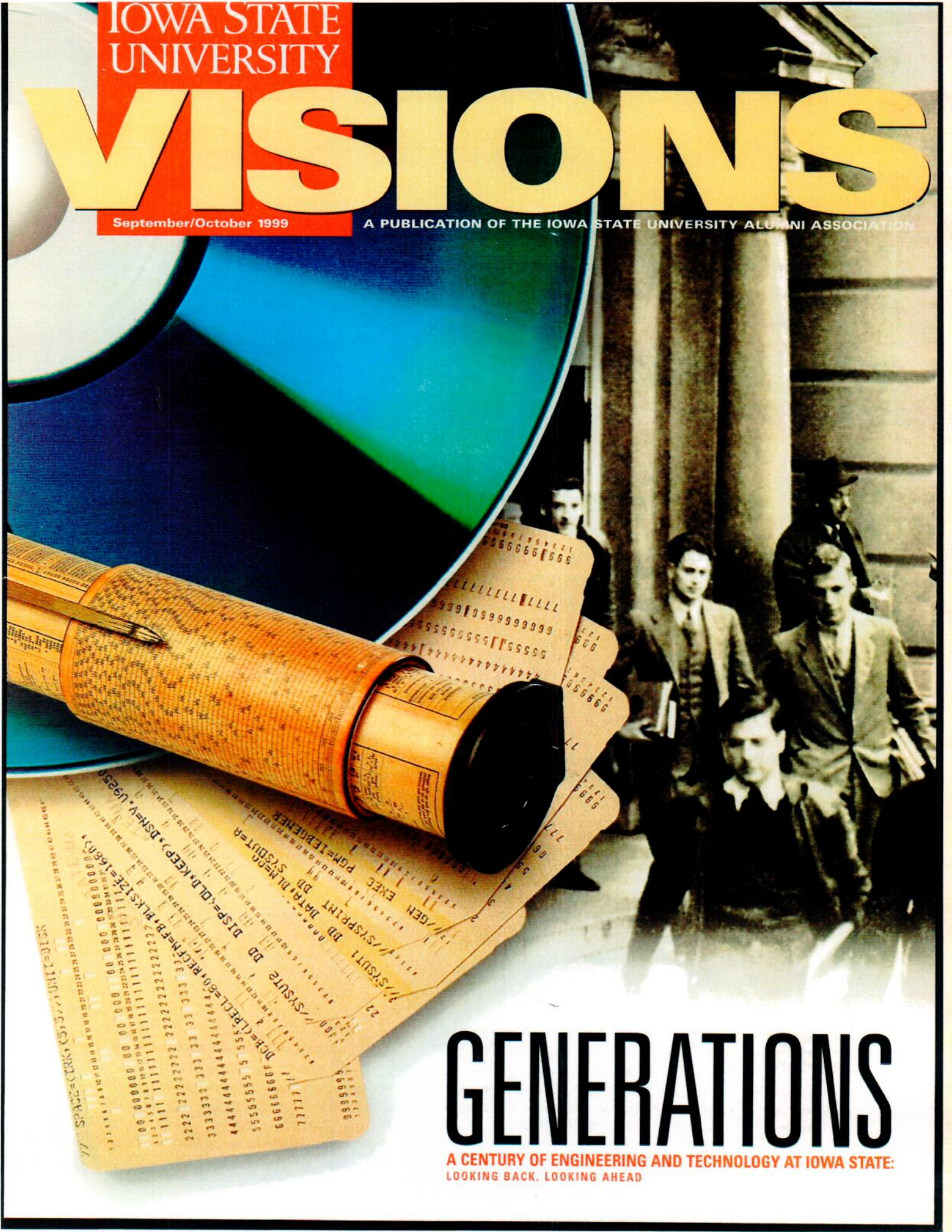


IOWA STATE
UNIVERSITY

VISIONS

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GENERATIONS

A CENTURY OF ENGINEERING AND TECHNOLOGY AT IOWA STATE:
LOOKING BACK, LOOKING AHEAD



EIGHTY-SIX YEARS AGO, the first member of the Liggett family came to Iowa State to enroll in the mechanical engineering program. Four generations of these young engineers have now embraced a campus that was a microcosm of a larger America – a country that would evolve so profoundly that each father and each son has a different story to tell.

