results.
Research and Graduate Studies at North Carolina State University

Bring on the Boomers!

RESEARCH ON AGING
Bring on the Boomers!
Passion and Potential Face Off with Challenges of Aging

In addition to the aging of its baby boomers, North Carolina’s population boom of the past few decades has included plenty of relocating middle-aged people as well as retirees attracted by the mild climate and amenities. The combination has raised the state’s median age by more than two years over the past decade, and the number of seniors in North Carolina is expected to continue growing in the coming years.

The aging population presents North Carolina with various economic, social, and medical challenges, especially for the oldest old, those with chronic medical conditions, and individuals with limited resources. It also offers opportunities to tap into the potential of older adults, says Dr. Luci Bearon, an associate professor in the Department of 4-H Youth Development and Family & Consumer Sciences. A social gerontologist for more than 30 years, Bearon says later life can be a time to grow and develop, discover new passions and purpose, and contribute to family, community, and society.

Research has shown, she says, that we can prevent, delay, reverse, or compensate for some physical and mental declines that we assume are inevitable. Bearon points out that aging research has become more interdisciplinary in recent years and that the field seems to have achieved a critical mass that is beginning to draw more funding from both government and private groups. “Much greater investment is needed,” she adds.

This issue of RESULTS highlights just some of the important NC State research efforts toward making aging a happier, healthier experience.
Slide behind the wheel of Dr. David Kaber’s baby, punch the gas, and watch the trees and buildings zip by. Just look out for a sudden collision that blocks an intersection or a construction project that closes a lane without warning. Plenty of people have experienced such road hazards without ever leaving Kaber’s lab in Daniels Hall. A professor in the Fitts Department of Industrial and Systems Engineering, he uses a high-fidelity simulator to measure people’s driving performance under various conditions. “With computer-generated graphics, we can control any event in the simulator,” he says. “It’s a safe way to look at performance in hazardous situations.”

“Older drivers compensate for their physical limitations with more mature behavior.”

A recent project compared the driving abilities of older and younger drivers on a city street with plenty of traffic, signage, and pedestrians, as well as on scenic, open roads in the country. Graduate student Yu Zhang, who designed the different scenarios, helps each driver get a feel for the simulator, which handles like a Taurus despite its Jaguar-like price. Three high-definition, wide-screen displays serve as the windshield and windows, with insets for the rear-view and side mirrors. Drivers in the simulator wear a head-mounted eye-tracker that uses infrared beams to monitor the direction of their gaze and how long they stare at certain objects. A “passenger” also sits nearby to ask questions about vehicle speed and events in the simulation so Zhang can gauge a driver’s awareness of the changing roadway situation.

The study found that drivers ages 65 to 81 have more trouble negotiating dynamic hazards, such as two cars colliding in front of them. Meanwhile, drivers ages 18 to 25 are more susceptible to problems with static hazards like construction barriers. Kaber attributes the former to age-related declines in mental and physical reaction time and the latter to younger drivers’ inattention. Older drivers also appear to have more difficulty with the “clutter” of an urban setting, he says, noting they tend to get tunnel vision and focus on what’s in front of them. “The data show some degradation of cognitive skills with age that impacts driving,” Kaber says. “That suggests older drivers might benefit from more frequent testing of their skills.”

Nonetheless, older drivers do demonstrate their experience in handling hazardous conditions, Kaber says. They control their speed and drive more cautiously as the complexity of the situation increases or if they have encountered an accident or construction zone. “Unlike younger drivers, who don’t readily adjust their behavior,” he says, “older drivers compensate for their physical limitations with more mature behavior.”
In a separate study, Gamaldo examined data from a group of older adults who, for two months, took daily short-term memory and problem-solving tests and measured their blood pressure every morning and afternoon. People who already exhibited high blood pressure performed poorly on the tests when their pressure spiked. Elevated blood pressure didn’t adversely affect the mental agility of those who weren’t hypertensive, however. “Stressful situations make it more difficult for some people to think clearly,” Gamaldo says. “It’s not clear why people with hypertension have a harder time than others processing information under stress.”

