SPECIAL LECTURE

Sound, Science, New Technology, and Emerging Nations

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I am passionate about the Asia-Pacific era. When I first came to Japan 38 years ago, many Asian countries still had curfews at night, and there were many military dictatorships. But now, it's become the growth engine for the world economy.

I think science and technology can help the emerging nations of Asia and the rest of the world meet the challenges they face. These emerging nations confront profound global issues that are quite different from those that Britain, for example, faced during the Industrial Revolution. In the past, you could just be concerned about your own country or your own locality, but you can't do that anymore. Whatever emerging nations do today is going to impact someone else, and whatever someone else does is going to impact them. So they have to partner with others. And in that sense, Sylff is a microcosm of the kind of communities we should create in the future.

The emerging nations hold the key to the future. They are consuming global resources at a voracious rate, and this is going to have a great impact on the Earth's environment. They are thus both the harbingers of opportunity and the source of threats that we have to deal with in the future.

One such threat is a global health and demographic crisis. The emerging nations are no longer saddled only with infectious diseases; they must now cope with more expensive, lifestyle-related diseases like diabetes, stroke, and heart attacks. As for the demographic crisis, countries like Japan complain that there are too many old people, while countries like Cambodia might say there are too many young people.

Global terror and armed conflict are, in many ways, the reverse of the global financial crisis. If sustainable livelihoods are not available, people are going to walk into the hands of someone who is less ethical about the way they do things.

The Asia-Pacific area is growing dynamically by conventional economic indicators, but it is also endangering the lives and futures of all of us. The first thing we should look at is our way of life. We are consuming in one year today what it took the Earth a million years to secure as fossil fuels.

There are new technologies that have brought our countries closer together. These are what I call mega-infrastructure systems:

international ports and airports, computer and telecommunication systems, and logistical systems. They are giving us tremendous opportunities, but we need to be able to manage them against cyber terror attacks. We've got to manage them against pirates.

In the Asia-Pacific era, for the first time in human history the majority of the world's population will be shaping the world's order, unlike during Pax Britannica or Pax Americana, when a minority set the values that others either accepted or were forced to accept. This is not going to be easy, however, because 60 percent of the world's population is not likely to be homogeneous. So, the new order will have to accept diversity.

I am not an expert in social systems. I am a simple natural scientist. But I do think we have to deal with a very rapid transformation of everything around us. This means we need to make quick decisions, but our social systems aren't responding rapidly enough. So when we look at government structures and social systems, we need to take into account the rapid transformation in science and technology. If our social and political systems aren't dealing with it, I would urge, like Hegel, that systems of rule be respected only as far as they continue to provide for human need.

We must be very careful not to be exclusionary, however. The emergence of terrorist groups is largely the result of exclusion. How do we create inclusive societies, and I think the core lies in the way we as educators deal with our students. If we can make caring, sharing human beings come out of our education systems, then we should be able to solve this problem of exclusion. So, education I think is the key to how we make a caring, sharing community of people.

Now I am going into my comfort zone, which is science. I have always wanted to see if we can't create an Asian community of scientists, and I am going to spend the rest of my life trying to do this. My definition of Asian science is that it must never be chauvinistic. Science must pursue the truth. For me, an Asian scientist is a person who was born and is working in Asia; a person who was born in Asia but is not working in Asia; or a person who was not born in Asia but is interested in working in Asia. This covers just about everyone.

The science in Asia, though, has some strengths and many weaknesses. There is a great deal of indigenous knowledge and wisdom, for example, but they are not necessarily at the forefront of our decision making. We lack rigor in our observation and analytical skills because a lot of modern science is reductionist, and by nature the people in this region are holistic in their values. It has nothing to do with them being bad scientists. They are always caught in this conflict between reductionism and holism.

Now, many of Asian science's outcomes today are what I call end-of-the-pipe technologies, which offer solutions to specific problems. Examples include wastewater treatment systems and air pollution systems. The other type is called "black swan" technologies, which are technologies that come out of the blue. I prefer to call them stuff-out-of-the-blue because it will give the term "SOB" a more favorable connotation.

Reductionism leads to many good devices, but we have to integrate them into systems, and Asian science is weak in this. We have a lot of knowledge floating around, but we need to link that with the wisdom in our communities. And to do that, we must strengthen Asia's science infrastructure. We don't have journals of the stature of *Nature* or *Science* in this region.

Now, Japan has a tremendous amount of technology. It has a very good program called Innovation 25, which by cabinet decree allocated money for breakthrough, futuristic technologies. Many developing countries can't afford to spend on technologies of tomorrow. They need practical solutions for today's problems. But if developing countries and developed countries can come together, very much like the way the Sylff community is built, then as you become a developed economy, you can

put aside more for the next century.

