

RESULTS

RESEARCH AND GRADUATE STUDIES AT NORTH CAROLINA STATE UNIVERSITY

SUMMER 2005

ECONOMIC DEVELOPMENT: MISSION POSSIBLE FOR NC STATE

From its earliest days in the late 1800s, when industrial and agricultural interests lobbied for a university to be created to bolster the North Carolina economy, NC State has made economic development as much a part of its mission as education and research. Today, that triple mission is probably more vital than at any time since those early days.



Workforce training is accomplished through a combination of applied degree programs, cooperative learning experiences, internships, distance education, and short courses. Researchers develop new products and services for industry and communities, and often work in tandem

with corporate scientists, strengthening the ties of companies to North Carolina. NC State has used technology transfer to create some 13,000 jobs in more than 50 spin-off companies. In addition, university extension programs in fields from engineering and textiles to design and forestry provide about \$200 million in annual benefits statewide by solving problems for individuals, companies, and communities.



While the Industrial Revolution left an impression on the 19th-century economy, giving rise to furniture and textile plants amid North Carolina's agrarian economy, the current technology revolution is thoroughly reshaping the state economy for the 21st century. Much labor-intensive factory work in furniture and textiles has moved overseas. Jobs that have remained on-shore often require science or technical skills, and many are in industries—from networking to biopharmaceuticals to nanotechnology—that didn't even exist a generation ago or are just now beginning to form. "We can't replace the traditional jobs we're losing, so we need to do more training and research to attract jobs in non-traditional areas," says Vice Chancellor for Research and Graduate Studies Dr. John Gilligan.

Everybody in the state benefits from having a world-class, land grant, research university, Gilligan says, because of the broad foundation the University has established in teaching, research, and extension over the years.

EVERYBODY IN THE STATE BENEFITS FROM HAVING A WORLD-CLASS, LAND GRANT, RESEARCH UNIVERSITY.

Working in teams, NC State researchers, educators, and extension service staff continue to address the needs of many industry sectors across North Carolina to help the state remain an economically competitive and attractive place to do business. North Carolina Commerce Secretary Jim Fain maintains, "Through the research being conducted in its colleges and the innovative ideas emerging from Centennial Campus, NC State has made and will continue to make significant contributions to the state's economy." ■

www.ncsu.edu/research/results

CHANCELLOR: ECONOMIC DEVELOPMENT IS MORE THAN JOB GROWTH

Chancellor James Oblinger knows NC State can provide crucial assistance to North Carolina's economy. ●



Chancellor James Oblinger visited all 100 counties in North Carolina while serving as dean of the College of Agriculture and Life Sciences and has seen the impact NC State research has on local economies statewide. RESULTS asked him to comment on the role fostering economic development plays in the University.



R: How do you define economic development? Is it all about jobs?

Chancellor: Prosperity for the state depends on our response to new and transforming industries. Collaboration, innovation, and a trained workforce are our primary responses, but to retain the high quality of life we have achieved in North Carolina, we must also pursue sustainable development.

The jobs created in North Carolina must be well-paid positions with long-term prospects for growth. Such jobs require a quality workforce—people who have the skills to handle current requirements and the educational foundation to pursue additional training. NC State works hard to fulfill its educational mission and produce graduates who can meet industry's needs, but students don't wait till they step onto our campus to start learning. We also work with our colleagues in K-12 education through programs like the Science House to instill in youngsters a love for learning that will carry into their adult lives. Along with trained workers, we need bold leaders, whether they are entrepreneurs or public servants making decisions for the betterment of the state.

Finally, sustainable economic development also must encompass environmental stewardship. We cannot afford to grow at the expense of North Carolina's natural beauty and resources, which are key not only to the quality of life we enjoy but also to industries such as tourism and agriculture. Given NC State's tradition in resource management, we will play a major role in balancing job creation with environmental protection.

R: The University's primary mission is education and research. Why is it important to create jobs?

Chancellor: At a land grant institution, extension is as much a part of our mission as teaching and research. Extension allows us to reach out into the state and helps us listen to individuals, companies, and communities, and respond to their needs.

Our history of delivering relevant and responsive results gives us credibility with industry and among political leaders as we move forward.

Also, we are partners with the state and with the people we serve. It doesn't benefit the University or the state to

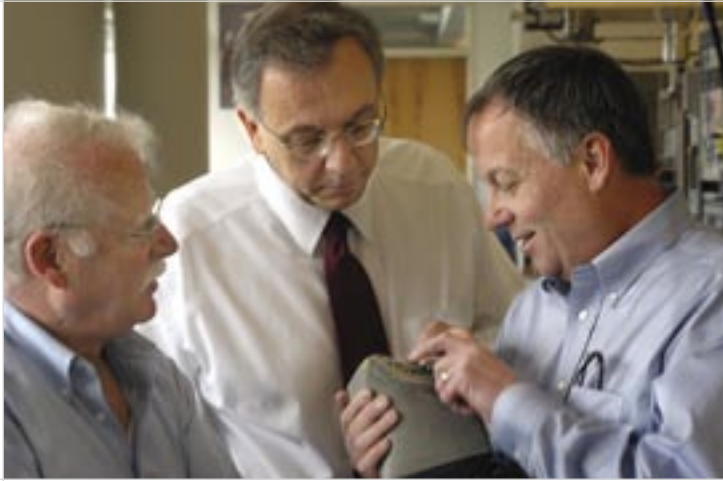
educate people only to have them go elsewhere for employment. We work with state and local leaders and industries to support business across the continuum of their growth—from start-up to maturity. Our faculty expertise, our research, our students, and our alumni all play a part in the economic health of the state.

R: You have taken the helm of the University at a critical juncture in North Carolina's history, as the economy continues a major shift to more skilled industries. How will NC State meet the increasing demands of this 21st-century economy?

Chancellor: Technology has created a new and expanding set of requisite skills for most jobs, and global competition has put a premium on the ability of companies—and, in turn, their people—to continuously innovate. NC State is also innovating to keep pace with the needs of our students, our faculty and staff, and the people of North Carolina. We like to describe our forward-thinking approach as "innovation in action." We not only use our traditional strengths in research and extension to become an engine for development, but also challenge our students to enrich society through their work.

