Engineering College Council
March 27, 2008
ILR Conference Center

Minutes

Members Present: Geoffrey Hedrick, James Becker, Samuel Fleming, William Hudson, Joseph Bonventre, Jay Carter, Evelyn Taylor Pearson, Frank Huband, Robert Shaw, Timothy Costello, Michael Goguen, Sophie Vandebroek, Susan Ying, William Shreve, Kent Fuchs, John Swanson, Roger Strauch, James McCormick, Elizabeth Altman, Venkatesh Narayanamurti, Kenneth Arnold, Christine Mazier, John Neafsey, Sarah Fischell

Emeritus Members Present: Richard Aubrecht

The meeting presentations can be found at http://132.236.67.210/ecac/ecc_ld.cfm.
User Name: spring08
Password: spring08

Prior to the start of the meeting Roger Strauch distributed an October 4, 2007 memo to President David Skorton, Provost Biddy Martin, and Vice President Charlie Phleger regarding the Cornell commitment to sustainability.

William Shreve opened the meeting and reviewed the agenda. Council members introduced themselves. Two new Council members, Susan Ying and John Swanson were introduced.

Kent Fuchs thanked all of the Council members for attending and announced the CEAA Conference on Sustainable Energy Systems to be held on Friday and Saturday (3/29 and 3/30). He shared that during the 11:30 closed session with the ECC he would focus on:

1. What keeps me up at night
2. What I worrying about

Kent Fuchs introduced Robert Buhrman and Alan Pau. Robert Buhrman, Sr. Vice Provost for Research and Professor in Applied and Engineering Physics, is in charge of all research at Cornell. The College of Engineering probably has the most complex relationship and set of issues that intersect with that office.

Alan Paau, Vice Provost for Technology Transfer & Economic Development, came to Cornell from UC San Diego and has a PhD in biological sciences and an MBA. He is working to transform CCTECH.

Cornell Research Report – Robert Buhrman, Vice Provost for Research, Cornell University

Cornell's research trend over the last eight years has increased, but in the last three years has been flat. This trend is consistent with the federal budget and our peers.

- See Slides 6,7,8,9, pgs 3-5 - Funding resources and trends
- See Federal R&D Funding Trends Slide11, pg 6 - Research has grown at end of the Clinton Budget due to NIH funding
- See Federal Research Funding Trends 12, pg 6 - We expect flat funding until next Administration
- See Recent Research Related Developments Slide 13, pg 7

Questions:
John Neafsey – How do you coordinate with the research activities at Weill Medical in NYC?
We don't interact with them, but we try to stimulate them and mutually support them. Michael Shuler, Director of the Department of Biomedical Engineering, has ongoing activity with surgery and neurology. Interactions are done at the individual researcher level. We are also putting a liaison staff person at Weill to help them make more use of the facility in Ithaca.

Donald Giddens – What is the cost sharing policy?
In the contract schools the overhead goes to the deans. In the endowed schools we will cost share. We share more substantially on cross-college proposals or equipment that will ensure broad use rather than proposals with silo effects.

Samuel Fleming – Where does Cornell stand in corporate sponsored research and what's up in that area?
We stand in the bottom of the top 10. The biggest question is, "How important is corporate funding?" Federal funding takes us to the point where corporations step in. I don't think corporations will be the drivers at Cornell.

Susan Ying – The NSF CAC proposal that is going out – is there corporate collaboration?
Yes – Intel and Dell are corporate partners on the proposal and we are also part of a NYS consortium, some of whom are users on Wall St. We are developing more corporate contacts though that proposal. If the Track 2 proposals come in, we are confident there will be high corporate use of the equipment. We will be the # 3 or 4 best super computer in the country and have better data storage than anywhere else in the world.

Joseph Bonventre -What are the research dollars per space square footage?
I haven't a clue.

Kent Fuchs-This metric is important for the medical profession.

Cornell Technology Transfer - Alan Paau, Vice Provost for Technology Transfer and Economic Development

CCTEC strategic focus for goals:

- See Slide 2, pg 1

We want to promote entrepreneurship community focused more on technology; our entrepreneurs have been primarily in the areas of business and the hospital industry. We are trying to attract alumni whose knowledge in technology investment will be helpful and keep the talent from leaving.

We are trying to improve infrastructure issues by forming an advisory committee with participation from senior leaders to the grass root levels of the university, and an industry advisory group. We also have a volunteer advisory group.

Outreach activities:

- See Slide 5, pg 3

Communication and managerial control:

- See Slide 6, pg 3

Questions:
Roger Strauch – We are licensees. How do you measure your progress? What are the revenues associated with the center and do you get credit for the licensing revenues throughout the university?
We want to measure the level of activities and how many deals we got – revenue is a measure. Ultimately, we want to measure how many successful products our technology yielded.

Robert Shaw – I have never seen any license opportunity out of Cornell. There has to be something that I am missing. At some point you ought to be able to self fund the research program out of the successful ventures that came from the government supported research.
We are not getting the message out, but we are working on it. We are trying to make an appropriate allocation of resources to move this forward.

Sophie Vandebroek - How many invention disclosures and patents do you fill?
We submit 200 disclosures a year, which is less than other schools. We are in the top 10 in filing patents, but we are not efficient in licensing them.

Joseph Bonventure – Does the hospital have a separate patent path?
No, they are now under me. We have four professionals working on this. Researchers may make a big discovery, but they may not know how it can be used.

William Shreve –Is one of the problems the 6-8 months of wrangling to get it in place?
That is not a real big problem with master agreements. It is always the details where we get stuck.

