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National Academy of Engineering
and
Alexander von Humboldt Foundation

**FIFTH GERMAN-AMERICAN FRONTIERS OF ENGINEERING SYMPOSIUM**
May 16–18, 2002
Washington, D.C.



Supported by grants from the U.S. Department of Energy and the Army Research Office

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## DISCLAIMER

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# GERMAN-AMERICAN FRONTIERS OF ENGINEERING SYMPOSIUM

Background

Since 1995, the National Academy of Engineering (NAE) has held an annual Frontiers of Engineering symposium that brings together 100 outstanding engineers (ages 30-45) from U.S. companies, universities, and government to discuss leading-edge research and technical work across a range of engineering fields. The goal of the symposium is to introduce these engineers to each other, challenge them to think about developments and problems at the frontiers of areas different from their own, and thereby facilitate collaborative work, the transfer of new techniques and approaches across fields, and establishment of contacts among the next generation of leaders in engineering.

In 1998, NAE expanded the Frontiers program into the international arena with the first German-American Frontiers of Engineering. Since then, four German-American Frontiers of Engineering (GAFOE) symposia have been held: the first in May 1998, in Dresden, Germany; a second in April 1999, in Irvine, California; a third in April 2000, in Bremen, Germany; and a fourth in October 2001, in Essen, Germany. The fifth symposium will be held May 16-18, 2002, in Washington, D.C. The Alexander von Humboldt Foundation is NAE's partner in this endeavor.

Aims

The activity aims to bring together outstanding, early-career German and American engineers from industry, universities, and other research institutions to introduce their areas of engineering research and technical work, thereby facilitating an interdisciplinary transfer of knowledge and methodology that could eventually lead to the development of cooperative networks of young engineers from both countries.

Implementation

Conferences are held annually, typically alternating between Germany and the United States, with about 30 engineers from each country participating. An organizing committee comprised of German and U.S. engineers develops the program for the event and assists in the selection of participants. Co-chairs for the 2002 GAFOE meeting are Sangtae Kim, Vice President and Information Officer, Lilly Research Laboratories, and Albert Weckenmann, Professor, Department of Quality Management and Manufacturing Metrology, University of Erlangen-Nürnberg. The topics that will be covered at the 2002 GAFOE symposium are: Options for Sustainable Energy Futures, Tools for Biomedical Engineering, New Trends in Urban Engineering, and Intelligent Transportation Systems.

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# FIFTH GERMAN-AMERICAN FRONTIERS OF ENGINEERING SYMPOSIUM

May 16-18, 2002
Washington, D.C.

PROGRAM

## Wednesday, May 15

7:30 p.m. Welcome reception at the Wyndham City Center Hotel *(Mt. Vernon)*

## Thursday, May 16

7:30 a.m. Breakfast at the National Academies Refectory *(Check Meeting Information section of agenda book for bus departure times from the hotel to the National Academies Building.)*

8:40-9:00 Opening remarks—Wm. A. Wulf, President, NAE
Manfred Osten, Secretary General, AvH
Sangtae Kim, Committee Co-chair (U.S.)
Albert Weckenmann, Committee Co-chair (Germany)

9:00-10:45 OPTIONS FOR SUSTAINABLE ENERGY FUTURES: THE ENGINEERING CHALLENGES
Organizers: Jane Davidson and Alfred Voß

*Biomass Energy*
Cynthia J. Riley, National Renewable Energy Laboratory

*Photovoltaic Prospects and Engineering Challenges*
Jörg Horzel, RWE Solar GmbH

*Clean Coal Technology*
Darren J. Mollot, U.S. Department of Energy

10:45-11:15 Break

11:15-12:30 OPTIONS FOR SUSTAINABLE ENERGY FUTURES (cont.)

*Sustainable Energy Provision: Energy Models for Decision Support*
Christoph Böhringer, Centre for European Economic Research

Panel

12:30-1:30 Lunch *(Refectory)*

1:30-2:15 Poster Session I

2:15-3:00 Poster Session II

3:00-3:30 Break

3:30-5:00 TOOLS FOR BIOMEDICAL ENGINEERING
Organizers: Bernhard Clasbrummel, Andreas Holzenburg

*Biochips in Noninfectious Diseases*
Gregory T. Fieldson, Biochip Consultant

*Advanced Sensors for Environmental Pathogen Detection*
David L. Stokes, Oak Ridge National Laboratory

5:00 Reception *(Gallery)*

6:00 Dinner *(Great Hall)*

7:00 *Dinner Speech:* Anita Jones, Lawrence R. Quarles Professor of Engineering and Applied Science, University of Virginia

8:30-10:30 Hospitality Suite at Wyndham City Center Hotel *(Monticello)*

**Friday, May 17**

7:30 a.m. Breakfast *(Refectory)*

9:00-10:30 TOOLS FOR BIOMEDICAL ENGINEERING (cont.)

*Telemedicine and the Olympic Spirit – Faster, Higher, and Stronger or Just Participating?*
Heinz Weber, University of Erlangen-Nürnberg

*Automated Teleconsultations via Medical Imaging Analysis and AI-based Diagnostic Support*
Stefan Gehlen, ZN Vision Technologies AG

10:30-11:00 Break

11:00-12:30 p.m. NEW TRENDS IN URBAN ENGINEERING
Organizers: Klaus Kunzmann and Miroslaw Skibniewski

*The Sustainable City – From Sectoral Approaches to Integrated Planning*
Rolf Messerschmidt, Joachim Eble Architectur

*Innovative Investment Planning Strategies for Urban Infrastructure*
Stephen C. Wooldridge, Europe Regional Medical Command, U.S. Army

12:30-1:00 Lunch *(box lunches)*

1:30 Tour: *Smithsonian National Air and Space Museum and other*

6:00/6:45 Reception/Dinner at Wyndham City Center Hotel *(City Center One)*

**Saturday, May 18**

7:30 a.m. Breakfast *(Refectory)*

9:00-10:30 NEW TRENDS IN URBAN ENGINEERING (cont.)

*Automated Traffic Signal Management Through the Internet*
Darcy Bullock, Purdue University

*Towards Walkable Cities in Germany*
Ursula Flecken, Technical University of Berlin

10:30-11:00 Break

11:00-12:30 p.m. INTELLIGENT TRANSPORTATION SYSTEMS: MANAGING TRAFFIC FLOW FOR SAFETY AND MOBILITY
Organizers: Ferit Kücükay and Christopher Poe

*Traffic Simulations Applied to Intelligent Transportation and Evacuation Scenarios*
Dirk Helbing, Dresden University of Technology

*Modeling Traffic Flow with ITS Data*
Larry Rilett, Texas A&M University

12:30-2:00 Lunch *(Refectory)*

2:00-3:30 INTELLIGENT TRANSPORTATION SYSTEMS (cont.)

*Use of Event Data Recorders for Evaluating Traffic Operations*
Karen Dixon, Georgia Institute of Technology

*Technical Challenges on the Way to a Crash Avoidance Car*
Alejandro Vukotich, Audi AG

5:30 Farewell Reception at Wyndham City Center Hotel *(Monticello)*

**Meeting Information:**

**Meeting Site and Hotel Accommodations**
**Transportation**
**Weather/Clothing Suggestions**
**Maps**
**Hotel Floor Plan**
**Bus Schedule (pink-colored sheet)**
**Brochure about National Air and Space Museum**

## MEETING SITE AND HOTEL ACCOMMODATIONS

National Academies Building
2101 Constitution Avenue, N.W.
Washington, DC 20418
Phone: (202) 334-2438
Fax: (202) 334-2290
(*http://nationalacademies.org/*)

Wyndham City Center Hotel
1143 New Hampshire Avenue
Washington, DC 20037
Phone: (202) 775-0800
Fax: (202) 331-9491
(*http://wyndham.com/CityCenter/default.cfm*)

## TRANSPORTATION

**By air:**

The Wyndham City Center Hotel is located in Washington D.C, which is served by Dulles International Airport (IAD) and Ronald Reagan-National Airport (DCA).

From Dulles:
Dulles International Airport (IAD) is approximately 27 miles from the hotel. Participants coming into this airport can take a Washington Flyer taxicab (*http://www.metwashairports.com/dulles/ground.htm*) to downtown D.C. for approximately $45.00 (without a tip).

Another option is the Washington Flyer Coach Service (*http://www.washfly.com*). This is a bus that will transport participants to the West Falls Church Metro station ($8 one-way or $14 round-trip). From there, travelers will take the Orange Line to the Foggy Bottom Metro station (a distance of 7 stops and approx. 18 minutes of travel time) for a fee of about $2. Foggy Bottom (*http://www.wmata.com/metrorail/systemmap.htm*) is about three blocks from Wyndham City Center (see map in this section).

Finally, Super Shuttle (*http://www.supershuttle.com/htm/cities/dca.htm*) offers wheelchair-accessible minibus service that can accommodate nine to twelve passengers. If a group is arriving at the same time, they may want to use this. Advance reservations are required, and can be made by dialing (800) 258-3826. The cost is $22 for the first person and $10 for each additional person (cash or credit card accepted). To return to IAD, you must make reservations 24 hours before your flight departure time.

From Ronald Reagan-National:
Ronald Reagan-National Airport (DCA) is approximately 8 miles from the hotel. Participants flying into Reagan-National Airport can take a cab to Wyndham City Center (*http://www.mwaa.com/national/ground.htm*) for no more than $15. Metrorail service is also available. Travelers wishing to use this option will take the Blue Line from the airport to Foggy Bottom Metro station. Foggy Bottom (*http://www.wmata.com/metrorail/systemmap.htm*) is about three blocks from Wyndham City Center (see map in this section).

**By car:**

Directions to the **Wyndham City Center Hotel** are as follows:

From the West: Follow I-70 E to I-270 S towards Washington. Take the Capital Beltway and then VA-193 (exit number 43-44) towards the George Washington Memorial Parkway/Georgetown Pike. Keep right at the fork in the ramp. Merge onto GW Pkwy S. Take the US-29 N exit towards Key Bridge/Washington. Merge onto N Lynn Street/US-29 N. Turn right onto ramp. Merge onto US-29 N/Whitehurst Frwy. Turn slight right onto K Street NW. Turn right onto 25th Street NW. Turn left onto K Street NW. Enter next roundabout and take 4th exit onto New Hampshire Avenue NW.

From the North: Follow MD-295 S towards Washington. Merge onto US-50 W. Stay straight to go onto New York Avenue NW, which becomes Mount Vernon Place NW. Turn left onto 9th Street NW. Turn right onto K Street NW. K Street NW becomes K Street NW/US-29. Turn right onto K Street NW. Enter next roundabout and take 1st exit onto New Hampshire Avenue NW.

From the South: Follow I-95 N. Take the I-395 N exit (exit number 170A) towards Washington. Take the VA-27/Washington Boulevard exit (exit number 8B) towards Pentagon/Arlington Cemetary/Rosslyn /Memorial Bridge. Take the US-50 W/George Washington Memorial Parkway North ramp. Keep left at the fork in the ramp. Merge onto Arlington Memorial Bridge. Turn slight right onto Lincoln Memorial Circle SW. Turn left onto 23rd Street NW. Enter next roundabout and take 2nd exit onto New Hampshire Avenue NW.

and directions to the **National Academies Building** are as follows:

From the West: Follow I-70 E to I-270 S towards Washington. Take the Capital Beltway and then VA-193 (exit number 43-44) towards the George Washington Memorial Parkway/Georgetown Pike. Keep right at the fork in the ramp. Merge onto GW Pkwy S. Take the I-66 E/US-50 exit towards Roosevelt Bridge/Washington/Rosslyn. Keep left at the fork in the ramp. Merge onto I-66 E. Take the US-50E/ Constitution Avenue exit. Stay straight to go onto Constitution Avenue NW/US-50.

From the North: Follow I-295 S towards Washington. Take the Howard Road exit (exit number 3B) towards downtown. Turn left onto Howard Road SE. Turn left to take the I-295 N ramp. I-295 N becomes I-395 S. Take the Maine Avenue/12th Street exit towards downtown. Keep right at the fork in the ramp. Merge onto 12th Street SW. Turn left onto Constitution Avenue NW/US-50.

From the South: Follow I-95 N. Take the I-395 N exit (exit number 170A) towards Washington. Take the VA-27/Washington Boulevard exit (exit number 8B) towards Pentagon/Arlington Cemetary/Rosslyn /Memorial Bridge. Take the US-50 W/George Washington Memorial Parkway North ramp. Keep left at the fork in the ramp. Merge onto Arlington Memorial Bridge. Turn slight right onto Lincoln Memorial Circle SW. Turn left onto 23rd Street NW. Turn right onto Constitution Avenue NW/US-50.

Directions courtesy of (*http://www.mapquest.com*)

Please bear in mind that if you will be driving directly to the National Academies Building, there is limited parking at 21st and C Streets, N.W., and it is on a first come, first served basis. Furthermore, you will need to let us know so that we may alert the guards. *Because bus transportation is provided, NAE will not reimburse for rental cars.*

## WEATHER/CLOTHING SUGGESTIONS

Washington D.C.'s average temperature for the month of May is 66.4 degrees Fahrenheit (19 degrees Celsius). The average high is 76°F, and the warmest day ever was 99°F. The average low is 56°F, and the coldest day ever was 34°F. The average precipitation for the month of May is 3.48 inches, with an average number of 11 rainy days. It is advisable to bring an umbrella. Lightweight clothing is comfortable; a sweater or jacket is needed in the evenings. Dress for the symposium is business casual, and ties for men are not necessary.

# FIFTH GERMAN-AMERICAN FRONTIERS OF ENGINEERING SYMPOSIUM

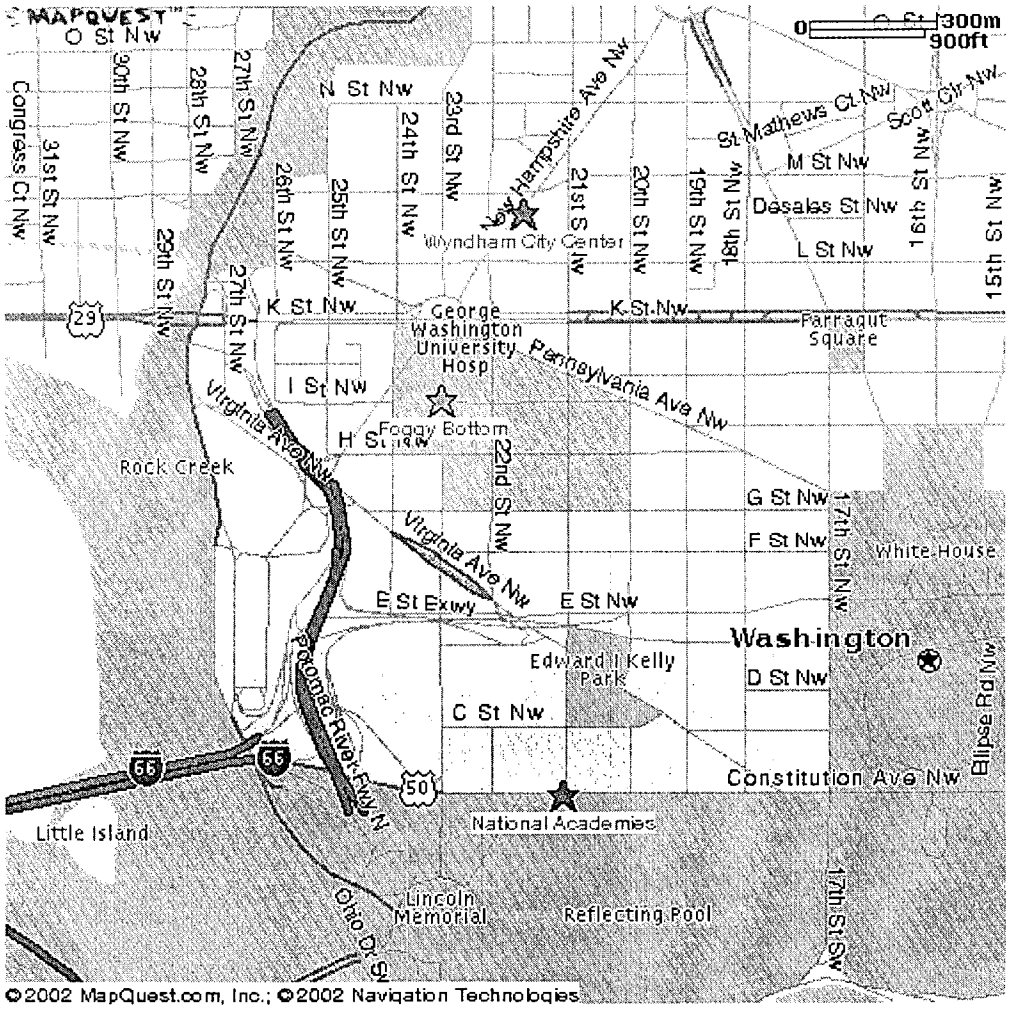
May 16-18, 2002

## AREA MAP

National Academies Building
2101 Constitution Avenue, N.W.
Washington, DC 20418
(202) 334-2438