Dr. Shevaun Neupert, who studies older adults’ responses to stress, says they routinely forget more when under stress. This is especially true if one has had an argument or experienced some other setback to an interpersonal relationship. Neupert, an assistant professor of psychology, is comparing her findings with studies on younger adults to determine if the stress-memory relationship is true for all ages or is more pronounced among seniors. “We can avoid some stress in our daily lives, but not all,” she says. “Recognizing that it could cause problems for older adults will help us develop coping mechanisms and support systems for them.”

The NIA wants to find ways to maximize older adults’ ability to live independently, so Dr. Tom Hess has been examining seniors’ judgment and decision-making skills. The psychology professor has found that, while seniors’ cognitive abilities decline, their base of knowledge
remains intact. So they usually choose to focus their mental energies on tasks and information that they deem most important. “Older adults tune out irrelevant information,” he says, “while younger people try to integrate every detail.”

“The brain doesn’t operate in a vacuum. Factors that adversely affect other systems in the body often diminish cognitive functioning as well.”

In spite of such “selective engagement,” complex situations remain especially challenging to seniors, Hess says. He cites as an example the recent addition of prescription drugs to Medicare coverage. People were given more than 50 plans to choose from, he says, and most were so overwhelmed by the information that they delayed making a decision and often failed to choose the best plan for their circumstances. Under an NIA grant, Hess is studying how older adults search information in making decisions. He monitors their heart rates as they pore over details and is looking for patterns in the sequence they use to go through information. “We want to identify things we can adjust,” he says. “Should we limit alternatives? Can we put information into context so they understand its impact on their daily lives?”

Seniors’ ability to handle daily chores like understanding nutrition labels or a monthly credit card statement has been Allaire’s research focus. The associate professor of psychology has developed a test to gauge memory and problem-solving skills on such tasks, which he says are better reflections of their ability to function in everyday life than more abstract cognitive tests. His tests have shown stress, mood, and other health factors affect older adults’ ability to function from one day to the next, so he advocates more comprehensive testing of people believed to suffer from a cognitive impairment. “One day is not an accurate picture of ability,” Allaire says. “The brain is very dynamic, and it’s pretty naive to base treatment on a snapshot.”

Allaire and Dr. Anne McLaughlin are now using Nintendo Wii games to determine how best to improve seniors’ daily functioning. “Many studies have shown that video games increase cognitive abilities, but no one has determined the reason for that,” says McLaughlin, an assistant professor of psychology. In the groundbreaking $1.2 million project, funded by the National Science Foundation with federal economic stimulus money, the researchers vary the difficulty level of a game and have some players teamed with partners while others go it alone. After a few hours of gaming, they test players’ memory and reasoning. McLaughlin says the ultimate goal is to build a prototype game loaded with factors that have demonstrated brain-boosting abilities. “There’s no guaranteed recipe yet for improving cognitive abilities,” she says, “but if we can zero in on a few aspects that can make a difference, it’s a start.”

Playing video games such as electronic drums has been shown to increase seniors’ cognitive abilities. NC State researchers hope to determine which gaming aspects produce the most positive effects.
Eat Right, Live Well

It's no secret people undergo many physical changes as they age. Some are obvious—hair loss, fading eyesight and hearing, chronic aches and pains—while others aren’t. Nutritional needs, for example, change as people get older because bodies don’t absorb vitamins and minerals from food as well. Dr. Jacquelyn McClelland says this puts many older adults at risk for malnutrition unless they learn how to change their diets.

A nutritional biochemist by training, McClelland has studied metabolism and nutrition for years, initially examining the link between diet and heart disease in fowl and cattle. She later moved her research into the “lab of life” in the Department of 4-H Youth Development and Family & Consumer Sciences, where she now spends time as a professor and nutrition specialist educating the public—primarily through Cooperative Extension agents—about healthy eating.

The top risk factors for malnutrition among older adults are eating alone, having a chronic disease, and taking several prescription drugs daily.

Through extensive surveys and focus groups, McClelland has determined the factors that put older North Carolinians at risk for malnutrition. The top ones are eating alone, having a chronic disease, and taking several prescription drugs daily. People who eat alone often wind up snacking instead of cooking a balanced meal, she says. Noting some drugs affect the way the body absorbs nutrients, she says that those with illnesses like diabetes or heart disease or who take multiple prescriptions need to pay more attention to their diets for proper nutrition.