On a comparative basis we are not that bad. The issue is always IP. Companies won't accept standard agreements. It will never be solved completely as long as companies insist on idiosyncratic demands. We are willing to negotiate up to a point.

Evelyn Taylor Pearson – When you mentioned an inventor portal, I was wondering how researchers are interacting with open innovation?
That is exactly how the university can contribute to industry. We really don't negotiate on ownership. We don't want to be perceived as hired guns for industry. The issues are:

- Ownership – If we invent it, we own it.
- We want an industry partner and will give you rights to use it-We are leery about industry wanting exclusive rights worldwide.
- Use it or lose it – don't put it on the shelf to keep it from competitors.

Susan Ying – We ran into a problem with grants at Cornell because of anti-terrorism clauses. What can we do about that?
Please send me an email about that and we can handle that off line.

David Croll – Bob, as you project forward and look at where our research grants are coming from, what changes do you see and what role could energy play particularly in relationship to other institutions?
I am unsure. The Es are driven by the federal dollars. The federal money is going to DoE for $5M a year centers. Universities, teams of universities, DoE labs, and university teams and DoE labs together can compete. DoE folks choose who to fund and DoE has a mission to maintain DoE labs. We are at risk if we predicate our future on DoE until we can open up their budget so that universities can compete fairly. We need to lobby to change this model, especially when energy is the issue of the next decade or century.
Kent Fuchs – I am going to make a copy of a white paper put together by the ASEE about university/industry collaboration.

Priorities for Cornell and the College of Engineering - David J. Skorton, President of Cornell University

Academic science is not on the national agenda. A group of university presidents have been working unsuccessfully for over a year to try to change this.

Is there a problem with science funding? We fund by far more science than anywhere else in the world; the U.S. has tons of money and the science funding has gone up 10 fold compared to the population growth. We need more money, and nowhere is that more true than in science and engineering.

I had the opportunity to travel to New Orleans to participate in the Clinton Foundation's Clinton Global Initiative University; one of the areas of special interest is energy and climate change. On Cornell's behalf, I was able to sign on to the Clinton Global Initiative involving our emerging Center for a Sustainable Future, which will address three major global issues: energy, environment, and economic development.

Our challenge now is how to build on Cornell's strengths, respond to the challenges we face as a university and as a society, and chart a course for the future.

Earlier this spring, we were able to present to the Board of Trustees a strategic plan for positioning Cornell as a leader in the 21st century. The decentralized nature of the university means that most of the serious planning takes places at the unit level – a process that ensures that those closest to the day-to-day affairs of each unit have a key role in charting its future.

The challenge at the university level is to preserve what is best about decentralization while also creating a document and a process that will give us an institution-wide perspective on our future. We have looked carefully at all the collegiate plans and unit plans prepared by the deans and vice presidents, and extracted common themes that apply more broadly to the university as a whole and that also reflect the current university leadership at the presidential, provostial, vice presidential and decanal levels.

In my State of the University Address last October, I outlined five "overarching goals" for Cornell. Over the course of the fall 2007 semester, we held three retreats to discuss these goals with the collegiate deans and vice presidents. We also have taken a hard look at the external environment for higher education and looked objectively at Cornell's strengths and areas in which we need to improve. The result is a planning document that reflects its decentralized nature and the overall vision that gives coherence and shared purpose to our individual initiatives. It builds on the work we have been doing to integrate academic and administrative priorities at the university level and includes strategies for achieving each of the goals.

The first overarching goal is: "Sustain and renew the exceptional intellectual quality of the university. Recruit, retain, and support a diverse and talented faculty, staff, and student body." This will require investment in areas of long-standing disciplinary and interdisciplinary distinction. We aspire to place 25 fields in the top 10 National Research Council rankings by 2015, as well as placing every professional school in the top 10 in its relevant rankings.

Kent Fuchs has set the bar even higher for the College of Engineering:

- To be considered one of the top five engineering colleges in undergraduate and graduate studies and to educate future leaders who are the most sought-after engineering graduates in the world.

- Areas of special focus include (1) systems biology and biomedical engineering; (2) nanomaterials, nanoscience, and nanodevices; (3) energy, environment and sustainable development; (4) information, computation and communication; (5) advanced materials; and (6) complex systems and networks.

Cornell's success, and the college's success, both depend on our ability to recruit and retain the very best faculty. Cornell is facing the prospect that as many as a third of our current faculty will be retiring within the next 10 to 15 years. Replacing these senior faculty members presents a wonderful opportunity for us to build strength in emerging areas and to diversify. The competition is very intense. Other top-ranked universities are facing the same demographic challenges that we are.

Dean Fuchs has shown leadership in this area. He hopes to grow the faculty by 30 , and also: "To recruit, retain, and enable a diverse community of exceptional faculty and students with a goal of attaining 35% undergraduate women and 10% undergraduate under-represented minorities; 30% graduate women and 7% graduate URMs and 20% faculty women and 7% faculty URMS.

The second goal is: "Enroll, educate, and graduate the most deserving and promising students at every level, regardless of background and economic circumstance. Provide students with a distinctive education and extracurricular experience in an integrated living-learning environment. Inspire them to be ethical and purposeful citizens of the world with a lifelong zest for learning."

This will require sustaining Cornell's commitment to need-blind admissions and meeting the full financial need of undergraduates and increasing financial support for graduate students. The College of Engineering has a goal of providing graduate fellowships to all 1st year Ph.D. students. We are in the process of phasing in a bold new financial aid policy for undergraduates that will effectively enable students from families with incomes below $75,000 to graduate debt free, and for those with incomes between $75,000 and $120,000 to have their need-based loans capped at $3,000 per year. We are paying for this through the investment pool and through the capital campaign.