Our Gateway Counties project, for example, is working in a dozen rural and urban counties, using our extension offices to become more proactive in meeting the needs of the people they serve. Once we learn their biggest concerns, we make the breadth of the University's resources available to address those concerns.

One of our best examples of innovation in action continues to be the growth of our Centennial Campus. A generation ago, we had hundreds of acres of raw land and an idea that business, government, and academia could work better if they worked together. Today, we have proven that concept, with students and faculty working side-by-side with corporate and government researchers to solve real-world problems. I see this model evolving over time as NC State continues to adapt to the changing economic development needs of the state. ■



NEW JOBS

HELPING AIRCRAFT AND INDUSTRY TAKE FLIGHT

“THE IMST’S ADVANCED MANUFACTURING TECHNIQUES WILL CREATE SKILLED JOBS IN THE STATE THAT AREN’T EASILY LOST TO FOREIGN COMPETITION.”

Engineers at the Naval Air Depot at Cherry Point are constantly under the gun to get military helicopters and transport planes off the ground when the aircraft hit the base for repairs. They don’t have time to study why breakdowns occur or how to prevent them. But a new partnership between NC State and Naval Air Systems Command (NAVAIR), which oversees Cherry Point, will provide engineers with the research support they need while serving as a potential magnet to attract military and commercial aviation suppliers to North Carolina.

The Institute for Maintenance Science and Technology (IMST) grew out of a two-year working relationship in which College of Engineering faculty and graduate students quickly addressed technical problems for Cherry Point like predicting the fatigue life on rotors and other components. “The military can’t achieve its objective of rapid and extended deployment when combat aircraft are grounded awaiting critical replacement parts,” says Dr. Jerry Cuomo, IMST co-director and distinguished university research professor in materials science and engineering.

“IMST PROVIDES A BROAD APPROACH TO TECHNOLOGY ISSUES THAT COULD HELP ANY MILITARY BASE.”

IMST’s goal is to nurture the creation of aerospace firms in North Carolina to become future suppliers of these often obsolete parts to the military. The Global TransPark in Kinston will serve as a hub for much of the research. The College of Engineering recently received a \$5.4 million grant to support its research from Golden LEAF, the foundation that funds economic development projects statewide with proceeds from the national tobacco litigation settlement.

Because of the unpredictability of part failure on older aircraft, “agile manufacturing” technologies—ways for suppliers to quickly and profitably produce small quantities of parts—are needed. “These have to be real-time solutions,” says IMST co-director Dr. Roger Sanwald, senior researcher in the Department of Materials Science and Engineering. “They aren’t your typical university research projects, although they could lead to new research for our students.”

Last year, the University signed a \$1 million contract to fulfill such task orders for NAVAIR through 2009. Chris Holder, acting head of research and engineering at Cherry Point, says this fills a gap in his base’s maintenance framework. The Defense Department doesn’t have the funding to conduct such research on its aging fleet of aircraft, and major military contractors have other priorities, Holder says. “IMST provides a broad approach to technology issues that could help any military base,” he says.

NC State wants to expand the IMST platform not only to other military installations—talks already have taken place with Fort Bragg and the Coast Guard station in Elizabeth City—but to civilian industries ranging from automotive parts to nuclear power plants. As ISMT co-director Dr. John Strenkowski, assistant dean for research in the College of Engineering, says, “The IMST’s advanced manufacturing techniques will create skilled jobs in the state that aren’t easily lost to foreign competition.” ■



Technicians at the Naval Air Depot at Cherry Point check damage to an aircraft. ●

ENGAGE EARLY, TRAIN OFTEN TO PRODUCE QUALIFIED WORKERS

NC State enters a new phase of workforce development this summer with the start of construction on the Biomanufacturing Training and Education Center (BTEC) on Centennial Campus. When the \$33.5 million center opens in early 2007, it will become the nation's largest university-based worker training center for the biopharmaceutical industry to meet current Good Manufacturing Practices standards set by the Food and Drug Administration.

"THE PEOPLE WHO USED TO GROW UP TO BE NORTH CAROLINA FARMERS WILL BE OUR FUTURE TECHNOLOGY WORKERS. WE HAVE TO HELP THEM SUCCEED."

BTEC is just the latest effort by NC State to meld its educational and economic development missions. From extension programs designed to help farmers and manufacturing plants improve productivity to research on K-12 instructional tactics to stimulate learning, the University has traditionally worked to produce tangible benefits to the state's economy through its teaching.

BTEC director Dr. Peter Kilpatrick worked with biopharmaceutical industry executives on the design of the 91,000-square-foot training center. ●



Biotechnology ranks among the fastest-growing industries in North Carolina, with some 20,000 people employed in close to 200 companies. It's becoming a focal point for the state's ongoing development initiatives. Golden LEAF is financing BTEC's construction as part of \$60 million earmarked for biotech training programs. The center will play a key role in attracting new biotech plants and helping existing operations grow by providing enough trained workers for these companies, says founding director Dr. Peter Kilpatrick, who also heads the Department of Chemical and Biomolecular Engineering. "This is an emerging industry in which we have a chance to be a world leader," he says. "But we're training only about 10 percent of the workers needed every year, which limits the state's growth potential."

Teaching and support labs capable of manufacturing and packaging biopharmaceuticals will make up about 60 percent of BTEC's 91,000 square feet of space. An advisory board that includes biotech executives helped the University design the building and draw up a curriculum that will have students working with cell culture, fermentation, and purification technologies. In addition to preparing NC State engineering and applied life science students for professional positions in biotech plants, the center will provide simulated production line training to students who have taken bioprocessing classes at North

Carolina community colleges. "It's not rocket science to figure out that training will attract companies needing skilled workers," Kilpatrick says. "We want to create economic opportunities for students in North Carolina."

For Dr. Hiller Spires, such opportunities start long before students hit the NC State campus. In fact, she says, they start with the learning experiences students have in elementary and secondary school. Spires is the director of the William and Ida Friday Institute for Educational Innovation, where researchers develop and test new teaching and learning strategies to improve education. "We want to help all students achieve," she says. "We're losing an opportunity to compete economically if students are



Dr. Hiller Spires and former UNC President William Friday are long-time proponents of creativity in teaching, which the Friday Institute for Educational Innovation (now under construction) will support through research. ●

opting out of math and science classes early on. We must keep them engaged.”