“If we hold four meetings on the same topic, we can help build behavioral changes in participants.”

McClelland researched various approaches to teaching older adults about good nutritional habits and found success with an interactive program at community sites where seniors, most with low incomes, gather for a daily hot meal. Her research team developed 14 educational modules on topics such as balanced diet, proper portions, and eating on a budget. The modules include songs, games, weekly challenges on subjects like reading labels, and taste tests to get people to try new foods, eat lower-fat foods, or substitute herbs for salt in cooking. “We’ve found that if we hold four meetings on the same topic,” she says, “we can help build behavioral changes in participants.”

A study of the effectiveness of an educational module McClelland’s team developed to teach people about vitamins and dietary supplements found that older adults who received such information were much more likely to increase their vitamin and calcium intake, read supplement labels, and talk to physicians about their use of supplements. In addition to changing people’s behaviors, McClelland says, the nutrition programs boost enrollment at sites where they are offered and give people an opportunity to socialize. “People just have fun when they’re learning,” she says, “which is a pretty good side benefit.”
Iron Seen as Target in Curing Eye Diseases

From “an eye for an eye” to “Old Blue Eyes,” the windows to the soul have been contemplated and celebrated for centuries by everyone from singers to poets to legal scholars. Although scientists generally understand how eyes function, some of the fundamental biology remains a mystery, says Dr. Chris McGahan, head of the Department of Molecular Biomedical Sciences in the College of Veterinary Medicine. She has devoted her career to unraveling these mysteries with the hope that age-related diseases like cataracts and macular degeneration can be slowed or cured altogether.

The $12 billion spent on cataract surgeries in the U.S. is the biggest single piece of the annual Medicare budget.

Using cultures of lens and retinal cells as well as tissue sections from eyes of humans and dogs, McGahan studies the role iron plays in damaging cells in the eye. Too much iron can cause oxidative reactions, while too little can lead to dysfunction in the cell. “We don’t understand very well how cells regulate iron stores,” she says. “But that’s important if we’re going to control eye disease.”

Cataracts, for example, form when proteins in the lens oxidize and aggregate, blocking light and clouding vision. McGahan’s research has shown that lenses secrete glutamate, an amino acid and neurotransmitter that is regulated by iron. Although that might appear unusual because lenses have no nerves, her studies have determined that glutamate is needed for a reaction that boosts the level of glutathione, an antioxidant that could act as a protective mechanism against the oxidative reactions that lead to cataracts.

McGahan believes that iron also could play a role in macular degeneration since it regulates the production of vascular endothelial growth factor (VEGF), which has been linked to the disease. VEGF is a chemical signal that spurs the growth of blood vessels, but excess blood vessels or leakage from them behind the retina can warp and buckle the smooth surface needed to transfer light and images to the brain.

“Slowing the onset or progression of these degenerative problems will give people better quality of life and save millions in medical costs.”

Controlling cataracts and macular degeneration is as important to McGahan as curing the two vision problems. Cataracts are the world’s leading cause of blindness, and the $12 billion spent on surgeries in the U.S. to replace clouded lenses is the biggest single piece of the annual Medicare budget. Furthermore, almost a third of people are at risk for macular degeneration by age 75. “With the increasing average age of the population, this will become a bigger issue over time,” McGahan says. “Slowing the onset or progression of these degenerative problems will give people better quality of life and will save millions in medical costs.”
Guardian Protein Could Keep Alzheimer’s at Bay

Alzheimer’s disease robs 5.3 million older adults of their memories, their work, and their family and social lives. The theft might be occurring because a “watchman” in the human brain has fallen asleep on the job, says Dr. Benjamin Bobay, a senior research associate in the Department of Molecular and Structural Biochemistry. So he is studying this watchman, trying to determine if he is truly sleeping on duty and how to help him provide better protection for the brain.

“There are a lot of pathways that lead to cell death. Calbindin is unique in that it can control several at once.”

Bobay’s watchman is a protein known as calbindin D28K, a neuro-protective molecule designed to ensure that certain processes in the brain occur normally. Calbindin protects the brain in several ways, such as binding metal ions and regulating other proteins. One of those proteins, caspase-3, is involved in the formation of plaques and tangles of protein fibers in and around brain cells, which are two hallmarks of Alzheimer’s. Elevated concentrations of metal ions—about three to five times higher than normal—have also been found near the plaques, leading researchers to believe that is another characteristic of the disease.