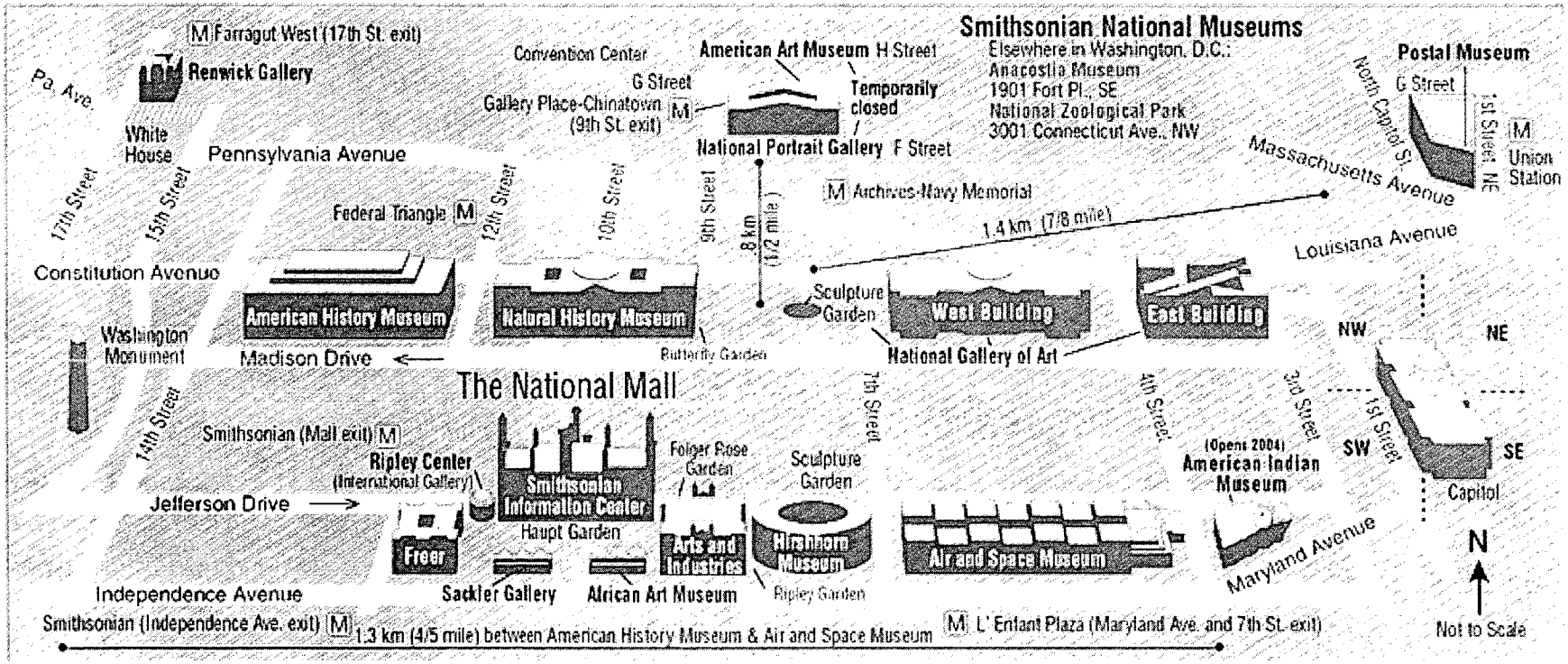
Wyndham City Center Hotel
1143 New Hampshire Avenue
Washington, DC 20037
(202) 775-0800

Foggy Bottom Metro Station
23rd and I Streets, N.W.
Washington, DC

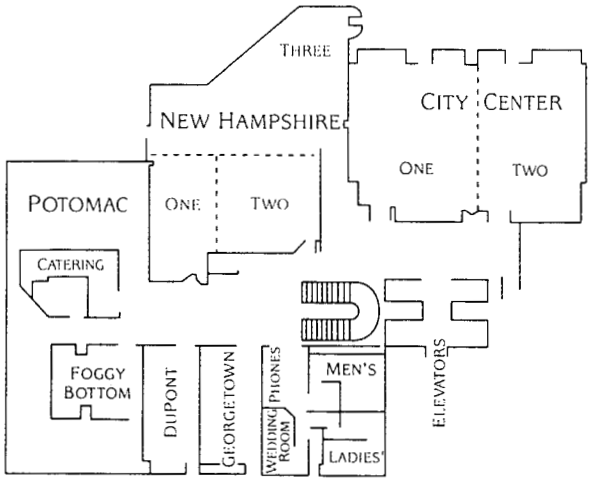


# Smithsonian National Museums

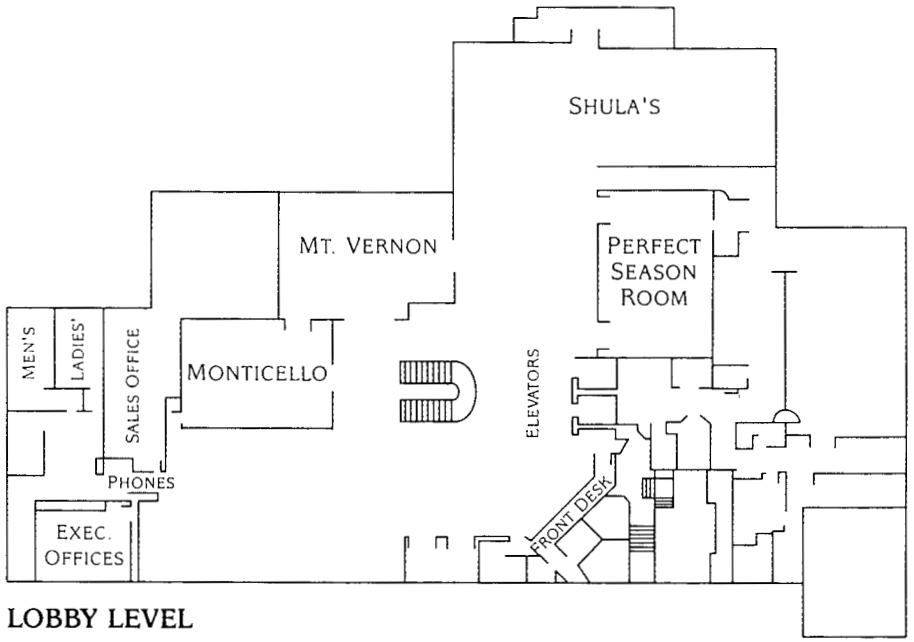
On and near the National Mall



CONFERENCE/MEETING ROOMS




LOWER LEVEL




LOBBY LEVEL

# WYNDHAM CITY CENTER℠
## WASHINGTON, D.C.

1143 New Hampshire Avenue, NW, Washington, D.C. 20037 202-775-0800 Fax: 202-331-9491
www.wyndham.com/citycenter

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**FIFTH GERMAN-AMERICAN**
**FRONTIERS OF ENGINEERING SYMPOSIUM**
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# BUS SCHEDULE

*From the Wyndham City Center Hotel to the National Academies Building, the bus will pick up directly in front of the hotel on New Hampshire Avenue. If the pickup point changes, please check with the Front Desk or the Doorman. An NAE staff member will also be available each morning at the hotel to assist participants.*

## Thursday, May 16

LEAVE THE WYNDHAM CITY CENTER for the National Academies Building
7:15 am
7:30 am

LEAVE THE NATIONAL ACADEMIES BUILDING for the Wyndham City Center
7:45 pm – *(two buses)*

## Friday, May 17

LEAVE THE WYNDHAM CITY CENTER for the National Academies Building
7:15 am
7:45 am

LEAVE THE NATIONAL ACADEMIES BUILDING for the National Air & Space Museum
1:00 pm

LEAVE THE NATIONAL AIR & SPACE MUSEUM for the Wyndham City Center
4:30 pm

## Saturday, May 18

LEAVE THE WYNDHAM CITY CENTER for the National Academies Building
7:15 am
7:45 am

LEAVE THE NATIONAL ACADEMIES BUILDING for the Wyndham City Center
3:35 pm – *(two buses)*

# FIFTH GERMAN-AMERICAN FRONTIERS OF ENGINEERING SYMPOSIUM

May 16-18, 2002

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# FIFTH GERMAN-AMERICAN FRONTIERS OF ENGINEERING SYMPOSIUM

May 16-18, 2002

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# FIFTH GERMAN-AMERICAN FRONTIERS OF ENGINEERING SYMPOSIUM

May 16 - 18, 2002

## PARTICIPANTS' AREAS OF RESEARCH AND TECHNICAL WORK

*Uwe Altrock, Technical University of Berlin*
My main fields of research interest are in planning theory, urban politics, planning history, and the development of planning instruments. I have conducted research or participated in research projects about city redevelopment in Berlin (Ph.D. dissertation), planning in the Soviet Union in the 1930s, and about local planning in Israel and Palestine.

*Thomas Bachmann, BMW AG*
My research interests are traffic safety and efficiency enabled by intelligent solutions for transportation systems (ITS). My scientific background focuses on vehicle safety (both active and passive) and driving dynamics. Main working areas are friction between tire and road, as a prerequisite of driving safety, and the development of driver assistance systems to support the driver in dangerous situations. I integrated modern vehicle systems, electronics, telematics, and their human-machine-interface in the "ConnectedDrive" concept.

*Frank Bär, Siemens Power Generation*
My interests are in power generation applications in advanced processes such as supercritical coal-fired plants, and utilization of coal in combined-cycle power plants. Examples include PPCC (pressurized pulverized coal combustion) and 2nd generation PFBC (pressurized fluidized bed combustion). I am also interested in clean coal technology in general, CHP (combined heat and power), and renewable energy technologies.

*Christoph Böhringer, Centre for European Economic Research*
My fields of interest include energy economics, computable general equilibrium modeling of energy-economy-environment, and quantitative analysis of energy and environmental policies.

*Thomas Brendecke, Technical University, Braunschweig*
My research interests are in real-time simulation, electronic transmission control systems, powertrain, and driver/route/vehicle modeling.

*Rolf Brendel, Bavarian Center for Applied Energy Research (ZAE Bayern)*
I work on crystalline silicon solar cells. Recently my group at ZAE Bayern (*www.zae-bayern.de*) developed a novel layer transfer process using electrochemically etched porous silicon. The process yields 15.4%-efficient and 25 μm-thin crystalline silicon solar cells. Powering satellites could be one of the applications for these novel devices.

*Darcy Bullock, Purdue University*
My teaching and research interests are in the general area of real-time traffic control and monitoring. My current projects include evaluation of intersection detection technologies, deployment of closed loop traffic signal control systems, deployment of Weigh-In-Motion systems, and evaluation of minimum retro-reflectivity standards.

*Jeffrey D. Carbeck, Princeton University*
I am a chemical engineer and materials scientist with expertise in biomaterials, biophysical and bio-analytical chemistry, nanomaterials, and molecular simulations. My research program is focused on using both experiments and modeling to engineer the stability of proteins, the affinity and specificity of drugs, the transport of proteins in nanoporous materials and interfaces between cells and synthetic materials.

*Bernhard Clasbrummel, Ruhr-University Bochum*
The main focus of our research is the transfer of automotive microsystems into medical applications. This includes implantable physical sensors with telemetric units for wireless data transmission. Areas of application are monitoring blood pressure, blood flow in cardiac bypass surgery, analysis of hip protheses loosening, or monitoring of electrosignals for rehabilitation in trauma patients. The other focus is in the field of telemedicine. We develop systems for the transmission of pictures, voice, and data for the transaction of virtual ward rounds by a doctor. Of special interest are miniature systems for diagnosis that can be used for home care monitoring.

*Jane H. Davidson, University of Minnesota*
My research focuses on indoor air quality and renewable energy technologies. In the environmental field, I am currently studying the use of activated carbon to control gaseous pollutants in homes, cars, and aircraft cabins and the chemical reactions that occur in corona discharges in electrostatic air cleaners. My work in renewable energy focuses on development of solar water heaters made of polymers and high temperature chemical reactions carried out in concentrating solar furnaces.

*Karen Dixon, Georgia Institute of Technology*
My general research program focuses on the safe and efficient use of the transportation system. My current research includes speed and safety analysis using personal vehicles equipped with event data recorder equipment. Other research interests broadly include highway and roadway design and safety, traffic flow and simulation, and computer applications to the road environment.

*Judy Dorsey, The Brendle Group, Inc.*
I am president and founder of The Brendle Group, Inc., an engineering services firm specializing in energy efficiency and environmental sustainability. I am particularly interested in topics that integrate energy and the environment, such as climate protection and sustainable design. I apply these strategies to a range of operations including ski resorts, breweries, school districts, municipalities, national parks, universities, and manufacturers.

*Markus Ewert, E.ON Energie AG*

Our research projects are all in connection with transformation, distribution, and use of energy. The main focus is in the field of new technologies:
- big power plants (i.e., pressurized coal combustion, new materials for turbines, new nuclear rectors, and solar thermal hybrid power plant)
- electrical grids (i.e., high-temperature superconductor and virtual power plant)
- small decentralized power plants (i.e., fuel cells, micro turbines, stirling engine, photovoltaic cells, and solarthermal collectors)
- use of energy (i.e., heat pumps and low-energy households)

*Brian Farhi, Florida Solar Energy Center*

My current responsibilities include testing and monitoring of grid-tied inverters for photovoltaics, training professionals in photovoltaic installation and related subjects, and management of FSEC's battery test facility.

*Gregory T. Fieldson,*

I am interested in the development of new tools for the acquisition and analysis of protein information. With the application of high throughput assays presenting diverse protein affinities and selectivities, and applying multiplex data analysis, it is possible to develop detailed profiles of the protein composition of biological samples. I believe that the knowledge that we obtain about proteins and their relationships will lead to a rapid expansion of our knowledge about the dynamic network of interactions that underlie the mechanics of life.

*Aimee Flannery, George Mason University*

My research is primarily focused on transportation operations and intelligent transportation systems. In addition, as a full member of the Transportation Research Board's Highway Capacity and Quality of Service Committee, I am leading the Committee's efforts to better understand travelers' perceptions of the quality of service provided by our transportation infrastructure.

*Ursula Flecken, Technical University of Berlin*

My research interests comprise the phenomenological, technical, ecological, economical, and social implications of the post-modern city. I concentrate on integration and controlling car traffic within a dense city; conditions for pedestrians, cyclists, and public transport; building density; and mixed use structures especially between residential and commercial/ manufacturing/industrial uses.

*Stefan Gehlen, ZN Vision Technologies AG*

My current research interests pertain to artificial vision, focusing further in process, person, and face recognition, along with medical image processing and image processing systems for application in automobiles.

*Carsten Gertz, Technical University, Hamburg-Harburg*

My main areas of research are integrated transportation and land use planning, implementation strategies for innovative transportation and land use policies, and effects of telecommunication on mobility and urban form. Current comparative research activities in the United States and Europe include 1) Public-Private Partnership for Urban Rail Transit: Lessons from Case Studies in North America and Europe (funded by the European Commission); 2) ISTEA/ TEA21: Lessons from a Landmark Bill for Transportation, Land Use, Air Quality and its Implications for policy changes in Europe; 3) Location-Efficient Mortgages (LEM): Can This Concept be Transferred from the U.S. to Germany?; and 4) effects of teleworking on travel behavior and location decisions.

*Sigrid Hafner, University of Paderborn*
My research interests are classification and data analysis. Since 1990, I have been working on artificial neural networks. I developed a system for automatic clustering of temporal data (MEKS) used in the automotive industry to develop new algorithms for motor management. Further applications will be in medical diagnosis.

*Dirk Helbing, Dresden University of Technology*
My research interests include multi-agent simulation of socio-economic systems; behavioral models, decision and game theory; self-organization phenomena in space and time; optimization of vehicle, pedestrian, and air traffic; stochastic systems and Monte-Carlo simulations; molecular dynamic, gas kinetic, fluid dynamic models; and micro-macro link.

*Wahid L. Hermina, Sandia National Laboratories*
I currently manage the development of science-based simulation software to support the design and qualification of microsystems for Sandia applications. My primary focus is on continuum and noncontinuum software for the simulation of gas dynamics and thermal transport in microscale devices.

*Andreas Holzenburg, Texas A&M University*
Original background of study: microbiology, botany and chemistry. Research and technical interests: microscopy and imaging in life and, more recently, material sciences. We are using electron microscopy and crystallography in conjunction with digital image analysis (3-D reconstructions etc.) to reveal structure-function relationships (and molecular dynamics) of complex macromolecular assemblies in the fields of bioenergetics (e.g. photosynthesis), genome structure, and medicine. Enabling challenges includes 2-D crystallization in and on lipid membranes, epitaxial crystal growth, exploitation of self-organizing molecular systems, and high-throughput imaging. Other technical interests include renewable resources, alternative fuels, and self-igniting engines.

*Jörg Horzel, RWE Solar GmbH*
I am developing advanced processes and systems for the diffusion and metallisation of industrial Si solar cells. Emphasis in my work is put on reliable high throughput processing.

*Timothy L. Jacobs, American Airlines*
My research focuses on the application of operations research for robust scheduling, revenue management, and integrated airline planning. My work in this area led to development of several software products and techniques like Sabre's patented O&D Fleet Assignment Model (O&D FAM) currently used by airlines throughout the world. At American Airlines, my research team focuses on strategic planning and revenue management solutions.

*Alan L. Jacobson, Ford Motor Company*
I am responsible for insuring durability is built in to all Ford vehicles designed in North America. This includes analytical and physical test planning, execution, and issue resolution. Previous work has included product design, computer-aided design, research and development, marketing and sales, and new business development.

*Thomas Kattenstein, Ruhr-University Bochum*

My main subjects are the efficient use of energy and the utilization of renewable energy carriers. Regarding our university, I am developing a conception for a new energy supply structure which contains energy-saving measures as well as options for an efficient energy conversion, e.g. gas engine block-type thermal power stations, fuel cells, and geothermal power plants.

*Erwin Keeve, Research Center CAESAR*

My research work is focusing on medical image post-processing and the development of bio-numerical methods and image-guided navigation systems in neurosurgery, cranio- and maxillofacial surgery and orthopaedics.