Meeting the second goal also requires us to create and support a learning community filled with opportunities in and beyond the classroom. The West Campus Residential Initiative is already providing opportunities for residents to enjoy a sense of community and connection to the faculty. We live with the freshman in Mary Donlon each fall.

Other distinctive aspects of the Cornell experience include opportunities for undergraduates to be active partners in research as Rawlings Presidential Research Scholars, or as participants in project teams.

The third goal at the university level is: "Enable and encourage the faculty, their students, and staff to lead in the preservation, discovery, transmission, and application of knowledge, creativity, and critical thought." Among the strategies we have identified here are to concentrate and make strategic use of resources in the social sciences, humanities, and arts, and address their "visibility". We need to continue promoting Cornell's New York City presence at the Weill Cornell Medical College—and also in the Ithaca-based sciences, social sciences, arts, humanities, and extension.

The fourth goal is: "Extend our leadership in the use of research and education to serve the public good, in fulfillment of Cornell's land-grant mission and its long-standing commitment to capacity building in communities in the U.S. and around the world." We need to focus on the translation

of research from the most basic to the most applied, and take advantage of Cornell's unique role in New York State and beyond.

On a trip to India I met with Cornell trustees Murty, Infosys, and TaTa, an alumni and leader of the TaTa group. They are devoted to improving life in India. What could Cornell do to help developing areas of India? We spent 1 ½ hours talking with the Prime Minister. We will engage in academic research with them.

There are also things that need to be done in upstate NY to help economic development. We need to make Cornell a leader in working for the public good. I called for a new Marshall plan. For example, we are working with 218 universities on an African initiative.

And the fifth goal is: "Ensure the long-term stability and quality of the institution through careful stewardship of its financial and human resources, its natural and built environment, and its critical infrastructure; use careful planning, efficiencies, appropriate integration of operations, the development of new income sources, and increases in private support as the foundation of our stewardship." We need to refine budget and capital planning processes and integrate values of sustainability into all aspects of campus operations; and meet or exceed the campaign goal of $4 billion for established priorities by December 2011.

The Board of Trustees recently approved a requirement that all new campus buildings of $5 million or more achieve at least Silver Leadership in Energy and Environmental Design (LEED) certification. We already have several "green buildings" on campus:

- Alice Cook House—first LEED certified residence hall in NYS,
- Weill Hall, our new life sciences technology building and future home of the Department of Biomedical Engineering, will be a "green building" – and we are "going for a gold" in terms of LEED certification,
- A new parking garage to be built as part of the reconstruction of the north wing of Martha Van will have a green roof,
- And as the College of Engineering moves head with its new facilities, including the new physical sciences building (which will include facilities for Applied and Engineering Physics); Gates Hall (for Computing and Information Science and Computer Sciences), and a replacement for Carpenter and Hollister Halls (currently in the beginning planning stages), green building principles will come into play as well.

The current $4 billion university-wide campaign will play an important role in many of these and other projects. In January 2008, we passed the halfway point with more than $2 billion raised toward that goal. The College of Engineering has a campaign of over $400 million, and it has also passed the half-way mark, but I know that the college has aspirations to raise a much higher amount – upwards of $700 million.

We live in a planning environment and continuously refine the budget and the budget processes. The Brazley survey of the cost of higher education shows the real issue is a lack of confidence in the fiduciary process at universities.

William Hudson – I have a question regarding corporate support of government supported research. Have you thought about linking up with business round tables? We broke into teams and presented issues around the hill. If you team up you could multiply your activity.
We are currently working with a partnership for NYC. Any ideas, names, strategies etc. are welcome. We are also trying to get to the candidates on this issue which has the potential to have a tremendous effect. Contact me with suggestions.

James McCormick – Can you comment on teaching excellence and the role of improving that in the plan?
Teaching excellence is enormously important. Research universities over the last 50 years have made their reputations much more on research than teaching. Cornell is ahead of the curve on teaching excellence – the senior faculty are amazing. As we go forward government funding is the most important factor and we need to get more of the market share. How can we do this and focus on teaching? Kent's 3:2:1 plan focuses on productivity. We can also achieve this in part through our tenure review processes. I thought the impact I had by teaching was a bigger impact than the actual papers that I published. The difficulty is putting good teaching into action by not promoting faculty if they don't teach well.

Roger Strauch – In California we were successful in having a public/private venture in building a center. The cost was shared - we do $50M – you do $50M. Are there opportunities like this in NYS?
There are non-energy opportunities. We have gotten some help from the last gubernatorial administration (Pataki). The SUNY system needs assistance to invest in faculty. The first dollar from the state ought to go there. There should be a contribution from the state in other areas too.

Donald Giddens – Could you comment on Cornell's international strategies?
David Wippman, Vice Provost for International Relations, the International Studies Advisory Council, and some of the deans are working on an international strategic plan. I will be able to answer that question in a more intelligent way in a few months. My predictions are that the interactions will be based on public service – how can we use our core research in an outreach capacity. The second type of opportunities will come about by partnering to change the local environment for education. For example our medical students educated overseas in Qatar. Every student except one was matched in an internship for post graduate training. They were seen as having the same quality education as students educated in the U.S. I am a strong defender of the faculty and deans rights to choose where they work – bottoms up. We will have an international plan by your next meeting.

