FALLING WALLS CONFERENCE
Berlin, November 9, 2011

The 3rd annual Falling Walls Conference brought together hundreds of (mostly young) scientists from around the world to present their innovations and discuss the process generally. On the 8th, 100 of them gave 3-minute "elevator speeches" describing their ideas. The pace on the 9th was much more leisurely – each presenter got a full 15 minutes to describe his or her work.

SUMMARY

Besides the substance of the speakers' talks, the importance of the Conference consisted of the facts that: 1) it is held, 2) these particular speakers were asked to speak, and 3) the speakers thought what they had to say was important. For example, Cass Sunstein, an Obama advisor, wrote the book *Nudge* in 2008, about decision-making architecture. But Elke Weber still lectures on this subject.

- The role of the military is changing, due to changed threats, new technology, reduced budgets and climate change. The use of force is an army's "core competency" and is what is left when budgets are cut. But force can create as many problems as it solves, increasing insecurity and reducing trust in government.
- Well-being is not only a matter of state-on-state security threats but also threats from terrorists, criminals, health and other factors which are not easily measured. If we measure well-being only in terms of GNP, we risk long-term sustainability and "running out of planet." How do we improve lives, using less, but still create jobs?
- What we measure often dictates what problems are attacked. The same is true with questions – the questions we ask and the way we ask them determines the answers we get. Formulating a good question requires knowing the border of what is known and what is knowable. Understanding the mind's decision-making process can also influence human behavior and effect change.
- Data - whether from stars or earthquakes or the human genome – is outstripping our ability to process it. Still, increased capacity to process data encourages the collection of data and the more precise measurement of things. Data processing and data collection go hand in hand. The act of organizing the processing of data is itself a science.
- Sexual reproduction consumes great amounts of energy but is a remarkably reliable way to reshuffle genes and permit natural selection to work. Non-sexual life forms are not as flexible or successful.
- The nature of developing medicines and therapies (initially a matter of luck and then of reviewing molecules) is now more personalized, focusing on individuals. This change means pharmaceutical houses will no longer be able to find blockbusters and create assembly-line drugs with wide applicability. But we should be able to avoid the ineffective (and therefore wasteful) application of therapies.

- Gambling and risk taking occur on a continuum and can be socially productive and socially acceptable or not. Societal tolerance for different kinds of risk taking changes.
- We can find adequate sources of energy. Storing it and accessing it efficiently is the bigger challenge.
- Laymen and even scientists talk about the “big bang” but there were actually many big bangs, all occurring simultaneously. How did they coordinate when there was no “time” as we know it?
- Alchemy exists but focuses not on transforming lead to gold but on substituting common, cheap molecules for precious ones and thereby solving expensive problems cheaply.
- Theoretical mathematics – the realm of a handful of uniquely gifted individuals – can have enormously important, practical applications centuries later.
- China has no interest in bailing out the Euro, especially not until the EU has dealt with the underlying problem – countries which cannot compete.
- Germany is trying to hold on to its young scientists and recognizes their importance.

DETAILED NOTES[*]

SEBASTIAN TURNER – Conference Organizer

This is a conference at which bright people from around the world listen to bright people from around the world. Academics usually change their behavior when invited to a conference. Not here. This conference will be more like a conversation. Here scientists will behave more normally. So this is an extremely "normal" conference with people behaving extremely “normally.”

This converted water pump station [where the conference is held] was part of the East German death strip. It is not by chance we picked it for our venue. Here we look to the future, not to the past.

To keep our speakers from going over their allotted 15 minutes, first a light will go on. Then, if that does not work, we have a recorded voice that says, "Come on dear, that's it." Yesterday it was used on 100 academics presenting their ideas for 3 minutes each. If the voice still does not work, a pantomimist from the audience will “assist” the speaker in concluding his or her remarks. [This system worked.]

HELGA NOWOTNY – European Research Council - Introduction

We will talk about science or “Wissenschaft” today, including social sciences. Europe is an attractive place to do scientific research. The ERC has financed over 2,000 projects recently. It is important to know where you stand and what has been done, what has been asked with what results. It is also important to determine the borderline between what's known and what's not. This produces a sense of direction. Finally, one must be persistent. Some scientific progress is serendipity, but much of it is a matter of asking good questions. Formulating good questions is hard to do but looks simple afterwards.