*Sangtae Kim, Lilly Research Laboratories*

I am vice president and information officer of Lilly Research Laboratories, where my organization provides IT leadership to research and development, regulatory affairs, clinical research, and program and product teams. From 1983 to 1997, I was a faculty member in the Department of Chemical Engineering at the University of Wisconsin-Madison. My group at the university developed computer programs used by biophysicists, chemical engineers, chemists, electrical engineers, and mechanical engineers. My research focus has been described as the intersection of applied mathematics, biological sciences, and information technology.

*Kevin T. Kornegay, Cornell University*

Our research seeks to develop fundamental knowledge and innovative applications in integrated microsystems that have sensing, computing, and communications capabilities by 1) understanding issues that impact the design of circuits for high data rate wired and wireless data links, 2) design and fabrication of microelectromechanical systems (MEMS), and 3) developing microfabrication techniques for heterogeneous integration of electrical and mechanical components comprised of dissimilar semiconductor materials.

*Ferit Küçükay, Technical University, Braunschweig*

The main research objectives of the Institute of Vehicle Technology concentrate on vehicle dynamics. A main part of the research objectives is processed in cooperation with industry. Presently, the following research objectives are conducted by the Institute of Vehicle Technology: objective assessment of subjective vehicle, driver and road characteristics regarding longitudinal, lateral and vertical dynamics; automation of balancing the shifting comfort in vehicles with automatic transmissions; simulation of vehicle dynamics with hardware in the loop (HIL); active noise control of interior noise of a vehicle; vibration perception of passengers; tire comfort of the full vehicle; straight running stability of automobiles; sensitivity analysis of vehicle bodyshells regarding torsional strength and weight; body dynamics, crash (static and dynamic); rattle behavior of manual transmissions; determination of representative load sprectra.

*Klaus R. Kunzmann, University of Dortmund*

I have been responsible for numerous research projects on innovative urban and regional development, on regional restructuring, and on planning education. My present research interests are on sustainable urban policy and European spatial planning, regional restructuring, and the role of creativity and the arts for spatial and endogenous economic development.

*James C. Malas, Air Force Research Laboratory*
Systems engineering research for integrated vehicle health monitoring. Recent advances in embedded/add-on micro-sensors, computer modeling of nondestructive evaluation responses, and cellular communications have opened-up opportunities for realizing whole new integrated vehicle health monitoring capabilities. Current research is aimed at developing systems engineering approaches for designing materials and structures with in-situ inspection and prognostic capabilities.

*Theresa A. Maldonado, University of Texas, Arlington*
Fabrication and characterization of nonlinear optical waveguides of dye-doped polymer systems by ionic self-assembled monolayers (ISAMs) techniques; analysis of optically anisotropic waveguides and devices; complete characterization of hybrid modes (propagation constants and field profiles) in nonlinear biaxial waveguides; rigorous coordinate-free electromagnetic theory of second-harmonic generation in inorganic and organic electro-optic biaxial materials/ waveguides; design of counterpropagating quasi-phase match devices for frequency conversion and all-optical switching; sensor design for remote detection of alcohol; guided mode resonant filter design, photonic antennas.

*Tonja Marquard-Möllenstedt, Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)*
I am interested in sustainable technologies for the energy sector, investigating innovative solutions, analysing feasibility, and markets. My research is focused on renewable energies, especially renewable fuels (biomass conversion, steam reforming, syngas/hydrogen generation) and solar thermal power processes. My lab activities comprise plant design, process analysis, and data processing.

*Rolf Messerschmidt, Joachim Eble Architectur*
I am working on urban planning projects with a concentration on sustainable urban development. The target is to implement aspects like energy-efficiency, watercycles, new mobility concepts, mixed use, and citizen participation in integral and interdisciplinary processes. My research interests are improvements within these aspects of sustainability and the development of strategies and tools to integrate them in urban planning and design.

*Darren J. Mollot, U.S. Department of Energy*
My research interests are in the areas of combustion, fluid mechanics, computer simulation (numeric modeling), and flow visualization. My masters thesis used helicopter rotor-inspired numeric models to predict dynamic stall of wind turbine blades (validated using wind and stress data from a Vestas turbine). My dissertation, and much of my professional life, has centered on combustion visualization (including laser tomography) and numeric modeling via commercial codes. I hold a patent for a low NOx combustion technique.

*Sharon L. Nunes, IBM Corporation*
My current focus is on emerging technology trends, with special interest in the intersection of genomics/proteomics with healthcare and the environment. I have a keen interest in the emerging trend of "in-silico biology" where simulation and modeling will displace significant amounts of lab experimentation.

*Christopher M. Poe, PB Farradyne, Inc.*

I am the the area manager in North Texas and Oklahoma for PB Farradyne, the intelligent transportation system (ITS) division of Parson Brinckerhoff. My focus areas are ITS, freeway operations, and multi-modal integration. I led one of the largest university-based ITS programs in the United States and have been principal investigator on projects involving ITS data management and warehousing, highway-rail intersection integration, transit operation integration, traffic signal system simulation, and HOV design and operation. I have also taught university courses in transportation engineering at the University of Texas at Arlington, Pennsylvania State University, and Texas A&M University.

*Laurence R. Rilett, Texas A&M University*

My research focuses on large-scale transportation system modeling. Specifically, I develop techniques for estimating origin-destination matrices, forecasting link and corridor travel times, routing vehicles through transportation networks, and calibrating traffic flow parameters in traffic micro-simulation models.

*Cynthia J. Riley, National Renewable Energy Laboratory*

I am most interested in the environmental, technical, and economic analysis of emerging biomass-based renewable technologies for the production of fuels and chemicals. I joined the National Renewable Energy Laboratory over 10 years ago after 13 years of working as a chemical engineer on the engineering design and construction of fossil-based energy facilities. I wanted to explore the possibilities of energy supplies and process technologies beyond oil, gas, and coal.

*Giorgio Rizzoni, Ohio State University*

My research activities focus on the modeling, control and diagnosis of automotive systems. These activities have involved a substantial amount of experimental research on engines and vehicles. Current activities include vehicle and powertrain diagnostics; powertrain dynamics and control; and the development of alternative propulsion systems including new engine concepts, electric, hybrid-electric, and fuel cell vehicles.

*Miroslaw J. Skibniewski, Purdue University*

Research in construction automation and robotics, computer-based decision support systems for civil engineering, construction and project management for advanced technology transfer, and international engineering education. Research interests span several interdisciplinary fields, including civil engineering, construction engineering and management, computer technology, systems optimization techniques, project management, and international studies.

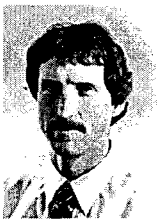
*Bayne Smith, URS Corporation*

My interests are primarily in the area of intelligent transportation systems. My areas of expertise are design of freeway management and traveler information systems, operations and maintenance of traffic control centers, and advanced traffic signal systems design and implementation.

*Jörg Starflinger, Karlsruhe Research Center*

My main research interests include 1) numerical 3-D-simulation of hydrogen distribution for safety assessment covering applications from accidents in nuclear containments to tunnel accidents, in which hydrogen-driven passenger cars are involved, and 2) thermodynamic analyses of IGCC power plants with different types of entrained-flow gasifiers and accompanying design calculations for the FZK biomass research gasifier.

*David L. Stokes, Oak Ridge National Laboratory*
My current interests are in the development of advanced technologies for optical detection in environmental and biomedical applications. Such technologies include surface-enhanced Raman scattering (SERS) and biochip-based detection systems. My goal is to make these technologies practical for field use.



*William C. Stone, National Institute of Standards and Technology*
My interests are in large scale manufacturing metrology and wireless information transfer; supply chain and inventory tracking technologies; precision tele-operable and autonomous processes, including automated steel and concrete construction; and the development of next-generation field sensors (RFID, MEMs, LADAR) and object recognition and SLAM (simultaneous localization and mapping) systems. I also maintain interests in structural, mechanical, electro-mechanical, and electro-optical systems design, simulation, dynamics, and integration.

*Kai Sundmacher, Max Planck Institute for Dynamics of Complex Technical Systems*
As a chemical reaction engineer, I am interested in the experimental and model-based analysis of complex chemical process systems. My current research activities are focused on fuel cells, membrane reactors, integrated processes combining reactions and separations, and on the production of nanoparticles by precipitation in emulsions.

*Tamara Troy, Xenogen Corporation*
My role at Xenogen Corporation includes research on understanding and modeling light propagation through tissue. Applying models to in vivo images allows for the quantitative determination of the biophotonic source within an animal and also leads towards the development of 3-D diffuse image reconstruction techniques.

*Niraj Verma, University of Southern California*
My current research is focused on two projects. With my colleague, Professor Tridib Banerjee, I am working on a book-length manuscript titled, *Probing the Soft Metropolis: From Chicago Models to Los Angeles*. Our goal is to study the limits of modeling in understanding cities and to propose ways of extending these limits by using metaphorical descriptions of important urban processes. A second project extends my previous work on using similarities between ideas as a method of inquiry. In this research, I am reconstructing some recent California policy initiatives, such as Three Strikes Law and Zero Tolerance Against Drugs, as problems of risk avoidance with the aim of understanding the nature of these policy initiatives.

*Alfred Voß, University of Stuttgart*
My areas of expertise include new energy technologies, including renewable energy; energy systems analysis and energy modeling; rational use of energy; and energy and the environment.

*Yulun Wang, Computer Motion, Inc.*
I am the principle architect and inventor of Computer Motion's robotic systems used in surgery, including the world's first FDA-cleared surgical robot. I hold over 50 patents and patents-pending covering robotics and computer design.

*Heinz Weber, University of Erlangen-Nürnberg*

My main interests are implementing higher quality video over IP into medical projects and coordinating different projects to provide a common telematic platform, realized by close cooperation between the university hospital and different research units, including some outside of the University of Erlangen-Nürnberg.

*Albert Weckenmann, University of Erlangen-Nürnberg*

My main research interests are in the fields of quality management (QM) and in manufacturing metrology (MM). Our work in QM is focused on qualifying known and well-tried methods for use with computers and in different industrial sectors. Our priorities in MM are in precision measurement of geometrical quantities of workpieces using optical and tactile instruments with accuracies in the submicrometer range.

*Christiane Weiß, VDI/VDE-Technologiezentrum Informationstechnik GmbH*

My company, VDI/VDE-IT (an offspring of the Association for Mechanical and Electrical Engineers in Germany), is managing the national funding program Micro-System-Technology (MST) initiated by the federal department of education and research. As a biomedical engineer I work in the field of medical applications. Additionally, I am responsible for public relations and organizing of MST-events.

*Charles J. Werth, University of Illinois at Urbana-Champaign*

My research focuses on the entrapment, dissolution, and bioavailability of pure phase organic contaminants in groundwater aquifers, and on the sorption of these chemicals to soils and sediments. In my research group we use magnetic resonance imaging and fluorescence microscopy to observe organic chemical transport and biodegradation in model porous matrices.

*Stephen C. Wooldridge, Europe Regional Medical Command*

The focal point of my research is the effective and efficient management of infrastructure assets (constructed facilities) for long-term benefit. Extensions of this broad interest include the study of infrastructure management systems and the emerging field of asset management systems. Specific areas of research have involved the development and application of decision support systems that incorporate condition assessment and master planning tools within a holistic framework for allocating scarce capital resources. Economic and facility deterioration modeling are critical supporting areas of study.

*Martina Zitterbart, University of Karlsruhe*

My research work focuses on networking and collaborative networked applications. Internet technologies, such as quality-of-service, group communication, and programmable flexible service platforms are of particular interest. Furthermore, protocols and algorithms for mobile communication including self-organized ad-hoc networks with small and mobile devices (e.g., sensors, watches) are investigated. Considering collaborative applications, research mainly focuses on group and social interactions for team-based learning with mobile learners.

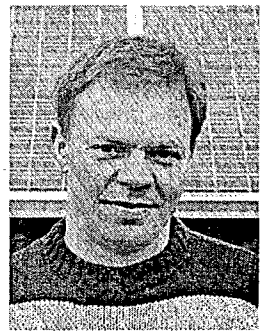
National Academy of Engineering

**FIFTH GERMAN-AMERICAN FRONTIERS OF ENGINEERING SYMPOSIUM**
May 16–18, 2002

SPEAKER BIOS

## OPTIONS FOR SUSTAINABLE ENERGY FUTURES: THE ENGINEERING CHALLENGES

**Christoph Böhringer** is director of research in environmental and resource economics and environmental management at the Zentrum für Europäische Wirtschaftsforschung (ZEW) in Mannheim, Germany. He studied industrial engineering (emphasis: business planning) from 1987 to 1991 at the University of Karlsruhe. Subsequently, he was a scientific coworker at the Institute for Energy Industry and Rational Application of Energies (IER) at the University of Stuttgart, where he attained a doctorate in 1995. From 1996 to 1998, he led the specialized group on "energy-industry analyses" at the IER, examining numeric efficiency and distribution analysis of environmental/political instruments, particularly the economic effects of national and international greenhouse gas reduction strategies in view of cost-efficient organization, occupational effects (ecological tax revision), location competition (international competititve ability), and regional and intergenerational load distribution (burden sharing and/or sustainability). Since 1994 he has regularly led international workshops on applied politico-economic modelling (emphasis: analysis of environment). He is also a training representative in economic science of the Universities of Tübingen and Mannheim.



**Jörg Horzel** is a research development engineer with RWE Solar in Alzenau, Germany. After graduating in 1990 from the University of Karlsruhe, he worked for three years as an application, development, and sales engineer at UBM GmbH, a small company that produces and develops noncontacting opto-electronic surface measurement technology. In 1994, Dr. Horzel started work as a research engineer in the industrial solar-cell research group of the Inter-University Micro-Electronics Centre IMEC in Leuven, Belgium. After finishing his Ph.D. in 1999, he remained as senior engineer with the industrial solar-cell group of IMEC where he was responsible for the pilot line laboratory. His activities focused on alternative metallisation techniques, rapid thermal processing, selective diffusion processes, and the development of novel diffusion equipment. Since October 2001, Dr. Horzel has worked on cell development for terrestrial solar-cell applications at RWE Solar.

**Darren J. Mollot** is a senior technical advisor in the Planning and Environmental Analysis Division of the U.S. Department of Energy (DOE) Office of Fossil Energy. This six-member division is made up of senior economists, scientists, and engineers who look 10, 20, and even 100 years into the future with an eye toward shaping current fossil energy programs to address future social and environmental needs. Prior to his current position, Dr. Mollot was program manager for Gas Turbine Systems, project manager for a wide variety of fossil fuel-based power system projects (including the Wabash Clean Coal Technology Partnership), technical liaison to the Power Systems Development Facility for two years, and a research engineer working on low NOx combustion issues. He also holds a patent on a technique to reduce NOx emissions in advanced pressurized fluid-bed combustion systems. Prior to taking a position with DOE in 1992, Dr. Mollot was a manufacturing engineer at IBM and a sales engineer for the Westinghouse Electric Corporation. He received his B.S., M.S., and Ph.D. in mechanical engineering from the State University of New York at Buffalo.

**Cynthia J. Riley** is process development leader in the Biotechnology for Fuels and Chemicals Division at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. She has a broad range of experience in the chemical and energy process industries with primary expertise in the technical and economic analysis of emerging alternative energy technologies. Ms. Riley has more than 23 years of experience, including alternative energy research with Exxon Research and Engineering Company, process design engineering with Fluor and Raytheon, and research engineering and management at NREL. During her 10 years at NREL, she has worked on DOE Office of Transportation Technologies programs, including biofuels, clean cities, Energy Policy Act implementation programs, and was the manager of the NREL Alternative Fuels Data Center. She led the analysis effort for the biofuels program and performed conceptual process designs and economic evaluations of biotechnology-based processes for the conversion of biomass to fuels and chemicals and led several major biofuels projects, including a multilaboratory peer-reviewed total energy cycle analysis of the bioethanol process and a cooperative research and development project with Amoco for the conversion of waste materials to ethanol. Ms. Riley has a B.S. in chemical engineering from the University of New Hampshire.

TOOLS FOR BIOMEDICAL ENGINEERING

**Gregory T. Fieldson** entered the field of biotechnology when he joined LumiCyte, Inc. to develop novel protein biochips for the company's SELDI-TOF technology. As a member of the initial team, he started the biochip laboratory operations and fabricated LumiCyte's first biochips. He was also responsible for diverse engineering tasks related to microarray biochip design, fabrication, and production as well as sample processing. Dr. Fieldson also worked on the design of the database architecture and developed bioinformatics tools for analyzing biochip data and identifying protein and peptide biomarkers. Prior to joining LumiCyte, he worked with ALZA Corporation as a research scientist in transdermal drug delivery. He was also involved in clinical and nonclinical research on drug delivery mechanisms and managed ALZA's efforts to incorporate computational molecular mechanics and molecular dynamics simulations into product formulation and development. Dr. Fieldson obtained his Ph.D. in chemical engineering at Johns Hopkins University.

**Stefan Gehlen** is chief technical officer at ZN Vision Technologies AG in Bochum, Germany. He received his diploma from the Darmstadt Technological University in 1986 in the field of electrical engineering with an emphasis on automation technology, artificial intelligence, and image processing. From 1987 to 1992 he worked as a research assistant at Darmstadt Technological University's Institute for Control Systems, and he received his doctorate with distinction there in 1993. Since he started working for ZN Vision Technologies (formerly Center for Neuroinformatics GmbH), he has been instrumental in the company becoming the market leader in the field of artificial vision. Today ZN Vision Technologies AG is a global leader in the field of facial-recognition systems and image-based medical diagnostic systems (e.g., for early detection of skin cancer). Dr. Gehlen is a member of the executive board of ZN Vision Technologies AG and VISIOmed AG, Bochum, Germany.