Let me give you some concrete examples. Japan, as you know, is known as a country which has a long cultural history and tradition, and it has an ethos of discipline, hard work, and knowledge not for its own sake but for how it impacts on others. Traditional Japanese values have a lot to offer to the new world order. Japan has a lot of science, particularly applied science, and they can solve a lot of the world's problems.

Japan has also made a tremendous contribution to peace and prosperity with its development assistance programs. So how do we use Japan's strength as a culturally profound nation, as a science and technology leader, and as a contributor to world peace and development? How to use Japan? Japan in a sense, I think, is the key to mobilizing a lot of what is good in Asia.

Japanese technology is largely end-of-the-pipe, but it can be inspiring. Dr. Masaru Kurihara's reverse osmotic filter can transform seawater into potable water with very little energy. The amount of water that is drinkable is 0.1 percent of the world's water resources. The moment you start using the 96 percent that is in the sea, we will change the water equation. So, Professor Kurihara's technology, although it started as a pollutant cleaning filter, can perhaps transform the way we look at water resources in the future. It's a breakthrough technology although it's end of the pipe.

Professor Hiroshi Shimizu and his colleagues have developed a motor for an electric car called Eliica. Now, I like fast cars and I have always shied away from hybrid vehicles. But, with the Eliica maybe even I will end up using an electric car. This car has been designed by Ferrari's chief designer and is faster than a Porsche. The important thing is that although it started as a technology to prevent emissions of carbon dioxide and nitrous oxides, it's become a breakthrough technology. The secret is that the motor is in the wheel.

When you have a motor in the wheel, all you need is a small control box, so this may radically change the shape of cars in the future. The first cars, if you recall, were quite similar to the horse and buggy, but they're not anymore. And a similar kind of transformation is going to happen in personal mobility and with smart-grid electrical systems powering these things; they might be like elevators going horizontally and vertically.

Professor Teruo Okano has developed a stuff-out-of-the-blue technology called cell-sheet reengineering. He cultures single-layer cell sheets in a Petri dish. The reason he can do it and we couldn't in the past was that every time we tried to pull the cell off, you damaged it; and when you damage it, it loses its value. He placed heat-sensitive protein under the sheet so that when it is cooled, it becomes hydrophobic and lets the cell go; when it's at room temperature it is hydrophilic and sticks.

This cell sheet can be placed on a damaged cornea or a damaged heart. A patient who had been on a heart-lung machine for four years was able to get up and lead a normal life eight months after this treatment started. I don't know what the drug companies think about it because it is transforming the pharmaceutical industry. There'll be tremendous resistance to these things, but it will change things in the end.

Professor Okano conducted his trials in the EU and in Japan. The trials were successful, but the Japanese government refused to give him permission to start regular treatment. What happened in the meantime is that the French government built a hospital for him and by the end of the year he started regular treatment in France. I asked Professor Okano about this, and he said "For many years I thought Japanese science must be for Japan, but now I think Japanese science should be for humanity."

That is the key. Use Japanese science for humanity. Japanese science has been insular, but its physicists and its chemists have come out of the shell and have started winning Nobel Prizes.

Now, one of the things I do is regenerate biodiversity. Japan has a few thousand plant species. But there are hundreds and thousands times more in the rainforests, and we only know about 6 percent of the visible flora and fauna. This diversity represents our bio-factories. The Asian region has some of the most biodiverse environments, but it is also losing them at the fastest rate.

How can biodiversity be regenerated? I just use nature's strength. I look for what I call "keystone species." In the case of the rainforests it's the giant fig. You can create a food chain that will sustain the diversity of life in the rainforest. Once you get them in the right place, the diversity returns almost magically.

I wasn't sure whether I could replicate this elsewhere. In my calculation it takes 40 to 60 years before full biodiversity comes back. I'm 63 now, and I'm not going to be alive when this biodiversity comes back. So, I wanted to do it faster somewhere else and I went to the coral reefs, and I found that you could do it within four to six years. So, you see, the key is finding a place where you can see the results because then it inspires you to do more.

Finding the keystone species is a hunch. It's not normal science. It's just sensing the forest until you find the key. The task requires someone who can understand the forest holistically. This is why I am saying there is a very symbiotic relationship between holistic knowledge and reductionism. Often the understanding of things holistic comes from understanding our social and cultural systems, not just necessarily from looking through microscopes.

Lastly, I would like to go to my pet passion because that I think is going to be the area that you might find most interesting, as it brings the social sciences and the natural sciences together: How climate change affects the taste of wine.

In one of our first investigations, we found that the major wine-producing regions are between a 10 and 20 degrees Celsius band. With climate change, this band is going to move. We studied the location, the growing conditions, climate and environment and found that it is sensitive to these transformations of time.