[*] All presenters got 15 minutes. The varying lengths of presentations in these notes may be due to my not having understood part or all of the presentation or, in very few cases, my not finding the presentation to be very good. There were 4 blocks of presentations with a short introduction and, at the conclusion, a discussion by the presenters.

MARY KALDOR – London School of Economics – War

An "urban warrior" exercise was recently held in a small town in England, dubbed for the exercise the "Southwest Protectorate." Its population was majority Anglican, with a 15% Muslim minority. It represented a country which had been invaded from the north. The local government invited NATO aid. The particular problem for the soldiers was how to take a nearby flat held by Muslims. Yes, NATO was invited in, but the unspoken motivation was to get the protectorate's oil. "Why not try to change the situation politically?" The military's answer? "War fighting is our core competency. We have to practice."

Since WWII, there has been a decline in national wars. More and more we see non-state violence, with violence against civilians, including forcing people from their homes. Often violence is criminal or financed by crime, crime which constitutes a predatory political economy. These are the "new" wars, but they are not really new. They are like the early modern period. During the Cold War they existed too but we didn't notice unless we were directly involved.

Generally speaking, the old tools of war fighting makes matters on the ground worse. Outside forces use old war techniques when they invade.

What is the new approach? We need to analyze what constitutes "human security." 1) It includes security of individuals in their neighborhoods (not just large groups behind national borders). 2) It also means security from violence and poverty and natural disasters. 3) There is a blur between internal and external sources of insecurity, between police violence and soldier violence. But external sources of insecurity may become more like internal ones, based on individuals and not states. A key focus of force is the protection of civilians instead of defeat of enemies. US General Petraeus stressed population security in Afghanistan. But these new ideas have not yet been transformed into new techniques. In Libya, the West used the same old methods. You cannot protect civilians with air power. It is a very crude, imprecise tool. Many innocent people died to win the Libyan conflict.

Budgetary cuts will mean that military organizations will protect their core, traditional roles, maximizing their focus on force. A lot of the violence in Afghanistan has been via long-distance air power. This has not been helpful. So there is a link between the current economic crisis and a coming military crisis.

It is not by chance that the current economic crisis occurred after 2 expensive wars. The same thing happened after Vietnam. Austerity increases insecurity which leads to danger. More migration also results. We lose trust in our institutions when they cannot keep us safe.

NICK BARTON - Institute of Science and Technology – Evolution

Let's go back to origin of life. Sexual reproduction breaks "walls"[†] between individuals. Most of the living world is invisible to us - it's on the molecular level. We all share the same basic chemistry. Our biological system allows reproduction with very few errors. We all share a common genetic system, one developed 3,600 million years ago.

[†] Reference to Conference title.

Biology consists of three main domains: bacteria, archara and eukayotes. The key development for us was eukaryotes. Bacteria are much less complex. We humans are a mixture of bacteria and eukaryote. They carry on the functions of humans. The beings we recognize as animals are a recent development, as shown by fossil records.

Why is sexual reproduction so widespread? How can complex organisms evolve? Genomes align and break and reform. So, reproduction is a reshuffling of genomes.

The "costs" of sexual repordiction are quite high. Finding a mate is risky and time-consuming. Then we recombine genomes (something that is hard to do) and then make random combinations. This leads to specialization: men have many small, mobile means of fertilization and women have a few big. immobile eggs. Males waste their energy on fighting others and on elaborate displays. These are very expensive. But we need sexual reproduction to permit natural selection.

How can natural selection pick out the combinations that work? Only a tiny fraction of DNA sequences fit. How do we bring them together? Furthermore, these processes have to work in sequence.

Asexual species do not persist. Natural selection works only when recombination is present. So selection and recombination work together. Barton has developed mathematical models. Suddenly we have lots of data, through the genome projects. This opens lots of avenues for research.

JEAN-LUC LEHNERS – Max Planck Society – Beginning of Time

The expansion of the universe was a big development of last century. Lemaitre developed the big bang theory. Then Hubble. The best evidence came from Penzias and Wilson in 1965.