A member of the team—led by William Neal Reynolds Distinguished Professor of Biochemistry John Cavanagh—that first discovered the structure of calbindin in 2006, Bobay now is studying how the protein carries out its various duties. He’s also looking at whether some functions impede others, which could possibly trigger the development of both plaques and tangles and the onset of Alzheimer’s. “There are many pathways that lead to cell death,” he says. “Calbindin is unique in that it can control several at once.”

Calbindin has six sites where it can bind metal ions, but only four are active. Bobay has found that, by adjusting a few amino acids, he can activate the other two sites without changing the structure of the molecule. Using nuclear magnetic resonance imaging, he is testing the protein with various metals—calcium, zinc, magnesium, copper, and iron—to determine if the structure changes as it binds different types of ions and whether it has an affinity for one metal over the others. Bobay also hopes to find out if any combination of attached ions helps or hinders calbindin’s ability to regulate caspase-3. He is working with researchers at the Mayo Clinic in Minnesota to test his findings in mice. “If we can find a way to slow the onset of Alzheimer’s,” he says, “this incurable and progressive disease won’t take such a toll on patients and their families.”
When Dr. Feinian Chen was a child, her parents were sent to northern China to teach, and they left her in Shanghai in the care of her grandparents. She recalls a happy childhood with them but now realizes the added strain rearing a grandchild placed on the couple. An associate professor in the Department of Sociology and Anthropology, Chen is now examining how the extra stress of caring for grandchildren affects the health of older adults. “It’s been a matter of great debate in the U.S. for some time,” she says. “Some studies suggest negative consequences, while others say it has positive effects.”

Chen turned to her native China, where multi-generational families and grandparental involvement in child rearing are common. “Grandparents are sometimes considered the primary caretakers in that culture,” she says, that noting that the strategy frees mothers to pursue more lucrative work outside the home. As part of a five-year National Institutes of Health grant, Chen is analyzing data in the China Health and Nutrition Survey, which has collected information from thousands of families for two decades. “The household surveys allow you to look at families and individuals over time,” she says, “and follow the trajectory of the grandparents’ health as their involvement in childcare changes.”

Her preliminary findings suggest that more childcare leads to more health problems for grandparents. Older adults in the survey reported they had more trouble walking, bending over, and completing other daily activities when caring for youngsters, and there was also a greater instance of chronic disease. Yet, Chen says, the negative link seems to dissipate when other variables are added to the mix, such as the age and number of children cared for and the age and gender of the grandparents. “We need to explore more health measures before drawing conclusions,” she says.

Chen also plans to use the Health and Retirement Study, a longitudinal study funded by the National Institute on Aging, to look at care-giving by older adults in the U.S., with a focus on differences between ethnic groups. “The norm among white, middle-class families is one of non-interference by grandparents,” she says. “But grandmothers play a strong childcare role in African-American families, and Hispanic families are often multi-generational.”

Older adults in a Chinese survey reported they had more trouble walking, bending over, and completing other daily activities when caring for youngsters.

As her parents and in-laws helped look after her 5-year-old daughter and 1-year-old son in recent months, Chen says she saw firsthand the benefits for older adults of caring for their grandchildren, and she expects her research to bear that out. “There’s plenty of stress,” she says, “but there are compensating effects, such as tremendous emotional rewards and bonding.”
The thought of planning for retirement strikes fear in the hearts of many people. They worry about not saving enough and are often baffled by available financial options. Procrastination only adds to the pressure over time. “As you approach retirement, you face a series of choices about how to handle your finances, many of which are irreversible,” says Dr. Robert Clark, professor of economics and professor of management, innovation, and entrepreneurship in the College of Management (COM). He says employers can help set people on the road to a sound retirement financially with a little basic education.

Working with Dr. Melinda Morrill, a research assistant professor of economics, and Dr. Steve Allen, COM’s associate dean for graduate programs and research, Clark has studied financial literacy programs offered by several major corporations that target employees age 50 or older. Companies like Raleigh-based utility Progress Energy and timber giant Weyerhaeuser offer such classes, Clark says, because they feel the added information will make workers value the benefits more. “The best place for adults to learn financial literacy is in the workplace,” he says.

