Testimony from Neil D. Kane, president and co-founder, Advanced Diamond Technologies, Inc. to the U.S. House of Representatives' Subcommittee on Research and Science Education, Committee on Science and Technology
Hearing: "From the Lab Bench to the Marketplace: Improving Technology Transfer"
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I'd like to thank Chairman Lipinski, Ranking Member Ehlers and the other members of the Committee for the privilege and honor to speak to you today. I represent on today's panel the perspective of the start-up company founder who has launched several businesses based on federally funded research performed at federal labs or at universities.

Advanced Diamond Technologies (ADT), a company I co-founded in late 2003 with Dr. John Carlisle and Dr. Orlando Auciello, both scientists at Argonne National Laboratory, is a company that turns natural gas (methane) into diamond. They're the technical founders and I'm the "business guy". You may remember from your freshman chemistry class that diamond is a form of carbon. Methane, a hydrocarbon, is comprised, as you might suspect, of hydrogen and carbon. At the right temperature and pressure, in a process very much like the ones used to make semiconductors, we can strip away the hydrogen, re-arrange the carbon atoms, and literally turn 50¢ worth of a commodity gas into several hundred dollars worth of diamond. The diamond we manufacture has a wide variety of commercial uses, described later, and isn't used for jewelry. Today we have 16 full time employees which include five Ph.D.s and seven master's degrees…that is, ¾ of our company have advanced degrees. We are working to build a manufacturing facility for carbon materials in our plant near Chicago that will be a model for what 21st century manufacturing will look like.

We are a nanotechnology company because we control the properties of diamond on almost an atomic scale…even though the products we make are very much macroscopic. What makes us unique is that our diamond, known commercially as UNCD®, is very smooth. It is smooth because it consists of individual diamond grains that are nanometers in size. We formed ADT around the vision that if we could take the world's hardest material, which has a dizzying array of beneficial electronic, physical and biological properties, and make it smooth, reproducible and affordable, then the number of uses for it would grow tremendously.

Our company, and the jobs it has created, would not exist were it not for the basic and applied research that the Department of Energy (DOE) funds at Argonne National Laboratory. The foundational technology, which we licensed in the form of a portfolio of about 15 patents, began as a research project at Argonne in 1992 supported by DOE's Basic Energy Sciences (BES). Later the Industrial Technologies Program in the DOE's Office of Energy Efficiency and Renewable Energy (EERE) provided core funding for applied R&D to develop the technology as a low friction, energy saving coating for industrial components. We are the beneficiaries of this research, which in total is about $15 million. In return for giving us the exclusive right to use these patents, Argonne receives ongoing royalties from commercial sales of the products incorporating the technology and also is a significant equity holder.

With our innovations, diamond can be used to make game changing products like:

- Bearings and seals for industrial equipment that last tens of times longer than current components while saving energy by running cooler due to diamond's low friction properties
- High performance wireless communication chips for secure military communications and phased-array radars
- Biocompatible coatings for implantable organs like artificial retinas

- Electrodes that can neutralize toxins, carcinogens and heavy metals in industrial waste water
- Durable nanoprobes for atomic-scale imaging and nano-manufacturing
- Wearable sensors for real-time detection of biological warfare agents
- Coatings for heart pumps that change the standard of care from temporary devices for patients awaiting heart transplants to permanent devices that won't form blood clots, thus allowing patients to live with them for years as an alternative to heart transplants
- And the list goes on.

Although we are still a small company, our products are being sold around the world today. We've taken the basic research performed over 15 years ago and are now turning it into exports that help improve the balance of trade and the competitiveness of the U.S. economy. Along the way we've been recognized globally for our innovation. More importantly we are creating jobs and building manufacturing capability in the U.S. that will strengthen our future industrial tax base.

My experience with technology transfer is by no means limited to Advanced Diamond Technologies. As Entrepreneur-in-Residence for Illinois Ventures, I was part of the startup team for four other university spinoffs, three of which have gone on to raise tens of millions of dollars of venture capital and collectively employ over 100 people in areas as broad as printed electronics and micro-inverters for photovoltaic systems. Through this effort I've negotiated license or option agreements at the University of Illinois, University of Wisconsin, Northwestern University, University of Pennsylvania and Oklahoma State University in addition to Argonne. When I managed the entrepreneurship center at Argonne, I used to sit in on the licensing meetings at The University of Chicago.

The National Science Foundation's SBIR/STTR program (referred from now on as the SBIR program) has had a profoundly positive impact on ADT's ability to bring products to market and create jobs. The SBIR program has provided funding to allow us to bring the technology out of the laboratory and develop it for commercial applications. Our technology was meritorious for its potential but was not ready for prime time when we licensed it from Argonne. The road from the lab to the marketplace, we have learned, is a long one for complex technologies.