In the beginning, there were no atoms but just particles bouncing together. Cooling allowed atoms to form. As atoms formed, the universe became more transparent and light. This was the cosmetic background of the universe. The universe was the same temperature, without large variations. Until recently, people believed that the big bang started from one explosion. More on this shortly.

We do not know how big the universe is but we do know its minimum size. The big bang did not have one starting place but many. And these big bangs were all almost identical and happened simultaneously. But how could these explosions be synchronized if there was no time? We have to communicate to coordinate, to synchronze. So we have to think of something happening *before* the bangs which caused them to synchronize. There are 2 theories on this. One is cosmic inflation - a small region blew up and stretched out, so that it was smooth and regular over large regions. The second is that the universe goes through cycles, getting larger and smaller. The reverse [getting smaller] caused the big bangs.

Both theories predict the same result but with different effects on the level of small details. Now there's a satellite which should help to decide which is more likely. So what more is there?

The best theory is the string theory - best but not tested. Both types of universe are possible from the 2 theories. If the string theory is right, all universes are real [?]. A new universe can form within an old one. But this is very rare. A new universe can be different from its parent universe. String theory says we have a multiverse - inside each. Some behave differently. Some have light and some not. Can we test

this? If we could see the remnants of a collision of two universes, we could. If they were formed close to each other and both expand, then they would collide. But we have found nothing yet. And we cannot calculate the probability. So we can only analyze on a mathematical level, not by practical observation.

REBECCA CASSITY – Goldsmiths, University of London – Gambling

We gamble in changing ways. The way we measure and regulate gambling has fallen behind. How do people gamble today? 30% gamble on line. The "Betfair" website is an example. [On stage, she places a bet on a hand held computer and describes all the countries through which the electronic impulse goes as a result of the single click.] These bets move beyond national boundaries, through many legal and tax jurisdictions.

Gambling is a kind of decision making. It takes place between people. We engage in gambling socially. The gambling industry produces culturally sensitive products. In casinos, the greeter greets patrons by name because it creates an atmosphere of trust. Gamblers in Macao play baccarat – a $23.5 billion industry - 90% of the time. But blackjack is the popular game in Las Vegas. In Macao most of the volume is with high rollers. Not so in Las Vegas. So gambling is done with globalized technology but on local levels with different regional variations.

Online gambling is an island-based industry for tax reasons. The UK is one of the centers. It has a long history of legal horseracing and a stock exchange. So being centered in London is not a matter of luck.

There is a social history to gambling. On Cyprus, engaging in gambling is a way boys become men. Slovenia has the highest concentration of gamblers: visiting Italians.

What is behind a person's decision to gamble or not? Why study gambling at all? It is a big, poorly regulated industry - the regulation is ad hoc. To shape the future of regulation, we have to understand cultures. It is an exchange which makes a productive use of risk. Stock jobbing replaced systems of trust. Stock market speculation achieved respectability. These classifications change - what is acceptable and what not? Day trading brings down “walls” between investing and gambling. So this behavior is all one continuum. What is the importance of thrift and saving and risk taking?

Q&A - What difference does research make?

Lehners – Through research, we find our place in the universe. But research is fascinating in itself. On a practical level, we may learn the existence of other universes. All cultures have myths of origin. The “creation” was either by an actor or cyclical. So what we have been discussing is a scientific "take" on basic human impulses.

Kaldor - Research can make us more secure. Research cannot make our lives better without changing how we do social science. There are traditional assumptions about war and state interests and methodologies. We see lots of conflict data, but all of it is based on certain presumptions. For example, to be considered a war, it has to have battles and a state must be involved. But if we start with different assumptions, then we are not sure whether violence is increasing or decreasing. So we see a full spectrum of nature, the effect of quantification and how the method of measuring defines the results.

Q - Attitudes toward war have changed. So our views of life change our research.

Barton - Diversity relates to innovation - try to make sense of how this process works and find out what variances have what effects.

Q - Also we transfer research techniques from one area to another.

Cassity - To regulate gambling we need to understand the mental process. Until now, regulators, research and industry all were in agreement on how to study the subject. Currently the focus is on the "problem gambler". But this focus has a disturbing political message: gambling is "harmless fun for most and a problem for only some who are defective." New research can possibly reopen the role of gambling in our lives and not just focus on addiction.