Tight budgets, teacher turnover, a lack of resources in rural school districts, and the continued emphasis on test results to measure success are major challenges for North Carolina’s education system, Spires says. The Friday Institute is tackling such issues with research on preparing veteran teachers to mentor new colleagues, creating virtual and physical models to help students master complex scientific concepts like genomics, and developing engaging math lessons that encourage girls and minorities to pursue algebra and other advanced courses. “It’s important that we support educators in their efforts to cultivate creativity and innovation in the classroom,” Spires says. “It’s not only important for student success, it’s vital to our economic and social future.”

Mike Smith, assistant director of Science House, holds workshops for teachers on innovative classroom demonstrations that hook students. ●



Photo by Sally Ramey

Across campus, the Science House has used creative methods to boost student enthusiasm for science for 14 years. Program Director Dr. David Haase echoes Spires’ contention that students lose interest in critical subjects long before they consider career options, noting that only 200 students a year statewide express a desire to major in math or physical sciences. “Kids are natural scientists because they’re so curious, but they don’t get much of a chance to tinker in school,” says Haase.

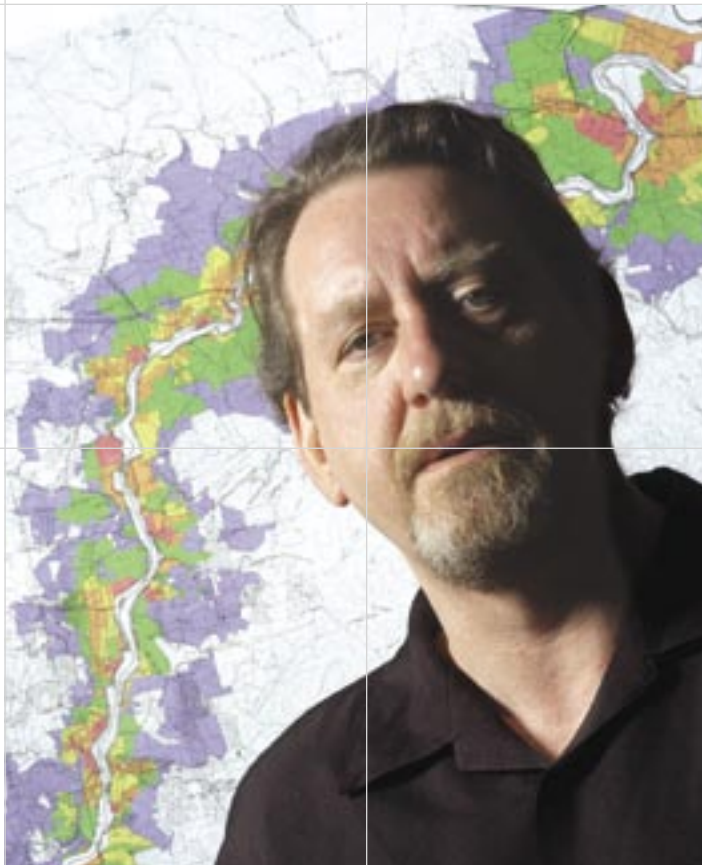
“IT’S IMPORTANT THAT WE SUPPORT EDUCATORS IN THEIR EFFORTS TO CULTIVATE CREATIVITY AND INNOVATION IN THE CLASSROOM. IT’S VITAL TO OUR ECONOMIC AND SOCIAL FUTURE.”

Working with smaller school districts, which often lack experienced science teachers, Science House staff train teachers to use hands-on experiments like creating slime or measuring water quality to intrigue students about chemistry or environmental science. Vans packed with microscopes and computerized lab equipment travel North Carolina backroads so teachers can conduct even more advanced experiments. Haase says excited students sometimes stay after school to use the equipment as much as possible before it is packed up for its next destination. “The people who used to grow up to be North Carolina farmers will be our future technology workers,” he says. “We have to help them succeed early on if the state is ultimately going to have enough trained people.” ■

The Science House electrifies teachers and students in rural school districts across North Carolina with hands-on experiments. ●

TOURISM

PROTECTING VIEWS FOR MOUNTAIN AND BEACH TRAVELERS



section of the parkway. The color-coded maps help Tomlinson educate people about protecting areas from development. Land trusts have already used the maps to target purchases of some properties and work with heirs to family farms to preserve others through conservation easements. “You can’t go out and make communities do good planning, but you can show them ways to avoid killing the goose that laid the golden egg,” he says.

As a child, Jay Tomlinson loved the drive from his home in Wilkesboro to his grandfather’s cabin in the mountains. The trip included a spell along the Blue Ridge Parkway, where the sweeping curves and scenic views captured his imagination.

“I always knew it was a special road. It was different and exciting,” says Tomlinson, now assistant dean for extension and engagement in NC State’s College of Design. Work he has done in recent years to map the vistas along the 500-mile parkway in Virginia and North Carolina could preserve that excitement for future generations of residents and tourists alike.

“SACRIFICING WHAT MADE A COMMUNITY ATTRACTIVE TO TOURISTS IN THE FIRST PLACE ISN’T AN OPTION.”

Conceived in the 1930s as an economic development program for the poor, isolated mountain region, the Blue Ridge Parkway has succeeded in drawing throngs of tourists annually, benefiting other attractions like the Biltmore Estate and Tweetsie Railroad. But population growth is closing in on the parkway—it is buffered only by a narrow corridor the government purchased decades ago—and left unchecked could diminish the road’s role as a tourism magnet in the future, Tomlinson says.

Using topographical maps, Tomlinson and Dr. John Fels, a cartographer and visiting professor of design research, created a digital mapping system that rates the “viewshed”—the areas that can be seen by travelers—along each curving

Even more than the parkway is to the mountains, N.C. 12 is the golden goose for the Outer Banks. The highway is the main drag for tourists, residents, and commuting workers alike in Dare and Currituck counties, and all of that traffic sometimes overwhelms the road. “Congestion is not to the point yet where it is discouraging visitors, but we want to address the issue before it gets there,” says Tom Cook, co-director of the Public Transportation Group in the Institute for Transportation Research and Education (ITRE), which is conducting a one-year study of Outer Banks traffic for area governments.

