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TEDx University of Oregon

February 2013

Good afternoon. It's an honor and pleasure to be with you here today – to share in conversation with so many people, from so many backgrounds, with so many talents, with so many insights, and from so many disciplines.

Disciplines.

It's an interesting term, isn't it? Disciplines.

In a university environment, especially, disciplines shape our departments, our courses, our students, our majors, our faculty, our tenure system, our employment prospects, our viewpoints, and, indeed, our values. And yet there is more. There are the commonalities among, the space between, the connections across. And it is that interdisciplinarity that I'd like to address today. In fact, I'm going to argue that the root of innovation itself – that Holy Grail of "I" words, universally hailed by politicians, business leaders, and NGOs alike – the root of innovation flows from the combination of radically different perspectives.

I say this not as a professor of business who specializes in innovation and entrepreneurship, although that is true; I say it as a professor of business who does not, in fact, have a degree in business.

Now, to illustrate what I mean by radical interdisiplinarity, I'm going to draw upon the Center for Computer Research in Music and Acoustics at Stanford, which is a Center based in the music department, but leveraging contributions from disciplines ranging from neuroscience to art history to electrical engineering. It's a center that I've studied for almost two decades in an ongoing quest to understand the relationship between curiosity and creativity, between innovation and interdisciplinarity.

Let me give you an example. But first, let's listen:

[Sound]

You're listening to "voices," a composition by John Chowning, the first of three "Johns" whom I'd like to introduce in this afternoon. Chowning, as you might expect, is a musician and he's a musician who leverages the power of the computer in order to create new sounds for use in his compositions. He's also the founder of the Stanford computer music center. "Voices" is the result of Chowning's curiosity, and I'm going to argue, incidentally, that intense curiosity is a critical ingredient for innovation. Chowning's curiosity at this point concerned the Oracle at Delphi, Greece and the ways the caves and chasms at Delphi may have shaped both its sound and the more general listening experience.

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Caves and chasms drive an intense curiosity in John Rick, too, the second of this afternoon's "Johns." John Rick is an anthropologist who focuses on the World Heritage site of Chavín de Huántar in Peru. It was at this site that he found a spectacular cache of ceremonial Strombus shell trumpets. [Sound] The sound you just heard is 3000 years old. Rick had a hunch that sound itself was important to understanding the Chavin de Huántar site, but without a background in acoustics or music, he was limited in his ability to pursue this hunch.

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Over a cocktail party, Rick met Chowning, the composer, and the two hit it off.

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Chowning brought a third John, Jonathan Abel, in to the conversation. Jonathan Abel is an MIT and Stanford-trained electrical engineer and an expert in digital signal processing and, specifically, in the digital modeling and manipulation of acoustic environments. The three Johns met in a conference room at the Stanford computer music center and sparked a collaboration that has helped to launch an entirely new subfield of archaeology – acoustic archaeology. It turns out that just as archaeological sites have physical properties that we can see and touch, they also have acoustic properties that we can hear and feel. The collaboration between the three Johns merged the science of electrical engineering and signal measurement, with the aesthetic sensibilities of music, with the cultural embeddedness of anthropology. In turn, it has led to some new insights about some very old sites.

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The most important part of this interaction, however, is not the emergence of acoustic archaeology itself, but rather the way in which the interaction shaped the three Johns as they engaged with others. These three researchers exist in a broader community…

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... and all three point to how their subsequent relationships and collaborations carry an imprint of the Chavin de Huantar experience.

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In turn, those collaborators, too, take the ideas, insights, and new perspectives forward into an ever-wider range of disciplines and relationships. Today, for example, geophysicists are drawing upon the same insights to consider how certain phenomena might be modeled not as seismic by rather as acoustic.

I think the efforts of the three Johns – and of the many, many others with whom they interact – represent innovation at its finest. Here, I use "innovation" not only to refer to widgets, gadgets, and black-boxed objects, but also new ways of thinking, new approaches to old problems, and actively putting these new approaches into action. Part of my argument is that the more diverse the ingredients,

the greater the potential for novel insights. Thus, allow me to distinguish radical interdisciplinarity from three other approaches.

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First, what I have in mind is not increasing specialization, as represented by the finer-tuned shades of red in this image. Consider the following example of what psychoacousticians call the "cocktail party problem." As humans, we have a remarkable ability to focus in on one stream of sound, as with a single conversation in a noisy cocktail party or the sound of one speaker or string quartet in an environment of multiple speakers and a string quartet playing simultaneously. We're still not entirely sure how the human brain accomplishes this feat. But we do know that the answer lies not in deeper specialization among cognitive psychologists alone. Instead, some of the most promising work on the cocktail party problem lies at the intersection of cognitive psychology with neuroscience, which describes the physiology of the brain itself, and with music – for composers have long understood how to write a melodic line that can be picked out amidst a full symphony orchestra in a hall filled with 2000 concertgoers. In other words, the answer lies in a combination of disciplines, not in specialization within disciplines.