**David L. Stokes** is a postdoctoral fellow at the Oak Ridge National Laboratory in Oak Ridge, Tennessee. He is currently involved in developing a fluidics-based biochip system for DNA- and antibody-based bioassays and an air sampling biochip system for detecting environmental pathogens, investigating spectroscopy-based techniques for monitoring soil-carbon systems, and conducting combusion analysis research for detecting carcinogens in cigarette smoke. His earlier research was devoted to capillary electrophoresis and the development of fiberoptic sensors. Dr. Stokes received his Ph.D. in chemistry from the University of Tennessee at Knoxville in 1999. He is the recipient of two R&D 100 Awards for the development of a surface-enhanced raman gene probe and surface-enhanced raman optical data storage. He is a member of the American Chemical Society and the Society for Applied Spectroscopy.

**Heinz Weber** is a surgeon, senior emergency room doctor, and medical nutritionist. He studied medicine at the Friedrich-Alexander University in Erlangen, Germany, and obtained his M.D., with an emphasis on biomedical analysis of hip prostheses. He received his certificate for general surgery in 2000 and now specializes in vascular surgery. Since 1993, he has been involved in telemedical applications in setting up a clinical patient record at Baden Hospital in Switzerland. From 1998 to 2001, he chaired the German Research Network "Gigabit Testbed South – Project 1.14," which is investigating the implementation of video-compression standards to improve tumour surgery by using video over ATM. Dr. Weber is president of the Telemedicine Section of the German Society of Surgeons and a working group on computer-assisted surgery and telematics and has given several talks about telemedicine at national and international meetings. He and his team provide an Internet portal (*www.blick-in-den-op.de*), which shows several surgical operations. The service has already been used by more than four million users.

## NEW TRENDS IN URBAN ENGINEERING

**Darcy Bullock** is an associate professor in the School of Civil Engineering at Purdue University in West Lafayette, Indiana. He received a B.S. in civil engineering from the University of Vermont (1987), and an M.S. (1988) and Ph.D. (1992) in civil engineering from Carnegie Mellon University. Dr. Bullock is a registered professional engineer in Louisiana and Indiana. Prior to joining the Purdue faculty, he was an assistant/associate professor in the Civil Engineering Department at Louisiana State University from 1993 to 1997. Dr. Bullock's teaching, research, and consulting interests are in the general area of intelligent transportation systems (ITSs). For the past several years he has been actively involved in the development of hardware and software for the next generation of ITS traffic-signal controllers. He is currently working on several sponsored projects involving real-time traffic-signal systems.

**Ursula Flecken** is a senior engineer and urban planner at the Institute for City and Regional Planning, Technical University of Berlin. Her primary fields of research are postmodern urban design and the transformation of cities in Poland and Cuba. She has conducted research at universities in Russia, Brazil, and Cuba. Her industry experience includes working with architectural firms in Aachen and Berlin, Germany, and Seattle, Washington, on streetscape planning and urban design, master planning of cultural sites, urban redevelopment planning, and traffic planning. Dr. Flecken spent a year at the University of Washington in Seattle in the Master of Urban Planning Program as a scholar of the German Academic Exchange Service (DAAD). She received her Ph.D. in 1999 from the Technical University of Berlin. Her thesis was on the development of urban design between 1960 and 1975 in West Germany.

**Rolf Messerschmidt** is leader of the urban planning team at Joachim Eble Architectur in Tübingen, Germany. He studied architecture and urban planning at the University of Stuttgart, completing his degree in 1999. In his current position, he leads urban planning projects in Germany and the Netherlands with a focus on sustainable urban development, that is, mixed use, participation, urban renewal, mobility, energy efficiency and solar concepts, water and resource saving cycles, and bioclimate. He has also been involved in citizen participation projects, the EU research project "Eco City" with the city of Tübingen, and development of "econnis" as a European network of interdisciplinary partners within the area of sustainable urban development. Since 2000, he has also been a part-time teaching assistant in urban planning to Professor Bott at the Institute for Urban Planning, University of Stuttgart. He was recipient of a prize from the Professor Albert Speer Foundation in 2000.

**Stephen C. Wooldridge** is the director of health facility planning in Europe for the U.S. Army. Based in Heidelberg, Germany, Major Wooldridge oversees the life-cycle management of a portfolio of health care facilities that comprise some 3 million square feet and nearly $1 billion in replacement value. Major Wooldridge is also responsible for providing guidance in the development and sustainment of contingency medical facilities throughout Europe, Africa, and Middle Eastern areas of operation. He began his military career at Fort Bragg, North Carolina, where he served as the brigade engineer for a rapid deployment (airborne) medical brigade. His following assignment was as a health facility project officer in the Northeast Region, where he assisted in managing the construction of a $250 million replacement hospital. He was later reassigned to the Health Facility Planning Agency at the Pentagon, where he served as assistant director of construction management and then as the chief of capital programming. In the former role, he assisted in managing more than 35 concurrent works-in-progress valued at nearly $500 million. In the latter capacity, he evaluated and recommended capital budgeting priorities for modernizing the Army's health facility portfolio, which includes more than 1,600 buildings worldwide valued at more than $8 billion. He was subsequently selected for an Army Medical Department Fellowship to pursue doctoral studies. Major Wooldridge has a Ph.D. in construction engineering and management from the Massachusetts Institute of Technology. He graduated with an M.S. in engineering (construction engineering and management) in 1992 and a B.S. in electrical engineering in 1990, both from Purdue University. He is a member of the American Society of Civil Engineers, the American Society of Healthcare Engineers, the International Facility Managers Association, the Association for Facilities Engineering, and the Society of American Military Engineers.

## INTELLIGENT TRANSPORTATION SYSTEMS: MANAGING TRAFFIC FLOW FOR SAFETY AND MOBILITY

**Karen Dixon** is an associate professor in the Department of Civil Engineering at Georgia Institute of Technology in Atlanta, Georgia. Her research interests include highway and roadway design and safety, traffic flow, traffic simulation, and computer applications to the roadway environment. Dr. Dixon is a registered professional engineer in the states of Georgia, North Carolina, Arizona, and Texas. She is recipient of the CETL/AMOCO Junior Faculty Teaching Excellence Award, the Bill Schutz Undergraduate Teaching Award, and the Teaching Excellence and Innovation Award given by the Georgia Tech School of Civil and Environmental Engineering, among others. Dr. Dixon received her M.C.E. and Ph.D. from North Carolina State University.

**Torsten Gollewski** is head of the Department of Advanced Development in Electrics/Electronics at Audi AG. After completing a degree in electrical engineering, Mr. Gollewski spent six years at TEMIC Automotive Electronics, a global automotive supplier specializing in automotive electronics, first in the Industrial Engineering Department, and then as a member of the International Junior Executive Group where he worked on several interdisciplinary projects at TEMIC sites in Nürnberg and Heilbronn, Germany, and Manila, Philippines. From 1995 to 1998, he attended Henley Management College in Great Britain, where he completed his M.B.A. In 1998 he worked in the business unit of Safety Electronics at TEMIC, where he was responsible for strategic planning and sales planning. In 2000 he moved to AUDI where he first worked as assistant to the director of electrics/electronics development before moving to his current position; the focus of his department is on driver-assistance systems.

**Dirk Helbing** is the managing director of the Institute for Economics and Traffic at Dresden University of Technology, where he is also a full professor. After finishing his Ph.D. in Stuttgart on modeling social interaction processes by means of game-theoretical approaches, stochastic methods, and complex systems theory, he completed his habilitation on traffic dynamics and optimization in 1996. He is the recipient of a Heisenberg scholarship. In addition to having two theses printed by international publishers, Dr. Helbing helped organize and coedit several proceedings of international conferences on cooperative dynamics in socioeconomic and traffic systems. He has published more than 90 papers, including several journal articles in *Nature*, *Science*, and *Reviews of Modern Physics*. He is also a reviewer for many interdisciplinary, physical, socioeconomic, and transportation journals, as well as science foundations (DFG, NSF). Dr. Helbing is coeditor of the *Traffic*

*Forum*, the *Econophysics Forum*, and the *Internet Journal of Cooperative Transportation Dynamics*. He has close ties with many international scientists (e.g., at the Weizmann Institute in Israel, Xerox PARC in the Silicon Valley, and the Collegium Budapest-Institute for Advanced Study in Hungary). He is also involved in multipartner research projects with Siemens, Volkswagen, DaimlerChrysler, and other companies.

**Larry R. Rilett** is an associate professor in the Department of Civil and Environmental Engineering at Texas A&M University in College Station, Texas. His primary research interests are intelligent transportation systems, with a focus on the use of ATMS data for real-time travel time forecasting, incident detection, synthetic O-D estimation, and real-time routing of vehicles. He is also interested in transportation systems analysis and modeling of large-scale transportation systems. Dr. Rilett received his B.S. and M.S. degrees from the University of Waterloo in Waterloo, Ontario and Ph.D. from Queen's University in Kingston, Ontario.

DINNER SPEAKER

Anita K. Jones is University Professor at the University of Virginia and professor of computer science in the School of Engineering and Applied Science. She is also the former chair of the Department of Computer Science.

The Honorable Anita K. Jones was sworn in as the director of defense research and engineering for the U.S. Department of Defense (DoD) in June 1993. In that position, she was responsible for the overall management of the science and technology program, including the Defense Advanced Research Projects Agency and the DoD laboratories. She was also the principal advisor to the secretary of defense for defense-related scientific and technical matters. In 1997, she returned to the University of Virginia.

Dr. Jones is currently the vice chair of the National Science Board, which advises the President on science, engineering, and education and oversees the National Science Foundation. She is also a member of the Defense Science Board and the Charles Stark Draper Laboratory Corporation and cochair of the Commonwealth of Virginia Research and Technology Advisory Commission. She has served on many other government advisory boards and scientific panels, including the Air Force Scientific Advisory Board, various boards and panels for NASA, the National Research Council, the U.S. Department of Energy, and the National Science Foundation. She is a member of the National Academy of Engineering and a fellow of the Association for Computing Machinery, the Institute of Electrical and Electronics Engineers, the American Academy of Arts and Sciences, and the American Academy for the Advancement of Science. She has been awarded the Computing Research Association's Service Award, the Air Force Meritorious Civilian Service Award, and the Department of Defense Award for Distinguished Public Service, and has been a Monticello Memoirs Fellow. The U.S. Navy named a seamount in the north Pacific Ocean (51° 25' N and 159° 10' W) for her.

Dr. Jones is currently a member of the Board of Directors of Science Applications International Corporation and Avaki. Other private sector experience includes serving as a founder and vice president of Tartan Laboratories, trustee of the MITRE Corporation, and a member of various academic and industrial advisory boards, including the MIT Lincoln Laboratories Advisory Board. Carnegie Mellon University awarded her an honorary doctorate in science and technology in 1999. She is the author of more than 40 technical articles and two books on computer software and systems.

Dr. Jones holds an A.B. in mathematics from Rice University, an M.A. in literature from the University of Texas, Austin, and a Ph.D. in computer science from Carnegie Mellon University. Her husband, Professor Wm. A. Wulf, is president of the National Academy of Engineering and the AT&T Professor of Engineering and Applied Science at the University of Virginia. They have two daughters, one living in the Seattle area and one in Bethesda, Maryland.

National Academy of Engineering
and
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# FIFTH GERMAN-AMERICAN FRONTIERS OF ENGINEERING SYMPOSIUM

May 16–18, 2002

Addendum to SPEAKER BIOS

## INTELLIGENT TRANSPORTATION SYSTEMS: MANAGING TRAFFIC FLOW FOR SAFETY AND MOBILITY

**Alejandro Vukotich** is deputy head of the Department of Advanced Development in Electrics/Electronics at Audi AG. After completing a degree in electrical engineering at the Technical University of Darmstadt, Mr. Vukotich spent 2 years at the research department of the Volkswagen Group in Wolfsburg, where he worked on the development of the advanced frontlighting system. Since 1999, as a member of Audi, he has been responsible for the development of driver assistance systems.

# OPTIONS FOR SUSTAINABLE ENERGY FUTURES: THE ENGINEERING CHALLENGES

Session Organizers:
Jane Davidson and Alfred Voß

The provision of energy plays an important role in a country's economic and environmental performance and the sustainability of its development. Sustainable development of the energy and electricity sectors depends on finding ways of meeting energy service demands of the present generation that are economically viable, environmentally sound, socially acceptable and do not jeopardize the ability of future generations to meet their own needs.

Innovative energy technologies will have to play a fundamental role in achieving sustainable energy futures. Hence the session will explore the extent to which new energy technologies can contribute to a cleaner and more sustainable provision of energy services. The options addressed are the use of biomass, photovoltaic systems, and clean coal technologies. Another topic will be devoted to the role of energy models for decision support in the context of sustainability.

# Biomass Energy

CYNTHIA J. RILEY
*Biotechnology Division for Fuels and Chemicals*
*National Renewable Energy Laboratory*

Bioenergy technologies use renewable biomass resources to produce an array of energy related products including electricity, liquid, solid, and gaseous fuels, heat, chemicals, and other materials. Bioenergy ranks second to hydropower in renewable U.S. primary energy production and accounts for three percent of the primary energy production in the United States.

Biomass includes the full range of plants and plant-derived materials, such as dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, and municipal wastes. The majority of non-food biomass is composed primarily of the natural polymers cellulose, hemicellulose, and lignin and is referred to as lignocellulosic biomass. One of the major near-term sources of biomass for energy is the residue left over after harvesting of existing food crops. As use of biomass surpasses the availability of currently available resources, new energy crops such as switchgrass are expected to come into play. A significant issue associated with energy crop development is the use of genetically modified plants. Scientific work is needed to establish benefits and risks associated with these new energy crops as well as the intensive agricultural practices required to increase productivity in a sustainable manner.

Biopower technologies are proven electricity generation options in the United States, with 10 gigawatts of installed capacity. All of today's capacity is based on mature direct-combustion technology. Future efficiency improvements will include co-firing of biomass in

existing coal fired boilers and the introduction of high-efficiency gasification combined-cycle systems, fuel cell systems, and modular systems. Direct combustion involves the burning of biomass to produce steam which is then used to produce electricity in steam turbine generators. Co-firing refers to the practice of introducing biomass in high-efficiency coal fired boilers as a supplementary energy source. For utilities and power generating companies with coal-fired capacity, co-firing with biomass may represent one of the least-cost renewable energy options. Biomass gasification for power production involves heating biomass in an oxygen-starved environment to produce a medium or low calorific gas composed primarily of hydrogen, carbon monoxide, and methane. This offers advantages over directly burning the biomass. The biogas can be cleaned and filtered and then used in more efficient power generation systems called combined-cycles, which combine gas turbines and steam turbines to produce electricity. The efficiency of these systems can reach 60%, compared to 33% to 37% for cofiring. In the future, as costs come down, we envision gasification systems coupled with fuel cell systems resulting in even higher efficiency electricity production.

Unlike other renewable energy sources that produce electricity, biomass can also be converted directly into liquid fuels, called biofuels, for our transportation needs. The most abundant biofuel already in use is ethanol made from starch and sugar crops. In the future, it is envisioned that ethanol will be made from all types of biomass resources. However scientific and technological innovation across multiple disciplines will be required to maximize the potential of this technology. In particular, breakthroughs in biotechnology are expected to lead to dramatic improvements in biomass feedstocks as well as biocatalysts such as enzymes and fermentation microorganisms. Cellulase enzymes are used extensively today in detergents and

the food processing industry. In order to use them in the production of relatively low value fuels and commodity chemicals from biomass, dramatic improvements in activity and production efficiency are required. Microorganisms have been used for thousands of years as biocatalysts to ferment glucose from starch and sugar crops into ethanol. The sugars from biomass include the six carbon sugars glucose, mannose, and galactose, and the five carbon sugars xylose and arabinose. It is the presence of significant quantities of five carbon sugars that is unique to lignocellulosic biomass as compared to traditional sugar sources. There are very few microorganisms that naturally convert five carbon sugars to products, and those that do are not very robust. Research today is focused on identifying and understanding the vast array of genetic structure and function and metabolic pathways found in microorganisms and using this knowledge to develop more robust fermentation microorganisms.

Conceptual process design and life cycle analysis are two major types of systems analysis tools employed to ensure the biomass technologies under development are cost effective, energy efficient, and environmentally acceptable. Conceptual process engineering data and design provides the basis for a realistic understanding of the engineering and economic issues and risks associated with new process technology. This knowledge is essential to guiding research and development as well as supporting demonstration and commercial investment decisions. Life cycle analysis is used to compare alternative routes to similar or replacement products and provide a comprehensive "cradle to grave" accounting of each product's flows to and from the environment. In general, biomass based products offer significant opportunities to reduce fossil fuel consumption and green house gas emissions when compared to their fossil based equivalents.

The vision for the future use of biomass is in a biorefinery. As the name implies, the biorefinery concept is based on lessons learned from the petroleum industry, which started out making a few basic energy products and evolved into today's integrated refineries that produce hundreds of products using highly sophisticated chemical and energy process technologies. Many of today's fuel ethanol plants take grain and make just two basic products – fuel ethanol and animal feed. They are biorefineries in the simplest sense of the word. Just as technology brought about improvements in yield and product slate for the petroleum refinery, so it will bring about greater efficiency and flexibility for the biorefinery.