As Iowa State University begins its year-long celebration of the role and impact of science and technology, **Advancing Technology: To Become the Best**, VISIONS examines a small piece of a large story – about a family, a college, and a country.

GENERATION

**A CENTURY OF ENGINEERING AND
LOOKING BACK, LOOKING AHEAD**



INNOVATIONS

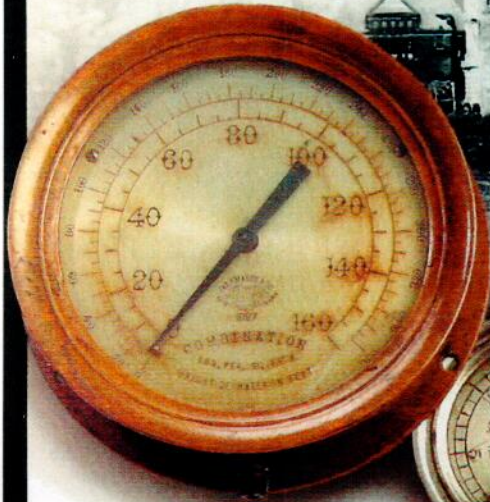
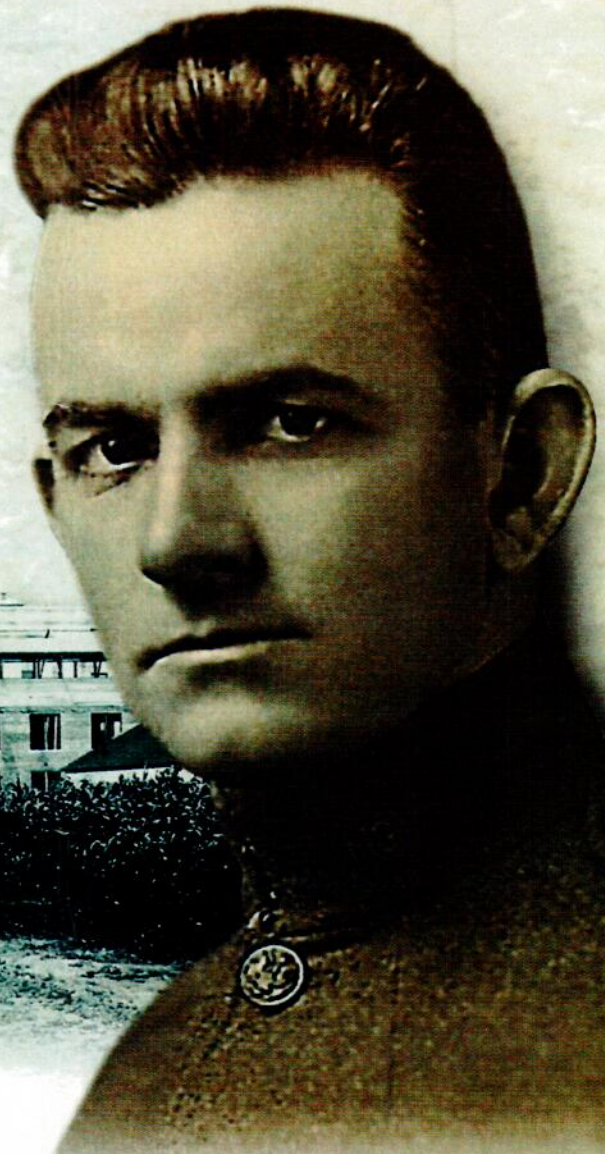
D TECHNOLOGY AT IOWA STATE:

By Karol Crosbie, Photos by Jim Heemstra
Historical photos courtesy of Iowa State University Library/University Archives

