

Technology Development Center

Fiscal Year 2015 Report



From Our Director



One of the programs managed by the Technology Development Center is the Technology Business Development Program (TBDP). This program is known generically as a “gap funding” program. Such funding programs fill a developmental no-man’s land where promising technologies arising from university research can languish for lack of even a modest amount of research support. This bottleneck, also called “the valley of death,” represents a gap seen in all technologies moving from research to development to commercialization. Technology is often seen as to be too applied to get traditional federal funding, and yet too basic to get normal industrial support—hence the gap. The TBDP helps fill this gap.

OSU’s TBDP was started in 2005; the TBDP seeks out research projects with high commercial potential and then helps those inventors reach that potential by supporting the project through to the point of licensing. The TBDP advises and directs funding, assesses the commercial potential of products, and assists in the formation of new companies and the licensing of new technologies to existing companies. Using funds from a series of internal grants and from royalties generated by OSU-licensed technologies, the TBDP also funds both the development of prototypes of new technologies and feasibility demonstrations. In addition, the TBDP supports researchers by providing them with opportunities for networking and for commercialization assessment.

Since the Technology Business Development Program began in 2005, it has provided \$2,376,119 to OSU. Outputs of the program include:

140 disclosures

88 patent applications/issued patents

30 licenses/potential licenses

25 start-up companies/interest in start-ups

\$10,871,823 in follow-on funding to OSU that can be traced back to TBDP awards

231 student employees have been supported by TBDP funds

18 students have been involved in business plan development for TBDP projects

93 publications produced

110 proposals have been funded and

306 proposals have been received/reviewed.

These numbers are our most conservative, and do not reflect the value of any of the companies that were started.

However, we are most proud of the \$4.50 that has been returned to OSU for every \$1.00 invested by the TBDP program.

Steven C. Price, Ph. D., Director, Technology Development Center

TDC

FY 2015 At-A-Glance



TBDP

Since program inception in 2005, TBDP has funded \$2,376,119 and generated:



Cold Plasma Technology/Plasma Pouch

The path to commercialization of inventions is never clear, and often takes many turns. Usually, the original idea for the use of an invention is not the final one, nor the most lucrative. Starting in 2003, Dr. Jamey Jacob, Professor in Aerospace Engineering and director of the OSU Unmanned Systems Research Institute, started research with the Air Force on using cold plasma to prevent planes from stalling due to reducing drag on the surface of wings. He had to design a plasma generation system that would create a plasma (plasma is a charged gas and sometimes called the fourth fundamental state of matter, the others being solid, liquid and gas) using relatively low amounts of energy. Dr. Jacob developed novel actuator configurations using battery powered plasma generators that converts ambient air into a plasma. The system also generates a force on the surrounding air, which is one aspect that made it useful for flow control. The same process makes it useful for sterilization, since the charged particles in the plasma kill germs and viruses, though at the time the mechanism was unknown.



L-R: Chris Timmons, Rohita Mal & Kedar Pai

So, the idea of using a plasma to enhance an aircraft performance turns into the idea of using a plasma to sterilize materials. Enter Dr. Kedar Pai, a graduate student of Dr. Jacob's. He and Dr. Jacob thought that perhaps the plasma could be used to sterilize any number of objects. In 2012 they applied the cold plasma technology to an enclosed system that could be sealed. Thus the Plasma Pouch was invented. A patent was applied for and is currently pending. Kedar completed his PhD on the topic of sterilization using cold plasma and determined the underlying mechanism. *Plasma Bionics LLC* is a limited liability company founded in March of 2012 by Drs. Kedar Pai and Jamey Jacob with its operations in Stillwater, OK. In 2013, the team was expanded to include Chris Timmons, Anuashka Sharma, Prateek Khare, and Rohita Mal. The cofounders, Kedar Pai and Jamey Jacob, developed the intellectual property, namely the plasma pouch at Oklahoma State University. With the help of the team and support from *Cowboy Technologies* and *Oklahoma State University (OSU) Research Foundation*, the co-founders are actively working on testing and commercializing this exciting tech-

nology. Over the last 12 years, more than \$350,000 in research grants and equivalent work hours have been invested in the development of this technology, funded by OSU Technology Business Development Program (TBDP), Cowboy Technologies, LLC, United States Air Force (USAF), and other funding sources with Jamey Jacob as the principal investigator and later with Kedar Pai as the research associate.