# Photovoltaic Prospects and Engineering Challenges

JÖRG HORZEL
*Terrestrial Photovoltaics Division*
*RWE Solar GmbH*

## The Role of Solar Energy

With the given background of a steadily increasing world population, increasing energy consumption per capita, and limited resources of fossil and nuclear fuel, the search and development of sustainable energy sources and a smooth transition to these technologies will be one of the most challenging tasks for the next decades and century. Assuming that yearly energy consumption will further increase in the future, the energy sources that play a major role today will be consumed within a few centuries. The challenge is to develop alternative energy forms that provide a sustainable energy source for the future and do not alter the global climatic and environmental conditions in a negative way.

A short view on the choice of energy sources available today shows that the majority of them are exhaustible. The fossil fuel sources (coal, gas, oil) required tens of thousands of years to be formed. These energy sources are so far covering by far the biggest share in primary energy consumption. They are at the same time valuable raw materials for synthetic products required by many industrial sectors. Also, the availability of nuclear fuel is limited, and this energy form causes additional long-term concerns related to the waste treatment.

Solar energy in the form of wind energy, water energy, photovoltaics (solar electricity), and solar thermal energy conversion are the best candidates for a long-term sustainable energy future. All of them have the potential to make a major contribution to worldwide energy

consumption. If, additionally, environmental issues are considered (contamination of the atmosphere, climatic changes), the choice for solar energy becomes even more evident. In particular direct conversion of solar radiation is a very clean form of energy that can be applied at each location where energy is required. Photovolatics can be easily integrated in buildings without negative impact (aesthetic or health-related concerns) for human beings or nature.

Thus, there is a wide range of applications of photovoltaics. In a number of fields, solar electricity is already today the most cost-effective choice. Remote power supply in regions far from an electricity grid; customer applications like car roofs, traffic signalisation, and emergency phone booths on motorways; and satellite power supply are some examples of these applications. The demand of developing countries to get access to energy supply is another big challenge for solar energy. As most of these countries have not yet developed efficient electricity grids, photovoltaics are often the best and most cost-effective choice to give the population of these countries access to electricity.

For industrialized countries, grid connected systems are of most interest as photovoltaics can be easily integrated in the existing electricity grid infrastructure and in buildings. This so far subsidized sector will develop in the next decades into a competitive energy alternative and a major industrial sector.

## Current State and Future Development of Photovoltaic Solar Energy

Photovoltaics (solar electricity) is probably the most elegant form of electrical power production. Sunlight is directly converted into electricity. Today the most dominant technology in the photovoltaic industry are modules from crystalline Si solar cells (market share > 80 %).

Despite an increase in the annual production of 20-30% per year over the last decade, this technology is so far not able to contribute a noticeable share to the annual energy production worldwide.

This contribution to the GAFOE symposium will discuss the perspectives of solar energy to become a millennium technology and 100 billion US$ business within the next decades. It will identify the challenges in Si substrate production and solar cell and module manufacturing in increasing the yearly production capacity by more than two orders of magnitude within the next 30-50 years. Learning curves from other industries and detailed feasibility studies predict in the same time frame a price decrease for solar energy by an order of magnitude. This will make photovoltaic energy conversion not only competitive with other energy sources but turn it into a major industry comparable to the microelectronics industry today. Thus, initial subsidies helping fast market growth and price decreases for solar energy are only required to bring solar energy to a 'take-off' stage. A time frame for this development will be predicted.

## Exemplary Discussion of Detailed Technical Challenges to Solve in Order to Meet the Required Throughput Increase

The presentation will then focus on the solar cell process in general and describe the current challenges in up-grading production capacity to decrease production cost. Competing approaches in research and industrial production to perform an emitter diffusion from phosphorous dopant sources will be discussed as an example and the challenges for further development will be sketched. The focus will be put on upcoming process technology and equipment development for the respective approaches. In particular, Rapid Thermal Processing

(RTP) for externally applied diffusion sources like spray-on phosphorous dopant coatings and a "continuous walking beam" furnace for all types of diffusion sources will be compared to a conventional conveyor belt furnace for externally applied diffusion sources. Throughput limitations with respect to the drastic production capacity increase that is foreseen for the near future will be discussed. Challenges to master the respective processes will be explained. The diffusion process together with the metallisation process are the most essential processing steps in solar cell production and determine to a large extent the final process result.

Unlike the semiconductor industry, there is so far no detailed roadmap and standardization in the technology for the next decades. A large number of opportunities is still open for further development. The development of innovative processes and related equipment that is especially designed for the photovoltaic sector offers in the past few years new perspectives to improve throughput, yield, and average conversion efficiency in solar cell production at the same time, thus leading to a noticeable decrease in production cost.

# Clean Coal Technology

DARREN J. MOLLOT
*Office of Fossil Energy*
*U.S. Department of Energy*

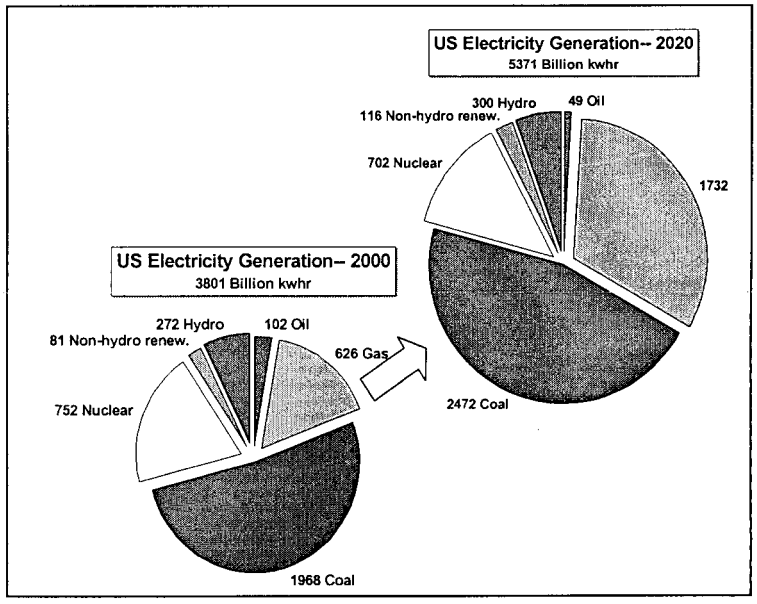
Clean Coal Technologies (CCTs) have been defined as "technologies designed to enhance both the efficiency and the environmental acceptability of coal extraction, preparation, and use." These technologies reduce emissions, reduce waste, and increase the amount of electrical energy produced from each ton of coal. Since 1970, emissions of conventional pollutants (i.e., oxides of sulfur and nitrogen as well as particulate) from coal-fired power plants have declined by 70% while the cost of electricity from coal-fired stations has steadily declined since the 1980s. Technology has progressed to the point that coal power plants can now be built that are as clean, in terms of conventional pollutants, as the cleanest natural gas power plants.

Over 50 percent of the electricity in the United States and more then 34 percent of the electricity worldwide is generated from coal. Even though those percentages are expected to decline slightly over the next 20 years, total electric energy use is projected to increase dramatically, resulting in an increase in worldwide coal use of more than 25 percent over the next 20 years. Whether you look at traditional pulverized coal or the most advanced combined cycle coal gasification plants, there is significant room for improvement in coal-to-electricity efficiency, emissions, and cost. Major challenges are in the areas of materials, sensors, control systems, gas separation, computer simulation, and systems integration. There are also several major advances in electricity conversion systems, such as fuel cells and advanced turbines, which could potentially further improve the efficiency of the more advanced coal-fired electric

generation systems. Since carbon dioxide emissions are likely to remain a significant issue, a host of technologies that are needed to capture and permanently store carbon dioxide are being developed.

It is still unclear whether coal and other fossil resources are destined to be transition fuels, keeping the world economy humming until non-fossil sources of energy are both technically and economically ready to replace them, or if fossil fuels will remain a long-term part of our energy mix. In either case, developing and demonstrating technologies that will make our current and future fleets of coal-fired power plants cleaner, more efficient, and lower cost, will continue to pay high environmental and social dividends. Remember, according to most forecasts, fossil fuels will be generating the bulk of our electricity for the remainder of all of our life times. That is a lot of coal and natural gas. We need to continue to develop and deploy the technologies necessary to use our fossil resources responsibly.

Data from EIA Annual Energy Outlook 2002



# Sustainable Energy Provision: Energy Models for Decision Support

CHRISTOPH BÖHRINGER
*Centre for European Economic Research, Mannheim*

The reduction of carbon emissions associated with the combustion of fossil fuels is a key challenge for sustainable energy provision. There are numerous proposals how energy policy should achieve the transition towards a less carbon-intensive global energy system. Rational policymaking requires quantitative estimates on the magnitude and distribution of induced adjustment costs for alternative carbon abatement strategies. As it is not possible to simulate the economic effects of energy policy interference within the real system, modeling adjustment based on sound economic theory is an important tool for decision support. The use of energy-economy models allows for the systematic and consistent analysis of alternative policy scenarios. However, usefulness of applied modeling requires a check of the underlying assumptions. Careful sensitivity analysis to assumptions is a prerequisite for gaining useful insights. While this is a major challenge, it is, at the same time, the major strength of systematic model-based analysis. We illustrate these ideas around a quantitative economic assessment of the Kyoto Protocol.

## TOOLS FOR BIOMEDICAL ENGINEERING

Session Organizers:
Bernhard Clasbrummel and Andreas Holzenburg

This session will cover four topics. The first speaker will introduce the world's most powerful proprietary biochip-based proteomics and informatics technology used to discover and validate protein biomarkers associated with changes in health. The detection of proteins on the surface of a biochip begins with a Surface-Enhanced Laser Desorption/ Ionization (SELDI) process (Seldiography), which is suitable for the analysis of any biological fluid including standard clinical samples. After protein selection, the surface is assayed with modified time-of-flight (TOF) mass spectroscopy. This method is extremely sensitive and permits, via the simultaneous identification of thousands of proteins, a characterization of the physiological state of the patient. Current examples include discoveries of biomarkers in patients with asymptomatic insulin-resistance and prostate cancer.

The second speaker will present an overview of advanced technologies aimed at the detection of environmental pathogens focusing on (i) Raman and surface-enhanced Raman scattering (SERS) as well as (ii) biochip-based detection. Raman spectra can yield very specific structural information about the sample and serve as a definitive tool in sample identification. The development of a compact Raman instrument suited for pathogen detection in the field will be presented. Biochips are two-dimensional biosensors that allow a simultaneous detection of multiple immobilized pathogens. The detection and analysis principles will be described, and a new compact, inexpensive, low-wattage 2-D detector equipped for studying biofluidics will be introduced.

The third speaker will describe progress in telemedicine applications in the last years through several examples. Colorectal and gastric cancer, the second leading cause of death in Europe, were the two topics chosen for testing the influence on quality of treatment by involving remote quality control mechanisms. Powered by the gigabit-testbed of the German Research Network, huge bandwidth was available to realize lossless encoding and decoding in video over ATM and video over IP. Thus, in providing the necessary quality of service, even transatlantic surgery became possible. But is it necessary? Nationwide ISDN-videoconferencing is often the first choice, since it is available everywhere and has enough bandwidth for still-video applications. In many cases, it is even replaced by video over IP-applications or VPN. Several gateways can combine ambulant and clinical networks. Objective measurements as well as study results are shown.

The fourth speaker presents the basic methods, problems, and limitations on the use of computer vision and computer intelligence processes in medical diagnostics through the example of the development of a picture-aided expert system for skin cancer recognition. The technical realization of the system development will be treated in detail, and the organizational steps necessary to build up a marketable medical product will be explained. The second part of the presentation deals with the transferability of the system for telemedical consultation using the example of skin cancer diagnosis. Furthermore, scenarios from telemedicine such as automated wound diagnosis and the possibilities of computer-aided teleconsultation will be presented.

# Biochips in Noninfectious Diseases

GREGORY T. FIELDSON
*Biochip Consultant*

## Biochips and Proteomics

Biochip technology was largely established by the development of microarray biochips for genomics research. The emergence of the biochip was perhaps an inevitable development, an expansion of existing chemistries and concepts into the information rich world of genomics. The GeneChip™, developed at Affymax, remains the best known example of a biochip.

The essential property of a biochip is the use of solid phase support and interfacial chemistry to capture molecules from a sample and present them for analysis. The use of a solid support provides the separation and isolation of an analyte, and creates the opportunity for high density microarrays of sampling sites. Combined with scalable production techniques, often borrowed from semiconductor fabrication, it also offers the potential of high sample throughput. There are no absolute restrictions on the types of molecules that can be analyzed using a biochip, only technical problems related to binding, retention, and assay.

With the maturing of genomics, some limitations of genome-based research have become apparent. Although extremely useful, characterization of a cell based upon its genes or gene transcripts is only an indirect view. From an engineering perspective, the complete state of a cell might be defined by its molecular composition. While this includes DNA, RNA, small molecules, and ions, this state is defined by proteins and peptides. Consequently, proteomics, the systems level study of proteins, represents a direct view of the state of a cell and its parent

organism. With some abstraction, in clinical practice the protein profile obtained from a biological sample may be seen as synonymous to the phenotype and overall health state of a patient.

## SELDI Protein Biochips

A major challenge in molecular biology, and particularly biochip development, is the detection of analytes present in mixtures at extremely low concentrations. Mixtures create limitations for the optical detection methods typically used with biochips, while low concentrations present problems when traditional separation techniques, such as 2-D electrophoresis, are applied.

Surface Enhanced Laser Desorption Ionization Time-of-Flight Mass Spectroscopy (SELDI-TOF MS) was developed in the last decade as a powerful tool for overcoming these limitations, and is now being commercialized by several companies including LumiCyte, Inc., which holds the rights to the underlying technology patents.

With a SELDI protein biochip, proteins are captured at a target site using techniques that are similar to traditional chromatographic techniques. The analysis of the biochips, however, is quite different. Instead of optical detection, the bound proteins are combined with a charge and energy transfer molecule and assayed using laser desorption ionization time-of-flight mass spectroscopy. With TOF MS, it becomes possible to simultaneously identify hundreds or thousands of different proteins and peptides bound to a single site. TOF MS is also capable of detecting analytes present in nanomole to sub-femtomole quantities, corresponding to millimolar to picomolar concentrations in a typical biological sample. Because of these capabilities, SELDI

biochip surfaces can be prepared with diverse chemistries that have varying degrees of protein-binding specificity, and their selectivity may be further enhanced through variations in protein capture and retention protocols.

## Bioinformatics with SELDI Biochips

In practice, the SELDI-TOF technique provides mass spectra of proteins unmatched in both its sensitivity and its ability to identify hundreds of proteins simultaneously. A collection of protein mass spectra can be obtained from diverse biochip surfaces, using varied protein binding protocols, creating a protein map. The information in this protein map combines protein molecular weight with chemical knowledge derived from the protein binding interactions at the biochip surface.

Protein maps are rich descriptions of the biological sample, which characterize the physiological state of a patient. Their information density and complexity often defies simple linear analysis. In order to best utilize this data, LumiCyte has developed software that incorporates the latest techniques for database mining, pattern recognition, and artificial intelligence. Some of the challenges include managing large volume data sets, searching for reproducible patterns in data, which has variable alignment and instrument artifacts, and dealing with the inherent variability present in biological samples. Classification and analysis methods that have been successful include both trained artificial intelligence tools, such as support vector machines and genetic algorithms, as well as unsupervised cluster analysis.

Applying these tools to the differential analysis of protein maps rapidly uncovers the extent and nature of protein variations. This analysis can be applied to samples from multiple

patients of differing phenotypes, where it leads to early detection of disease, even in asymptomatic patients. It also provides a powerful tool for discriminating between physiologically distinct diseases that present similar or even identical symptoms. With samples from a single patient, differential analysis of protein maps reveals early onset of disease, disease progression, and the patient's response to therapy.

## Challenges of Protein Biochips

A number of challenges remain that define the current boundaries of SELDI biochip technology. For physical scientists, the optimization of surfaces that capture and present proteins is an ongoing activity, and the development of TOF MS for detection over an even wider dynamic range is essential to finding rare, important proteins in the presence of ubiquitous, common proteins. For biological scientists, sequencing proteins that are discovered with SELDI-TOF MS and interpreting the complex network of revealed proteins are tasks that expand with every new sample set. For applied mathematicians and software engineers, creating new pattern recognition tools is important as we attempt to identify weaker and weaker signals in the protein map.

# Advanced Sensors for Environmental Pathogen Detection

DAVID L. STOKES, Guy, D. Griffin, Brian M. Cullum, Joel Mobley, and Tuan Vo-Dinh
*Advanced Biomedical Science and Technology Group*
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This discussion provides an overview of advanced spectroscopic technologies developed at Oak Ridge National Laboratory (ORNL) for the detection of environmental pathogens, including: 1) Raman and surface-enhanced Raman scattering (SERS), and 2) biochip-based detection.