REINHARD HUETTL – Acatech - Introduction

Innovation often has a technical basis but it also moves into social context. Thus, social sciences are important. We also have to understand human behavior to understand innovation in areas of sustainable growth.

AARON CIECHANOVER – Technion - Disease

There have been 3 drug revolutions. Initially drugs were developed largely by serendipity. For example aspirin was a chance development by Felix Hoffman. He decided to synthesize aspirin to try to help his father's arthritis pain. The discovery of penicillin by Fleming is another example. There was a Petri dish that showed a halo where bacteria do and do not grow.

The second revolution was chemistry, *i.e.* not just luck. Many compounds were discovered and then screened for their effects. Statins are like this.

The third method is new and is highly personalized medicine. Individual DNA is profiled and we will find and apply specialized drugs which apply to that particular DNA combination. There is not one such drug that fits all. For example, breast cancer is a big group of diseases. Often, we do not diagnose this disease properly. The diagnostic process can be a matter of life or death. For some, particular drugs are a waste of time and money. There are lots of different receptors which not all patients have. We have to identify new target receptors. This process is based on the human genome. The genome sequencing process used to take months and cost hundreds of thousands. Now we can sequence a person in a day for less than $1,000. We start with DNA, but then have to move on, down to RNA and then down to proteins.

There is no free lunch. We are at the end of the blockbuster era. This is because there is no one drug solution for a disease. Also, we are hampered by the lack of helpful animal models. The costs of developing customized drugs instead of mass-produced ones is high.

Malignancies are a product of genomic instability and so they produce many changing targets. Some are caused by genes, but this is not clear.

ANASTASIA AILAMAKI – Ecole Polytechnique Federale de Lausanne – Data Deluge

Consider the history of development of the common toaster. It took little time to change toaster models from a fork and bread over a fire to the modern pop-up. It also took little time to develop the car. But nothing progresses faster than computers. Computer memory doubles every 18 months. But data collected expands even faster than computers' capacity to process it. What do we do with that gap?

Look at the human genome [again the subject of sequencing]. The cost of mapping the human genome has dropped dramatically. So now we can sequence everything. We gather it, but in such great quantities that we cannot process it all.

Shifting to astronomy as a subject of data management, telescopes produce lots of information. If data is of a modest size, we just look at it and draw conclusions. But as data grows, the process of processing is not scalable. It takes a lot of time. So we try to find methods or structures to apply to the data. The 2021 human brain project is mainly a data integration problem.

If something takes too long to analyze, the researcher loses context. We need efficient date management, communication between computer science and the end user. To organize a data management process, we have to know the question. Building a solution is a sequence of steps. Look at cooking. A chef faced with preparing a 7 course meal needs 10 hours. His client wants it done faster and says just use a lot of sous chefs and divide the project up. But what if there is only one salt shaker? How do you manage cooking with 40 cooks? Parallelism doesn't always work.

ROBERT SCHLOEGL – Max Planck Society – Energy Supply

The Internet generates more C02 than Germany

Most energy is based on combustion. It is very hard to eliminate nuclear energy [as is being done in Germany] and reduce electricity consumption accordingly. We need to store energy. Sugar is the storage method of food energy. It takes energy to store it, to convert it to sugar and then convert sugar into useful energy. The price - loss - of using this method is high. We have to find a more efficient way to store and use power, for example solar. We pay too high a price for changing these molecules from one form to another. We have to find a process like photosynthesis. That took millions of years to develop and we have to find a new version in just 20 [when German nuclear power will end].

0.17% of the earth's surface should be enough to generate energy for all our needs. But we have to store this energy - by means of chemical banks. Other methods are not efficient enough. We understand what we need to do, but not how.

The solution to our energy needs is not just chemical. We also need to change human behavior. Chemists give us options but the user has to decide which option to use. It takes decades and generations to convert to this new system.

ELKE WEBER – Columbia Business School - Resistance to Change

We are creatures of inertia and have a status quo bias. Possible changes are usually not adopted. We know what we should do but it is hard to change. Change requires payment of upfront costs and self-control. Self-control is a personal characteristic that varies from person to person. A long-term study

was done with children who could get either one cookie now or two later. Those who could wait for the second cookie did better in many respects later in life.