Robert Shaw – Many are putting their money into 529s - education funding plans. The S&P has been flat but the cost of education is on a rocket ship ride. What can be done to try to control the costs? Cornell should take a leadership role.
I was at the University of Iowa for 26 years. That was a very inexpensive place. In the years that I was there – in a 6 year period the tuition went up 70%. There is a problem. In schools that do a lot of science and have excellence in teaching, their budget is primarily personnel costs. It is a high human service kind of industry and I believe you can't make it efficient by using technology. The rest of the university budget is where you have to look carefully. But now we are experiencing a building boom. The Medical School expansion, Weill Hall (life sciences) and others are unbelievably expensive projects. We try to build them in a more efficient way and use green technology.

The next layer of discretionary costs is running a university that is decentralized. Are we doing communication and technology in the most efficient way? We can coalesce efforts but changes will be of a second order effect. Tuition is going up at a rate not much more than the Higher Education Price Index (HEPI). It is inflationary and I am not going to participate in a dumbing down of the university. I want to hold down the rate of cost growth. We have a bigger endowment because we are a bigger university. We have to think on the revenue and the cost side. It is a huge issue. It costs about $1100 a week to go to Stanford or Cornell.

Energy Curriculum – Teresa Jordan, Chair of the Department of Earth and Atmospheric Sciences (EAS) and Paulette Clancy, Director of the School of Chemical and Biomolecular Engineering (CBE)

Paulette Clancy – We are at an early stage of determining the energy curriculum and want your input. We are excited that Jeff Tester will be the Croll Chair of Sustainable Energy.

Our philosophy:

- See Slide 2, pg 1

Education is our focus today broken into the undergraduate, Master of Engineering, and PhD curriculums. We already have a joint MEng/MBA program and we are considering whether there should be a PhD level core curriculum, graduate field, or minor in energy.

Hallmarks of the Cornell education:

- See Slide 5, pg 3

Intended impacts of the educational program:

- See Slide 6, pg 3

These goals are important, but we are just starting to make the right connections.

Undergraduate education key goals and questions to the Council:

- See Slide 7, pg 4

We have more focus in the Master of Engineering program that is largely project based. Our current project is looking at how much energy could be saved by changing the windows in Olin Hall. How can Cornell save 15% energy?

Chemical Engineering has an MEng concentration in Energy Economics and Engineering. We also have a new joint Engineering/JGSM program combining an MEng in sustainable energy with an MBA (the MESE program). At this level our question is, "How can we best market existing MEng degree programs in sustainable energy systems?"

At the doctorate level we are questioning, "What should the core set of courses be for a PhD student? How do you take the depth of knowledge in a technical field and be prepared to be environmentally benign?" We plan to develop a core set of courses to provide a systems view of sustainable energy systems:

Graduate education:

- See Slide 9, pg 5

At this point we believe that there should not be a degree in Sustainable Energy. We lack sufficient depth. Should we create a graduate field of Sustainable Energy and offer a grad minor?

We are seeking your input on how to define and spread energy literacy at the undergraduate level, how to expand and market our MEng and MEng/MBA sustainable energy programs, and how to structure PhD level training and pick the appropriate core courses and thesis topics to bring together energy and the earth's concerns from the outset.

From your perspectives and business experience, what are the big holes? How do we balance a broad education in energy-earth systems against deep technical knowledge within existing fields?

See Slide 12, pg 6 - Committed to sustainability

Questions:
William Hudson – I am a believer in letting the free market system determine the direction of the curriculum. What kinds of roles are the students playing when they graduate? Where is the market for these people? There is a lack of knowledge about energy efficiency in the building industry.
Paulette Clancy – Oil and gas industries have come back with a great force. 15-20% of Chemical Engineering graduates are going into these industries and also into green fuel companies.

Frank Huband – I see fossil fuels and renewable energy. In the middle isn't there nuclear? Is there any thought about nuclear? Pragmatically there will be more nuclear plants in the next 5-10 years.
Paulette Clancy – We see that nuclear is part of the equation of education and we have a course in that area. That is one of the reasons we think we need to educate engineers in the social context.

John Neafsey – Do you see delivering this as a spectrum so that your students can evaluate the options? Ethanol is the biggest joke.

Michael Goguen – Sequoia helped create 720 companies. Sustainability has gotten big – the third largest area of development. What is it that would make the Cornell graduates most attractive? A resume from an undergraduate should illustrate that the candidate is a great candidate. It shouldn't be buried -- it should be focused and visible.
Paulette Clancy – We agree. We would like to see a formal minor that is noted on the student's transcript.

Robert Shaw – There have been studies that predict 40 million green jobs in the next decade. Most people don't know anything about the sustainability subject. We are into 3rd-5th generation initiatives. Full systems analysis and understanding how it plays into the entire economy is important.

Susan Ying – One of the important sectors is the transportation industry – automotive and aerospace. We should be building cars that don't adversely impact the environment.

Roger Strauch – I want to reinforce your focus on energy literacy. Tomorrow's citizens won't be able to weigh in without energy literacy. You are on the right track if you think about what it takes to make us all energy literate. Ultimately we will apply that to where we go to work, how we vote, and how we allocate resources in the years ahead. The most important goal is to be leaders in the vocabulary and basic concepts.
Paulette Clancy - We agree. We have a captive paying audience in the freshman at Cornell. Then maybe we can go outside to have an impact.

Timothy Costello - We focus on the discrete application of energy. Network management and power distribution are also going through massive change. How will solar power be financed? We need to consider the network and economic models that will make the systems sustainable.

Paulette Clancy - We couldn't agree more. Our first alliance will be with Applied Economics and Management (AEM). Maybe it is time to hire new people in the power distributions systems areas.

Christine Mazier – It is tough to influence policy makers by introducing freshman courses. If one of the challenges is informing public opinion, one of the ways is to form a minor between public

health and journalism as we did. You might have a similar influence on journalism students coming through Cornell.
Terry Jordan– Last year we had a focus on sustainability communications. We also have the advantage of cooperative extension as a ready made agent for outreach beyond the university. We feel compelled to define the few fundamental pieces of knowledge to communicate.