In Raman scattering analysis, a high-power, monochromatic light source is shined on a sample, and scattered light is collected and analyzed for changes in energy, as evidenced by very discrete bands in the resulting spectrum. These slight energy changes correspond to vibrational modes of the irradiated sample. Raman spectra can therefore yield very specific structural information about the sample, and even serve as a definitive tool in sample identification. A disadvantage of the Raman scattering process is very low efficiency, often necessitating the use of large, high-power lasers and advanced instrumentation. One way to offset this drawback is to implement the surface-enhanced Raman scattering (SERS) effect, which results from the interaction of sample molecules with specially-textured metallic surfaces, referred to as SERS substrates. The SERS effect can routinely produce $10^6$-$10^8$ factor enhancements in Raman signal when a properly developed substrate is used. This presentation covers several types of SERS substrates based on nanotechnology developed at ORNL, for use in trace-level quantitative analysis (Vo-Dinh and Stokes, 2001). One example, silver-coated polystyrene beads, is

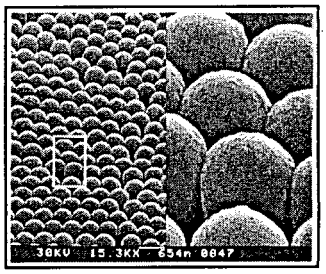


**Figure 1.** SEM of a SERS substrate composed of silver-coated polystyrene beads. The beads are approximately 500 nm in diameter. Source: Vo-Dinh, T. *et al.*, *Anal. Chem.*, **1998**, 71, 358-363.

illustrated by the SEM in Figure 1. This figure illustrates the excellent uniformity of this planar surface-based SERS substrate, which enables trace-level quantitative analysis of compounds of environmental interest. Furthermore, the substrate can be stored for several weeks without losing significant SERS activity.

In addition, the development of a compact Raman instrument is described. This instrument, illustrated in Figure 2, includes battery supplies and an on-board computer, making it totally free-standing and totable. A primary component of this device is an acousto-optic tunable filter (AOTF), which is a compact, solid-state dispersive device capable of rapid and random wavelength selection. The AOTF itself can fit in the palm of your hand, yet it yields spectral resolution adequate for Raman scattering spectroscopy. For example, a SERS spectrum of parathion (28 ng) is shown in Figure 3.

**Figure 2**. Compact Raman instrument developed at ORNL

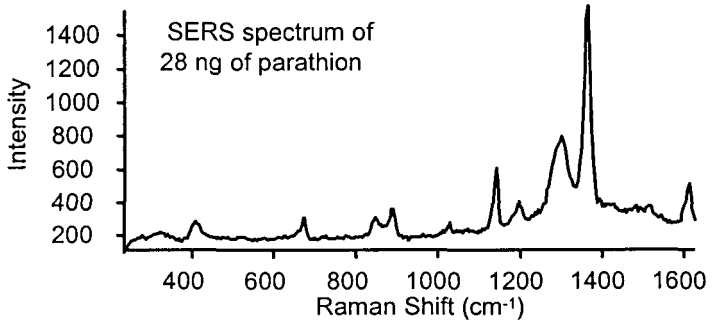


**Figure 3**. SERS spectrum of a 28 ng sample of parathion deposited on a microparticle-based silver substrate.

Another area of advanced sensing developed at ORNL is biochip-based optical detection. Biochips are two-dimensional biosensors that can enable the detection of multiple pathogens simultaneously. They are generally composed of a sampling platform and a 2-D array detector. The sampling platform consists of an array of bioreceptors that can selectively capture pathogens, products, or remnants from specific pathogens. Once immobilized on the platform,

the biological samples can be stimulated with a laser and analyzed for light emission. Often, the detection of biomolecules is facilitated with fluorescent dye labels that are compatible with the laser source. At ORNL, we have developed a 2-D CMOS-based detector which is inexpensive, very compact, and requires minimal operating power. A schematic diagram of the optical system integrating the 2-D detector with a sampling platform and laser excitation source is illustrated in Figure 4. A key advantage of this device is its capability for multiple, multifunctional assays in a single operation. For example, Figure 5 illustrates results of assays for HIV DNA and p53 protein, performed simultaneously on a single sampling platform. The 4 x 4 bar graph corresponds to signals from the 4 x 4 pattern of a microdot array spotted on the sampling platform. This pattern was aligned with the 2-D layout of photosensors. We have been taking steps to integrate the 2-D detector with sample platforms and fluid-based sample and reagent delivery systems (biofluidics) (Stokes et al., 2001). Furthermore, the biochip-based system with biofluidics has been packaged in a compact box.

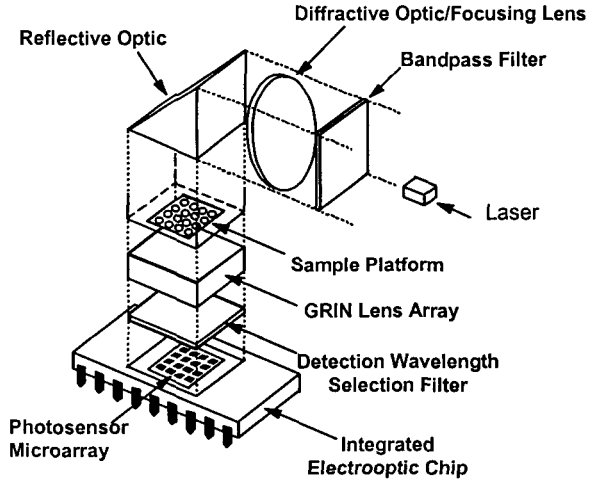


**Figure 4.** Schematic diagram of the ORNL biochip optical detection system. Source: Vo-Dinh, T. *Trends Anal. Chem.* **1998**, 17, 557-582

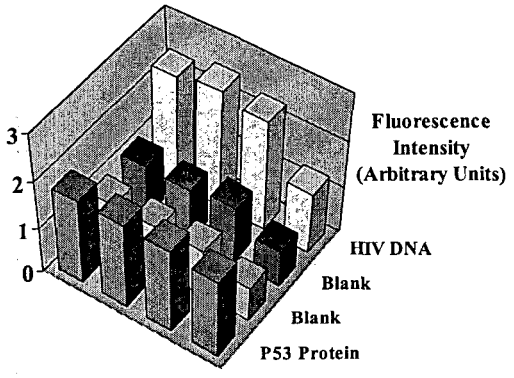


**Figure 5.** Results of biochip-based assays for HIV DNA and p53 protein, performed simultaneously on a single sampling platform.

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# Telemedicine and the Olympic Spirit – Faster, Higher, and Stronger or Just Participating?

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Today telemedicine is an omnipresent feature nationwide, and available almost world-wide. The list of telemedical applications includes, among others, teleconferencing, tele-endoscopy, tele-radiology, tele-pathology, and tele-surgery. Operating faculties have many needs for telemedical applications, including, communication of audio and video for educational purposes, gathering a second opinion, or providing an external quality control-mechanism, as well as the storage of data in electronic patient records in order to have all information available everywhere at any time.

Computer-assisted surgery has come up in the last years and supports us in treating our patients (some examples are shown), and even remote surgery has been shown to be possible. Nowadays, research in Erlangen focuses on optimisation of the endoscopic pictures in minimally invasive surgery and in integration of CT- and MRI data in surgical procedures. Connecting high-quality data with computer-assisted surgery allows the patient to be treated much more effectively.

Performing tele-surgery means handing over part of our medical responsibility for the patients not only to computers but even to whatever figured the "lines". Nowadays, several different manipulators are in use, and the step from working at a console next to the OR to working at a console miles away is not too far, with even transatlantic surgery becoming possible (Operation

Lindbergh). This means treatment via satellite, ISDN, or other "cable-based" networks with all the attendant problems in quality of image transfer and latency. Objective measurements as well as studies showed that latency is the main problem for live transmissions and should be reduced to less than 200 msec. Picture quality and sharpness is often directly related to the video compression format used and the available bandwidth.

Necessary for optimal use of telemedicine is an infrastructure providing us with both the necessary quality of service and safety.

From 1998 until 2000, giga-bandwidth was only available in a research project carried out by the German Research Network named "Gigabit Testbed South," but now giga-bandwidth is available nationwide with several gateways to international networks. The Gigabit Testbed evaluated methods of coding and testing of applications in tumor surgery that require transmissions of high resolution motion pictures with the highest degree of color depth and simultaneous audio. With three channels each with a capacity of 2.5 GBps, high-quality pictures as well as simultaneous audio could be sent. Video and audio signals were transmitted between the operating rooms in Munich and Erlangen by using video over ATM (MPEG2, M-JPEG). This form of telepresence aimed to establish external quality control mechanisms in tumor surgery. Since this form of online presence not only required extremely high resolution and color depths when transmitting motion images but also exact synchronization of audio and video with minimal delay, it posed the highest demands on the network and quality of service as well. (1)

Having these networks available on request is the best source for live transmissions for high quality educational purposes for conferences, such as the World Congress of High-Tech 2000, Hannover or the German Society Of Surgeons 2001, Munich.

For obtaining a second opinion, often ISDN-based videoconferencing systems are used. A 6-S0 videoconferencing system enables a hospital to participate in national and international connections for scientific and medical purposes and even for connections with general practitioners to perform teleconsultations. In the past, this was used for several connections within the German Society of Telematics and computer-assisted surgery, as well as for educational conferences nationwide, within Europe, and overseas.

Video over IP in a unidirectional form can be used for webstreaming events. Starting with a student project "Web-based Learning by Live-Streaming," Internet history was made with three more projects: an open-heart-procedure, an endoscopic transthoracic operation, and the remote-streamed operation of the 100th kidney transplant in Catherine's Hospital, Stuttgart. Until April 2002, there were more than 4 million hits registered to these videoclips, which showed the benefit for both the public and patients of using the Internet.

Finally, electronic patient records can be used to combine all these multimedial approaches and hold them available everywhere at any time.

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# Automated Teleconsultations via Medical Imaging Analysis and AI-based Diagnostic Support

STEFAN GEHLEN
*ZN Vision Technologies AG*

The growing pressure on costs in the health care sector compels all concerned parties to search for new ways to treat patients. A key technology with substantial potential for its applications is telemedicine. By using modern information and communications methods, important patient information is available through quick and transparent means.

With telemedical patient care (telediagnosis, televisits, telecounseling), the doctor and patient are connected via appropriate interfaces. Necessary additional measurements (temperature, blood pressure) are recorded and conveyed. Appropriate data management systems, such as the electronic patient file, allow smooth information exchange between treating physicians and prevent otherwise necessary multiple analysis.

Image communication presents a significant component of a telemedical diagnosis. With practically all dermatological and traumatological evaluations, the image analysis of the (injured) skin is the basis for diagnosis and therapy. Therefore, when such a case is handled using telemedicine, for example in the capture and transfer of wound images, image quality must be high enough to support reliable analysis. In order to achieve this, minimum requirements for image capture and communication (e.g., measurement standards, color standards, image resolution, and sharpness) must be determined.

On the other hand, methods for modern image processing and pattern recognition offer the potential to relieve physicians of routine evaluation of images and to evaluate important image properties automatically. This is exemplified, for example, by a camera-based system for skin cancer detection.

As advanced cutaneous melanoma are still incurable, early detection by means of accurate screening is vital. Pigmented skin lesions can be analyzed by an experienced dermatologist using a epimicroscope (dermatoscope). In clinical practice, the diagnosis is usually based on the mnemonic ABCD rule, which is a linear combination of the four characterizing attributes (asymmetry, border, color, diameter). Furthermore, the pigment and color structure and texture inside the skin pigmentation must be considered. Using computer vision techniques, all these parameters are computed from the captured image and displayed for the physician.

When examining skin lesions it becomes clear that dermatologists base their decisions on experience, as well as on complex inferences and extensive knowledge that cannot be condensed into the four parameters of the ABCD rule. For the design of the computer-aided diagnostic system, we have shown that artificial neural networks (NNs) outperform other data-driven or statistics-based decision methods. The main feature of NNs is parallel processing in a large group of relatively simple but highly interconnected processors and the ability to self-organize or adapt through so-called learning algorithms that change the connectivity between the units. NNs are capable of experience-based learning of complex relationships by repeated exposure to examples much in the same way that their biological counterparts learn to make their differential diagnoses. In order to train NNs well, however, examples from a broad population with different skin types are required.

Such a data collection has been realized within the DANAOS study (Diagnostic And Neural Analysis Of Skin cancer). Over a period of several years, thousands of captured skin pigmentations were collected and systematically analyzed at 14 clinics throughout Europe. Today, the system that has been developed achieved a diagnostic quality that surpasses that of today's dermatological specialists. This expert system can also be used for computer-aided telediagnosis. Because the development method is generic, an expert system for other diagnostic purposes could just as well be built.

## Relevant Publications

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# NEW TRENDS IN URBAN ENGINEERING

Session Organizers:
Klaus Kunzmann and Miroslaw Skibniewski

Sustainability will be the key challenge of city regions in the 21st century. Suburbanization has reached its limits in the Western hemisphere and beyond. Ecologically unacceptable, socially detrimental and uneconomic land consumption and urban sprawl have become a growing concern both in the United States and in Germany. The response to the complex phenomenon of urban growth is the desire to achieve the paradigm of the compact city, a city that develops within its already built-up area and leaves the urban fringe widely untouched. While the idea as such seems to find more and more public acceptance, there are considerable obstacles to promoting and achieving it. There are many social, economic, political, and technical dimensions to overcome. Value systems and cultural traditions may have to be influenced, security issues addressed, and economic rationales scrutinized. In addition, the technical dimensions of the compact city have to be explored, such as the stapling of urban functions, issues of energy optimization, or utility management conservation. Traditional approaches to urban design are unsatisfactory.

Hence, the session on the "New Trends in Urban Engineering" will explore to which extent new technologies and new approaches to urban planning and development can be applied to achieving a sustainable compact city under conditions of a market economy.

This session will focus on advanced technologies and sustainable approaches to city planning, operation of urban transport infrastructure, and facilities management in the built environment. The following topics will be discussed:

1. Lessons to be learned from cities in Germany, which are successfully pursuing the long route to comprehensive sustainable urban development.

2. Economic modeling and innovative investment planning strategies for facilities and urban infrastructure.

3. Advanced technologies for traffic signal systems design and management.

# The Sustainable City – From Sectoral Approaches to Integrated Planning

ROLF MESSERSCHMIDT
*Urban Planning Team*
*Joachim Eble Architectur*

## Sustainable Urban Development

The renowned Wuppertal Institute for Climate, Energy, and Environment applied global demands according to global carrying capacities to Germany. The result of these studies was a national environmental program with the demand to reduce consumption and emissions by 80 to 90 percent by the middle of this millennium. Urban development is an important part of sustainable development in translating these goals into local action items. An example is the energy sector: of Germany's total final energy consumption, 29 percent is used for private households and 30 percent for transportation.

For the international URBAN21 Conference 2001 in Berlin, sustainable urban development was defined as follows: "Improving the quality of life in a city, including ecological, cultural, political, institutional, social, and economic components without leaving a burden on future generations." This means it is necessary to integrate ecological, social and economic contents with classical aspects of urban planning. Built projects often have only one main aspect or only a few aspects of sustainability. These projects may have very interesting or experimental approaches focusing on one specific aspect; however, the goal is to develop integrated solutions that deal with many different aspects of sustainability.

## Modules and Examples

Modules such as energy, transport, water/wastewater, or urban climate are useful in order to translate the general demands into actions on the planning level of a city district. These modules provide concrete measures, criteria, and principles such as active and passive use of solar energy, wastewater treatment, cold air drainage corridors, public transit concepts, mixed use as well as the necessary sizes and dimensions. It is important to deal with the interrelation between the different measures and to work with their connections.

The following examples are model projects that demonstrate the realization of these measures:

- The community expansion *Neckarsulm-Amorbach*, located north of Stuttgart, is the furthest-reaching urban planning project when it comes to seasonal storage of solar energy. It features large collector panels and a seasonal underground duct storage facility.
- In *Culemborg*, located in the Netherlands near Utrecht and situated in a water conservation district, the planners worked sensitively with the different water cycles: The rainwater of the buildings is seeped away, the street runoff is treated, and wastewater is used for the generation of biogas to operate a co-generation power plant. Further aspects are mixed use, sites for experimental building development, and citizen participation.
- The *Vauban* district in Freiburg, situated on a former military site, is the home of a solar-oriented development with large photovoltaic panels and a co-generation power plant to serve the entire district. The solar multi-deck parking structure is an example for the integration of a transportation concept that provides centralized parking and car-free core areas with a solar energy concept. Further measures are the retention of rainwater and citizen participation processes.

- The *Prisma* is part of the urban renewal project Gostenhof-Ost, situated in the inner city of Nürnberg. It is a block development with high density, mixed use and big greenhouses that combine a solar energy concept and a rainwater management system.

## Planning Strategy, Application and Visualization

The high complexity of sustainable urban development is one reason, among others, why many built projects tend to be sectoral and often have only a few aspects of sustainability. This was the starting position for the development of a design tool that supports the integration of urban planning issues with ecological/social aspects in an integrated and interdisciplinary process.

The design tool suggests a planning strategy that helps develop abstract structures graphically, following measures that are provided by modules (described earlier), for example, energy. Then these abstract structures are projected onto the study area and separately developed. The resulting structures are combined to form different concepts according to the modules and are finally evaluated. Superimposing the concepts helps generate a variety of different scenarios, for example, with high quality energy or water concepts. Of course there are interrelations between the structures. That means that the feedback of the superimposition affects the individual concepts, but it does not change the basic criteria in this iterative planning process. The scenarios of superimposed concepts offer a selection of possible solutions. They are presented as structural graphics like an abstract sustainable masterplan that includes the important rules for the sustainable urban development of the planning area.

The application of this strategy to Karlsruhe Southeast, an inner city district located on a former railway site, shows how this tool helped integrate sustainability in urban development, helped organize urban processes, and helped develop planning approaches. For one scenario, landscape and building structures are put in a concrete form and are visualized with a VRML 3-D model for use on the Internet. Rules that guarantee the urban, ecological, and social qualities are shown for a selected development site.

This should give you an outlook on how planning tools can help to enhance the quality of the discussed aspects, how to make their integration easier, and how to make the process more transparent.