In June 2004, before we had any external funding, we received our first Phase I SBIR to develop diamond-coated seals for industrial pumps. This vote of confidence got our company started and was the catalyst that secured our first angel financing about a month later. Today, after a follow-on Phase II award and IIB supplement, we're selling diamond-coated mechanical seal faces globally and are just beginning to enter our growth phase. We've gotten one more Phase II and have several more Phase I projects in process that we hope will lead to future products. All told we've received commitments of about $3.3 million in NSF grants, with approximately 10% of those funds going to university collaborators to support graduate students. Most of the products we are selling commercially today were once the subject of NSF SBIRs or STTRs, and each of the Phase II awards we have received is now generating commercial sales.

During the same interval we've raised approximately $6 million from investors. The SBIR grants have allowed us to bring the technology to a level of maturity to make our investment proposition palatable to private investors since we have to compete for their money against the array of other investment opportunities available to them. We don't request grant funds just to do contract R&D. All of the grant proposals we have written have been targeted toward doing the translational work necessary to convert great science into great products.

There are many ways to transfer technology into the commercial realm, and my remarks are confined to doing so through the creation of startup entities. Through my experiences starting companies based on university or federal lab research, I've noticed a number of challenges:

- Good researchers are often not good business people, yet
- The researchers are needed in the company at its founding to ensure that the technology is properly transferred to the commercial realm. In addition to the professors, in each company I've been involved with, the graduate students or post docs coming out of the research program had a prominent role on the founding technical team. In some cases this has been hampered by immigration issues (discussed later).
- The transaction costs of executing licenses from universities and federal laboratories are too high, and I've seen deals go awry due to "deal fatigue". Imagine deep-pocketed investors interested in starting a company who walk away because they couldn't secure rights to the technology on reasonable (in their eyes) license terms. It has happened. In my experience the institutions always underestimate the time and money needed to turn their innovations into commercial products.
- The researchers have no calibration about what they can expect in terms of equity and compensation for participating in getting a company formed. The fear among the researchers that they're not getting treated fairly has, perhaps surprisingly, been one of the biggest impediments in getting companies started. War stories are abundant and anyone who has done this at least once has at least one story to tell.
- Institutional constraints on researchers make the process difficult. The researchers (often professors) have to pursue this as an extra-curricular activity. When we got ADT started, my co-founders at Argonne, although they started the company with the full cognizance of management, had no incentives to do so except their equity participation in the company. At the same time, there was no relief for the things they were measured on, like publications, and thus they essentially had two jobs for quite some time. They each came away with a piece of the company, but their achievements in getting the company started were not recognized in their professional trajectories at Argonne. I've heard stories of tenure-track professors at universities say that they can't participate in a company right now as it would harm their ability to get tenure. Get tenure first, they figure, and then start a company.

Despite all this, I've learned over the past ten years that *the real challenge is not transferring the technology out of the laboratory—it's transferring the technology into the marketplace*. If we do everything right except get products to market, we've accomplished nothing. A professor friend of mine said, "When the technology leaves the lab, it's 5% done."

The cost, time and expertise needed to turn great science into great products is where a gap really exists. This is referred to as the "valley of death", a term often attributed to Ranking Member Ehlers. The "valley of death" is the chasm that exists between basic research (often funded by NSF) and the private financing which becomes available once the technology has proven commercial potential. We've closed this gap by using SBIR programs to de-risk the technology to a point where we can attract private capital.

Some of our products have gone through several years' worth of qualification testing by our large customers, and these are very expensive activities to fund because the marketing and development expenses are incurred in the present whereas the payoff, in the form of sales, will happen in the future. Today we sell diamond-coated mechanical seals for pumps, such as those used on Navy ships. Even though we've got the product ready today, the Navy will need to go through at least a year of qualification testing before our products could be used on their ships.

DOE's EERE has created a program called the Technology Commercialization Fund that is geared toward these types of development activities, further bridging the "valley of death", and it expressly excludes scientific research. I encourage the Committee to review this program. The TCF has allowed us to bring a new type of diamond bearing product to market, leveraging work that was funded by an NSF SBIR, which leveraged basic and applied science originally conducted at Argonne, which was augmented by private financing (the TCF program requires cost sharing). We have a large international customer poised to order over a million dollars of new product in the next 12-24 months as a result.