Geoffrey Hedrick – The rest of the university should have a passing understanding of things like efficiency. We drove the nuclear industry out of business through people who got emotional about the situation without an understanding of the technology. The average person should have more than the specifics of their field but a broader education including the ability to write and read and of the understanding of the fundamentals that go into energy production and distribution. Sustainability is going to become a political issue and an uniformed electorate has the potential to make bad decisions.

Sophie Vandebroek - Clean technology also includes water, air, and waste. How does it all fit together and how does it relate to your major in environmental engineering?
Paulette Clancy – That is a big question. Once you start trying to inter-relate energy and economics you have difficulty with people who don't have an education in one of the two areas. We are trying to offer short courses on things like solar cells for architects, and thermodynamics for economists so that students can move on to take something deeper.

There is a link to environmental engineering. Terry Jordan and I focus on systems modeling, the climate, earth systems, and energy. All of the students will think about these issues from day one and will have two advisors: one focused on energy and one focused on the environment. Graduate students are now more knowledgeable than their advisors.

Teresa Jordan – Environmental Engineering is a well established program in BEE and CEE. Our mission has been to focus on that which was missing. The chairs of BEE and CEE were part of the team that worked together to make energy visible and a strategic goal in the college. We have to take advantage of everything that exists too.

Evelyn Taylor Pearson – I applaud this effort. I wonder how integral it is to the basic engineering programs and the use going out into industry. How will it be integrated into all of the engineering programs?
Paulette Clancy – It is very important to CBE. For the last 15 years our students have been taught to develop benign systems.

In summary I have heard that:
1. A systems engineering approach is necessary,
2. There is a need for broader energy literacy at the undergraduate level,
3. There is a need for deep experts in specific areas at the graduate level,
4. Energy is only one piece of a sustainable future - There are lots of resources that are running out,
5. The university as a whole needs to be aware of all four of these issues.

Handouts provided to the ECC after lunch included:
- The March 25, 2008 Chronicle Online announcement of Jefferson Testers appointment as the Croll Professor of Sustainable Energy Systems.
- ASEE Public Policy Briefings – (1) Energy and (2) University-Industry Partnerships and Technology Transfer

Cornell Center for a Sustainable Future - Sidney Leibovich, Interim Associate Director of the Energy Institute and Professor of Mechanical and Aerospace Engineering

- See CCSF Mission – Slide 2, pg 1

There are three common themes that cut across these initiatives:

1. Connectivity
2. Communication
3. Making things happen

Sustainability issues will dominate society and we need to educate people who will have to deal with these problems. We are well positioned to take on this task at Cornell.

We want to establish linkages internally at Cornell. The CCSF will provide a central point of contact for those outside Cornell and help us connect with industry; this will heighten our visibility.

About 20% of the faculty at Cornell are working on sustainability. We will lay the groundwork for responses to proposals that call for large interdisciplinary efforts. Another goal is to strengthen our impact by taking a broad collaborative interdisciplinary approach.

We need to establish partnerships. We are often unaware of what the real problems are and don't necessarily know what the people who are dealing with these problems every day know. These partnerships will help us set our directors.

In 2004 there was a report recommending the establishment of the Center and the connection of it to a larger sustainability initiative. President Lehman's call to engagement included Sustainability as one of the three priority areas. The Provost's Task Force on Sustainability followed up this call with a report in March 2006. In June 2007 an Implementation Committee appointed by the Provost also issued a report resulting in the establishment of the CCSF and following the original recommendations of the task force. Initially the CCSF will focus on energy, environment, and economic development. The Energy Institute, which preceded the Center, will be led by the College of Engineering and supported by CCSF.

CCSF will be an umbrella organization. It will include Architecture, JGSM, Human Ecology and Agriculture and Life Sciences. It will not manage research or instruction. Participants will be from units university-wide and the first year of funding ($3M Total and $1.65M for programs) will come from internal Cornell donor and general funds. In the future the CCSF will be funding through the endowment, gifts, and support from external partners. This is not how Centers in the past have operated. This new Cornell model makes the administration a little uncomfortable because they are paying for it.

CCSF plans to work towards its goals by:

- See Slide 9, pg 5

The first three items will be accomplished in the first year. The model is different than most venture opportunities. The money goes out to get things started but no money is expected to come back in. The first seed funding will be issued in May and will give a preference to proposals with potential early impact and those that involve cross disciplinary collaboration. Each of these grants will be for 6 months to 2 years. Unsuccessful ones will terminate. Successful ones will receive other funding and continue on their own. Workshops and symposium will be seeded.

Frank DiSalvo is currently the Director of CCSF. Sid Leibovich is the Associate Director for the Energy Institute. CCSF has an internal Faculty Advisory Committee and an external Advisory Committee. Jeff Tester, once he has arrived at Cornell, will step up to the Associate Director for the Energy Institute position.

We have already started to assemble teams to respond to proposal requests. The most immediate one is the DoE basic energy sciences one.

Current Energy Research Groups include:

- See Slide 12, pg 6

Questions:
William Hudson – I downloaded both the reports and looked at the makeup of your committee and linking that to our discussion about building awareness. It is in good position to help understand how we bring awareness amongst the student body in the area of sustainability (freshman year orientation). You might want to use that committee.
That committee was an interesting one and a good one to work with. The center will follow the general guidelines of the report.