# Innovative Investment Planning Strategies for Urban Infrastructure

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Civil infrastructure, such as, buildings, roads, rail, water, sewer, and communications, provides a long-standing built environment in which public and private enterprise works and thrives. Nowhere is this more evident than in urban settings throughout the United States and Europe, where built facilities are interconnected in complex ways to move people, goods, and information, and, some suggest, to provide competitive advantage. The dynamics of enterprise and urban evolution continually strain the built environment, which is shaped and reshaped in response. Accompanying these dynamics are the day-to-day use, aging, and effects of the natural elements, requiring consistent sustainment. The persistent need to maintain and modernize the built environment is generally met by economic, social, and political realities. That is, too many groups and individuals with different agendas advocating worthy goals compete for too few dollars (euros). Moreover, investment needs for long-lived facilities tend to emerge subtly over time and are often inextricably linked to their respective causes. Resulting capital investment in urban infrastructure is, thus, characteristically fragmented – across facilities, needs for funds, and measures of performance.

Emerging concepts – total asset management and comprehensive decision support tools – propose holistic approaches to capital planning and budgeting for infrastructure. The degree to which current research and practice embraces the notion of holistic planning varies widely and

tends to focus exclusively on either existing assets or new development. This presentation describes a segment of research – initiated at the Massachusetts Institute of Technology and currently applied within the U.S. Army – that explores a new, comprehensive approach to developing and evaluating facility investment strategy. The approach builds on the products and outputs from two fundamental tools employed by engineers and planners: condition assessment and master planning. Central to the approach is a conceptual framework that integrates facility investment needs and performance (condition) data within a broader planning context. The framework links obsolescence and deterioration theory to the life-cycle costs associated with existing assets, as well as the development of new facilities.

An index-based methodology is employed to objectively measure and understand facility condition. The "condition index" is a ratio of assessed facility deficiency costs over facility replacement value. The index method readily scales from a single facility to a collection of different facility types by simply summing deficiency costs and replacement values for multiple assets. Additionally, the "condition index" coupled with deterioration modeling provides a relative measure for comparing across facilities and over time. A "condition index" is linked to the integrated investment types in the conceptual framework, providing a means for engineers and planners to investigate the impact of various degrees of financial commitment across a portfolio of facilities. Costs and values thus provide an economic basis and a common denominator for evaluating various facility investment strategies.

The conceptual framework and "condition index" are applied to a military campus located in Heidelberg, Germany. The intent is to demonstrate: 1) How these tools can be applied in an urban infrastructure setting, albeit on a smaller scale, and 2) How these tools can

ultimately direct scarce capital resources while balancing current and future facility conditions. The application proceeds from a public planner (owner) perspective, where facility investment policies and incentives are aligned with socioeconomic values and political interests.

The implications of this research to urban engineering and planning are manifold. First, this new approach to formulating facility investment strategy is based on the demand for capital, rather than the supply, as is commonly practiced. Second, the approach is comprehensive in how it deals with infrastructure assets and types of investment and condition. Third, the approach is based on rational indicators of condition and funding impact, providing an objective complement to the array of strategic variables considered in developing and evaluating investment strategy. Finally, the approach and supporting tools are generic to long-lived assets and are thus applicable to a wide range of facility types.

# Automated Traffic Signal Management Through the Internet

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Increasing traffic at intersections within urban areas has caused concern for safety and congestion as far back as the 1850's. The first attempt at controlling intersection traffic was the development of manually turned semaphores in London, England in 1868, which were operated by police officers (Wolkomir, 1986). These devices were first introduced in the United States in 1908 in New York City and quickly spread. The electrification of urban areas led to the development and installation of the first electrically operated traffic signal in Cleveland, Ohio in 1914. By 1932, the last hand-cranked semaphore on Parkside Avenue in Brooklyn was replaced by an electro-mechanical controller.

For nearly 50 years, from the 1920's until the 1970's, the electro-mechanical controller dominated the traffic signal systems market. Cycle lengths were programmed by installing appropriate gears, and the cycle was split into various intervals by inserting pins on a timing dial. To accommodate variations in traffic demands, the concept was extended to provide "three dials." Also, to ensure that adjacent intersections were operating as a "traffic signal system" with predictable cycle length, splits, and offsets, a "seven-wire" interconnect procedure was developed so that adjacent electro-mechanical controllers could work together in a systematic manner (Kell, 1991). Even as we approach the turn of the century, there are many urban areas with traffic signal systems based upon three dial electro-mechanical controllers and seven-wire interconnect systems. Furthermore, much of the terminology that was developed to describe the

electro-mechanical systems is still in use today to describe parameters in modern microprocessor-based controllers.

## Emergence of Microprocessor Based Traffic Signal Control

In the early 1960's, computers were introduced to traffic signal systems. In 1963, Toronto, Canada installed the first computerized traffic signal control system. These developments progressed at a relatively modest pace until the 1970's, when microprocessors became commonly available and smaller distributed systems were developed. Over the next twenty-five years, competing vendors rapidly implemented a tremendous amount of real-time control algorithms on proprietary hardware and communication infrastructure. This resulted in agencies acquiring dozens of incompatible systems that could not be easily integrated. In the early 1990's, efforts were initiated to develop standard communication protocols (Seymour, 2000). This effort was successful at defining common data objects. However, new deployments have been slow to embrace these standards completely due to old communication infrastructure and limited development tools available for deploying the standards.

## Emergence of IP-Based Traffic Signal Control

The recent convergence of inexpensive Internet Protocol (IP)-based communication infrastructure, a large work force trained in IP and Web tools, and the urgent need for agencies to deploy open architecture systems, have led to a number of novel IP developments (Hunter-Zaworski, 1999; Lucas, 2000; Engelbrecht, 2001). As we begin 2002, Houston is scheduled to deploy radio-based IP communication at 800 intersections, and San Francisco is planning a fiber-

based IP communication deployment for their traffic signals. These recent developments present both new opportunities and new challenges:

- Vendors of traffic signal equipment are being challenged to recast proprietary communication infrastructure into a standards-based protocol. However, there is not clear consensus regarding which standards will emerge the winner. Given the relatively low margins in this industry, it is difficult for vendors to justify significant investments when they are not certain they will receive a return on their investment.
- Extensible Markup Language (XML) solutions are beginning to emerge. These provided greater access to data for management and, possibly, commercial purposes. However, these XML solutions demand considerable bandwidth that is often not cost effective to provide.
- If XML solutions are embraced, care must be taken not to repeat problems of the past where each vendor defines his own interface, making system integration particularly difficult and costly.
- The traffic control community is trying to balance what information is possible to disseminate vs. what information is appropriate to disseminate – particularly with regard to mobile phones and in-car devices that may create distractions that reduce safety.
- Web servers are emerging on a variety of traffic control equipment providing greater access for management and maintenace. However, at the same time this introduces some serious security concerns.

## Conclusion

In summary, the adoption of IP-based communication standards is a logical development for deploying traffic signal systems and will solve many communication infrastructure challenges. IP-based communication will also easily enable important new capabilities such as "ftp" services, email-pager notification when critical components fail, and further management decentralization. However, many of the broad integration issues that have challenged the industry for the past 30 years will continue to challenge the industry, and some new issues such as security will emerge.

This presentation will focus on challenges and opportunities of moving towards "Automated Traffic Signal Management Through the Internet" within the technical, financial and administrative constraints of this field.

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# Towards Walkable Cities in Germany

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The presentation provides an overview of the leading-edge developments in Germany towards the concept of the Walkable City. Cities in the U.S. and Germany face growing challenges in ecological, social, and economic sustainability. Air pollution, waste of the essential natural resource land, lack of safety, and social and economic segregation are crucial problems to overcome in our cities. The Walkable City is one possible answer to reach a lively, integrated, effective, and clean-air living environment.

The concept of the Walkable City aims at a city structure in which most distances can be covered by walking, by cycling, or by public transport. This means that the public space needs to be designed in such a manner that walking or cycling is safe, time efficient, and pleasurable. The elements of the Walkable City are: a high building and population density, mixed land use, a polycentric structure, a transport system compatible with the city, and a high-quality public space.

The impact of the Walkable City on sustainability affects various ecological, economic, and social dimensions. Automobile journeys can be reduced; this effects a decrease of pollutant emission and a saving of land for streets and parking. The high building density of the Walkable City also results in an economical approach to land consumption and leads to savings in heating energy. Finally, the Walkable City promotes safe public space.

Although the paradigm of the Walkable City is widely accepted and applied in German city planning politics, there are numerous obstacles to overcome. Due to economic factors and distance-oriented lifestyles, a growing separation of urban functions and sub- and deurbanization are occurring. In addition, large-scale retail and recreation facilities with large catchment areas at the urban periphery increase traffic volumes.

Despite these obstacles, some German cities are successfully heading towards the Walkable City by realizing elements of it. What are their strategies of urban planning? The following are examples of forward-looking projects.

- Multi-story and multi-family housing is the preferable form of a dense and land-saving city, but still there is a demand for occupier-owned and single houses. The city of Berlin promotes single-owned residential units, which at the same time have the qualities of a single-family house and are dedicated to economy of space.
- The city of Münster is intensifying density in existing commercial areas, mainly by reducing traffic space and by inventing land-saving commercial buildings.
- The existing built-up area needs to be further developed in order to save the urban fringe. The so-called "land-saving management" in Berlin aims at the mobilization of currently unused land within the inner zone (brownfields, vacant lots, vacant buildings). A database in the Internet provides information about the location, size, price, present ownership, building regulations, and possible uses of all unused parcels of building land within the limits of the built-up area.

- Finding new ways of implementing mixed use structures, the city of Hannover is one which is successfully restructuring a former industrial area into a neighborhood with offices, recreational and cultural facilities, housing, and industrial use.
- Münster is also an example for traffic planning aiming at a modal split (proportion of means of transport) in favor of public transit, cyclists, and pedestrians. An underground parking garage for bicycles has been built in front of the main railway station and many streets in Münster are designed for purposes other than car transport.

Normally only single elements of the Walkable City can be realized. It is extremely difficult to follow an all-embracing concept, because specific social, economic, and political preconditions need to be present in the respective site. However, there is one project in Germany that fulfills all required elements comprehensively. It is Germany's leading-edge project of the Walkable City: the "Südstadt" in the city of Tübingen. A brownfield area formerly used by the military is being developed into a neighborhood for 6,500 residents and 2,500 jobs. A great portion of the development is new construction, but also many of the existing former military buildings are being converted into dwellings, businesses, and cultural facilities.

A very ingenious concept of mixed use between residential, industrial, office, retail, culture, and leisure is being realized. The various uses are being integrated within the individual plots and buildings. This very fine-grained concept of mixed use is being implemented through careful management by the developer, which is the city authority.

All construction is being realized with the newest technical standard of ecology. All technical infrastructure and buildings are constructed in such a way that all limited natural resources are being spared. The density is relatively high. Buildings have three to five stories.

Private open space is small. As a compensation for this, the public space—streets and squares—is reserved mainly for lingering and play. No parking is allowed in the public space except by disabled individuals and for certain businesses. Parking spaces are concentrated in several automated parking garages.

All in all, the Südstadt project represents a very mature system of mutual planning between the developer and later users. A high degree of ecological, social, and economic sustainability is being comprehensively accomplished. With this project, the city of Tübingen is making a serious move towards becoming a Walkable City.

Various measures that have been taken towards the Walkable City were presented. These could only be realized in a specific environment with suitable social, economic, and political conditions. The open question is: How can these kinds of measures be implemented in a broader way? As we have seen, there are a great number of soft factors involved such as societal influence. But there is also a strong need to include the possibilities made available by technical progress. How can they be matched with the needs of the Walkable City?

# INTELLIGENT TRANSPORTATION SYSTEMS: MANAGING TRAFFIC FLOW FOR SAFETY AND MOBILITY

Session Organizers:
Ferit Küçükay and Christopher Poe

Transportation systems involve the safe and efficient movement of people and goods. Fundamental to this objective is the understanding of traffic flow and the resulting applications. This session starts with research on the latest methods of modeling traffic flow. The second speaker will present research on traffic modeling using data from intelligent transportation systems. The next set of speakers will discuss research involving individual vehicles in the traffic stream. The third speaker will discuss a project using advanced technologies to track individual vehicles for the study of safety and traffic operations. The last speaker will talk about intelligent driver-assisted systems in the vehicle to aid drivers in operating their vehicle in traffic.

# Traffic Simulations Applied to Intelligent Transportation and Evacuation Scenarios

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Interest in the subject of traffic dynamics is surprisingly old. In 1935, Greenshields has carried out early studies of vehicular traffic, and already in the 1950s, a considerable publication activity is documented by journals on operations research and engineering. These papers have already addressed topics like the fundamental diagram between traffic flow and vehicle density or the instability of traffic flow, which are still relevant. The reason becomes understandable through the following quotation from H. Greenberg in 1959: "The volume of vehicular traffic in the past several years has rapidly out-stripped the capacities of the nation's highways. It has become increasingly necessary to understand the dynamics of traffic flow and obtain a mathematical description of the process."

More than forty years later, the situation has deteriorated a lot. Some cities like Los Angeles and San Francisco suffer from heavy traffic congestion around the clock. In Europe, as well, the time that drivers spend in traffic jams amounts to several days each year. During holiday seasons, jams may grow up to more than 100 kilometers in size. Vehicle emissions like $SO_2$, $NO_x$, CO, $CO_2$, dust particles, smog, and noise have reached or even exceeded a level comparable to those by industrial production and those by private households, which are harmful to the environment and human health. On average, every second driver is involved in one accident during his lifetime. In Germany alone, the financial damage by traffic due to accidents

and environmental impacts is estimated at $100 billion each year. The economic loss due to congested traffic is of the same order of magnitude. However, the traffic volume is still growing because of increased demands for mobility and modern logistics, including e-commerce.

Without any doubt, an efficient transportation system is essential for the functioning and success of modern, industrialized societies. But the days when freeways were free ways are over. Facing the increasing problems of individual traffic, the following questions come up: Is it still affordable and publicly acceptable to expand the infrastructure? Will drivers still buy cars in view of streets that effectively turn into parking lots? It is for these reasons that automobile companies started to worry about their own future and decided to spend considerable amounts of money for research on traffic dynamics and how the available infrastructure could be used more efficiently by new technologies (telematics / ITS).

At this time, physicists became interested in the field of traffic dynamics. Meanwhile, many important effects have been revealed and explained. Some of the questions now understood are the following: Why are vehicles sometimes stopped by so-called "phantom traffic jams," although they all like to drive fast? What are the mechanisms behind stop-and-go traffic? Why are there several different kinds of congestion, and how are they related? Why do most traffic jams occur considerably before the road capacity is reached? Can a temporary reduction of the traffic volume cause a lasting traffic jam? All of this is important to understand from the perspective of intelligent transportation systems (ITS). Surprisingly, speed limits can speed up traffic under certain conditions, and traffic lights at on-ramps can reduce overall travel times. Driver assistance systems have a particularly high potential. And decision experiments are carried out in order to learn re-routing strategies which do not invalidate traffic forecasts.

A lot has also been learned about pedestrian streams. In particular, we understand why pedestrians moving in opposite directions normally organize in lanes, while similar systems are "freezing by heating." We also know why panicking pedestrians produce dangerous deadlocks and how these can be avoided by a skillful design of buildings.

## Relevant Publications


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# Modeling Traffic Flow with ITS Data

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## Intelligent Transportation System Overview

The U.S. transportation system consists of more than 6.3 million kilometers of highways and roadways. This infrastructure supports more than 6.2 trillion kilometers of travel and 4.8 trillion ton kilometers of truck freight. It is expected that travel demand will increase by 30 percent in the next ten years (1). The increasing demand for transportation coupled with the growing inability to expand the transportation infrastructure has led to considerable interest in Intelligent Transportation Systems (ITS). In its most basic form, ITS involves the use of advanced computing, information systems, and communications technology for the control and management of traffic and transportation infrastructure (2). One of the more visible aspects of ITS are Traffic Management Centers (TMCs) which gather traffic data, such as volume, speed, and travel time, from sensors that are located throughout the system. The sensor technologies that have been used include inductance loop detectors, automatic vehicle identification (AVI) detectors, and closed circuit TV cameras. The traffic data is used to monitor the state of the transportation network and identify problems such as accidents. If a problem is detected, operational decisions, such as dispatching emergency crews and changing traffic control signal timings, are implemented. In addition, information about the problem may be provided to travelers. Depending on the TMC, this may be done through such media as changeable message signs, the Internet, cable TV channels, and radio. In addition, many TMCs provide continuous,

real-time traffic monitoring information on web sites (3,4,5). TMCs obtain and archive large amounts of traffic data and because the focus is on daily operations, this data is rarely utilized after it is archived. This presentation will demonstrate two examples of how this data can be used to better meet the goals of the TMCs and the traveling public.

## Forecasting Link and Route Travel Times

In order to be most useful to travelers, TMCs should provide link travel times that are based on the time at which the driver is expected to arrive at a given link, rather than link travel times that are based on current conditions. This would be particularly important for trips where the expected arrival time at a link is relatively far into the future, and it is unlikely that the current link travel time will remain constant. Therefore, the TMCs should be able to forecast link and corridor travel times into the near future. Recent work on using artificial neural networks to accomplish this goal will be described. The test bed is a 22.5-kilometer section of U.S. 290 in Houston, Texas. It was found that real-time link travel time information has value for an average of approximately 15 minutes in comparison to historic link travel time information. It will be shown that the proposed forecasting models can increase this to over thirty minutes.