Using the cold plasma generation technology, the device can rapidly sterilize medical instruments at room temperature, with no water or chemicals, and with little power input. The medical instrument sterilization device proposed here consists of a control console that powers the device and a pouch wherein the instruments are sterilized. This next generation device uses just air and electricity to sterilize a wide range of instrument sizes, with the pouch serving both as the sterilization chamber and a sterile containment unit that can be taken to the point-of-care. This allows for a rapid, inexpensive sterilization process without any concern for post-sterilization contamination. Additionally, the pouches can be stored for long durations in any location. The control console has no moving parts and is therefore expected to have an exceptionally long lifespan. Most excitingly, since the mechanism of bacterial inactivation, as seen from preliminary studies, seems to be due to mechanical damage to cellular structure, bacterial development of resistance may be unlikely. This device will provide a more rapid, more efficient, and less expensive sterilization solution for all kinds of devices. These substantial benefits will be highly motivating for potential customers to make the switch to the Plasma Pouch

The initial target market is veterinary practitioners. Essentially any medical practitioner or organization that uses reusable medical devices is the potential customer. The inventors will initially approach veterinarians, followed by dentists, then physicians. The initial end-users of the product will be veterinarians that are engaged in small and large animal practices, especially mobile veterinarians. There are around 1,148 animal hospitals and 3,156 primary animal care firms in the US, with more than 2,000 firms providing mobile services. Conversations with local veterinarians have revealed a pressing need for effective alternatives to conventional sterilization devices, such as autoclaves, in terms of price, efficiency, mobility, and operating costs. As long as the product meets or exceeds the sterilization effectiveness of autoclaves, veterinary practitioners, we hope, will be highly motivated to make the switch to the Plasma Pouch. Following penetration of the veterinary market and demonstrating compliance, FDA approval will be sought, allowing entry into the much larger medical markets. Veterinary practitioners will be targeted in the initial phase due to lower regulatory costs and requirements, providing an initial target market potential of approximately \$250 million.

Antibiotic Alternatives for Livestock & Poultry

Antibiotic resistant infections (ARI) are becoming an urgent public health threat. According to the CDC, two million people in the US become infected with ARI, leading to 23,000 deaths each year⁽¹⁾. Evidence continues to emerge that antibiotic overuse in livestock is a key contributor to the increase of ARI.

Public outcry against antibiotic overuse in food production has led to Chipotle Mexican Grill Inc., Tyson Foods Inc., Pilgrim's Pride Corp., Perdue Foods LLC, and others in implementing antibiotic use restrictions. Lawmakers have taken note as well. The FDA has outlined guidance for the judicious use of antibiotics, including restricting medically important antibiotics in livestock starting in 2017.

This has created an immense immediate need for animal producers. Antibiotics are not only used for therapeutic and prophylactic purposes, but to promote feed efficiency. In other words, they make an animal larger with less food. Producers are desperately searching for alternatives that can promote overall health and feed efficiency.