ITRE has gathered local input in five community meetings and is looking at locales from Cape Cod to Florida barrier islands to see how other coastal resort communities handle traffic problems. Lifestyle changes, such as shifting the check-in days on some beach rental houses or having commuters use shuttle buses, might have the most impact. “Widening a highway isn’t always the best answer,” Cook says. “Sacrificing what made the community attractive to tourists in the first place isn’t an option.” ■



INDUSTRY GROWTH

GENETICS PRODUCING STARS OF CHRISTMAS

As Dan McKinney scans the Fraser firs on his hillside farm in Mitchell County, he glimpses the future of North Carolina's Christmas tree industry in a two-acre stand of young trees. The trees in the test plot run by NC State are growing at a faster clip than surrounding trees while boasting the same full look that have made Fraser fir a holiday must across the country in recent years. "What NC State is doing is the future of the industry," says McKinney, president of the North Carolina Christmas Tree Association. "It's going to allow us to produce a better tree and eventually grow them faster, which means more revenue."



"WITH RESEARCH INNOVATIONS, NORTH CAROLINA GROWERS CAN CREATE A PREMIUM BRAND FOR THEIR TREES (TO) HELP THE STATE MAINTAIN ITS REPUTATION AS THE INDUSTRY STANDARD FOR FRASER FIR."

Despite their seasonal nature, Christmas trees have a \$100 million annual economic impact in North Carolina, putting the state in second place nationally in the value of trees harvested for holiday buyers. As part of the only university-based research team nationwide dedicated to the study of Christmas trees, Drs. John Frampton and Eric Hinesley work hard to help the state maintain its competitive edge. "Technology offers us an opportunity to produce the best quality, fastest-growing trees to meet the market demand," says Frampton, an associate professor in the Department of Forestry.

A tree geneticist whose wife has to choose the family Christmas tree because he is so picky, Frampton is creating improved versions of Fraser fir by grafting cuttings onto the roots of other types of fir trees or by cross-pollination. The modifications are designed to combat two threats to the trees: Phytophthora root rot and the balsam wooly adelgid. Root rot is caused by a soil-borne fungus that can take acres of land out of Christmas tree production for years since Fraser fir has no resistance to the disease. Tree farmers can spray to rid their plots of the adelgid, an aphid-like insect that sucks nutrients from trees, but doing so increases the use of pesticides and adds considerably to production costs.

In addition to his work on grafting, species trials, and selection of better quality, faster-growing trees, Hinesley focuses on customer service issues like shearing techniques that produce well-shaped Christmas trees and more effective preservation of trees after harvest. Good marketing is critical in helping North Carolina's Christmas tree industry fend off growing competition from Northeast and Great Lakes states, where tree farmers are now planting Fraser firs because of their popularity and high profit margins. "With the research innovations and the effort NC State has put into agriculture and forestry extension services, North Carolina growers can create a premium brand for their trees," says Hinesley, a professor in the Department of Horticultural Science. "That would help the state maintain its reputation as the industry standard for Fraser fir." ■



Drs. John Frampton, left, and Eric Hinesley are part of the only university-based research team in the nation to study Christmas trees. ●



INDUSTRY GROWTH EQUINE HEALTH PROGRAM BREEDS SUCCESS

VERC's location in Moore County makes it a prime site for extension programs to work with North Carolina horse owners and veterinarians. ●



cvm.ncsu.edu/docs/ehp.html

The sweet smell of hay wafts by on a spring breeze, as dappled sunlight scatters through budding tree branches and horses munch contentedly in small fields of grass near a highway. The pastoral setting belies the critical importance of this Moore County farm to North Carolina's equine industry. The NC State College of Veterinary Medicine's Equine Health Program (EHP) has established the farm—the Veterinary Equine Research Center (VERC)—as the primary outreach center to introduce the 4-year-old EHP to horse owners and veterinarians statewide.

VERC sits in the heart of North Carolina horse country, and its history dates back more than 40 years. Yet, few in the horse industry are aware of its existence, let alone the research conducted there and the clinical services offered, according to Dr. Richard Mansmann, EHP director. In fact, many horse owners across the state still get lab tests done in Colorado or Michigan. "We're fairly new, so we still have to prove we're capable and define ourselves," Mansmann says. "But there's certainly a major need for equine health services in North Carolina, as well as across the Southeast, that we can fill."

The horse industry had an economic impact of more than \$700 million statewide in 1996, with more than 30,000 horse owners and about 6,500 people employed in the industry, according to the most recent study by the NC Department of Agriculture. Effective marketing of the resources offered at the CVM campus in Raleigh and through the extension satellite at VERC could raise those numbers, Mansmann says.

"HAVING MORE REPRODUCTIVE SPECIALISTS IN NORTH CAROLINA ATTRACTS MORE BREEDERS (AND) IS GOOD FOR THE INDUSTRY."



In addition to his research, Dr. Carlos Pinto performs clinical services for horse breeders, such as transferring embryos from show horses and young mares to surrogate mothers. ●

Dr. Carlos Pinto splits his time between Raleigh and VERC, where he runs an equine assisted reproduction lab in what once was the post-operative recovery room of a former animal hospital. He oversees clinical services like collecting, freezing, and shipping stallion semen for breeders and transferring embryos from show horses and young mares to surrogate mothers. He also works with graduate students on research projects like developing a hormonal test to predict equine fertility, which would allow horse owners to schedule breeding.

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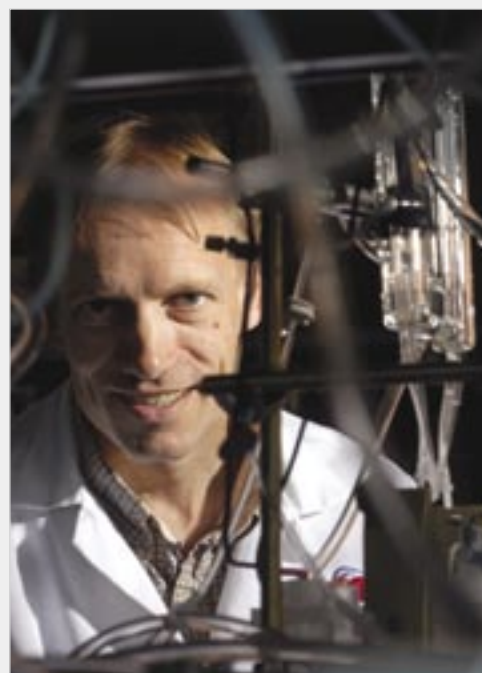
A Brazilian who became fascinated by cows and horses only after he left São Paulo to attend veterinary school, Pinto still describes himself as “not a horse guy.” But he welcomes the task of getting NC State’s equine reproductive studies program off the ground. “It’s a huge challenge to build a program from scratch,” he says. “We want to become a major training ground. Having more reproductive specialists in North Carolina attracts more breeders and provides the benefit of advanced reproductive services. That is good for the industry.”