The TMC can add further value to their customers by also providing route information. Drivers use numerous quantitative and qualitative criteria when choosing a route including, but not limited to, travel time, number of signals, travel time reliability, safety, familiarity, and congestion. Therefore, the TMC is faced with solving the multiple objective route selection problem. Ideally all Pareto-optimal routes would be identified and the best route identified for

the traveler. However the solution algorithms are NP hard and therefore a methodology for identifying $k$ reasonable routes was developed. The approach is demonstrated using a route choice decision for an emergency medical service vehicle.

## Traffic Micro-Simulation and ITS Data

In recent years, micro-simulation approaches have become increasingly important in transportation system modeling. Among other things, they are used extensively in traffic operations modeling, evacuation studies, and traffic signal optimization. The results of micro-simulation models are very sensitive to the input parameters. One important input is demand information, which is often in the form of an origin-destination (OD) matrix. Because an OD matrix is prohibitively expensive to obtain directly, it is often estimated using observed data from the traffic network. The proper calibration of the input parameters and the use of statistically based OD estimators are essential to the successful application of a micro-simulation model.

Because the observed ITS data is related directly to demand, it may be used as input for OD estimation. The OD estimation problem is underspecified and various estimators have been proposed over the years. An approach based on a recently developed statistical procedure, known in the statistical literature as the $L_2$ error ($L_2E$), is demonstrated. This approach is robust to outlier data and has the added benefit that the asymptotic variance, and therefore the associated confidence interval, of the OD estimate can be derived. A genetic algorithm-based optimization methodology for calibrating traffic micro-simulation parameters using ITS data also will be presented. The methodology is tested on the large scale, high resolution, and low fidelity

traffic module of TRAffic Network SIMulation System (TRANSIMS). TRANSIMS was developed at Los Alamos National Laboratory as part of the Traffic Model Improvement Program (TMIP) and is designed to simulate all individual travelers across an entire metropolitan area. It was found that the goodness-of-fit values found using the proposed approach were approximately 50 percent of those obtained using a standard calibration approach and approximately 15 percent of those obtained using the default parameters. Lastly, a methodology for estimating the OD matrix and calibrating the traffic micro-simulation parameter set simultaneously is proposed and preliminary results discussed.

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3. San Antonio TransGuide Website. *http://www.transguide.dot.state.tx.us/*
4. Houston TranStar Website. *http://traffic.tamu.edu/*
5. Washington State Department of Transportation. *http://www.wsdot.wa.gov/PugetSoundTraffic/*

# Use of Event Data Recorders for Evaluating Traffic Operations

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Historically, researchers' and practitioners' abilities to evaluate traffic operations has been limited to data available using field measurement data collection techniques such as the measurement of spot speeds or traffic volume. This information was then supplemented with physical site information including variables such as road geometry, driveway density, adjacent land use, and functional classification of road. A linkage between type of driver and driver performance could generally be extracted, on a limited basis, from traffic simulator studies or closed-track tests. The ability to evaluate human performance, vehicle performance, infrastructure compatibility, and their interaction could only be achieved using surrogate testing measures.

The development of event data recorders (EDRs), commonly referred to as "black boxes," for the aviation industry created an opportunity for transportation engineers to apply this unique technology to better understand traffic operations and safety. In fact, some automobile manufactures such as General Motors routinely put EDRs in their high-end vehicles.

Currently, researchers at the Georgia Institute of Technology are equipping 1000 private vehicles with EDRs. The data from these devices will be applied to several research problems. One research application is the identification of driver-selected speeds for varying urban street environments. Armed with a better understanding of how physical road features influence operating speeds, future road designers will be able to anticipate and restrict the speed on a road

by modifying the design prior to its construction. A second research effort using the EDR technology will study the influence of vehicle speed on a crash event.

The equipment used for this project includes geographic positioning systems, accelerometers, brake pedal sensors, windshield wiper status indicators, cellular telephones, seat belt sensors, and receptors to determine if a cellular telephone (other than that used by the EDR) is in use in the vehicle. The equipment will not be prominently located in the vehicle, but positioned under the rear seat or in the trunk region. The GPS location information (available for 5-second time intervals) and the vehicle speed and accelerations (available for 1-second time intervals) will be recorded and periodically transferred to the Georgia Tech data server via telephone access. The duration for data collection will be 2 years with a typical vehicle data transfer period of once every one to two weeks. Each vehicle driver will complete a driver profile form and a 3-day travel survey form to help identify trip behavior and driver characteristics. This data will be available to the Georgia Tech team.

Sample data from this ongoing study will be presented and EDR data applications will be discussed. The use of EDR data for wide-scale applications is subject to limitations including data accuracy, data ownership issues, and privacy issues. The use of this type of data promises to offer researchers a robust and significant source for future transportation research based on a realistic driving environment.

# Technical Challenges on the Way to a Crash Avoidance Car

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Electronic systems have been increasingly finding their way into the motorcar in recent years. Many technical innovations on the vehicle, such as navigation systems, electronic stability systems, engine management etc., have only become possible because of this development. Previous mechanical systems have either been improved or replaced. This has become possible as a result of the enormous rise in processor performance at the same time as a drop in the cost of chips. In the period from 1990 to 2000 alone, processor power in terms of MIPS/SW rose by a factor approaching 10 million. As yet, we can see no end to this development according the principle of Moore's Law.

There will be further electronically based innovations to vehicles as a result of this development. This means that the next step will represent yet another revolution in motor vehicle construction. Previously, the car was a system that was controlled by the driver in terms of its actual functions, such as acceleration, braking, and steering. In the future, driver-assistance systems will aid the driver in his/her management of complex driving situations. In a further development stage, drive-by-wire systems will enable active intervention in the operation of the vehicle, and actively prevent accidents. In addition, the vehicle of the future will become increasingly aware of its environment in many different ways by means of special sensor systems. The car is thus becoming a system in which the driver is removed from the innermost control loop.

Driver assistance systems that are available today or are in the process of being developed can already make a considerable contribution to reducing the number of accidents still further. Functions such as night vision, lane departure warning, or lane change support are examples of this.

In order to get significantly closer to creating a crash avoidance car, the following key functions will be necessary:

- Sensors for the exterior of the vehicle
- Amalgamation of sensor data
- Error-tolerant, deterministic, electronic architectures
- Display technology
- Human/machine interface and warning strategies
- Drive-by-wire systems

In this context, sensor technology will take on an essential role, as it will be providing, on the one hand, the broadest spectrum of technology (camera systems, radar, infra-red lasers, 3-D sensors), and on the other hand, important basic information for driver-assistance systems from the vehicle's surroundings.

The human/machine interface and warning strategies represent yet another challenge. Wide-ranging investigations into driver-psychology will be needed in order to give the driver adequate warning in critical situations. This includes taking into account the condition of the driver, such as his/her tiredness, just as much as suppressing a navigation message that is due to be given in favour of a warning message. In addition to which, systems such as telematics, car-

to-car communication and road-to-car communication, in combination with onboard systems, offer plenty of potential for creating a crash avoidance car.

In order to come to terms with this complexity, it is also necessary to take advantage of experiences from other fields, such as IT technology, medical technology, and the computer industry. At the same time, it is essential to create the legal basis and preconditions for this field of innovation, which may become very complicated, particularly when active intervention is undertaken to prevent accidents.

The complexity of functions connected with creating a crash avoidance car will also require a redesign of the product development process. For example, serious expansion of the simulation department will be necessary in order to reduce the time taken by trials. Furthermore, it will be impossible to carry out tests on the driver's reaction to warnings when tired, for example, without exposing testing personnel to danger. In addition, the complexity involved in developing driver-assistance systems, from external sensors to Human Machine Interface (HMI), is best managed by means of network organizations.

There still remains the question of how the driver will in the end react to systems of this type in the long term. Or what would you say if in the future your car tells you that you are driving too fast for the current weather conditions, if it protects you from an accident resulting from a careless lane-change by "tearing" the steering wheel out of your grasp, of if it takes you safely through a corner that you drove into much too fast?

# Lillian M. Gilbreth Lectureships by Young Engineers

The Lillian M. Gilbreth Lectureships by Young Engineers were established in 2001 by the Council of the National Academy of Engineering as a means of recognizing outstanding young American engineers and making them more visible to the NAE membership. Recipients of the lectureships will have the opportunity to make presentations at NAE's Annual Meetings in Washington, D.C. and National Meetings in Irvine, California. Initially, they will be selected from among presenters at the NAE's Frontiers of Engineering Symposia.

Each lecturer will be asked to give his/her Frontiers presentation, updated as necessary, in one of the venues listed above. The talk will describe an area of research or technical work and not be limited to a review of the speaker's own work. Lecturers will receive a plaque, an honorarium, and travel expenses to the meeting. Funding for the lectureship is derived from income on an endowment that has been designated for the encouragement of young engineers.

The first lecture took place at the October 2001 NAE Annual Meeting in Washington, D.C. The recipient of that lectureship – Eric Green, Chief, Genome Technology Branch, and Director, Intramural Sequencing Center, National Human Genome Research Institute, National Institutes of Health – was a speaker at the 2000 U.S. Frontiers of Engineering Symposium. Four recipients gave lectures at the NAE National Meeting in February 2002.

The Gilbreth Lectureships are named in honor of Lillian Gilbreth, the first woman elected to the National Academy of Engineering (1965) and a pioneer in the field of Human Factors.

* * * * *

We would appreciate your assistance in the selection of future recipients of the Lillian M. Gilbreth Lectureships by indicating below your choice of the <u>two U.S. speakers</u> at this meeting who had the most technically interesting and effective presentations. The talks should describe an area of research or technical work and not be limited to a review of the speaker's own work. Please return this form to the registration desk.

1) _____

2) _____

Thank you.

**FIFTH GERMAN-AMERICAN**
**FRONTIERS OF ENGINEERING SYMPOSIUM**
May 16-18, 2002

EVALUATION FORM

Dear Participant:

To help us evaluate the effectiveness of this year's symposium, we would appreciate if you would take a few minutes to complete this evaluation and provide your comments and suggestions. Space is available on the second page for additional comments on any of the questions. Return the completed questionnaire to the symposium registration table by the afternoon of Saturday, May 18, or mail it to the address at the bottom of this page.

We appreciate your suggestions and comments.

* * * * * * * * * * * * * * * * * * *

NAME (*optional*) _____

Your role in this symposium? (Please check one.)

_____ Organizer
_____ Speaker
_____ Other participant

1. How do you rate the usefulness to your professional development of this symposium relative to all the other away-from-home meetings you attended during the past year?
___ top 25% ___ top 50% ___ bottom 25%

2. What do you think about the range of session topics?
___ too broad ___ about right ___ too narrow

3. Have you gleaned material useful to your own work and research from the *presentations and subsequent discussion*?

• from presentations in your discipline
___ very useful ___ useful ___ marginally useful

• from presentations in other disciplines
___ very useful ___ useful ___ marginally useful

4. Have you gleaned material useful to your own work and research from *informal discussions* with other participants?

   • from informal discussions about your discipline
   ____ very useful ____ useful ____ marginally useful

   • from informal discussions about other disciplines
   ____ very useful ____ useful ____ marginally useful

5. Have you identified potential collaborative opportunities as a result of the symposium?
   ____ yes ____ no ____ possibly

6. Have you identified potential applications of interdisciplinary approaches, tools, and/or analysis methods to your research activities?
   ____ yes ____ no ____ possibly

7. How could these symposia be made more useful to the participants?

8. What topic or topics would you recommend for future German-America Frontiers of Engineering symposia?

## ADDITIONAL COMMENTS AND SUGGESTIONS

## About the U.S. National Academy of Engineering and the Alexander von Humboldt Foundation

U.S. National Academy of Engineering (NAE)

The National Academy of Engineering is a private organization established in 1964 under the congressional charter originally granted to the National Academy of Sciences (NAS). For over 135 years, the National Academy of Sciences has provided independent, objective, scientific advice to the nation. Today, the National Academies consists of four entities: the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine (IOM), and the National Research Council (NRC). The NRC, jointly administered by the NAS and the NAE, is the operating arm of the NAS, NAE, and IOM. More than 4,800 of the nation's most distinguished leaders in science, engineering, medicine, and related fields have been selected by their peers to be members of the Academies and the Institute. These individuals and other experts serve on the hundreds of study committees active at any point in time. The NAE has about 2,000 members. In addition to supporting the work of the NRC and other elements of the National Academies, NAE conducts activities of special interest to engineers through its independent program. The Frontiers of Engineering program falls under this category of work.
*Website: http://www.nae.edu*

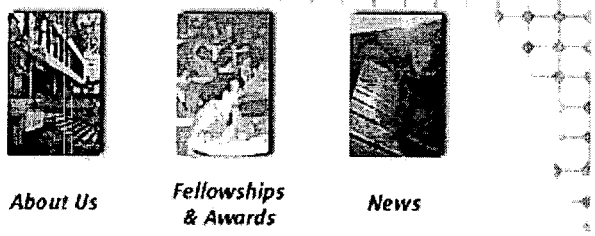
Alexander von Humboldt Foundation (AvH)

The Alexander von Humboldt Foundation—originally established in 1860 in memory of the eminent scientist and explorer Alexander von Humboldt—devoted itself until 1923 to financing research by German academics abroad. The Foundation was re-established in 1925 with the aim of supporting foreign researchers and doctoral candidates engaged in studies in Germany. In 1953, AvH became an independent foundation under private law, and since then has sponsored more than 20,000 scholars from 125 countries. Each year, the Alexander von Humboldt Foundation grants

- Up to 550 research fellowships to highly qualified foreign scholars up to the age of 40 and holding doctorates, enabling them to undertake long-term periods of research in Germany;
- Up to 150 research awards to internationally recognized foreign scholars;
- Up to 150 Feodor Lynen Research Fellowships to highly qualified German scholars up to the age of 38 and holding doctorates, enabling them to spend periods of research abroad;
- Up to 12 Max Planck Research Awards to German and foreign scholars for international cooperation;
- 10 Bundeskanzler Scholarships for prospective leaders from the United States and Russia;
- a number of further research fellowships for special purposes.

*Website: http://www.humboldt-foundation.de*

Alexander von Humboldt
Stiftung / Foundation




## CONNECT

## GAF Follow-up Program for Participants of Frontiers of Research Symposia

It is a general aim of the German-American Frontiers of Research Symposia to enable young American and German scholars to establish long-term binational cooperations in order to strengthen the transatlantic relationship between both countries. To achieve this goal every participant is given the opportunity to keep in contact with another participant of the partner nationality after the conferences have taken place. The GAF Follow-up Program allocates **residence allowances for working visits** in the partner country **for up to 30 days**. Grants are provided for working visits to prepare joint research articles or research projects.

### Application Requirements:

The applicant must have participated in a GAF conference (GAFOS, GAFOE) in the USA or in Germany within the past three years, and must have started a cooperation with a second participant of the partner nationality. Applications are possible within a period of up to 3 years after having participated in the last conference. Both cooperating partners are entitled to apply. This means that applications can be made for mutual visits up to a maximum of 60 days within a total period of 3 years. Successful long-term cooperations resulting from these grants have to be announced to the Alexander von Humboldt Foundation (AvH).

### Allowance Rates:

For working visits lasting **up to 22 days** the allowance is calculated on the basis of **daily rates** valid at the time of the application. There are three different grades according to the position held by the applicant:

Grade A: EUR 90 per day (Assistant Professor, post-doc)
Grade B: EUR 100 per day (Associate Professor, Senior Lecturer)
Grade C: EUR 130 per day (Full Professor, Head of Research Institute)

For working visits lasting **longer than 22 days** a **monthly lump sum** is granted:

Grade A: EUR 2,100 per month (Assistant Professor, post-doc)

Grade B: EUR 2,300 per month (Associate Professor, Senior Lecturer)
Grade C: EUR 3,000 per month (Full Professor, Head of Research Institute)

The AvH does not cover any additional costs.
Payments are made to German bank accounts only. Grants for German applicants are transferred to their German bank accounts whereas grants for American applicants are transferred either to a private German bank account or to the host institute's bank account or to the university register office where the allowance is paid out in cash to the applicant.

**Application:**

Complete applications for residence allowances **must include the following documents** which have to be submitted either in **German or** in **English**:

- filled in application form
- description (up to 5 pages) of the research plan of both cooperating partners with exact objectives (possibly with indications of planned visits of both cooperating partners to conferences or lectures at the partner institute)
- invitation letter of the host in Germany or the USA
- list of publications within the last 3 years

- Please fill in the application form electronically or in printed letters.
- Please structure your publication list as follows:
  A. books
  B. magazine and book articles
  C. published talks given at conferences
  D. patents

**Download application form in the following formats:**

| **DIN A4:** | **US Letter:** |
|---|---|
| Word 6.0 | Word 6.0 |
| RTF | RTF |
| Post Script | Post Script |
| PDF | PDF |

Please send your complete application papers to the following address:

Alexander von Humboldt-Stiftung
TSHP Section
Irene Beyer
Jean-Paul-Str. 12
53173 Bonn
Germany
E-Mail: TSHP@avh.de

**Deadline:**

Applications can be submitted to the TSHP Section of the AvH at any time. The applicants are informed in writing about the result of their application within a period of 3 months.

Please note the following points:

- Make your application well in time prior to your planned working visit. The AvH needs approx. 3 months to process your application.
- Discuss all details of your planned working visit - including the dates of your planned visit - **with your host** in the USA or in Germany **first**. Please also send him/her your research plan and your list of publications.
- The AvH **does not cover any additional travel costs**.

**Download information sheet in the following formats:**

| **DIN A4:** | **US Letter:** |
|---|---|
| Word 6.0 | Word 6.0 |
| RTF | RTF |
| Post Script | Post Script |
| PDF | PDF |