William Shreve – How do you expect continuing funding to come for the Center?
We have a donor David Atkinson who will partially fund the Center by giving $1M each year for 3-5 years. There is a need for additional donors and there will also be an endowment fund. The expectation is to build an endowment to support the Center.

William Shreve – Who are you hoping to partner with and how are you going to build those partnerships?
That is Dave Deitrichs job. He has just been hired and is making contacts with potential corporate partners throughout New York State and beyond.

Donald Giddens – There are a lot of stakeholders and a lot of interested parties. I looked at the timeline and about how fast things are going. I urge the college to not be held back by the slowest link in the chain when you are dealing with such a diverse group of people. Be the lead dog and push it as fast as you possibly can. Don't be held back by others. The strategy is to make progress and show results to the donor.
The implementation committee recognized that each of the three Es will develop at their own pace and the energy initiative will develop the fastest. I think that is the case.

Sustainable Energy Research and Education – Jeffrey Tester, Professor of Chemical Engineering, MIT, and future Croll Professor of Sustainable Energy Systems and Professor of Chemical and Biomolecular Engineering, Cornell University

There are many opportunities for multiscale, multidisciplinary energy research here. I want to talk about the metrics and dimensions of sustainable energy and the variety of definitions. Cornell is a much bigger challenge than at MIT because you have so many parts here.

Looking at impacts at all scales is something engineers didn't used to do. Now we are using quantum mechanics and looking at systems. Making students aware of the economic well being, social justice and equity is critical. If we expose our students to this early on it will make a big difference. So here are the five-Ds:

1. Discovery
2. Definition with basic research
3. Development of technology

4. Demonstration at commercial scale
5. Deployment in the field

We try to expose students to a rich base with a lot of uncertainty and risk in it and many different optima on a complex surface. This is the dimensionality of this problem.

After you have worked in the area for a while the attributes are easy to identify:

- See Slide 5, page 3

Qualitatively this is easy, but when you try to quantify it is extremely complex. This is not a list of singular solutions. There are a lot of uncertainties in the potential impacts and damages that might result from that.

Research and education are synergistic, but research across disciplinary boundaries occurs naturally in many situations but not in all. It is not natural for economists to interact with engineers. Only a few institutions are really capable of providing a comprehensive multidisciplinary energy education.

The assets of Cornell are so strong that it really makes sense to focus on education. We are facing a shortage of graduate students and faculty to carry out the transformational change that we need to do. They need to understand the sustainability language to make good energy choices.

We also feel that getting students involved in deployment to address societal needs and to get the institution itself to really buy into this not just by creating it but also by allowing the task force to have the resources for implementation. Coherency and depth across disciplines is not widely practiced. The undergraduate curriculums are constrained and somewhat inflexible and students may not have enough time to complete this education without taking a double major or staying another year. The sustainability major may not be the appropriate vehicle to get the kind of exposure to sustainability ideas. It may have to be a minor or a secondary master's degree.

General approach taken at MIT:

- See Slide 9, page 5

After four or five years we started writing a textbook that tries to teach students how to do analysis. It doesn't propose a particular set of solutions but tries to teach system analysis in the context of many uncertainties.

We developed a roadmap of outputs for undergraduates: perspectives, foundations, integration and advanced knowledge. We try to place subjects in the structure to show what we would like to see. This helps us think through it as a faculty.

The last slide is concept thinking about creating an institute wide undergraduate minor. There are only double majors now – which take a special person. A minor should be digestible and should allow a student to count some of their requirements towards a minor as well as to take special subjects to develop knowledge and understanding within each domain: science domain, technology domain and the policy/business domain. Supporting this kind of effort with teaching assistants and faculty time is not easy.

Questions:
Robert Shaw – Why not make the energy program a test case for partnerships with industry to produce things that could be turned into a commercial application? From a venture point of view it is not feasible: (1) faculty are not interested in leaving and (2) there is no infrastructure. Select a set of venture players to look at technologies coming out of energy research. Have faculty

come to Boston once or twice a year to meet with the investors and see where it goes. If it works in energy, maybe it would work in other places and increase IP.

Richard Aubrecht – Missing in your course descriptions is an analysis of what is proposed—is it a long term successful possibility or not?. Analyze energy ideas on the basis of BTUs in versus BTUs out. Fundamentally in the long term the technology will win out. Why am I not hearing that in any of the discussion about education? It will drive the economics.
It is something we believe in and make that point in daily discussions in class and in looking at life cycle costs and the analysis of many options. People need to understand the dimensions of making assumptions about energy input versus energy output. They are not as simple as you think. When we do the biomass case, for example, we talk about Pimenthal's and DoEs analysis at the two ends of the spectrum. Students don't have to be experts, but they have to be skeptical.

Richard Aubrecht— I am suggesting taking it beyond that in terms of the analysis you ought to start with the BTUs – BTUs in versus BTUs out - then do the analysis – not the other way around.
Let me share an example. We have students from Harvard in our MIT course. Most are out of the government school and they don't appreciate what we are talking about. We spend a lot of time teaching them the laws of thermodynamics. They then help us with the other side of the domain: economic analysis, thinking about policy, thinking about poverty etc. It is a good, but hard, balance. You are right on.