The CVM already is world renowned for its treatment of gastrointestinal problems in horses. Dr. Anthony Blikslager is building on that reputation with research on using drugs similar to Vioxx to treat colic. He has worked for eight years to find an anti-inflammatory drug that could relieve the pain caused by colic without the adverse side-effects of current medications. “They’re good painkillers, but they’re not that friendly to the gut,” he says, noting the drugs inhibit the ability of a horse’s stomach and intestines to repair the ulcers created when colic twists them into knots and cuts off blood supply.

Having grown up on a horse farm in England and now co-owner of a stable near Raleigh, Blikslager has seen the devastating effects of colic firsthand. Although only 1 to 2 percent of cases are fatal—a couple hundred horses a year in North Carolina—he quickly acknowledges the statistics aren’t small when it’s your horse that is stricken. To speed post-operative recovery and improve a colicky horse’s chance at survival, he hit upon the notion of using COX-2 inhibitors, the same type of drugs used to treat arthritis in humans with no stomach upset. Federal regulators pulled many of these drugs off the market in recent months after studies linked them to heart problems in humans. Blikslager says that could open an avenue for the equine market, which drug makers usually ignore because it’s fairly small. “Horses have the perfect diet and lifestyle for a good heart, so the likelihood of them encountering problems is very remote,” he says.

But a lifestyle of exercise sometimes produces muscle and joint injuries, which is what Dr. Rich Redding plans to address with a new equine sports medicine program. Meeting in a converted operating room at VERC, Redding introduces the newest imaging technology to horse owners. MRI is available to equine patients in only a few locations in the world, but none with the capabilities of the Iams Pet Imaging Center on NC State’s Centennial Biomedical Campus.

The images give Redding a better picture of tendon and ligament damage so he can design an appropriate treatment regimen. He also is studying the use of equine adult stem cells to heal joint injuries. “Our ultimate goal is to make the tendon or ligament as strong as it was before the injury,” he says. “We’re trying to take clinical cases and work them up with as much advanced technology as we can. The sports medicine program is a way to introduce our capabilities to horse owners and veterinarians.” ■



Vioxx being pulled from the market for human patients could make it more available to treat colic in horses, Dr. Anthony Blikslager says. ●

Drs. Richard Lemaster, left, and John Stewart use engineering and materials science to help furniture makers and their machinery suppliers compete globally. ●

INNOVATION

TECHNOLOGY GIVES NEW TOOLS TO FURNITURE INDUSTRY



for example, study how diamond coatings can make saws and other tools last longer. Meanwhile, mechanical engineers examine the effects machine speed and vibration have on production and use sensors to monitor machining conditions and detect defects in wood surfaces.

When the Sherrill Furniture plant in Hickory repeatedly found itself with broken-down machines rather than finished occasional tables, plant manager Andy Matton put in a call to the Wood Machining & Tooling Research Program (WMTRP) at NC State. Researchers there told him he would have more success if he slowed his production line slightly. “In our applications, we sometimes push the systems beyond the breaking point,” Matton says, adding that the advice worked. “We’re not having that problem anymore since we backed off a bit.”

“WE’RE GETTING INTO AREAS WHERE WE DON’T HAVE EXPERTISE AND DON’T EVEN KNOW WHERE TO START. NC STATE IS THE ONLY PLACE YOU CAN GO TO GET ANSWERS.”

Founded more than a decade ago to stem the steady erosion of North Carolina’s once dominant furniture industry, WMTRP is the only program of its kind in the United States. It also is part of a 12-university research effort funded by the U.S. Department of Agriculture to find ways to make the wood products industry more competitive globally and environmentally friendly at home.

In what amounts to a giant woodworking shop on Dan Allen Drive, WMTRP founder Dr. John Stewart and director Dr. Richard Lemaster talk above the whine of saws about the applied, inter-disciplinary research used to develop better equipment for tool manufacturers and improved production processes for furniture companies. “A lot of companies aren’t able to help themselves because they can’t afford in-house research departments,” Lemaster says. “We do that work for them.”

The program focuses on technologies not normally associated with couches and chairs. Materials scientists,

“Some people think that Elvis has left the building as far as a good portion of the furniture industry in the state goes,” says Stewart, a research professor in the Department of Wood and Paper Science in the College of Natural Resources. “But there are many firms that still have success here, and they are thriving because of lean manufacturing and technological innovation.”

But getting an industry steeped in tradition like furniture making—and, in turn, their machine suppliers—to accept new technologies continues to be the main challenge for WMTRP, even as these companies face growing competition from overseas, Stewart explains. Appearances at trade shows, articles in industry journals, and technology transfer have been effective in converting manufacturers to new systems and processes.

Matton at Sherrill Furniture is one such convert, saying NC State understands the needs of domestic furniture manufacturers in an evolving industry. “We’re getting into areas where we don’t have expertise and don’t even know where to start,” he says. “NC State is the only place you can go to get answers.” ■

“THERE ARE MANY FIRMS THAT STILL HAVE SUCCESS HERE, AND THEY ARE THRIVING BECAUSE OF LEAN MANUFACTURING AND TECHNOLOGICAL INNOVATION.”

INDUSTRY TRANSFORMATION

FROM GOLDEN LEAF TO GREENER PASTURES

While the Specialty Crops Program is most known for produce like sprite melons, Dr. Jeanine Davis focuses her research on native plants like black cohosh (top) and Echinacea (below) that can be used as medicinal herbs. ●

Farmers in eastern North Carolina knew they were in trouble. Tobacco was falling out of public favor, and prices for cotton, peanuts, and soybeans were sagging. So they asked NC State, the Cooperative Extension Service, and the NC Department of Agriculture to find some alternatives to agricultural mainstays in the state—crops that offered a decent value and had good growth potential. A decade later, the NC Specialty Crops Program has farmers statewide cultivating everything from melons to mushrooms to medicinal herbs, and reaping millions of dollars that they wouldn't have seen otherwise.



