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My name is Thomas Zurbuchen. I am a Professor in Space Science and Aerospace Engineering at the University of Michigan. I run a Masters of Engineering program in Space Engineering. I also ran a PhD program in Space Science until a couple of years ago. I am now the Director of the Center from Entrepreneurship at the University of Michigan, dedicated to the empowerment of students, faculty, and staff within the University, as well as being an enabler for the entrepreneurial community in Michigan and elsewhere.

In mid-January this year, the MESSENGER spacecraft flew by Mercury and provided the first look at our innermost planet since the mid-seventies. On MESSENGER there is a small instrument—weighing only 3 pounds—that was built at the University of Michigan. The Fast Imaging Plasma Spectrometer (FIPS) provided us with the first measurements of Mercury's thin atmosphere and the first ever plasma ion measurements from this battered magnetosphere. FIPS almost did not make these historic, exciting, and enlightening measurements because of ITAR.

You can tell from my accent that I did not grow up in the U.S. I was born in the mountains of Switzerland. I have been a proud U.S. citizen for close to four years. But in 1999, I was still on an H1 visa. We had been working on a proposal for a totally new and innovative sensor that would allow us to measure plasmas but weigh only 10-20% as much as traditional sensors. We had some tough electronics to build and I was heading a very small, but fantastic team—almost all of them U.S. citizens. Then, in 1999 the Strom Thurmond National Defense Authorization Act was signed into law. All of a sudden the level of concern about export controls escalated. Now, transfer of knowledge or know-how to a foreign national was defined as export. Because of my citizenship, my status on the project changed, though the actual project did not. Other participants on the project outside of the U.S. felt that, by law, I could no longer work with my engineers, or discuss technical details—details that needed lots of discussion. I was stuck. Wasn't I doing fundamental research? It sure seemed that way: What can you possibly use the ion sensor for? Our ion sensor was clearly and only designed for research use. But, FIPS was specifically designed for use in space and there was therefore no question that we fell under ITAR—and that was serious. I remember two principal impressions from that time: How helpless I felt and how humiliated. There was nothing I could do: we did not know how to get clearance and the University of Michigan was largely confused by export issues and averse to accepting any projects that imposed restrictions on access by foreign nationals. But that did not matter to our suppliers, collaborators, and federal agency project managers who were scared of violating federal export laws. I also could not imagine how I could use FIPS to hurt the U.S., and I felt this was implied by the rule.

Fast-forward ten years. My lab looks very different. I do not have any foreign nationals working there. We now have rooms and servers that are locked off to fulfill contractual conditions. And we still struggle with the same problem: Due to ITAR, foreign nationals are still under a handicap with regard to participating in space research at a university. Although the ITAR problems are much less if a project is solely fundamental research, these days, space projects are overwhelmingly collaborations with organizations that are not U.S. universities and

therefore do not have the benefit of the fundamental research exclusion. At a minimum, faculty members at the University must have extensive interactions with the collaborators; and such interactions by foreign faculty members are hindered by the ITAR rules. This hindrance can result in the University not hiring the best faculty for the desired areas of research, or can result in foreign faculty (like I was) from participating in projects for which they are best suited. ITAR thus remains an obstacle to universities and the United States and keeps them from being the leaders in space research.

ITAR also discourages the best students from attending U.S. universities and contributing to and enhancing the excellence of our space research, both at the universities and subsequently in industry.

I run a Masters program in Space Engineering that prepares students for careers in aerospace engineering. This year I have two students out of forty who are not U.S. citizens. Contrast that with an average of 25% of Masters students across the College of Engineering who are foreign born. They have absolutely no hope of finding a job in the U.S. space industry, while their U.S.-born colleagues, many of whom hadn't done nearly as well in class, get multiple job offers. The best student I ever had is now a test pilot for EADS because as a German he could not get a job in the U.S. Another student of mine is running an advanced space communication program in CNES, the French space agency, after he also failed to get a job in the U.S.

Let me assure you that I share a key value that undoubtedly initiated these problems: I do not want to have any crucial technology get into the wrong hands. More importantly, I do want the U.S. to be the dominant country in all the areas that create technological leadership and ultimately enable a better and safer life for my family.

On the other hand, there are many examples of the dire consequences of these overly restrictive rules: The best high-resolution space clocks you can buy right now are built in Europe. They were not built there until a few years ago. The European Galileo program—the European version of GPS—couldn't get U.S. technology, so they started a crash program of their own to develop what they needed. I don't have to tell you that the U.S. has very little influence on the limiting of the exportation of European technology to nations whose space aspirations may worry the U.S.

I would also propose that the premise of ITAR protection is wrong and inconsistent with the basic rules of technology development. As I mentioned, I am the director of the Center for Entrepreneurship at the University of Michigan College of Engineering. In this role I deal with emerging technologies, new innovations, new businesses, much of this involving students. We are "surfing the wave of innovation." There is one rule that I see at work every day: Technological leadership comes from aggressive offense not from a defensive posture. The only way for the U.S. to maintain dominance in space engineering is to outperform innovators worldwide. We can't build a wall around progress and lock it up. We have to stay out front of the race for innovation and leadership.

I personally believe in the importance of U.S. research universities in this struggle for leadership. In the end, success will boil down to two key ingredients: the talent that can create the next victory and the environment that encourages our best to excel. This is of course true for all engineering disciplines. But, interestingly, most other disciplines have created methodologies that dramatically differ from aerospace engineering.

In general, at the University of Michigan College of Engineering we are emphasizing three key elements: entrepreneurship, interdisciplinary design, and international cooperation. We have a goal that within 5 years 50% of our students will spend one semester abroad. Our students

work around the globe and their engineering products address global needs and opportunities in all sectors: energy, sustainability, health science, computer science, and many more.

Contrary to the general approach for the College, aerospace engineering, especially its elements that relate to the design of space systems, is moving backwards. ITAR is a major obstacle to the participation in space research by international faculty and students and to the desired and needed international cooperation.

In summary, ITAR regulations, designed to guide and protect, have confused us and they have made us vulnerable. But, the most important consequence ITAR has had for the University of Michigan Department of Aerospace Engineering is that it has led to loss of quality and to isolation from other disciplines and their progress.

So, how did FIPS make it to Mercury, you might ask. The answer is: We got lucky. Just a few months after getting isolated from my own project, I received my Green Card. Our Canadian-born mechanical engineer, however, lost his job. Still, we managed to pull it off. FIPS was built at the University of Michigan and involved 3 graduate students and well over 40 undergraduates. Many of these students are now turning into leaders in the aerospace industry.

On behalf of my colleagues and myself, I thank the Committee for their attention to this important topic. In my opinion, international, open collaboration is the only way we can assure that space technology continues to be invented at our nation's best universities.

Thank you.