The prefrontal cortex is the center of this capacity. It is partly genetic. But there are also situational aspects - how forward looking are we? How can "decision architecture" make us all be more foresightful?

When faced with a decision, we engage in an internal argument about the pros and cons of action. It happens automatically and sequentially. But in what order? The first question we pose to ourselves has more information. We suppress other options. It is very important which alternative we consider first. The status quo is usually considered first. But we can assign a new way of behaving as the status quo. This is a way to change. Legislators can do this in the political process. For example, Germans now have new energy-saving light bulbs. Americans see legislation on this point as being too paternalistic and reject it. But there are other, less heavy-handed ways to achieve the same end. Every country has different default settings. Consider organ donation: if you do not act, what happens? The way in which the organ donation question is posed dictates the outcome. It dictates not just who is willing to give organs but also the number of transplants. How do we describe meat as 75% lean or 25% fat? If we call a security fee a tax, Republicans will not support it. (Everyone laughs; a variation on this joke is made by other speakers.)

Political leadership means doing something despite initial opposition. We change by taking action. For example giving up eating meat. To change our behavior, we make a public announcement that we are changing. We remove all meat from the refrigerator. We establish safeguards so we do not backslide. Ulysses asked to be tied to a mast to change his behavior. So we have great opportunities to set wise default choices. The public does not like change. But public opinion finally comes around. [Not discussed was the damage BAD policy choices can have by misuse of these same techniques. It presumes someone knows better what is good for the person who thinks he/she is making up his/her own mind.]

STEWART WALLIS – The New Economics Foundation, London – Misleading National Indicators

Why do we produce? To consume? But not all consumption is satisfying. It is not an end in itself. At some point we have consumed enough. Many of our current world problems result from parts of the world having been left behind. The solutions for these problems have to be regional but the solutions are in the hands of nations. Well-being has more to do with family and friends and social integration. Through consumption we increasingly generate global problems including climate change and resource depletion. Markets alone do not deal with these issues. We need to supplement these market forces. Cooperation is possible once we see the need. To make global cooperation and communication possible, we need to see the need and implement change.

What gets measured gets done. So a key factor in making changes is measuring the right thing. We are measuring the wrong thing. Look at the 4 "un's":

1. Unattainable – We face the risk of climate change but also life supports systems and ecological systems. 15 of 25 ecosystems are in decline.
2. Unfair – The 400 richest Americans have the same wealth as bottom 150 million.
3. Unstable - Too much debt. Our economies are built for efficiency and not for

resilience.

4. Unhappy - In the UK, the economy develops, but we are not getting happier.

Robert Kennedy stated, "GNP measures everything except what makes life worthwhile." Just looking at GDP is like driving a car without a speedometer. We are going fast, but are we going in the right direction? Or do we drive full speed in the wrong direction? The goal of a good economy should be well-being and social justice within fair ecological limits.

Flourishing and well-being are interchangeable. One can be happy while on drugs but not be flourishing. How we feel about life depends on our psychological resources and how we live. So there are internal and external aspects. There are 5 daily factors of well-being – be connected, be active, take notice, keep learning, and give. It matters whether we watch what's around us. Who of the audience really looked at the conference surroundings? What's across the river from the conference site? The least economic aspect of these is also important - giving. Give time, love, and resources. But also pay attention to external conditions. If unemployment, inequality, instability, environment and fragmentation go up, well-being goes down.

The speaker is working with the UK government to come up with ways of measuring well-being. The results will be made public in July 2012. What improves lives and acting on that information is the serious business of government. What are the implications of measuring well-being? In 10 years the new well-being indicator will be the headline indicator and GDP will be secondary.

How do we measure well-being, environmental resources and economic activity? How do we change environmental aspects into well-being?

A chart presented showed happiness and ecological aspects to achieving well-being on a country-by-country basis. In the US, people have a longer life but consume a lot. Costa Rica has a high level of well-being *without* using nearly as many resources. What are the implications? Sports and music have a real impact on well-being. The design of work places matters, too. What do we want in life? Might we make a value shift? Could a change in measurement and valuation help with climate change?