Joseph Bonventre – Cornell has an unfair advantage having the Agriculture School and space. The students made it clear at lunch that the some of the most powerful experiences are the projects and we heard this morning that Cornell is producing 15% of its own energy. I wonder if this could be laid out in a creative way as a testing ground to build some things, create some things – physical things here - getting people together and excited by that to learn by doing to help realize the campus idea.
That is a great idea that has been discussed in regards to teaching labs linked to the Center on energy or sustainability. I was talking to Susan Henry this morning about that. It would be a terrific opportunity for Cornell. Maybe that is a way in the short term to put this together. You need teaching space, discussion space, space for visitors, and a working laboratory that shows there are multidisciplinary parts to this. Think about how students would react when they come here and this is one of the first things that they see.
William Shreve – What about the basic level of knowledge versus learning the subject in depth?
We had this discussion with a group of faculty and found it wasn't very productive (scientists, engineers, and social scientists). We separated them, put the engineers in one box and the science people in another, and the social science faculty in another, and let them define energy literacy key elements for an undergrad or grad student and it is slowly coming together. Once people believe that this is not just another program that will marginalize their discipline, they will find their way through this. I think it has a probability of working here in a much larger context.

Joseph Bonventre – Maybe you said it before, but what department are you in?
I am in Chemical Engineering at MIT. I will be in Chemical and Biomolecular Engineering at Cornell, but the Center is a multidisciplinary initiative across the college. I will have to wear two hats but that's not necessarily a conflict of interest – it makes it interesting.

Kent Fuchs– Let me share the context for Jeff's position. We decided as a college to push ahead with the energy part of the Cornell sustainability initiative. We got resources from David Croll to do this and conducted a search across the college. We had four finalists and Jeff was our top choice and each candidate was in a different department. Jeff will wear three hats: One in the Sustainability Center, one in the energy initiative within the college, and one as a faculty member in CBE.

Energy Panel: Michael Goguen, Sequoia Capital; Evelyn Taylor Pearson, BP; Robert Shaw Jr., Aretê Corporation

Sequoia Capital is into broad sustainability issues including water technology, green and clean, and brown tech – cleaning up or improving existing technology. The timing is better than you think to do something at Cornell. Economic forces like oil resources and global security coupled with environmental concerns and public awareness (Gore's movie) equal the perfect storm. That translates into things we should care about in this environment:

- Heightened corporate interest – higher and more hungry for innovation
- Student interest – this has caught a lot of people's interest who ordinarily wouldn't have been interested in CS or CE.

The challenge is that the area is similar to the challenge we had when we started investing across this area because it is incredibly broad. This is a tactical challenge because the area stretches across so many disciplines and schools.

I suggest that the university not be completely purest in terms of the completely green technologies – the ones that fit every bullet on the criteria list. You can make a dramatic impact with technologies that improve things a bit. The industry, venture capitalists and corporations, is extremely eager, including oil and gas companies, for any innovation that can make a dramatic impact. Specific areas of interest include:

- Energy efficiency – a near term area - getting more out of what we have
- Energy storage – there is a need for breakthroughs
- Electrification of transportation – is on the verge of being viable - better batteries
- Fuel conversion/gasification technologies – those are near term as well. Companies are currently turning municipal waste into something - garbage in – jet fuel out

The core area of nanomaterials has brought near term applications for clean, green technologies. Specific problems to be solved involve surface areas and nanomaterials dramatically increase surface area whether it is a membrane in a fuel cell or a solar cell, or solar thermal using photonic focusing properties of nanoparticles.

Be sensitive to what industry is very hungry for. A global big picture philosophical concept is important but don't forget the pragmatic innovations that could make a big difference.

Robert Shaw - Research to Enable a Sustainable Energy Future

About 6-8 years ago I started spending a lot of time on the carbon problem; it breaks down into two issues. One of them is the existing fleet. Very few people focus very much on the fleet. That is what got us in trouble and it is not going away soon.

The far more important issue in my mind is the 17 TW Green Energy Gap by 2050.

There are twin challenges:

- Enhanced energy efficiency to deal with the existing fleet
  New sources to fill the Gap

- Student overlay – Cradle to Cradle – design is a statement of intent so in a process, product, or system design you are reflecting what you actually intend. If the product or process is highly polluting, it means that in effect that is what you intended.

The nuclear industry is dealing with the 17 TW problem. It is the new resources that will be needed to be added to the system in order to avoid going over 550 parts per million of carbon. The total amount of energy worldwide is in the order of about 11-12 TW. We are at 380 and approaching 400 ppm of carbon quickly. It was at 250 ppm for the last 150,000 years and in the last tiny piece of time it has shot up.

The numbers on the chart (See Slide 3, pg 3) are not Argonne's but rather Nate Louis's numbers from Cal Tech. They appear in a National Academy report. The basic point is that there are really only two options.

The 17 TW problem equals 17,000 1-GW reactors when today the world's entire fleet is only 400. The other interesting option is the solar option at 600 TW. My view is that the ultimate solution has got to be the solar/hydrogen approach. We have at best a decade before we go over that magic number of 550. Should we invest in retooling industry or the space program? My view is that we need to refine, improve, and find cost efficiencies of these two technologies. Hydrogen is substitutable everywhere you can now burn a fossil fuel. It substitutes easily for natural gas and petroleum in virtually any application.

We need to work on new ways to enhance efficiency, increase lifetime, and provide storage. The solution is materials. Systems have to be put in place too but you can't do anything if you don't have the stuff that makes it work. A few things that are very interesting include:

- Nanosilicon wires – for producing pv
- Quantum dots – increase efficiency – we can do photovoltaic efficiencies approaching 50% conversion (average today <20%)
- Carbon nanotubes for hydrogen storage
- Chemical and metal hydrides
- Membranes for improving the lifetime and cost effectiveness of fuel cells

An example of the perfect study is a paper published in January out of Prof. Wiesner's group with Frank DiSalvo and others. They came up with a way to produce a couple of important materials, one of which is porous films of crystalline metal oxides, in a single step instead of multiple steps. That is a step towards cheaper production of materials towards fuels for the future.

