communities.

Dan's academic qualifications include a Bachelor of Science and a Master of Science (in Industrial Relations) from the University of the Oregon . He also attended the Kennedy School of Government at Harvard University and graduated with a Master of Science in City and Regional Planning.

For more information see [http:// Websiteinnovationmatters.com](http://Websiteinnovationmatters.com)

**Talk 4: Kurt Zatloukal, Professor, Medical University Graz**



**Profile:**

Kurt Zatloukal, M.D. is professor of pathology at the Medical University of Graz, Austria and is director of the Christian Doppler Laboratory for Biospecimen Research and Biobanking Technologies.

His research focusses on molecular pathology of diseases as well as biobanking and related technologies.

He coordinated the preparatory phase of the European biobanking and biomolecular research infrastructure (BBMRI) within the 7th EU framework programme and is now director of the Austrian national node of BBMRI-ERIC.

He led in the FP7-funded large integrated project SPIDIA the development of new European standards and norms for pre-analytical processing of tissue samples for molecular diagnostics.

He is and has been involved in developing the ethical and legal framework for medical research and health care in Austria.

He is member of the Austrian Arzneimittelbeirat and the scientific board for genetic testing and human gene therapy at the Austrian Ministry of Health, and member of the Austrian Standards Institute. He has published 189 scientific papers and was co-inventor of 15 patents.

For more information see [http://ae-info.org/ae/User/Zatloukal\\_Kurt](http://ae-info.org/ae/User/Zatloukal_Kurt)

## **Moderators and coordinators:**

Abstract:

Moderator and coordinator of Sessions: Declan Kirrane, Hermann Maurer and Kurt Zatloukal. For the first two see below, for Zatloukal see session “Future of Medicine” or “The 100 Year Starship Project”.

### **Declan Kirrane, Managing Director of ISC Intelligence in Science,**



Profile:

Declan Kirrane is Managing Director of ISC Intelligence in Science, a specialised science, technology and R&D public affairs firm based in Brussels. ISC develops and implements Strategic Research Agendas for science and technology-based organisations in the EU and US.

His practice area covers IP, R&D consortia development, management and dissemination and his specialities are in themes of ICT, health, security, defence, space and related policies, legislation, programmes and funding mechanisms.

Mr. Kirrane has a background in analysing the relationship between public and private R&D funding and the impact on R&D performance: he has worked extensively on science and technology policy evaluation methodologies and technology options for policy- and decision-makers.

The EU’s Digital Agenda, emerging European space, security and defence policies are part of his remit.

He launched the CORDIS Science News Service for the EU, has edited CORDIS Focus and the Innovation and Technology Transfer (ITT) Newsletter, both published by the European Commission.

Declan is a graduate of University College, Dublin and the Dublin Institute of Technology.

For more information see [http:// iscintelligence.com](http://iscintelligence.com)

**Hermann Maurer, Board Member Academia Europaea, Professor for Informatics, Graz U. of Technology**



**Profile:**

Study of Mathematics at the Universities of Vienna (Austria) and Calgary (Canada) starting in 1959. System Analyst with the Government of Saskatchewan and mathematician-programmer with IBM Research 1963-1966. Ph.D. in Mathematics from the University of Vienna 1965.

Assistant and Associate Professor for Computer Science at the University of Calgary 1966-1971. Full Professor for Applied Computer Science at the University of Karlsruhe, Germany, 1971-1977, and Visiting Professor at SMU, Dallas, University of Brasilia (Brazil) and University of Waterloo. Full Professor at the Graz University of Technology since 1978, and active in other endeavours, like as Dean of Studies and later founding dean of the faculty of informatics. Director and board member of various research organisations and companies.

During sabbaticals, adjunct Professor at Denver University 1984-1988, professor for Computer Science at the University of Auckland, New Zealand 1993-1995 and visiting Researcher at Edith Cowan University, Perth, Australia in 2003.

Has received a number of awards, among them three honorary doctorates from the Universities of St. Petersburg, Karlsruhe and Calgary. Foreign Member of the Finnish Academy of Sciences since 1996 and member of the Academia Europaea since 2000 where he is currently one of the directors of the board. In January 2001 he was awarded the "Austrian Cross of Honours for Arts and Science Class I" and in July 2001 the "Large Medal of Honour of the Province of Styria".

He is author of twenty books, author of more than 700 papers, member of the editorial board of numerous journals program committees of conferences, in particular one of the founders of the conference series ED-MEDIA. He was project manager of a number of multimillion-dollar undertakings including a patent for optical storage device, the development of a colour-graphic microcomputer (MUPID), electronic teaching experiments, multi-media projects such as "Images of Austria" (Expo'92 and Expo'93), of electronic publishing projects and of the development of the first second generation Web Based Information System Hyperwave; participated in a number of EU projects.

**Main research and project areas:**

Networked multimedia/hypermedia systems; electronic publishing and applications to university life, exhibitions and museums, Web based learning; languages and their applications, data structures and their efficient use, computer networks, computer supported new media, and social implications of computers, including authoring science fiction stories and novels.

**Present and Previous Positions**

- Member of the Board of Trustees of Academia Europaea since 12/2012
- Chair of Section Informatics of Academia Europaea from 2007-2012
- Full Professor for Computer Science, Graz University of Technology, Austria, since 1978
- Full Professor for Computer Science, University of Karlsruhe, Germany, 1971-1977
- Assistant and later Associate Professor for Computer Science, University of Calgary, Canada, 1966-1971
- Ph.D. in Philosophy (Mathematics), supervisor Professor Edmund Hlawaka 1965
- 
- Fields of Scholarship
  - formal languages and automata
  - algorithms and data structures
  - networked multimedia systems
  - web science
  - digital libraries
  - e-Learning
  - societal implications of Informatics
  - science fiction samples▪
- 
- Honours and Awards (partial list)
  - Honorary Doctorate Polytechnical University of St. Petersburg 1991
  - Foreign member of Finish Academy of Sciences 1996
  - Enter prize, Styrian Chamber of Commerce 1999
  - Integrata price 2000
  - Member Academia Europaea 2002
  - Cross of honour for Arts and Science, Class I, Republic of Austria 2001
  - Large medal of honour, Province of Styria 2001
  - Honorary Doctorate University of Karlsruhe 2002
  - Honorary Doctorate University fo Calgary 2007
  - Chair of Section Informatics Academia Euopaea 2008
  - Member of Board of Trustees Academia Europaea 2012

More see [http://www.ae-info.org/ae/User/Maurer\\_Hermann](http://www.ae-info.org/ae/User/Maurer_Hermann)