The Dean of the College of Engineering talks about energy.

As this issue of Convergence makes clear, engineers and scientists at UC Santa Barbara are engaged in wide-ranging research related to energy — its sources, its environmental impact and its efficient use. Matt Tirrell, the Richard A. Auhll Professor and Dean of UCSB’s College of Engineering, recently sat down with the magazine’s senior writer, Tom Gray, to talk about UCSB’s important role as a source of new energy technology, now and in the future.

Convergence: Energy efficiency, conservation and alternative energy are hot topics these days, and a lot of research institutions would want to call themselves leaders in any of these areas. What makes UC Santa Barbara a leader?

Tirrell: Well, we’re trying to take a really sharp focus. And to be really specific, our skills and emphasis are not mainly on increasing the supply of energy. We’re talking about new technologies that deliver quality-of-life solutions by meeting people’s demand for
energy while being more efficient about it. In other words, we’re after technologies that deliver results without wasting energy. So I’m differentiating our focus from research directly on environmental impacts, though there could be ramifications in the environment. I’m also not appealing specifically to human virtue. I’m not saying you should have a smaller car and make sure you recycle everything. That’s what I call conservation.

Convergence: Speaking of demand-side technology, what kind of start has been made in that direction at UCSB? What is going on now that points you toward new advances?

Tirrell: The biggest one, of course, is solid state lighting. Its entire rationale, more or less, is built around more efficient use of energy going into lighting. The second is a whole range of things that I call energy-efficient electronics, or new ways of doing computing. Most of the heat in computing is generated by pushing electrons through materials. But there are other ways of computing. Moving light through materials generates almost no heat. Flipping spins in materials – spintronics and quantum computation – generates almost no heat. There are big efforts in these areas at UCSB, and if they pan out, computing and other electronic functions will be much more energy efficient. Then there are bigger system-wide kinds of things. We have a group of people in electrical engineering working on lower power-consumption designs for chips. There are people in computer science who are using algorithms to try to make more energy-efficient networks so that a network has some intelligence; not every appliance or machine has to be on all the time; you can deploy the resources intelligently, when they are needed and you manage this using an innovative computer algorithm.

And, a group here has put forward a proposal for an engineering research center based on materials for transportation. This center would focus on a combination of things but mainly lightweight materials and high-temperature materials – such as high-temperature engine parts, so that engines could run hotter and therefore more efficiently. I think there’s a lot of power behind that initiative, coming out of our structural materials group and our high-temperature materials group. A lot of what we’re talking about here is based on materials science, in which UC Santa Barbara Engineering and Science is particularly strong.

An LED (Light Emitting Device) makes efficient use of energy.

Convergence: Speaking of materials science, how many of these efforts are essentially a re-branding of what UC Santa Barbara has been doing all along? What you’re talking
about spintronics, lightweight materials in aircraft engines, and so forth -- is well-established here. Is what you plan going forward any different from what you would be doing anyway?

Tirrell: Well, we have to certainly bring something substantial to the story in order to have any muscle, rather than just create something we haven’t done before. But I understand your point: What can be new about this? I think there can be lots of things. One is creating energy for the developing world. That might involve coupling more than one technology, like marrying our solar energy with our solid state lighting group. Think about what happened in Africa with telecommunications. They skipped the wired phase and have gone directly to wireless. We might be able to avoid building a lot of power plants in Africa. Instead, we might use technologies that marry solar with efficient delivery systems for lights and displays and so on. That’s the kind of thing that could happen as a result of the work we plan to do here.

Convergence: At UCSB, how much of this marriage between areas of technology is going on now, and how much do you want to push further?

Tirrell: I would like to push a lot of these things further. You know, people get grants for what they’re doing. Different people fund solid state lighting and organic semiconductors. It’s not that these groups don’t want to work together towards these goals. If the right kind of funding became available, I’m sure they would. We would then generate more powerful collaborations on our campus.

Convergence: So you believe government and industry need to redirect some of their current funding?

Tirrell: I think there needs to be a much more astute direction. I’m a little baffled by certain things that are going on, like biofuels. I think we have plenty of stuff to burn for the foreseeable future, and I don’t really see a great advantage in creating more, given the adverse climate implications. I guess I’m really trying to shine the spotlight back on the demand side rather than the supply side, and I think people are a little mixed up on what can produce really valuable returns on investment in the short term. For instance, the land mass that would have to be committed to growing the fuel that we need is huge.

