Two family teams, one academic and one private, net state millions in NIH grants

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Summary:

As part of our "Roadmap Progress Report" feature, we have chosen bioscientists who have landed multiple grants from the National Institutes of Health. According to Arizona's Bioscience Roadmap, meeting and exceeding the large amounts of NIH funding attained annually by leading bioscience-research states is instrumental to Arizona's success as a bioscience contender. Ranu Jung and Jimmy Abbas are bioengineers at Arizona State University who have won more than $4 million in grants in the past few months. Ed and James Koeneman are the founders of Kinetic Muscles Inc. (KMI), a medical-device company that has helped bring more than $3 million into the state.

Full Story:

Ranu Jung and Jimmy Abbas, a husband-and-wife bioengineering team at Arizona State University, are researching how to develop a unique artificial limb. Unlike devices currently available, their prosthesis will not just attach to the body but fuse to it, "talking" and communicating with the nervous system as if it were a natural limb.

Ed and James Koeneman, founders of medical-device company Kinetic Muscles, developed their own device a few years ago to help stroke survivors recover normal function in their hand, foot, and arm. Their product, which uses air muscles to help individuals move their limbs, has already been approved by the Food and Drug Administration and is in demand and about to be sold nationwide.

Ranu Jung

From a healthcare perspective, these two families who call Arizona home are pioneering technology that promises a brighter future for those with impaired movement. From an economic development perspective, they bring in millions of dollars in grants from the National Institute of Health.

Three years ago, Battelle released Arizona's Bioscience Roadmap, a long-term plan for Arizona to achieve national recognition in the biosciences. In the report it emphasized the importance of NIH funding, "the gold standard for biomedical research funding."

In the three short years following the release of the Roadmap, Arizona has witnessed a significant increase in federal research dollars pouring into the state. In 2004 Arizona matched the top-10 states in the annual growth rate of NIH grants, a goal achieved three years before its 2007 target date. In addition, the state is 75 percent of the way to accruing $274 million in annual NIH research funding, another 2007 Roadmap goal.

Arizona's recent success in landing NIH grants highlights the efforts of the researchers working around-the-clock and winning the awards. Vicki Chandler, director of Bio5 and a Regents professor at University of Arizona, recently received the NIH's prestigious Directors' Pioneer Award, which includes $8 million in funding. Arizona Cancer Center researchers won more than a dozen grants in 2005. Kiisa Nishikawa, a professor at Northern Arizona University, landed two grants, one for minority student support and the other to study biomechanics.

In addition, researchers all over the Valley did their part. Institutions including Sun Health Research Institute, the Translational Genomics Research Institute, and the Biodesign Institute all landed multiple grants last year.

For this "Meet the Players" feature, we wanted to highlight researchers from academia and industry who have played major roles in helping Arizona achieve its NIH funding targets.

Ranu Jung and Jimmy Abbas, directors of the Center for Rehabilitation Neuroscience and Rehabilitation Engineering, part of the Biodesign Institute at ASU, moved to Arizona three years ago and have lost no time in establishing their presence. In just the past few months the two have netted more than $4 million in grants.

Ed and James Koeneman started their business, Kinetic Muscles, in 2001 when the economy was crumbling. Yet the business, which focuses on stroke rehabilitation, is thriving due in part to the more than $3 million grants the Koenemans and their institutional partners have won from the NIH.

For Jung and Abbas and the Koenemans, the NIH dollars are a means to an end. The husband-and-wife, father-and-son teams ultimately aim to improve the health and quality of life for Arizonans, Americans, and people all over the world.

"One of the marketing reports says that neuroscience today is where cardiac science was thirty years ago. So neuroscience is really in its infancy," Ed says. "It's exciting to be at the forefront of a wave that's going to take over the world of medicine."

Tinkering around the kitchen table

Just east of ASU sits KMI's business headquarters, sales division, manufacturing facility, and design center. Posters crowd the walls of the cramped office space. Although the small warehouse seems to bust at the seams with equipment, papers, and materials, it is a long way from where Ed and James Koeneman began: the kitchen table.

In the late '90s, Ed, an electrical and computer engineer, decided to leave his job working on circuits and slot machines to stay at home with his first child. His dad, a bioengineer and a retired medical device company executive, joined him. Together the two tinkered around with "air muscle" technology.

"Everybody talks about starting a company in their own garage," Ed says. "Well, the garage in Arizona is too hot, so we started on the kitchen table."


Ed (seated) and James (standing) Koeneman pose with their flagship body-teaching device, the Hand Mentor.

"Air muscles" function as the basic element of KMI's technology, which consists of a number of body-teaching devices called "Mentors." Air muscles are rubber bladders that deflate and inflate, mimicking the movement of natural muscles. In the hand, foot, and arm mentor, the air muscles allow the strapped-on devices to move the limbs in a safe, fluid motion.