James Sharp's family had grown tobacco for generations in Wilson County, but he wanted a way to diversify beyond the golden leaf. Now, he has some 300 acres planted with green leaf—lettuce and cabbage—as well as cantaloupes and sprite melons. The guidance Sharp received from the Specialty Crops Program made the switch possible. "Tobacco farmers can't afford to take on a lot of risk," he says, "and they eliminated most of that for me by finding crops that would grow well in the area and that would be good sellers."



Photo by Becky Kirkland



Davis says, while medicinal herbs like Echinacea and ginseng can be grown on smaller plots in the mountains. "We want to give farmers a good reason to stay on their land, and show them their work and their land can still produce a good return," she says.

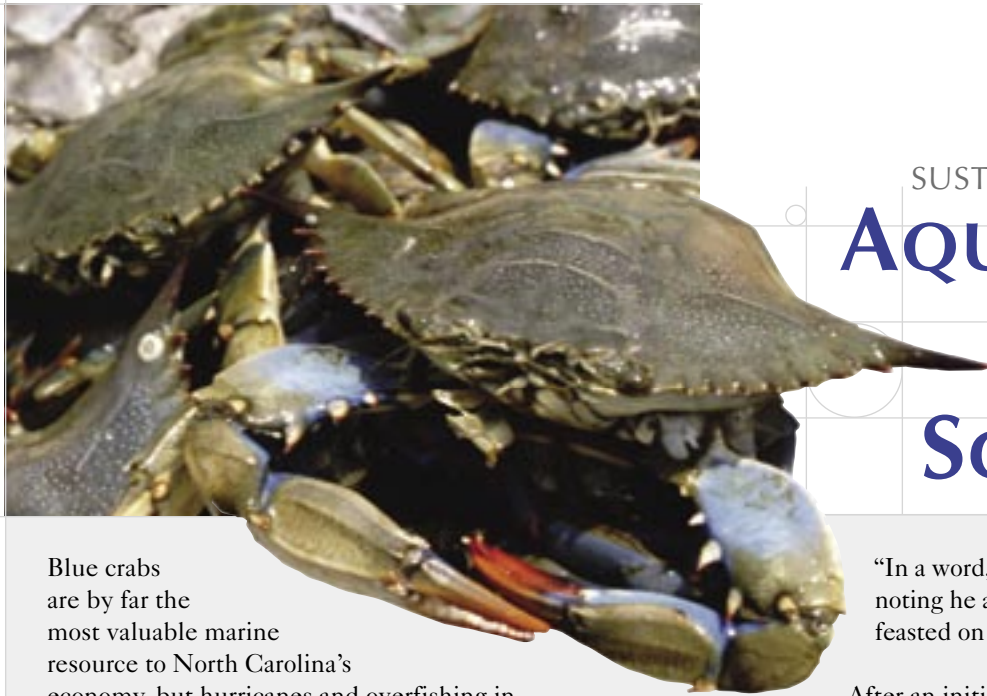
Diversifying North Carolina's produce also makes North Carolina more attractive to agribusiness companies, says Bill Jester, an extension associate in the Department of Horticultural Science. State agricultural officials routinely meet with representatives from global produce suppliers, he explains, and one has even suggested building a plant near Charlotte to produce bags of pre-cut lettuce. "North Carolina wasn't known for quality produce before," Jester says, "but we're changing that image for a lot of people—good for farmers and the state." ■

"NORTH CAROLINA WASN'T KNOWN FOR QUALITY PRODUCE BEFORE, BUT WE'RE CHANGING THAT IMAGE FOR A LOT OF PEOPLE."

That's exactly how the program is supposed to operate, says Program Coordinator Dr. Jeanine Davis, an associate professor of horticultural science located at the Mountain Horticultural Crops Research and Extension Center in Fletcher. Advisory boards of farmers and produce buyers suggest crops that are needed on the market and should grow well in North Carolina, such as mushrooms, blackberries, and wild leeks known as ramps. "We're not necessarily looking for what's hot today," Davis says. "We're looking for high-quality niche crops that will provide a strong market and good value for growers."

Before farmers get a crack at the crops, University researchers spend a couple of years experimenting in trial beds—measuring yields, studying disease resistance, testing consumer tastes, and addressing potential shipping problems. County extension agents help recruit growers, and the Department of Agriculture provides marketing assistance. Larger farms in the eastern half of the state are better suited for commodity crops like cantaloupe and lettuce,

"WE'RE LOOKING FOR HIGH-QUALITY NICHE CROPS THAT WILL PROVIDE A STRONG MARKET AND GOOD VALUE FOR GROWERS."



SUSTAINABLE DEVELOPMENT AQUACULTURE PROJECTS SCALING UP

Blue crabs are by far the most valuable marine resource to North Carolina's economy, but hurricanes and overfishing in recent years have decimated the blue crab population in the Albemarle and Pamlico sounds. Less than 43 million pounds of the shellfish were caught in state waters in 2003, down 31 percent from just five years earlier. If harvests continue to struggle, the state could begin enforcing catch restrictions next year designed to help the population recover—rules that also would make it more difficult for crabbers to make a living.

Enter Dr. David Eggleston, part-time rock drummer and full-time crustacean researcher, who wants to change the rhythm of the crabbing industry by farming them in ponds across eastern North Carolina. Although blue crabs spend most of their lives in the open ocean or the brackish waters of coastal estuaries, Eggleston's studies show the creatures could actually grow faster in ponds because fresh water helps their body tissue expand whenever they molt. And the taste?

"In a word, they were delicious," he says with a grin, noting he and his marine science students have feasted on some of their freshwater experiments.

After an initial study in a Belhaven crabber's backyard pond last year, Eggleston is planning large-scale trials in Plymouth this summer. He will track costs and yields and hopes to determine that crab farming makes economic sense. "We have to take fishing pressure off the wild stock to preserve the future of the industry," he says. "Taking advantage of unused farm ponds offers a development opportunity to the eastern part of the state and gives crabbers a chance to expand their business."

AQUACULTURE IS AN INDUSTRY THAT
ALLOWS SUCCESSFUL FARMERS TO DIVERSIFY
THEIR OPERATIONS. IT'S NOT A SAVIOR FOR
A FAILING FAMILY FARM.