“It’s difficult to say how much knowledge about personal finance is enough, but certainly, having more information available is better.”

Retirement planning has become more critical in recent years with the switch to 401(k) plans and the past year’s stock market chaos. A few generations ago, when many large employers offered pension plans, workers received a set monthly benefit after retirement. The advent of 401(k) plans in the 1980s means that employees are now primarily responsible for funding their own retirement accounts. Clark notes that, although the plans offer more flexibility, they also pose more financial risk to employees because they can fluctuate wildly with the stock market. Poor decisions by a worker today could mean a poorer retirement tomorrow.

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The company-sponsored classes the NC State researchers studied range from lunch-hour seminars to three-day, off-site programs that cover financial knowledge, retirement funds, Social Security, and Medicare. They tested workers before and after they attended their company’s program to assess their knowledge, and Morrill says workers were answering more questions correctly after the seminars. “It’s difficult to say how much knowledge about personal finance is enough,” she says, “but certainly, having more information available is better.”

Clark says workers seem to take advantage of that extra information. Surveys of workers after the programs found that many were shifting their expected retirement dates to delay tapping into savings or reallocating retirement funds so they could be used differently. “Older workers with incorrect or limited information make poor choices,” he says. “These programs help them make informed decisions, and they are acting upon them.”
The first baby boomers may be turning 65 in two years, but don’t expect the generation that has spent a lifetime setting trends to slow down. AARP has found that four in five boomers plan to work well past the traditional retirement age. An aging work force—over one-third between the ages of 55 and 64—presents opportunities and challenges to employers. Older workers offer experience and reliability, but that is sometimes offset by lower productivity caused by declining physical abilities. Dr. Sharon Joines is working to help companies adapt their equipment and processes to ensure that older workers remain productive.

If we can keep people from being fatigued at the end of the day, they will be more productive overall.”

An assistant professor of industrial design and researcher for the Center for Universal Design, Joines has older adults test various textured grips on tools and screw-off lids. She monitors electrical impulses in their arms to measure muscular activity, as well as how quickly their muscles fatigue and recover. Her research has disproved a widely held theory that older people need wider surfaces to grip so they can generate more force. But she’s still uncertain why they prefer chunkier designs in products. “We’re starting to pull some threads together with our work,” she says, “but there’s still a lot left to understand.”

Joines is an industrial engineer by training who formerly oversaw research at NC State’s Ergonomics Center. She moved to the College of Design after studying some companies and noticing that many of the problems workers experienced could have been resolved sooner by simple redesigns. “The design stage is where we need to start effecting change,” she says. In addition to her grip studies, Joines is testing the range of motion for older workers seated at a desk to determine whether altering the way office tasks are performed would ease strain and fatigue. “If we can keep people from being fatigued at the end of the day,” she says, “they will be more productive overall.”

Over one-third of U.S. workers are between the ages of 55 and 64.

To demonstrate her thinking to companies, Joines and her students have developed “an aging suit.” She takes the kit to conferences and has people don Velcro strips and braces that limit movement from their fingers to their knees. A dab of cornstarch on the fingertips mimics decreased tactile sensitivity, while glasses with lenses partially obscured demonstrate the limits of bifocals for some workers. “We want people to experience what older workers experience on a daily basis,” she says. “We hope they will look to these workers for input as they design their workplaces and their products.”
Scientists Seek Relief

The debilitating effects of osteoarthritis impact an estimated 27 million Americans, forcing them to adjust their everyday lives, from work to social activities, to limit the pain in their joints. The cause of arthritis is unknown, but NC State researchers have turned to the somewhat odd combination of pig knees, synthetic fluid, and mathematical formulas to study the chronic condition from different perspectives. They hope to understand it better so treatments can eventually be developed.

People are more likely to develop osteoarthritis if they’ve previously had a joint injury, says Dr. Peter Mente, an associate professor of biomedical engineering. So he routinely obtains porcine joints from a Burlington sausage plant and brings them back to his lab, where a device he assembled hammers and twists them to simulate an impact like slamming your knee into your car dashboard during a collision. Banging on the erstwhile ham hocks lets his research team study how the cartilage in the joints responds to injury.