The SBIR/STTR programs are among the most important programs for stimulating entrepreneurship and they are the envy of governments around the world. The programs should be expanded, and the dollar amounts should be raised. Agencies like the Environmental Protection Agency have paltry SBIR budgets compared to NSF and the Dept. of Defense, yet environmental issues ranging from clean water to environmental damage in the Gulf of Mexico are top U.S. priorities. The SBIR program is a great way to unleash the creativity and innovation of U.S. researchers in a competitive process to address these national issues. Compared to many other government programs the cost is insignificant, yet the potential return is quite high—because it's an investment in America's competitiveness, not an expense.

With my experience in starting many companies, I've formulated a number of principles, or best practices, that have become part of my startup template:

- The scientific team (professors, researchers) must have equity participation in the startup companies in return for their cooperation to ensure successful knowledge transfer. Their ownership should have a vesting schedule that is conditioned on their active involvement.
- Researchers need trusted counsel to advise them otherwise the process gets bogged down by them feeling they're getting a raw deal. The earlier these advisors are identified, the better.
- To be able to attract private capital, the licenses to the intellectual property need to be exclusive even if they are for a limited field of use.
- The people that make it work and create the value—the employees of the company—should share in the fruits of their work. The founding technology is a critical element, but it often is not worth much until the employees develop it.
- Even if the company is able to attract SBIR funding, some private capital is still needed for the company to prosper. Said another way, you can't build a company if your only source of funding is the government.

My recommendations to tech transfer offices:

- Their institutions must have sabbatical programs to permit technical founders to work in the company to transfer the knowledge but have a job to come back to. In two of the companies I've started, tenured professors (or equivalent) have left their positions to join the companies they helped form. This was good for the companies, but it is unclear if it was desirable for the institutions.

- Make licensing terms and conditions more transparent to lower transaction costs and facilitate company formation. Each institution should publish its standard agreements along with stated expectations for critical deal terms and conditions (such as exclusivity and royalty rates). While some worry about giving up a technology too cheaply, the reward will be recognition as an easy place to do business. With that recognition will come more startups, more economic development activity in their communities, more job opportunities for graduates and more wealthy alumni not to mention lower overhead in the tech transfer office.
- The universities should view tech commercialization as being consistent with the career advancement of their faculty. Is it ill-advised to have tenure committees look to a researcher's record of creating economic wealth from his or her work as part of the criteria?
- Although all universities offer some type of training to their faculty about startup formation, I've not seen any that address the cultural differences between being a faculty member and being a member of a startup team, yet most of the friction I've seen occurring among startup team members is due to these issues. Matters of collaboration, confidentiality, competition, market focus and subordination are all critical for career researchers to understand. Not all academics may want a role in a startup, but if they take that role, since many other careers and investment dollars will be at stake, they should know what is expected of them. I've seen too many examples where the expectations were unmet, causing major problems, because they were not clearly explained at the outset.
- Additionally, since startup companies provide great career launch pads for graduate students with subject matter knowledge in the technology, I've often found that these grad students (or post docs) lack the horizontal skills that are necessary to succeed in a commercial company. I'm an advocate for universities providing training to students in non-traditional academic areas such as: time management, project management, budgeting, non-technical writing, presentation skills and basic sales skills. While technical acumen is paramount, the success or failure of these individuals in the startup companies, in my experience, is almost entirely due to their soft skills.

NSF, due to its historical role as the funding source for science and engineering, has an opportunity to influence practices at universities and thereby stimulate the "innovation ecosystem". NSF should:

- Create a framework whereby each university publishes its license template and financial expectations for license agreements. Right now it's an opaque process where the university always has the advantage due to their knowledge of what others have paid for their technologies.
- Encourage universities to recognize tech commercialization as an important adjunct to basic research whose aims are not in opposition to basic research.
- Shorten the review cycle for SBIR/STTR proposals. The current times are not compatible with the life cycles of small businesses.
- Take a leadership role in stimulating the commercialization of basic research. NSF does a great job at supporting basic research, and the SBIR program is integral to helping translate research into small businesses. But there's another step missing…that of bringing products to market. NSF funds cannot be used for commercialization. There's a need for the government to provide additional funding sources to allow early-stage companies to get over the "valley of death". Doing so is not corporate welfare. Rather it helps to ensure that the taxpayers get a return on their initial investment in basic research.
- Encourage universities to provide training in the non-technical, horizontal skills described above.