Some growth is economic and some not. If we continue as we currently operate, we will run out of planet. If we brake now, we put people out of work. So we need to be a market economy but with a different metric.

LUI OLIN – China International Capital Corporation – Global Debt

Why is a Chinese talking about European economics? In the last 2 years, global debt has gotten worse and worse. Greece itself represents only 2.5% of the EU's GDP. But Greece also represents a group of high debt countries and how they deal with it. Debt sustainability has 3 parts:

1) Debt level - Everyone knows that Greece and Portugal have solvency problems, not liquidity. So we need a way to reduce the debt level and grow the GDP.
2) Interest rate - If interest is high, the burden is larger. So if it is above 15%, then it's very dangerous.
3) Accumulation of debt - It's fixed for posterity. To bring down this debt, a country needs more tax revenue. But generally higher taxes contract a country's GDP.

Until now, the EU has supplied only liquidity support. If there is a "debt overhang" [debt that can never be paid off, no matter what reforms a person or country adopts], adding more debt does not help. The EU need to work out a solution involving fundamental change.

The current discussions about "restructuring" the debt [write-downs of the amount owed] are so far only very vague. Will the market accept the idea that this arrangement is sustainable or only short term? Countries [China] are reluctant to give money to help solve this problem because the EU has two groups of countries – those with a trade deficit and those with a surplus. As a result, competitive countries have to support those who haven't worked hard or efficiently. This support seems unreasonable to the market. Furthermore, we need to deal with the issue of debt overhang. If not, a default is inevitable. The ECB already buys a lot of bad debt; this is a case of trading good assets for bad ones.

So, we have to deal with the debt overhang and with leveraging up the EGLSS. Possibly the fund could get outside funds. But if it gets outside funds, those sources consider whether this is an investment or a bail out (what interest in bail out)? Greece needs to be "on the hook" in order to force it to change. If this is supposed to be an investment, then the investor has to look at the promised return. Europeans are reluctant to invest in the solution. Why? If there is a guaranty of repayment, then what is the level of guaranty? 10% or 100%? Any investment is a waste of money if the problematic behavior does not change. If debt goes down but the problematic behavior does not change, then the debt goes right back up again. Essentially the EU has not yet come to grips with the missing part of the EU structure. It has to do this itself and cannot expect others, especially not the Chinese, to solve this problem for them. Note, too, that although China does have a trade surplus which produces funds that could be invested in the EU, assuming the right conditions, the funds which are free to invest are only the *current* surplus, not the accumulations of past years, which are already invested.

ROBERT E. HORN - Stanford University – Organizational Ignorance

The largest risks we face are "wicked problems and a social mess." Often problems are a whole set of interrelated problems. They are complex and ambiguous. We have no standard view of what is going on. The problems are tightly interconnected. Visual representations of these messes and their interconnected problems and help in dealing with them.

Why are these messes important? Because messes are the context in which business and government strategies are made. They create business risks. [He provides a graph with interconnected messes described with a mix of language, pictures and interconnected lines – illicit drugs.] How do you name the mess? How do you normally work with messes? Messes are different from mere problems. They are not like building a building or solving engineering problems. Don't treat a mess like an ordinary problem.

We can work with a visual language to help us deal with these messes – a combination of words, images and shapes - each interrelating with other aspects and doing what it does best. For example radioactive waste. Asked to create an understanding of what happened, his team created a mural 5'x16'. Facing another mess, the English had trouble aligning members of a government ministry. Drawings help show patterns and connections.

In another case, to deal with the mess, Horn's team started with the result they wanted and worked backwards. They created the "must have's" that were midway along the way to the solution.

LALEJANDRO LITOVSKY – Earth Security Initiative - Ecological Risk

Climate change is a threat to international security. There are changes and connections between climate and civil war. The problem of water and rain is not a problem of the equator but of other places dependent on the water. Rain falls in China, but where does it come from? The Brazilian rain forest and Congo basin are like a pump, turning water into water vapor to transport. So what happens if we take out the rain forest? The Brazilian rain forest is lost to expanded cattle ranching, which in turn is driven by demand for meat due to population growth and an expanding middle class. When the value of gold goes up, more mines are economically viable and so more trees are cut down in the Amazon. Investment analysis is not good at looking of these combined changes and hidden costs.