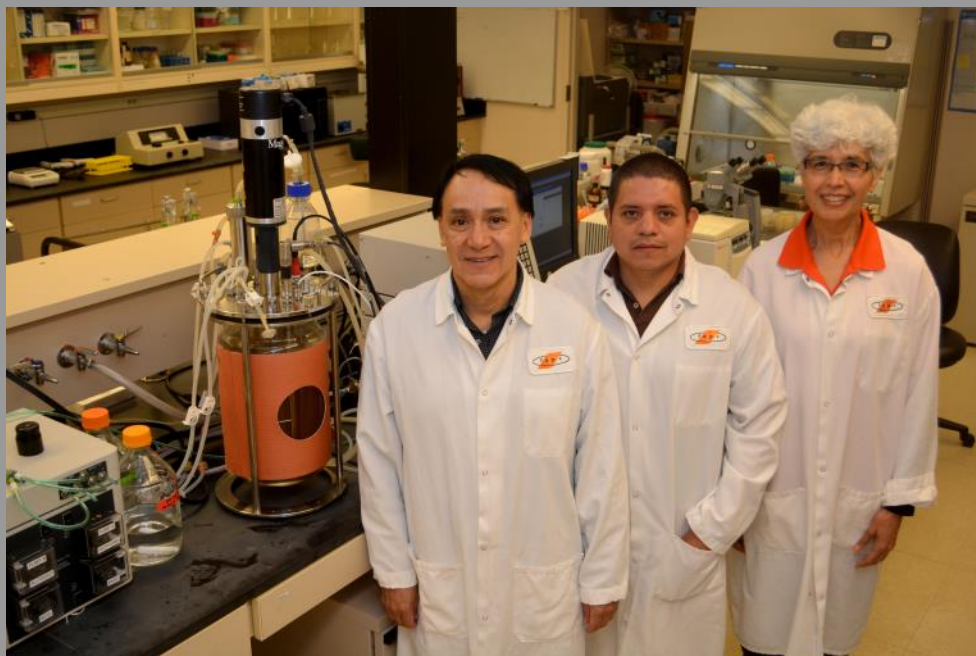
OSU is at the forefront of identifying new technologies that can be used as antibiotic alternatives. Dr. Patricia

Rayas-Duarte, a biochemistry and molecular biology professor, is utilizing a unique screening system to identify probiotic strains that will help animals grow quickly and stay healthy.

Experimental results showed that in the first two weeks broiler chickens that received probiotics had a higher weight gain and lower death rate than control broilers, demonstrating the great potential for this technology. The TDC has filed a patent application for the identified strains and future research is being conducted to evaluate additional strains and optimize concentrations.

A visiting assistant professor working with Dr. Rayas-Duarte, Dr. Alejandro Penaloza says "This research can bring health benefits to chickens and people by maintaining healthy microbial community in the intestines of the chickens. This would maintain healthier chickens and reduce the use of antibiotics. Additionally, the use of probiotics also can generate ecological benefits and increase the efficiency of feed conversion of the broilers."

Dr. Rayas-Duarte's work in this area has been largely funded by the Technology Development Business Program (TBDP), TDC's gap funding program.



The team working on identifying novel probiotics pictured (from left) Drs. Alejandro Penaloza, Zorba Hernandez and Patricia Rayas Duarte.

Antibiotic Alternatives for Livestock & Poultry

(cont.)

Dr. Glenn Zhang, an animal science professor, has identified several groups of patent pending compounds that have the capacity to enhance the animal's own innate defense system. This research is an alternative to researchers searching for probiotics and prebiotics⁽²⁾ as antibiotic alternatives. Dr. Zhang says, "With the ability to promote animal health and productivity, our immune boosting compounds have a strong potential to replace antibiotics."



Dr. Glenn Zhang is using a unique approach to identify novel compounds that enhance a user's own innate defense system as a replacement for antibiotics.

Funding from the USDA and TBDP program supported the initial studies for this work. Cowboy Technologies has furthered this research, providing assistance to Dr. Zhang through sponsored research funding and collaboration with his current OCAST OARS award. They continue to support the product's research development and commercialization pathway.

Dr. Peter Muriana, an animal science professor, has identified probiotic lactobacillus strains that produce powerful antibacterial bacteriocins with different modes of action. Dr. Muriana says, "By combining



Dr. Peter Muriana pictured in his lab where his focus is identifying bacterial strains that produce powerful antibacterial bacteriocins.

those with different modes of action, we can see a synergy of antimicrobial activity against foodborne pathogens." Mixtures of these bacteriocins have already shown to be effective food preservatives against foodborne pathogens, and could potentially be used in animal feed.