Initially Ed and James thought the device would be used to help people with carpal tunnel syndrome. But when they took the device on its first tour of clinics, they came across a development in neurological science that would give their device a new purpose: A researcher at Barrow Neurological Institute of St. Joseph's Hospital told them about neuroplasticity, the brain's ability to reorganize itself by forming new neural connections and pathways throughout a person's life.

Prior to the discovery of neuroplasticity, scientists thought only young, developing brains could rewire and adapt to changes. That is no longer held to be true. Therefore, if a stroke or some other trauma damages neurons in the brain, other neurons or areas of the brain can sometimes take over the lost function.

Ed and James learned that stroke patients were clamoring for therapy that would help them regain normal functionality. However, the protocol required intense repetitive training. Formal training with a physical therapist calls for 30 hours and $6,000 a week, an expense insurance companies do not cover.

"The patients would go away frustrated because nobody can afford $18,000 for three weeks of therapy," Ed recalls. "So the scientists at Barrow said 'give me something I can send home with the patients to help them do repetitive training on their time.'"

They returned to the kitchen table and began to hammer out the details for a business.

"Nobody at the time was addressing the needs of the stroke patients," says Ed. "It was a very underserved and frustrated population."

In 2004 there were more than 4.8 million stroke survivors living in the United States, with almost 600,000 new stroke survivors each year, according to the American Heart Association. The American Stroke Association reports that Americans will pay $57 billion in 2005 for stroke-related medical costs and disability.

Understanding the size of the market and the need for a product that would reduce the cost of healthcare for stroke survivors, the Koenemans decided not to license out their prototypes but build a business around them instead.

"Since the stroke patient is affected up and down one side of the body, you have products coming out for the hand, the knee, the foot, the elbow," says Ed. "Coupled with the size of the population we were addressing, it made good business sense to start a company and develop these as a line of products rather than just something for the hand."

The Koenemans started their business in 2001, in the depths of the recession. Receiving little response from investors, they turned to government funding. It took three submissions before they landed their first $100,000 small business innovation research grant (SBIR) from the NIH in the summer of 2003.

"But from that first one we gained momentum," Ed says.

Just two years later, the Koenemans and their collaborators have landed more than $3 million in NIH grants. According to Ed, stroke and stroke rehab are "hot button" issues at NIH. That translates into larger grants. After receiving money for the hand mentor, the Koenemans won a grant to develop a foot mentor. Whereas most grants similar to theirs were awarded $100,000, they received $200,000 for targeting stroke rehab.

More recently the Koenemans received a grant from the NIH to conduct clinical trials for the hand mentor. Those grants, called Phase II grants, normally receive between $750,000 and $800,000. The Koenemans were awarded $1.2 million.

Because government grants only cover research and development, the Koenemans turned to ASU's Launch Pad program, a 12-week entrepreneurial coaching course, to jump start their business. The course gave the two engineers business tools that helped Kinetic Muscles finally take off.

"That course really put our feet to the fire, thinking about the business side and asking the business questions," Ed says. "Our focus shifted to generating more and more sales, proving that people would buy our product."

Their sales chart took a sharp turn upward, and since then, the father-son duo has seen remarkable results.

In 2004, Kinetic Muscles was named Start-up of the Year at the Governor's Celebration of Innovation and in 2005 won the Medical Device Company of the Year award from the Arizona BioIndustry Association. More than 50 patients and at least six clinics now use the hand mentor, which costs a little under $4,000. Blue Cross Blue Shield paid a claim for a hand mentor this year--one of the first private insurers to do so. The business is about to close a significant angel-investment round, and Ed is meeting with potential sales and marketing partners who will distribute the products nationally.

Last May ABC World News Tonight featured KMI's robotic device called RUPERT that moves the hand, elbow, and shoulder together. And ASU Professor Jiping He, who collaborated with the Koenemans to design RUPERT, is developing a virtual-reality system to link to the robotic arm.

In addition, and most importantly for Ed, his technology is changing people's lives.

"We have a lot of people getting better. One patient came to our Christmas party last year, and he said, 'Ed, I hung my Christmas lights for the first time in 12 years.'"

Near the entrance to the Koenemans' office hangs a picture of their first eight patients. Ed says the picture hangs prominently to remind everyone of the company's purpose.

"It's neat to see the effect you are having on people's lives," he says. "That's why you get involved in bioengineering."

Better living through lampreys

The theme of improving the quality of life runs through the stories of Jung and Abbas as well. Jung's research is driven by the need to find therapies for the more than 250,000 victims of spinal cord injuries and the more than 50,000 new amputees a year.

But science-as-public-service is not the only similarity between the two. Coincidentally, Jung and Abbas and the Koenemans also all engage in research that lies at the crossroads of neuroscience and bioengineering, two areas listed among Arizona's strengths in the Roadmap:

"What make Arizona distinct is that research drivers in the state not only address therapies to treat neurological-related disorders themselves, but they also have a strong focus on rehabilitation to deal with the conditions related to those disorders."