Dr. Dave Eggleston's work on raising blue crabs in farm ponds could help the crustaceans maintain their status as North Carolina's most valuable marine resource. ●

Unlike crabs, freshwater fish have been farmed for decades, from trout runs to catfish ponds, but Dr. Tom Losordo believes production could be improved by getting the fish out of the ground—ponds are too cold for some species—and into indoor tanks. In a corrugated metal building off Lake Wheeler Road known as the Fish Barn, the agricultural engineering professor oversees a series of 15,000-gallon tanks teeming with tilapia, yellow perch, and other species. He has tweaked his system for years—adjusting water levels, feeding schedules, and waste filters—and each tank now produces about 11,000 pounds of fish every six months.

The Fish Barn system is so recognized that Losordo travels the globe presenting scientific papers and technical workshops on indoor fish farming. But in North Carolina, he spends a lot of time talking people out of going into the business. Aquaculture is an industry that allows successful

Tilapia is the prized catch of Drs. Tom Losordo, left, and Dennis DeLong. The Fish Barn operations they build can generate 22,000 pounds of fish annually. ●



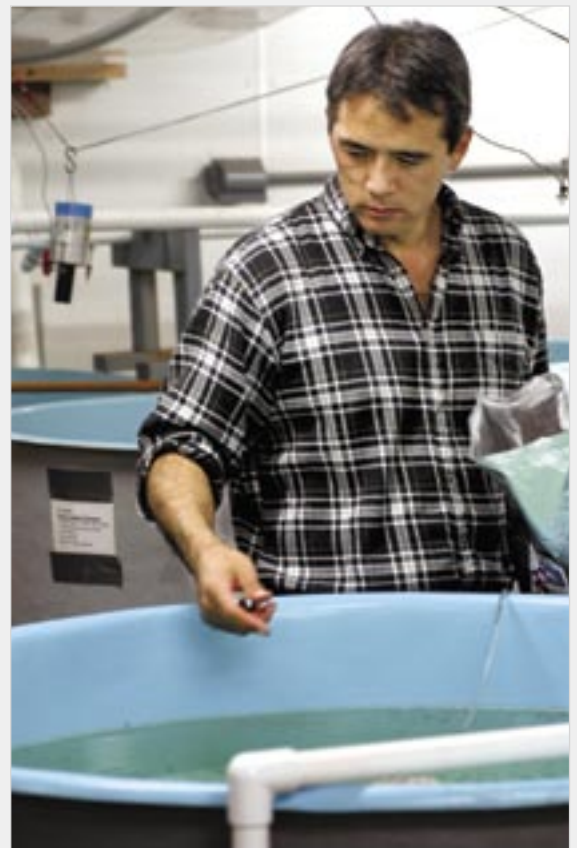
“WE’RE JUST TAKING (NC STATE’S) KNOWLEDGE AND APPLYING IT ON A COMMERCIAL SCALE.”

farmers to diversify their operations, he says. It’s not a savior for a failing family farm. “My job is not to build an industry quickly. My job is to help build an industry in the state that lasts and that continues to grow.”

Ten Fish Barns have been built statewide in the past seven years, with Southern Farm Tilapia marketing fish from all but one. The Nash County-based company, which also owns one of the few tilapia hatcheries on the East Coast as well as a processing facility, sells about 2.5 million pounds of fish annually. President R.C. Hunt says NC State’s technical expertise helped him apply the business skills he had honed in cattle and pig farming to a new market. “They taught us the engineering and the chemistry and motivated us to strive for improvements,” Hunt says. “We’re just taking their knowledge and applying it on a commercial scale.”

Dr. Harry Daniels expects Fish Barns around the state to one day supply Southern flounder to supermarkets and sushi bars nationwide. The associate professor of zoology is working with Losordo to adapt the indoor system to the flat fish, which prefer piling up along the bottom of the tanks to swimming around. “Because aquaculture can be done anywhere, we need to focus on higher-grade niche businesses like this to be successful,” Daniels says.

A former Peace Corps worker who once rebuilt fish hatcheries in western Africa to feed growing populations, Daniels now works to build an all-female species of Southern flounder to fill Fish Barn tanks because the female fish grow three times faster than males and are more marketable. By fertilizing flounder eggs with sperm from black sea bass and pressurizing the egg enough to retain the mismatched genetic material, Daniels and Drs. John Godwin and Russell Borski have created male flounder with no Y chromosome. These so-called XX males can then be bred to produce all female flounder and improve a farmer’s yield. “Breeding these fish and raising them in tanks is a major accomplishment,” Daniels says, “one that will offer economic opportunities to farmers across North Carolina for years to come.” ■



Dr. Harry Daniels runs a pilot hatchery off Lake Wheeler Road to raise Southern flounder from eggs to market size in a controlled environment. ●



HIGH-TECH JOBS

EMBEDDED SYSTEMS RESEARCH DRAWS ENGINEERING JOBS

Enjoy snapping photos with your cell phone? Using a fob on your keychain to beep your car doors locked and unlocked? Sleeping soundly while a monitoring system checks your home for potential danger and disaster? Embedded systems make such daily conveniences possible, and NC State's research into these miniature computers is bringing jobs to the state in addition to making life easier for North Carolina residents.

"SOME (COMPANIES) RECOGNIZE OUR WORK PLAYS A ROLE IN HOW FUTURE SYSTEMS ARE DESIGNED OR OPERATE, AND BUILDING RELATIONSHIPS WITH THOSE PEOPLE WILL BENEFIT OUR STUDENTS AND THE REGION."

The two-year-old Center for Embedded Systems Research (CESR) in NC State's College of Engineering is one of just a handful of university research centers nationwide to focus on embedded systems. The tiny computers are embedded as mere components in a larger system to provide better performance or additional features. CESR's Dr. Alex Dean, an assistant professor of computer engineering, says they are the basic workings of most advanced electronics today, offering designers a nexus between computer chips and software code. "It's extremely expensive and time-consuming to build systems," he says. "So all of the complexity has been shifted into the software, which is easier to develop and debug, while one microprocessor satisfies the computing needs."

QUALCOMM AND RENESAS TECHNOLOGY HAVE ESTABLISHED DESIGN OPERATIONS IN THE RESEARCH TRIANGLE AREA, IN PART, FOR THE CHANCE TO WORK WITH CESR RESEARCHERS AND TALENTED NC STATE GRADUATES.