This technology was recently licensed to Nutrition Physiology Company, LLC (NPC), a leader in microbial technology and the leading royalty generator at OSU from a previously licensed probiotic. Dr. Muriana is now testing this technology for multiple applications under the sponsorship of NPC, who hopefully will then commercialize the final products.

With projects identifying probiotics, immune boosting compounds and bacteriocin producing bacteria as antibiotic alternatives, OSU has the capacity to help solve one of our most important present-day public health threats. These projects will also help establish OSU as a powerhouse in the area of antimicrobial alternative research and continue to enhance OSU's reputation as one of the top universities in food supply research.

⁽¹⁾ <http://www.cdc.gov/drugresistance/index.html>

⁽²⁾ While probiotics introduce good bacteria into the gut, prebiotics act as a fertilizer for the good bacteria that's already there.

'From Lab to Mobile' connects OSU to the Internet of Things

The Oklahoma State University App Center has started a networking meetup group on campus for researchers and students to exchange ideas and solve problems using mobile computing, including mobile apps and the Internet of Things, as an integral part of research.

Internet of Things is an up-and-coming concept which relates to a system of physical devices connected to the Internet which gather and transmit data. Examples include smartwatches, thermostats, connected cars, appliances and even some lightbulbs.

The first meetup in January brought together OSU researchers from various disciplines who are working on and interested in mobile computing, mobile apps, wearables, mobile health solutions and robotics. App developers and UI/UX designers also attended the event.

The focus of the meetup is to facilitate discussion around topics related to mobile apps and the Internet of Things by bringing in expert speakers. Internet of Things was the topic of discussion during the inaugural meetup.

David Allen, director of product development for AT&T's IoT/M2M Solutions group, spoke at the January meeting to help OSU students and faculty realize the potential of the Internet of Things, which he called the next digital revolution after the Internet and wireless connectivity.

"There are many Internet of Things applications," said Jai Rajendran, manager of the App Center. "An easy

example of this concept is the smartwatch. It's connected to the Internet and gives the user quick information on-the-go. A more complex example would be the use of connected sensors and devices in Smart Cities where a municipality can monitor, manage and control devices real-time. Think connected traffic lights, connected vehicles and utilities."

About 40 people from various departments attended the meetup to learn about the future of mobile computing. The meetup offered a structured networking session where people had the opportunity to learn about others area of research and make connections. A networking session was moderated by Russ Hopper, senior licensing associate at the Technology Development Center. At the end, Scott Davis, licensing associate at the Technology Development Center, presented the process of technology commercialization at OSU.

"From the App Center's side of things, we want to encourage people to take their research from lab to mobile by creating apps and devices on campus," Rajendran said. "We also want to connect people across disciplines in the hope that inter-disciplinary teams could be formed to conduct research in these topics."

Rajendran hopes to have a "From Lab to Mobile" meetup once a semester. He said plans are in the works to hold the next event this fall. To learn more about the App Center, as well as a recap from the meetup in January, visit appcenter.okstate.edu.