Jung pushes the envelope of neural engineering, defined by the Roadmap as "the interface between the nervous system and artificial devices that replace lost senses or missing limbs." She envisions technology far more advanced than any on the market.

For example, currently one of the most advanced prostheses on the market is a myoelectric prosthesis that uses embedded electrodes to detect and amplify muscle action from contracting muscles in the non-amputated portion of the limb. Jung envisions a technology smarter than that where the prosthesis is controlled by the nervous system and functions like a normal limb.

James Abbas

Jung has already shown that the technology is possible through her research on lampreys. While at University of Kentucky, she explored whether artificial spinal cord parts could be interfaced with the natural spinal cord of a lamprey. She successfully managed to fuse the two and got them to work in sync.

Jung published her results in the journal *IEEE Transactions on Neural Systems and Rehabilitation Engineering* and it caught the eye of Army officials.

"Now the Army has contracted with us to see if humans can control prostheses and work in sync with it in that way," she says, explaining how her business, AdveNSys was born.

Jung's work is part of an emerging field known as biomechatronics, labeled by *Technology Review* in May 2005 as one of the top ten emerging technologies.

The potential market for the biomechatronic business is huge, especially as hundreds of wounded American soldiers return from Iraq. In addition, the American Academy of Physical Medicine and Rehabilitation reported that physiatrists treat some 50,000 new amputees a year.

The potential for application is even bigger than many realize because, according to Jung, "adaptive technology is the way of the future."

"You probably know so many people who have a false tooth or glasses or an insulin pump, or some technology; almost all of us have something attached to us. We're not even thinking that we have it, but we do."

Jung and Abbas recently received a planning grant from the National Science Foundation to develop a Center of Excellence for Adaptive Neuro-Biomechatronic Systems. Such a center would allow leadership in the field not only by developing technology but also by understanding how it is possible for technology to adapt to and be controlled by the nervous system.

"What would happen if the body and technology co-adapted?" Jung asks. "Then you have an optimal learning going on between the technology and the nervous system."

It is a big vision for the future, one that will influence bioengineering, neurological science, and the practice of medicine.

"Tomorrow's physicians are going to be a different kind of physician," says Jung. "If you walk in and have a pacemaker on you, they won't say it's the engineer's job to figure out what the pacemaker is doing. It's going to become the physicians' job to understand the interaction."

The complexity of it all is astounding, but for Jung, the complexity is what drives her.

"Complex, adaptive systems have always intrigued me," she says.

When Jung was an electrical and computer engineering student in India, she was torn between the engineering track and the medicine track. While working on her senior design project, she discovered she could do both by pursuing a career in bioengineering.

That took her to Case Western University where she studied the interface of engineering and life sciences and inquired why certain blood pressure changes were happening. Figuring the only place she could find an answer was in the brain, she began her doctoral work trying to find which areas of the brain control the cardiovascular system and the respiratory system.

It was the start of an interdisciplinary scientific career focused on exploring the interaction of the different systems in the body. Jung believes this approach is the future of medicine.

"You have to be able to map not just the genes of the cells but also the pre-cellular--all the way up to the systems—to be able to get improved overall function."

According to Jung, a whole-systems approach will open up multiple opportunities for physicians and researchers to diagnose problems and provide therapy.

In preparation for a future in neuroscience where anything is possible, Jung is diversifying her own project portfolio.

Jung and Abbas are also conducting groundbreaking research on neural prostheses that, through electrical stimulation, replace function lost as a result of spinal cord injuries. They recently received more than $800,000 from NIH's National Center for Medical Rehabilitation Research to develop more efficient neural prostheses that adapt to individual needs and provide improved therapy.

"We want to design treatments so that they are personalized for someone, and they change as that person changes and moves."

In addition, Abbas, Jung, and their institutional partners were among only 11 grant recipients to land a $1.3 million award from the NIH to purchase the Valley's first animal-imaging system.

For Jung, the MRI spectroscopy system is necessary in order to continue tapping into the mysteries of neurological science.

"In rodents with incomplete spinal cord injury, we were able to improve walking after electrical stimulation therapy," says Jung. "We want to look and see if there's reorganization happening in the brain."

Since moving to the Valley just three years ago, Jung and Abbas have brought in more than $4 million for their center. And their momentum has yet to let up, which is just the way Jung likes it; in fact, she and Abbas chose to come to Arizona because they saw it as a place that would help them move forward with their work.

"We came here to dream our dreams," she says.

More information:

Kinetic Muscles

Center for Rehabilitation Neuroscience and Rehabilitation Engineering

Arizona Bioscience Roadmap

American Heart Association, stroke statistics

American Stroke Association

National Spinal Cord Injury Association

American Academy of Physical Medicine and Rehabilitation

"The Impact of Emerging Technologies: 10 Emerging Technologies," *Technology Review*, May 2005