The Congressional Record of 1875 documents the menace cost challenges of automobiles and gasoline. This is symptomatic of what worries me about the energy people in general is that we are so stuck in our past place and we need to break away to solve our carbon problem.

Evelyn Taylor Pearson – BP has an effort in alternative energy. The expectation is that fossil fuels will be important for decades to come. The rise of international oil companies and the amount of reserves they hold. Reserves to production rates world wide are around 40 – in Saudi Arabia the rate is about 80. In North America over the next 20 years our proven reserves could be depleted. We could be increasingly dependent on external sources for these fuels. With the U.S. and China both being major users and a limited amount of reserves, security of supply and security of economic prosperity will be great concerns. They are driving the search for diverse supplies.

Greenhouse gases our increasing along with increasing concern about their effect. How can we minimize the impact on the earth and on human populations? We will see a mix of energy resources with an emphasis on a zero or near zero carbon foot print. CU is well positioned with its broad influence to have an impact.

Provide advice on technology recommendations and provide technical solutions to alternate energy sources. Integrate this work with energy companies. Potential sources will include bio-fuels, bio-mass fuels, and energy crops. Processes for fuel production such as microbes releasing energy to produce energy will also have potential.
BP is looking at bio-fuels, solar energy, wind, geothermal, fuel cells, and hydrogen power. We are building two hydrogen power plants enabled by carbon capture and sequestration. We don't see hydrogen used for transportation.

Enablements to cleaner energy include:

- Carbon sequestration
- Limitations on transporting energies – alternate transportation and distribution
- Enhanced oil recovery
- Identification of oil and gas, natural gas, clean coal technology – we have a lot of coal reserves
- Increase efficiency of energy use
- Waste energy use and energy conservation
- Efficient power systems – distribution, vehicle technology, improved batteries that are stronger and have a longer life, improved vehicles and vehicle production
- Mass transit systems – we missed an opportunity for efficient designs as the population shifts to a more urban setting
- Consumer education

The College of Engineering can provide:

- Advocacy
- Understanding of cause and effect
- Advice regarding technology
- Expertise

A lot of the impact in 20 years will be driven by decisions today. Every week 1 GW of coal fired plants are being built without abatement. Fuel efficient vehicles have not been improved enough. Urban/Suburban design has not helped enough.

Discussion:

Michael Goguen – At Stanford two graduate students combined effort and formed companies with a market value of greater than $200B. Market sizes in this area will be at least an order of magnitude bigger. If Cornell had innovations with a massive impact you are talking about at least as big an opportunity.

Susan Ying – Did I hear right that BP doesn't think Hydrogen will be used for transport?
Evelyn Taylor Pearson – Yes – We don't think efficiency and infrastructure issues will make it feasible.

Robert Shaw – That question always comes up. NSF is doing an analysis. Infrastructure cost runs less than 10%. Total cost is measured in a few months of the Iraq war – 10s of billions. Honda, GM, and Toyota don't think that infrastructure is the issue, but the cost of vehicles is. As a societal cost it is not large and infrastructure should not cause concern. With economy of scale eventually it will be cost efficient.

David Croll – Why did you pick a $50M/year for 10 years with a small group as a research structure instead of spreading the money more broadly?

Evelyn Taylor Pearson - BP started an energy biosciences institute with Berkeley, Illinois-UC, Lawrence Livermore Lab, and over 150 researchers from BP. We are working on some public research and some proprietary research and specifically looking at problems in area of getting energy from bioscience. The approach provides an ability to have more direction over the research and to be able to manage what research will be done. It is very early in the process and we don't have results yet.

William Shreve – It is a perfect storm and these problems won't go away quickly. It will take investment over a decade. How patient will the venture community be as we start looking at longer term solutions?

Michael Goguen – There is instant gratification now. There are dramatic markets for things that could help. The solar market, for example, is a rising tide. If you make good solar panels, you can sell more than you can make but that doesn't last –it is a temporary cycle. Many of the areas that I defined as needs are short term. Take the battery -- there is a good coverage across the spectrum and there are people paying real dollars right now.

William Shreve– Improvements in new materials will take a while before they translate into a product or solution.

Robert Shaw – The time scale on lithium ion batteries wasn't as long as you might think. It took less than five years to develop and market and the market went from nothing to over a billion in that period.

William Shreve – That usually happens when you are replacing a technology. If you are creating something new it takes longer.

Robert Shaw – Everything in energy is substitution. (Tim Costello concurred.)

William Shreve – Look at energy from florescent bulbs. It is taking a long time to get it started.

Sophie Vandebroek – What are the key problems not yet being addressed sufficiently?

Michael Goguen - We are talking about a spectrum of problems to be solved and some research topics could have immediate gratification. Other important problems have a much longer time period and require societal change.

William Hudson – I don't see the disruptive change on how energy is delivered. China for example leap frogged over wired to wireless. The energy distribution is being developed in the same way. I don't yet see the disruptive technology to replace what we have and public policy is not driving significant change. There is a lot of criticism of the oil industry right now to invest in fuels other than oil. Biomass has totally disrupted our food source economy and is not scratching the demand for gasoline. We are not getting a lot of help from public opinion or our government.

Mike Goguen– Electric cars went from golf carts to the Tesla (100% electric with 135 mpg equivalent) in the last five years. Some are practical and get 100 miles on a charge.

Geoffrey Hedrick – It might be easier than distributing hydrogen.

Michael Goguen- If there was a fairly dramatic shift from fuel to electrons it would make a big difference. Solar is also hopeful and the cost is coming down. People forget that parity compares cost against a baseline and that baseline, electricity, is going to skyrocket.