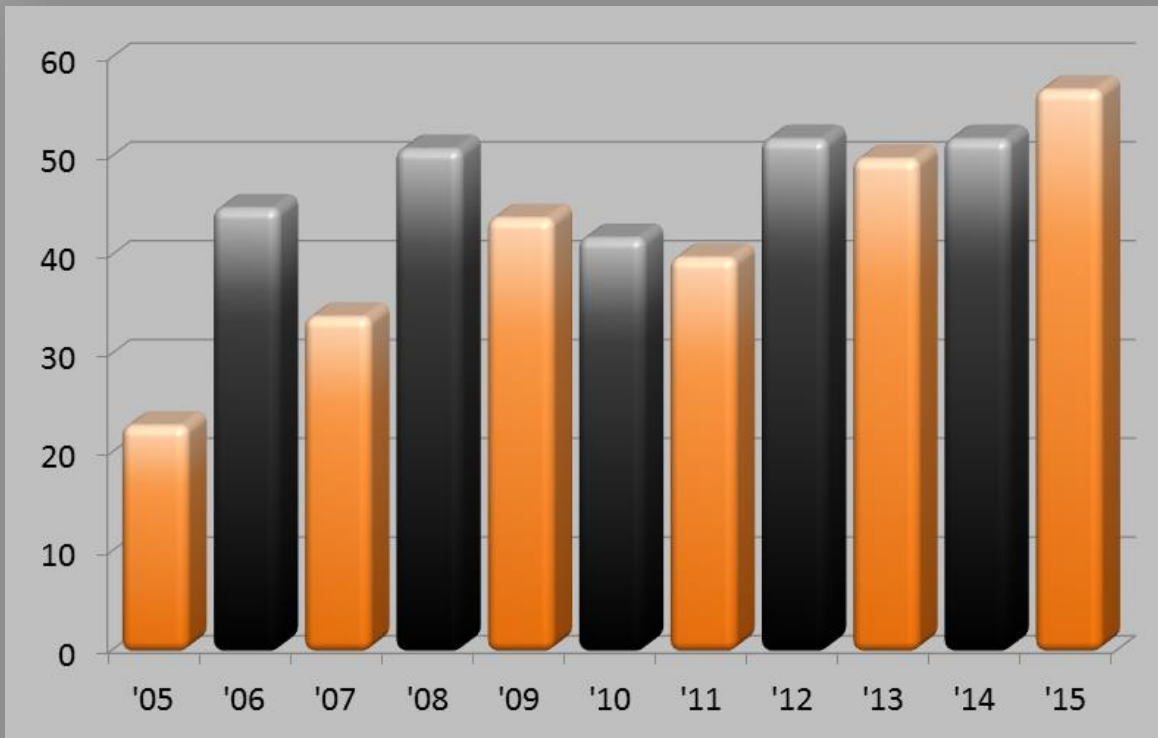
Story by Matt Cohlma



David Allen, director of product development for AT&T's IoT/M2M Solutions group, spoke to a networking group at the OSU App Center From Lab to Mobile event. Allen described the Internet of Things as the next digital revolution.