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Second, what I have in mind is not collaboration among the usual suspects: chemistry and biochemistry; art and art history; accounting and finance. Those mixtures are important and those mixtures can be innovative, but they are not radical. They do not require one to move across barriers. And they are not as likely to encounter the resistance that we see when medieval poetry meets mechanical engineering; when art history meets astrophysics; or when economics meets English.

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Third, what I have in mind is not hierarchical. We have a long history of interdisciplinarity through hierarchy in organizations. For example, technology-based R&D-intensive companies, where I focus my research, long privileged engineering and product development over marketing and sales; when we teach entrepreneurship today, however, we emphasize the importance of integrating these functions, so that marketing shapes the product development process itself, rather than simply selling whatever they're told. Incidentally, the most successful startup companies today take this non-hierarchical approach.

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So, if I don't mean increased specialization…

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…or the usual suspects…

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…or hierarchy, then what do I mean by radical? I have three senses of the term “radical” in mind.

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First, radical is transformative. It’s not casual or surface-level, but rather far-reaching and thorough.

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Second, radical is a noun, referring to those people who act to realize thorough or complete reform. Here, the action is important. Radicals don’t sit on the sidelines; they actively engage in the change that they want to see. Incidentally, it’s interesting to note that the rise of interdisciplinary programs on U.S. university campuses coincided with the 1960s. That’s not a coincidence.

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Third, as anyone who grew up in the 1980s knows, radical is rad. It’s cool, awesome, and gnarly, all rolled into one. And radical interdisciplinarity is certainly that.

So, what do we need to engender radical interdisciplinarity? I’d like to argue that there are four fundamental requirements.

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First, we need diversity. We need different disciplinary backgrounds. Different perspectives. Different skills. We also need these people to be what have been called “T-shaped people”: People with deep expertise in some area, so as to contribute uniquely, and with interest and breadth across areas, so as to see how this depth might apply to a variety of problems or in a variety of settings.

It’s also important to note that you cannot select who you need in advance. Had Jonathan Abel assembled a team in advance to help him with the digital signal processors that he develops for recording studios, it is highly doubtful that he would have included an anthropologist in his group. Thus, diversity, in a sense, must be appreciated for diversity and not with a specific end goal in mind.

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Second, we need an appropriately sized pool of people. Perhaps it is obvious that if we include too few people, the novel connections themselves are limited.

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But, we also face a problem with too many people. As sociologists and social psychologists have long documented, once organizations or other groups pass a threshold size, people form homophilous cliques – collections of other similar people. Again, we lose the benefit of diversity.

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Thus, like Goldilocks and the three bears, the idea is "not too big and not too small." The Stanford center, for example, intentionally maintains a size of around 50 people, which happens to be fall right within the range that organizational sociologists recommend.

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Third, we need "churn" or turnover. When I meet with business leaders who seek to understand the university, I remind them that we are an organization that, by design, turns over 25-percent of our most important people every year: In fact, we celebrate their departure with an event called graduation. We also celebrate the arrival of a new group with convocation. There is a lesson here for innovation and interdisciplinary networks. They cannot be static, or else they degenerate into old ways. At the Stanford center, for example, composers describe how they have to move on after some period of time or else their compositions start to sound like everyone else's. In a totally different domain, the U.S. military's DARPA organization, known for its incredibly innovative practices, limits their program managers to a tenure of five years. Churn…

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… is key.

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Finally, we need the ties among individuals themselves. Establishing ties can be difficult, particularly across diverse disciplines. Towards this end, music can be a wonderfully universal and approachable language, as with the Stanford center. Shared tools and artifacts, like computers or Strombus shell trumpets, can offer a common frame of reference, even as they're interpreted differently through different eyes. Big, hairy problems, such as climate change and social justice, can serve critical roles in motivating people to come together in the first place. In fact, arguably the only way that we'll solve such problems is by drawing on diverse disciplines. And, of course, parties, food and drinks can help – as with John Rick and John Chowning conversing at a cocktail party.

But there is one other crucial ingredient, too, which was shared with me by Max Mathews. Mathews was an engineer at AT&T Bell Labs in the 1960s and he is considered the "father of computer music" – the first person to formally propose that a computer could, in fact, be a musical instrument and not just a giant calculator. A year before his death, I asked Mathews how he thought to merge the then-nascent discipline of computer science with music, of all things. He replied that he wasn't a very good violinist. "In fact," he said," if I were a better violinist, I probably wouldn't have bothered with the computer." The point is that Mathews contributions stemmed from a fundamental respect that the computer scientist had for the musician. And this may be the most important ingredient of all: For it is the respect that the computer scientist has for the musician; that the musician has for the engineer; that the engineer has for the anthropologist; and that all of us might have for one another that truly gives rise …

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…to innovation.

Thank you very much.