Mente’s experiments show that many chondrocytes, the cells in cartilage, die on impact. Others that are seriously damaged basically shut themselves down to die later on, with the number of cell deaths spiking within two weeks. The loss of chondrocytes causes the cartilage tissue to break down, he says, increasing the wear and tear on the joint. Although the surviving chondrocytes attempt to rebuild the tissue, the new molecules being made are often not the same as those in a normal, healthy joint. “These cells aren’t programmed to do a lot of repair,” Mente says. “So what comes back after an injury usually isn’t as good as what was there before.”

“The mechanical and physical surroundings have an important function in regulating the health of the cells.”

Mente is now working with Dr. Melissa Ashwell in the Department of Animal Science to examine changes in gene expression and metabolic pathways in chondrocytes after an injury. He also is working with colleagues at the College of Veterinary Medicine Small Animal Hospital to compare his post-injury findings with instances of naturally occurring osteoarthritis. “You usually don’t know cartilage is eroding until you’ve got bone-on-bone contact,” Mente says, noting the tissue has no blood supply or nerves. “We’re trying to trace it back to see if there are markers that can help diagnose it earlier.”
Scientists Seek Relief for Aching Joints

One marker Dr. Mansoor Haider has noted is changes in the mechanical and physical properties of chondrocytes. The associate professor of mathematics has developed models to study how the cells respond to different forces. He is working with a Duke University Medical Center orthopedic lab that harvests chondrocytes and their protective “capsule” of collagen—together they’re known as chondrons—from surgical waste following joint replacement operations. Computing the differential equations in his models allows Haider to subject the chondrons to a variety of stresses, strains, fluid shears, and changes in ion concentration. “The mechanical and physical surroundings have an important function in regulating the health of the cells,” he says. “Any disruption of the environment can throw them off balance.” He uses these models to confirm clinical findings of the Duke researchers and to provide them with leads to study.

“"If we can understand the role and importance of the different systems affected by osteoarthritis, the design of better, targeted treatments might be possible.”

In one study, for example, Haider developed a formula to estimate stiffness of the chondron’s outer capsule by measuring how much a chondron isolated in the lab deformed when suction was applied. He determined that the stiffness decreases by 40 percent in arthritic tissue. In a follow-up study, computational models simulated stresses and strains in the cellular environment of cartilage subjected to dynamic compression. The simulations demonstrated that the capsule acts as a “mechanical transducer” as well as a protective layer for the cell, and that osteoarthritis alters both functions. “We believe the cells use strain to detect and respond to alterations in their surroundings,” he says. “Strain can be a good thing if it’s not too great.”

Cartilage isn’t the only part of a joint affected by the onset of osteoarthritis. Dr. Wendy Krause, a polymer scientist in the College of Textiles, is studying changes to the synovial fluid that lubricates the cartilage. The fluid, which also supplies nutrients to and removes waste products from the chondrocytes, has always fascinated Krause because of its unusual mechanical properties. For example, its viscosity increases over time under a steady shear force. A healthy joint lubricated by synovial fluid has roughly the same amount of friction as a sharp skate on a sheet of ice, says Krause, whose research team blended a synthetic synovial fluid to model changes to the fluid found in arthritic joints. They combined saline, a biopolymer known as hyaluronic acid, and plasma proteins albumin and gamma globulin, then varied the concentrations of the proteins as they tested the model fluid with a nanoindenter. The device drags a tiny diamond tip through a drop of the fluid to measure friction and viscosity. Krause’s tests have shown the concentration of proteins to be critical to maintaining a low level of friction. “If we can understand the role and importance of the different systems affected by osteoarthritis,” she says, “the design of better, targeted treatments might be possible.”
Now Hear This: Process Can Customize Ear Implants

Late-night infomercials and full-page magazine ads tout the benefits of hearing aids that either look like Bluetooth headsets or fit inside the ear and can’t be seen at all. But neither has the capability of devices being developed by Drs. Roger Narayan and Yuan-Shin Lee, which are crafted to replicate the function of the bones in the middle ear. The innovative process the two researchers use could also customize hearing implants for individuals.