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Convergence: How much is politics interfering with funding decisions, and what could be done about that?

Tirrell: I suppose if I really knew what could be done about it, I would run for Senate rather than be a dean. But I don’t think there’s a chance that corn has anything to do with our energy future, [though] maybe grass and cellulose and that sort of thing do. I understand that the American Physical Society has just commissioned a study headed by Burt Richter, a Nobel Prize winning physicist at Stanford, to analyze the kind of investment and return that could be expected from different technologies. I think we need more of that, and less politically-influenced discussion.

Convergence: In terms of return, what is it the primary goal we should be seeking in energy research? Is it mainly climate-related now, or is it security related?

Tirrell: Well, I think all of those things are important for society at large. The thing I like about focusing on energy efficiency and technology is that it is indeed related to climate change. The 2006 Stern Review on the Economics of Climate Change says that a consistent reduction of 3% to 4% a year in energy demand would essentially be consistent with getting carbon emission levels down to a safe level. But that’s not exactly the argument that I’m making. My argument is more that demand is growing and that it has to be met somehow for example, in the developing world. And if we don’t think about technologies that do it, we really are going to have an energy crisis and possibly a social crisis. I’m trying to some extent to divorce what I’m saying from an ecological/environmental climate-change argument.

Convergence: Why would you want to do that? Is it because it’s less political?

Tirrell: Yes. I don’t want our research to have to rise or fall on people’s views about climate change. And I believe that a real hook on this issue for many people — those who are prepared to invest in new technologies — is that we’re not making arguments that are politically based but are talking about things that lead to new businesses, create jobs, create wealth and have a societal benefit economically.

Convergence: You mentioned earlier that you are not trying to appeal to human virtue. That raises the question of whether the goals you talk about are achievable without some kind of behavioral changes. How much can technology and the research you’re talking about solve the world’s energy problem, and how much of a push is needed from public policy, not just to change behavior but to encourage adoption of the new technology?

Tirrell: I personally believe that that would be a good idea — that some incentives and policies should be developed to promote the use of new technologies. But I’m guessing that this will be a lot easier once a few more technologies prove themselves, and there’s always the risk that less efficient technologies will get the most encouragement. Right now, with lighting for example, even as strong as the case for solid state lighting appears, there are people questioning whether it will be a practical part of the solution in your lifetime or mine. You know, Australia has banned the [incandescent] light bulb after some period of time. This is driving the use of compact fluorescents, and, you know, this will also drive a lot of new installations based on compact fluorescents, and a certain
amount of capital investment is married to the idea of compact fluorescents. If that gets a leg up, fluorescents may be here for a long time and solid state lighting may have trouble competing with them. Even if solid state lighting is more efficient, which is indisputable, it would require another round of expensive capital investment.

Convergence: Here’s a historical question. Roughly 30 years ago, there was a huge level of concern about energy and much effort to achieve “energy independence,” but much of our effort back then seemed to do little good. What’s the danger of the same mistakes being made now? How are things different this time?

Tirrell: My gut feeling is that there’s not much danger of the same mistakes being made, but I’m having a little harder time coming up with a convincing answer to the second part of your question: What’s really different this time? I think more people are more afraid of the climate consequences. I think people thought we were running out of oil in the 70s. I don’t think they believe this now. The high price of oil right now is a demand-driven thing, not really a supply-driven kind of thing. Oil is available for at least 50 years. This is a long time in most people’s mind. It’s not going to be there forever, but the price is high now because we don’t have the refining capacity, people are driving more, they just want more of it, and it takes a lot to turn oil into gasoline.

Convergence: Looking ahead, do you foresee any breakthrough energy technology that will make a huge difference in energy efficiency, say, 10 years from now? Is it solid state lighting or something else?

Tirrell: I would say solid state lighting is definitely a part of it, and I think, really, on the alternative energy side, solar energy is the most important thing.

Convergence: How does hydrogen fit in?

Tirrell: Well, hydrogen is not an energy source but a strategy for transporting energy. So your question is really a question of what is best and most convenient to turn solar energy into? using it to produce hydrogen or to generate electricity directly, for instance. Of all the alternative energy sources, solar is by far the most important. There’s so much of it, and there are good ways to improve our efficiency in capturing it. A lot of the developments in solar will be based on materials science and chemistry, having to do with the structure of matter, the capture of solar energy and the efficiency
of transformations that you can make and control. I have the highest hope by far for solar energy.

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