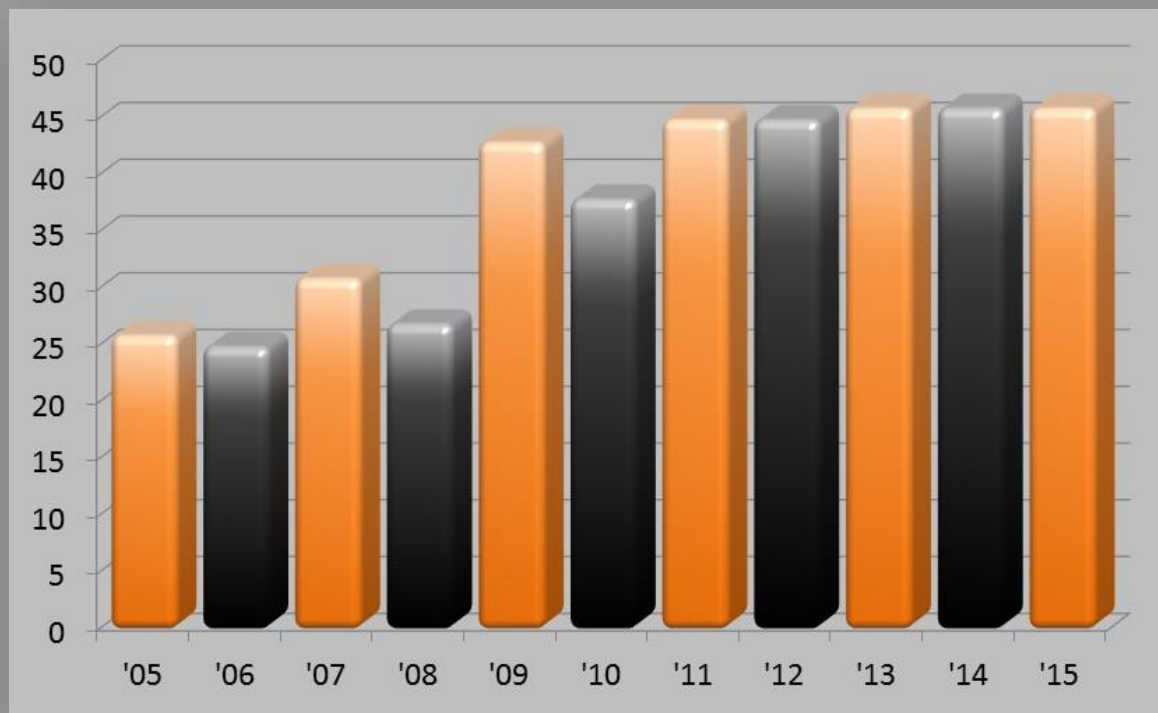
DISCLOSURES PER YEAR

2005-2015



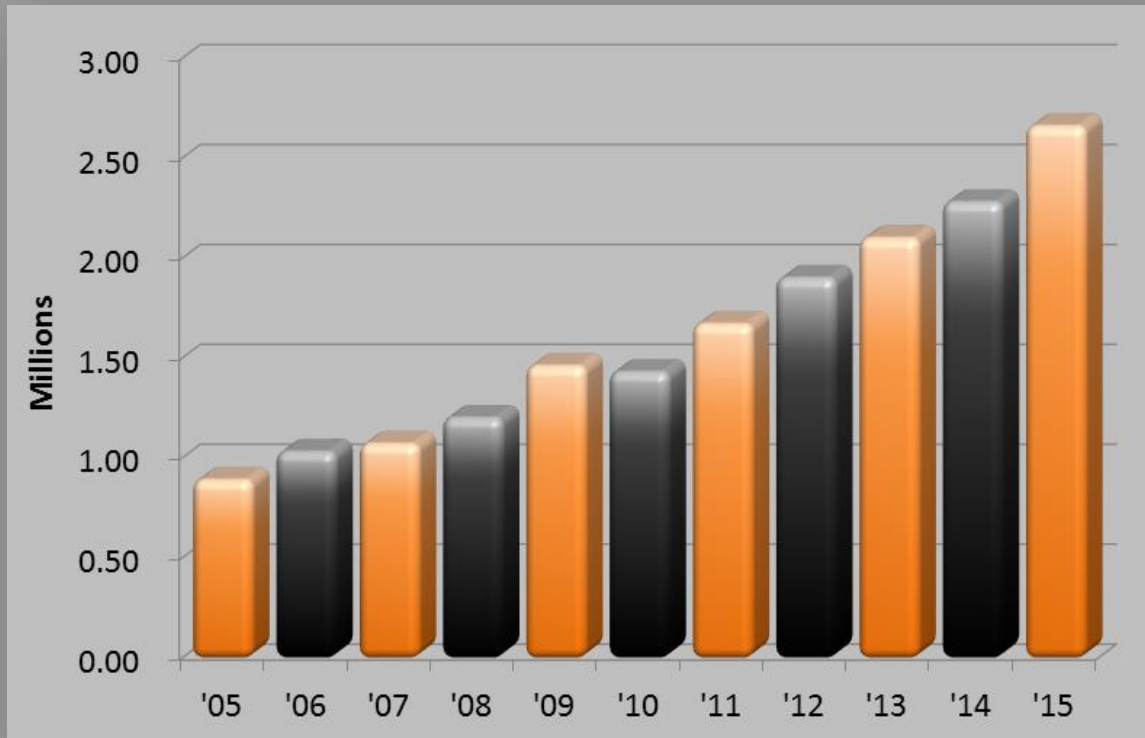
NUMBER OF LICENSES YIELDING INCOME

2005-2015



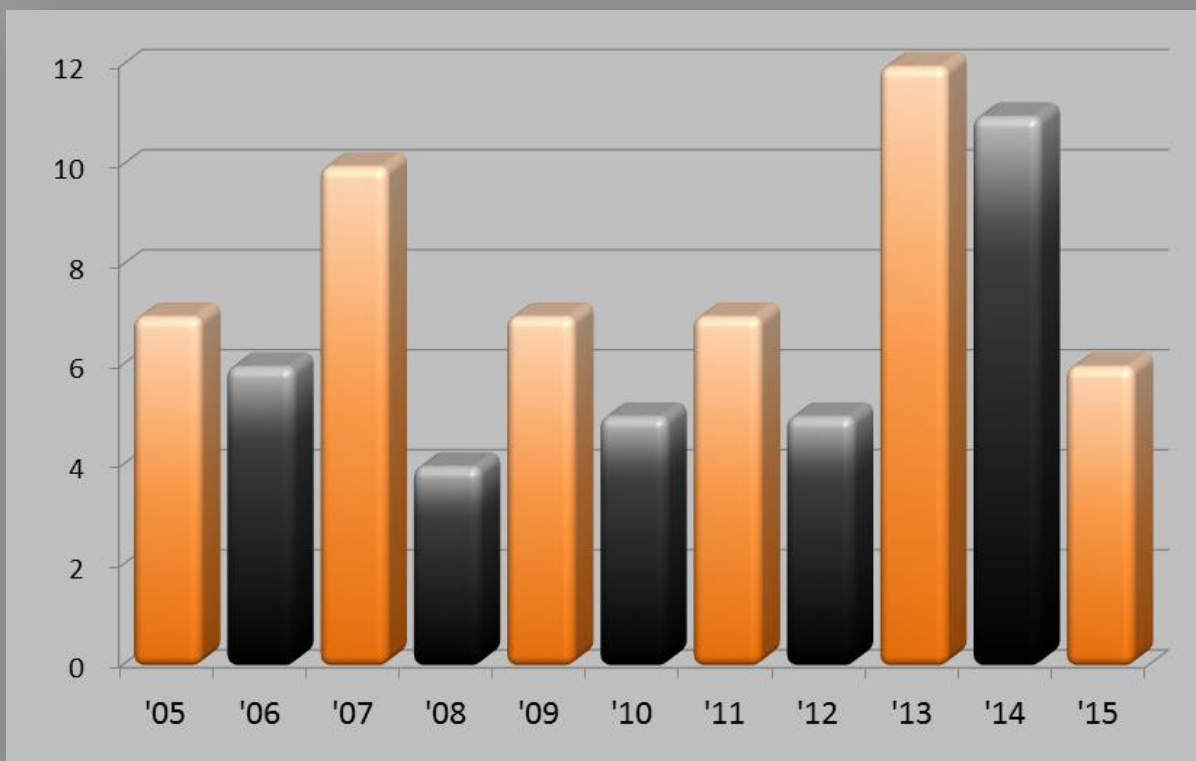
LICENSING INCOME PER YEAR

2005-2015



PATENTS PER YEAR

2005-2015



Final Thoughts

From our Director

In the field of technology transfer it has always seemed to me that OSU's "peer" institutions are those institutions that have a comparable research base, since the outputs we are concerned with, such as inventions, come about as a result of research.

The Association of University Technology Managers does an annual survey of research institutions and reports on University "outputs."

The latest available survey, which covers the 2014 Fiscal Year, allows us to benchmark ourselves against our peers. To help us understand the outputs of institutions similar in size to OSU, we identified Land Grant institutions that had research expenditures ranging from \$88mm to \$188mm, bracketing OSU's \$139mm by +/- \$50mm. 12 Land Grants fall into this range.

The average royalties received by all 12 Land Grants is \$847,914. I'm pleased to report that OSU's royalties of \$2,182,271 exceed the average by \$1,334,357, and exceed the 2nd highest by \$427,480.

Steven C. Price



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