Other recommendations to the Committee

- Rather than seeing themselves as stewards of public property, due to the Bayh-Dole Act, universities have to come to believe that innovations developed with federal funds are theirs. I suggest modifying Bayh-Dole to require that any license agreements executed for subject technologies become publicly accessible. This should be legislatively mandated. Universities will vigorously oppose it, but it will level the playing field and reduce transaction costs across the board. This action will dramatically shorten the time needed to get companies formed and licenses executed. From the university or federal lab standpoint, the public contract should change from "the government funded it but we own it," to "if we want to profit from retaining title to the intellectual property which was funded by the taxpayers, then we have to be willing to tell the taxpayers what we charged them for it."
- Lower the size standards for SBIR/STTR. Today the limit is 500 employees and that's set by the Small Business Administration. Any company with 500 employees is a going concern that has over $30 million in annual revenue…and probably much more…whose ability to fund research and product development is much different than companies with less than 50 employees that are still not profitable. The needs of startups are different than companies with hundreds of employees, and the SBA needs to create segregated programs that reflect these differences.
- Encourage the SBA to create a Micro Business Administration—the MBA—to focus on the constituency described above. Small businesses are the source of most net job creation in the U.S., but for startup companies based on federally funded research to get big, they need programs that are appropriate for their fragile state when they are embryonic.
- A tax policy that favors investing in small businesses. In some states, like Illinois did recently, tax credits are available for qualified investments in startups. This needs to be part of federal tax policy.
- A major impediment to our getting started was the risk to the inventors of leaving their positions in a federal lab and joining the company. There was no program whereby they could join the company for a period of time and then return to their position. A sabbatical program for federal laboratory employees who start companies based on their research is something this Committee can make happen. It will lower the career risk for the scientific founders and ensure higher probability of technical success.
- An overwhelming majority of the technical professionals who have applied for jobs with us are foreign students without permanent work visas. The policy of educating foreign students and sending them home against their desires when they graduate doesn't make sense on any level. Others have proposed the "earn a degree, get a work visa" program, and I wholeheartedly endorse this. The Startup Visa initiative is a twist on this theme, and it also makes good sense. Current immigration policy limits our ability to attract the best and brightest into U.S. companies. What's worse is that we nonsensically will educate anyone only to then deprive them of their desire to ply their trade in the U.S., and we demand that they grow the economies and competitiveness of their home countries.

  I know of one instance where a foreign student graduated with a Ph.D. and he was offered a position in a startup company that was based on his thesis work. But the company couldn't get a work visa for him because the H1-B quotas had been exceeded. So his thesis advisor, who was the founder of the company, had to get him a research position at the university to keep him in the country until the H1-B visas opened up. Needless to say this activity created manifest conflicts of interest all around. An enlightened immigration policy would eliminate these kinds of behaviors.

Summary

My company is developing important new technologies and generating good jobs today because of taxpayers' investments in basic research augmented by the availability of SBIR funding from NSF to refine that technology. Our success benefits many facets of the U.S. economy—its tax base, its exports and its global competitiveness. But with advanced technologies, it can often take years, even under the best of circumstances, to secure commercial success. I encourage this Committee to see tech transfer as an investment in the economy, not an expense, and to implement the changes needed to stimulate this investment.

Neil D. Kane

Neil Kane is president and co-founder of Advanced Diamond Technologies, Inc., a firm he founded in 2003 by licensing technology from Argonne National Laboratory (U.S. Dept. of Energy). Mr. Kane is the former co-Executive Director of the Illinois Technology Enterprise Center at Argonne and Entrepreneur in Residence with Illinois Ventures, LLC. In these roles he was founding CEO of several startup companies based on university or federal laboratory research. He has closed multiple rounds of venture capital from various sources and has secured numerous SBIR/STTR and other government contracts and awards.

Earlier he was Regional Business Development Manager for Microsoft Corporation in Chicago. In this role he identified, negotiated and closed a $25 million equity investment. He began his business career at IBM where he was the liaison to Andersen Consulting (later Accenture) and helped create the strategic business alliance between IBM and Accenture that became the model for the industry. In this capacity he earned membership into IBM's Golden Circle. He began his career as a manufacturing engineer in IBM's San Jose, California disk drive facility where he designed robotic tooling.

He holds a Bachelor of Science degree in Mechanical Engineering from the University of Illinois at Urbana-Champaign (high honors) and a Masters of Business Administration from The University of Chicago. He has attended graduate school at the Australian Graduate School of Management at The University of New South Wales in Sydney and did further graduate study in Japan on a scholarship from the Japan External Trade Organization (JETRO). He was named a 2007 Technology Pioneer by the World Economic Forum and attended their annual meeting in Davos, Switzerland in 2007 and 2008. In 2007 he received recognition from the National Science Foundation for Outstanding Entrepreneurship, and in 2009 he was named a "Mover & Shaker" by Frost & Sullivan.