What is the real scientific significance of climate change? Until the Industrial Revolution, the concentration of carbon dioxide was about 280 parts per million. This kept our biosphere in stable equilibrium. Shortly after World War II, after about 200 years of industrial activity, the figure rose to 320 ppm. Today, the concentration is between 380 and 390 ppm.

One of the biggest future generators of climate change is water vapor. As sea temperatures rise, water will evaporate, and this is going to accelerate global warming.

The point at which the glaciers and permafrost will melt is 450 ppm. The influx of cold water into the sea will change the deep oceanic currents, which are our climate-stabilizing conveyor belts in the seas. This concentration is going to be reached much sooner than we

think. We are now increasing our greenhouse gas emissions at roughly 2 ppm per year. Even if the pace remains constant, we'll reach 450 ppm in only 35 years.

How can we prevent this? We'll have to apply mass mitigation technologies in the most polluting sectors like power, transport, and steel. A second approach is carbon capture and sequestration, an area in which Japan has good technologies.

Imagine the impact of climate change on our agricultural system, which employs a tremendous number of people around the world. There would be mass unemployment and chaos. This is the true significance of this research, since the grape is an extremely good biosensor. What you find using grapes and wine should be applicable to Sri Lankan tea or Oita rice. If we can get the methodology right and share it, it would be fantastic.

This research involves having very sensitive sensors embedded in the soil, trapped around the plant, and open to the skies; this information is gathered on a real-time basis, making agriculture a much more precise science than it was before. This precision, moreover, is affordable. This year we are looking at the growth of grapes; next year we'll look at winemaking, and the year after that we'll be looking into the food culture around wine.

So far, we've had many heartwarming encouragements. People have asked if they can use the technology for growing mangoes, rice, and tea. It's overwhelming when you have a big public response to a crazy idea, and that's what drives scientists.

Now, one good project has many, many derivatives. We've been able to predict how the soil and the bio-elements of the soil will respond. We've been able to observe microclimate trends quiet closely, and as a result we've been able to predict frost. Predicting frost is something that will be a great help to any farmer. A crop can be lost in early May if we let the frost come in.

I also found that in our monitored fields we were pruning too early. We were throwing away nutrients while they were still up in the branches. If you wait until it goes down into the roots, next year you'll have a healthier plant, and you'll need less fertilizer.

We also learned when to have water and when not to have water. How can we select new sites, and which varieties of grapes are appropriate for those sites? What is the optimum harvest date?

What I'm saying is that in addition to a long-term vision of adapting to climate change, research must also be useful to people in the short term. And when it is useful in the short term, a community will gather around it.

The prefectures of Oita and neighboring Kumamoto manufacture around 20 percent of Japan's high-end silicon chips. We've got a lot of silicon, but we have no Silicon Valley. Palo Alto is much smaller and less interesting than Beppu, so what makes Silicon Valley tick? It's the young people who come to Stanford, who then go out and set up businesses there. APU has the same kind of vibrancy, so I hoped to create a set of laboratories around us. For four years I went from committee meeting to committee meeting, but there was no investment decision by the time I left here on December 31, 2009. So I turned to private industry.

In February, I found someone who was interested because he wanted to make a research institute for his company. I urged him to make it an open innovation forum where you get lots of ideas and lots of outcomes. And he fell for it. He asked me to give him a proposal, and by April he decided he was going to do it. I think by January next year we can start building. It will probably take seven or eight months to finish it, so, by the time our students come back after summer vacation, they will have a front-end digital technologies laboratory.

The laboratories will look at how digital technologies impact on culture and tourism. We're planning to digitally archive the cultural heritage of Kyushu and Okinawa. The scanners that we use won't just give us beautiful pictures but will also tell us what the paints are made of and what the substrate is made

of. This is going to change the way museum people look at digital artifacts.

It would have been easy for me to lie down and give up when my trustees wouldn't give me the money. But where would that leave the young people? I want their bright eyes to become brighter because they are the future.

So, this is what drives me. As my colleague said, we get all our energy from the classroom, we must give something back and this is my small contribution to the university that gave me six of the most fantastic years of my working life.

WELCOME RECEPTION

Entertainment by APU Students

Following the Special Lecture, Sylff Administrators Meeting participants attended a Welcome Reception at the APU cafeteria featuring performances by Japanese and international APU students.

A member of the Huayi Chinese Traditional Art Union perform a traditional Chinese performing art.

APU Samulnori Team Shinmyoung turned in a rousing performance of Korean percussion instruments.

A toast by Carlos Azzoni of the University of São Paolo.

Nohgaku Circle members demonstrate a Japanese stage art going back 600 years.