The professors and students in CESR's Centennial Campus offices research challenges like conserving energy in systems that tend to stretch battery and power supply limits and finding the most efficient way to translate advanced software code into simple computer language that a processor can understand. Another area of interest is guaranteeing the timing of all software code and hardware to ensure that a system runs predictably—an especially critical function in embedded systems like automotive airbags and anti-lock brakes. "A system solution isn't one that merely operates. You have to have something that is cost-effective, can be repaired, fits into the space you have for it, and doesn't use a lot of energy," Dean says.

Companies like cell phone maker Qualcomm and semiconductor manufacturer Renesas Technology recognize the pivotal role CESR plays in creating the next generations of electronics. Both companies have established design operations in the Research Triangle area, in part, for the chance to work with CESR researchers and snap up talented NC State graduates. Red Hat, a world leader in open source software development with headquarters on Centennial Campus, has also partnered with the center, bringing more research opportunities and potential jobs.

"Most companies want a faster return on their investment than long-term research provides," Dean says. "But some recognize our work plays a role in how future systems are designed or operate, and building relationships with those people will benefit our students and the region." ■

Miniature computers run systems from automotive airbags and anti-lock brakes to cell phone cameras. ●



Drs. Warren Jasper, Brent Smith and Keith Beck, left to right, invested more than 40 years combined to develop their dye bath monitor and controls. ●



TECHNOLOGY TRANSFER

TEXTILES' HOLY GRAIL: NEW LIFE FOR DYE PLANTS

Incorrectly dyed fabric can cost a textile dyeing plant between \$1.5 million to \$5 million annually. Officials at HueMetrix, Inc., say that's usually the difference between a profitable operation and a shuttered one. Spun out of the College of Textiles last year, the company has developed a monitoring system its founders hope will eliminate financial red ink at North Carolina textile plants by ensuring red dye and other colors come out looking as they should on fabric.

"THIS IS A QUALITY CONTROL TOOL THAT SHOULD OFFER NORTH CAROLINA COMPANIES A COMPETITIVE ADVANTAGE."

Dyeing has traditionally been more art than science for textile firms, with supervisors relying on knowledge gained through years on the job to get the best color matches on fabric in a dye bath. Still, about 5 to 15 percent of a typical plant's production has to be re-dyed or thrown out because colors didn't come out right the first time, says Dr. Brent Smith, Cone Mills Professor of Textile Chemistry. "There are so many things that you can't control, from the water quality to the phase of the moon, so shades sometimes vary from one dye lot to the next," he says.



Part of a student team that wrote a business plan for the dye monitoring technology, Kelly Wright is now business development director for HueMetrix. ●

Smith and Drs. Keith Beck and Warren Jasper have collectively put about 40 years of research into building what they call "the right first time system," upon which HueMetrix is based. The system pulls a drop out of the dye bath every minute during the 45- to 50-minute dyeing process and injects it into a monitor, where a spectrophotometer is used to obtain real-time measurements of each dye in the bath.



A small dyeing machine in the College of Textiles helps test HueMetrix's "right first time" system. ●

HueMetrix's automated control system then makes any necessary adjustments to the water temperature, dye levels, or other variables to ensure the fabric is dyed properly. "Dyeing isn't simple. You have to work to make it work," says Jasper, associate professor of textile engineering.

The research might have just remained in the lab if not for a team of graduate students in the College of Management's HiTEC program. Searching for a technology to commercialize two years ago, the students seized upon the monitoring system idea and did enough market research to convince NC State officials it could form the basis of a viable spin-off. "This is the Holy Grail for the textile industry," says Kelly Wright, a member of the HiTEC team who joined HueMetrix as director of business development after earning her MBA. "There is a huge need in the industry to decrease errors and make things right the first time."

"DYEING ISN'T SIMPLE. YOU HAVE TO WORK TO MAKE IT WORK."

As company officials continue working to make the system small enough and strong enough to fit into the harsh environment of a dye plant, they're sorting through numerous eager textile firms to pick test market partners, says Beck, head of the Department of Textile Engineering, Chemistry and Science. "This is a quality control tool that should offer North Carolina companies a competitive advantage in addition to saving on the bottom line," he says. ■

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INDUSTRIAL RECRUITMENT

PLAYING ON TEAM
NORTH CAROLINA

A former venture capitalist, Ted Morris is used to gambling on ideas with enormous potential that are unproven outside the lab. As director of the NC State Economic Development Partnership (EDP), he is placing much safer bets—matching the University’s proven research abilities with known local and regional resources—to attract business with enormous potential to North Carolina.

Created in 2003, EDP provides a point of contact for the North Carolina Department of Commerce and local agencies seeking NC State’s assistance in landing industrial recruiting targets. Previously, agencies went through individual colleges or programs for help, but Morris is in position to marshal all University resources into “rapid response teams” to sell corporate executives on the potential for research collaborations if they locate or expand operations in the state. Computer science faculty and logistics experts, for example, helped in discussions with Dell before the computer-maker decided to open an operation in Forsyth County.

But as recruiting becomes more competitive both domestically and globally, a more critical role for EDP is to tap the corporate relationships of NC State researchers and work with economic developers to target industries even before companies are ready to expand. “We no longer operate on a cold call model of going after every lead,” Morris says. “We have to use our regional assets and the University’s strengths to locate niches where we can be most successful and then pursue those industries.”

Medical and biotextiles—products ranging from wound dressings to surgical sutures to artificial skin—is the first target industry. EDP has partnered with Wake County Economic Development on a precision marketing initiative to attract advanced textiles companies to the Raleigh area. They are banking on the expertise of the College of Textiles and its Nonwovens Cooperative Research Center, as well as science and engineering resources throughout NC State, as a drawing card to build an early leadership position in the nascent industry. Morris says the state could then use that as a foundation to draw even more firms and related industries. “We have to demonstrate to companies that choosing not to locate in North Carolina is a competitive disadvantage,” he says. ■



“WE HAVE TO DEMONSTRATE TO COMPANIES THAT CHOOSING NOT TO LOCATE IN NORTH CAROLINA IS A COMPETITIVE DISADVANTAGE.”

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RESEARCH AND GRADUATE STUDIES AT NCSU

RESULTS

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