The bones of the middle ear—scientifically known as ossicles and commonly referred to as the hammer, anvil, and stirrup—sometimes break down because of age, illness, or injury. “Other bones can be reformed after a trauma,” says Narayan, a physician and professor in the Department of Biomedical Engineering. “But the repair process for ossicles is limited.” Other attempts to replicate ossicles have been prone to infection or degradation, and they didn’t always meet individual needs. So Narayan designed an implant that resembles a thumbtack—a flat head atop a narrow shaft—to fill in where nature fails. Small spikes on the head of the device help promote cell growth so it can attach to the ear drum.

Using a process called two-photon polymerization, Narayan directs pulses of a laser at a hybrid ceramic-polymer resin. Each pulse lasts a quadrillionth of a second and can be focused on a micron-sized area, creating a reaction in which only that area hardens. The process allows an implant to be built quickly, layer by layer, he says, adding that slight adjustments in the laser’s aim can produce devices to match the anatomy of specific patients.

Lee, a professor in the Fitts Department of Industrial and Systems Engineering, is developing a computer-aided design program for physicians to use MRI or CT scans to provide a guide for the laser to create the custom implants. Narayan and Lee are evaluating the mechanical properties of the devices to optimize their design, and graduate and undergraduate students have constructed an apparatus to examine the devices’ acoustical properties. “The material gives us the elasticity and vibration properties of natural bone,” Lee says.

Laser pulses create a reaction in a hybrid ceramic-polymer resin to allow a middle-ear implant to be built quickly, layer by layer.

The device hasn’t been tested yet in humans, but Narayan points to two advantages that will accelerate deployment once tests are completed. The ceramic-polymer material, often used in reconstructive dentistry, is already approved for clinical use, and the laser process doesn’t require expensive clean rooms for production. “We’re excited about the opportunities this novel prosthesis fabrication technology presents,” he says, “especially for patient-specific prostheses on a small scale.”
Going for the Green at 57

Inside a Mechanical and Aerospace Engineering (MAE) lab building tucked away in the west end of campus, a gray-haired man tinkers with equipment in a biofuels lab. Tim Turner is a baby boomer on a crusade, trying to refine a process that can turn animal fat and waste grease into hydrocarbon fuels. He developed the process three years ago with three NC State professors. Although Turner could be mistaken for a professor himself, he’s actually a 57-year-old graduate student embarking on a career in the green economy.

Turner earned bachelor’s and master’s degrees in electrical engineering from NC State in the late 1970s and spent more than two decades as a software developer and aerospace industry consultant. Then, the 9/11 terrorist attacks put him on a new path of delving into a long-held interest in sustainable energy. “We have an unsustainable energy economy based on imports,” he says. “September 11th really crystallized everything for me.” Turner initially planned to focus on hydrogen fuel cells, but once he learned about biodiesel through work at the North Carolina Solar Center on campus, he figured that could be a more immediate solution to U.S. energy needs.

With encouragement from his wife and their children, Turner left his consulting business behind and returned to school full time. He’s since won a National Science Foundation fellowship to support his research and a Small Business Innovation Research grant for a start-up he formed to test biofuels. He’s also part of the team using a $2 million federal stimulus grant to find ways to transform oils from algae into fuel. “I’ve always preferred the creative and problem-solving aspects of engineering,” he says, adding that he’s been able to draw on his previous experience for his research. “It’s all cumulative. The way to come up with new technology is to make connections with what you already know.”

“Tim has many productive years ahead of him, and he’s doing something important with them.”

Family support, both emotionally and financially, was crucial to his success, Turner says, and he cautions other older adults looking to follow a similar path. “This has to be something you really want,” he says. “The system isn’t really expecting someone like me.” For example, he’s not interested in grading papers at his stage in life, as young graduate students do. “I was looking for a collaborative research relationship that would take advantage of my experience,” he says. He seems to have found one with MAE Professor Bill Roberts, who’s 12 years his junior. Roberts says Turner’s background has been beneficial to the biofuels research, and other graduate students view him as a second professor in the lab. “Tim has many productive years ahead of him,” he says, “and he’s doing something important with them.”
On the cover: Standing in NC State’s Court of the Carolinas today, Tim Turner has a bit shorter hair than he did when he first attended NC State in the 1970s, earning bachelor’s and master’s degrees in electrical engineering. See story inside back cover.