FERENC KRAUSZ – Max Planck Society – Microscopic Motion

How can we see fast motion in a microscopic world? First, we need light. Light is the charged moving of electrons. On the eye, the charge hits rods creating oscillation and an electric current transmitted to the brain. Electron motion emits and detects light. So there are two motions, closely connected.

What is an attosecond? How brief is one? The shortest period most people deal with is a second, about the speed of a heart beat. A nanno is a billion times shorter and an atto is 1 billion times shorter still.

With a strobe we can freeze motion of a moving point. We need shorter pulses to capture the movement. Lasers can do this with different colors and different wave lengths. This is the key to capturing the pulses. The laser sets the object in motion and the item emits a shorter burst of light when it reverts to its old, unaffected state. With this tool we can capture electron motion. We take lots of pictures and then slow them down, creating a sort of slow motion. Attoseconds permit this, too. The same principle applies to electrons moving in atoms. It is a sort of magnification of time.

What difference does this make? It can help in determining the eye's function. It can also be applied in analyzing a chemical bond. If an electron motion is initiated, the structure may change. This may cause malfunctions. Establishing broadband theories will be used in cancer treatment. Electrons are also responsible for information technology. Microwave impulses turn electric circuits off and on. This technology allows billions of calculations a second. We may be able to replace microwaves with light waves or molecular electronics. This would speed computer calculations by a factor of 100,000. One application might be the improved and speedier prediction of natural disasters.

INGRID DAUBECHIES – Duke University – Computer Stupidity

Are computers stupid? Maybe. Try logging in with a password which is slightly off. They, along with so much else, are made in China. These goods then have to be shipped. Who keeps track of all those containers full of goods? Surprise - Berlin is a center of shipping software. Computers also permit analysis of airflow on airplane wings, testing various configurations. The winglets now seen on many planes were not developed in wind tunnel experiments; they were computer generated using software models.

What else do we do with computers? They can be used with nifty mathematics. For example they can be used in determining global topography. We can record data from all earthquakes. Earthquakes can be felt around the world. The rays are bounced through the earth. So you get information on the earth's mantle. We know where and when it would come *if* the earth were perfectly round.

The brain is folded over on itself, making point mapping difficult. Computer models permit us to map the surface much more accurately and determine what portions are adjacent to what other portions. The same techniques apply to the ossified bones of animals and tracing how they develop over time.

Another application is art history. Van der Weyden had a workshop. Under the surface of paintings attributed to him, we can detect different styles of drawings, all from the same period. Computer analysis of these sketches has helped determine which paintings were by him and which by students. For a paper on this analysis, see: http://www.math.princeton.edu/~ingrid/Fine_arts+Math/MoMA.pdf

PAUL CHIRIK – Princeton University – Sustainable Chemistry

Synthetic chemistry makes valuable molecules in a sustainable way. All of the following examples rely on substituting something inexpensive for something valuable, mainly precious metals such as platinum, iridium and rhodium (which is even more valuable than platinum and used in car catalytic converters). This is a new sort of alchemy.

The cheap production of ammonia (NH3) was developed by Carl Bosch and is often cited as the most important technical advancement of the 20th century. In another example, rust found on dirt has been substituted for osmium (number 76 on the periodic table of elements). To find these substitutes, we need to understand and manipulate electron chemistry and multi-electron transfers.

For instance, plants needs hydrogen and platinum to make bio fuel. How do you do this? Through research, it has been determined that an iron compound now can do what used to be done with platinum, saving millions.

Silicon compounds are needed for lots of products. For example they can make filling beer bottles more accurate by reducing foam. Besides the costs of these precious metals, if a product is based on platinum, the price goes up and down dramatically. A further benefit of these substitutions can be the reduction of by-products or the creation of less harmful by-products.

In New Zealand the invasion of gorse, with lots of thorns, was a problem for the sheep farmers. They had to unstick sheep. One molecule changed the solution to this problem. It helped create the "Superspreader." By use of this product, NZ farmers can use much less herbicide to control the gorse.

CEDRIC VILLANI – Universite de Lyon – Economics, Physics and Geometry

[Much of this talk related to Mr. Villani's heroes and their contributions to mathematics, often with applications first seen many years after their deaths. They can all be read about in Wikipedia or other sources.]

Bernhard Riemann (a 19th century German mathematician famous for his hypothesis) created non-Euclidian geometry. It is particularly helpful in dealing with curves and hyperbolic surfaces. Riemann's ideas influenced Einstein. They also found application in any GPS device.

Another great mathematical thinker was Ludwig Boltzmann (Austrian, 1844-1906), who developed a theory of gas. S=k log W. This describes the distribution of molecules and found applications 100 years later.

Leonid Kantorovich is another mathematics hero. His work affected taxi fares, for example. He was awarded the Nobel Prize in 1975. He was given a problem a plywood, but his solution to the problem has applications on Wall Street. There are lots of computer tools [linear programming] that are based on his work. He created the lazy gas experiment with Lott and the Monge-Kantorovich optimal allocation theory.

Q+A

Even before the application of lasers, scientists *could* indirectly "see" the phenomena they now can more precisely measure. Visualizations are ways of communicating. If they help others predict outcomes, then they are thought of as working. Predicting outcomes using these tools are often a result of a sort of sophisticated intuition. Reality is a product of all our sensory factors, but a lot is going on. What you think you see goes through a long path electronic/chemical path. Our nerves are always going. Reality is a sort of controlled hallucination. What *is* reality and how far is it from modeling?

MISC.

The speakers all stayed for the whole conference and could be engaged 1:1 in a specially designated area. In a conversation with Nick Barton, he recounted supervising an expensive drilling program in Ireland. His employer was looking for limestone deposits. Barton had noticed calcium deposits on the tea kettles of some of the farmers he spoke with – while getting permission to drill on their farms. He switched from drilling new wells to surveying tea kettles. He predicted, based on the tea kettles, where he would find limestone. Then he drilled a few test wells based on his predictions. The switch saved his employer huge drilling costs.

Annette Schavan, Minister of Education and Research, gave a speech which I found too unimportant to recount here. However, when leaving the conference on the S-Bahn, I happened to talk with a young scientist who had participated. He though her speech was wonderful. To him it showed that Germany cared about its scientists and that he had a future in Germany.

ANGELA MERKEL – Federal Chancellor (Spoke earlier in the program; inserted here due to different sort of content.)

November 9th is a good day for new perspectives. It is an important date on the German calendar. The one in 1938 [Kristallnacht] was much more horrible than anything else we face today. Here, today, we speak about the future, but with the memory of what Germans did then, in 1939. In 1989, November 9th was an indescribably happy day. The drive of humans towards freedom was stronger than concrete.

In the last 22 years, Berlin has become one of the liveliest cities of the world. It looks *forward.* The architecture of Berlin is creative and multi-faceted. Falling Walls is about learning from each other and ending barriers of knowledge. Scientific advances are important. So Germany has to remain and grow as a place for science. Look at our opportunities and our advantages. Demographics and natural resources are not the answer for Germany. Our eyes and our competency are our future. So we have to invest in human capacity. We must create new transparency and opportunities. We must support science. Germans need not stay in Germany with the wall gone. So Germany needs to work to keep our best and brightest. But each new answer brings new questions. The Internet and information technology are among the biggest developments.

The world now has over 7 billion people. When Konrad Adenauer was Chancellor there were only 2.5 billion. How do we live today without unduly burdening the future? Yes, we face debts [referring to the Euro crisis] which are a big question today. But we face other, longer-term challenges. Already 200 years ago German scientists wrote about sustainability ("Nachhaltigkeit"). And we still face the same issue. Confronted with unhappy questions, we *do* come up with alternatives. Changes are not as easy as they may seem. We have to think not just about current debts but also about the future and sustainability. So...the EU is our future. Even as the biggest economy, it's not much in terms of the whole world. So a lot must change. Intentions are good, but we need rules and systems which have to be followed. To do this, we need structural changes, including new treaties. This need comes at a time when the public is tired of treaties. A political society must be able to make these decisions in an effective way. These challenges are to be solved by more Europe, not less. Each country has concerns about other countries. Worries do not stop at the border.

We are happy to get advice, but it has to come soon. The world does not wait for Germany.

Rudolph (Rob) Houck
rhouck@rhoucklaw.com