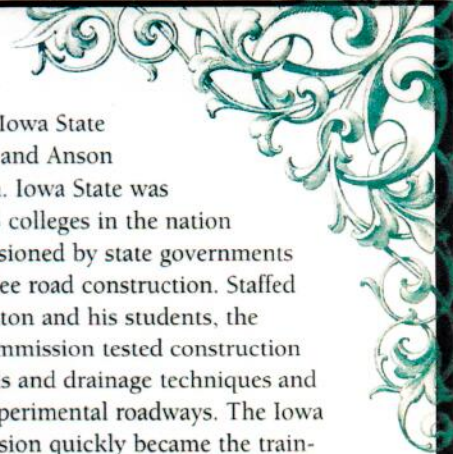
John T. Liggett

Paving the Way

It was the great age of invention, the new frontier of American industry. For the first time, Americans owned their own cars—but where were the roads? It was a time of racial segregation and women's suffrage, of assembly lines and new technological feats. Then, in 1914, America was swept into the first World War, and the need for trained engineers was greater than ever before.



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IF JOHN T. LIGGETT was like most freshmen, he was oblivious to the cultural changes that swirled around him when he arrived on the Iowa State College campus in 1913. The son of a tailor and interior decorator, John had set his sights on one thing: to become an engineer.

He left his rooming house, headed toward campus, and took his seat in Engineering Hall (now called Marston Hall) to be welcomed by one of the most influential engineers and educators in the country—Anson Marston. “I extend to you a welcome from your chosen Alma Mater,” Marston told the collected freshmen. “You are strong in numbers... You must be tested and perfected in many a fiery furnace of experience before attaining the complete, all-around engineering strength essential to the real engineer.”

Although we don’t know the exact nature of all the “fiery furnaces” young John Liggett would face, we do know that one of them was calculus. By the end of his sophomore year he had flunked calculus, and spent the following summer taking a cram course on differential equations. “For six weeks I didn’t get back to Des Moines,” he plaintively reported in his memoirs. “When I did get back, I phoned Beulah for a date, and found she was dating another fellow.”

America comes of age

As John Liggett struggled to create his own personal foundations for a career in mechanical engineering, his country was undergoing a similar struggle. When John arrived on campus, Americans were almost uniformly united in their resistance to entering the war, which was beginning to boil in Europe. *I Didn’t Raise My Son to Be a Soldier*, was a popular song; Henry Ford, a colorful and vocal personality, was an avowed pacifist.

The United States was as unprepared technologically to enter the war as it was emotionally. Ironically, although Orville and Wilbur Wright had achieved the first successful flight

in 1903, Americans lagged far behind Europe in aircraft development. When John was a freshman, the U.S. military owned only six aircraft.

By the time he was a junior, both the technological and sentimental tides had turned. College students were an important target in the propaganda that first declared “I want you!” and posters that showed Germans with spiked helmets and bloody mouths. The military now owned 411 aircraft. In two years, the numbers would explode to 8,000 training planes and 12,400 fighters.

The birth of the military’s air defense had significant effects on engineering and technology and on land grant colleges, which were vital training centers. Precision engineering, high tensile steel, the creation of fiber glass and plastic adhesives, new lubricants, high-quality fuels, and powder metallurgy were developed. The United States had historically depended on Europe for the bulk of organic chemicals; the organic chemical industry came of age, as for the first time, chemicals were needed for munitions.

Digging out the Hupmobile

John’s parents, Joseph and Effa, owned a 1913 Hupmobile—one of only about 1.7 million cars registered in the United States. But driving the Hupmobile to many rural areas in Iowa was an adventure in mud. Because the automobile industry was in its infancy (Ford began using assembly lines for production when John was a freshman), there were fewer than 20 miles of paved roads in the state.

Few institutions and men were as significant players in the war against

mud as Iowa State College and Anson Marston. Iowa State was one of 13 colleges in the nation commissioned by state governments to oversee road construction. Staffed by Marston and his students, the road commission tested construction materials and drainage techniques and built experimental roadways. The Iowa commission quickly became the training school for other states’ engineers,

which helped standardize rural road construction nationwide. Marston became known as the man who “lifted Iowa out of the mud.”

But if cars were mired in mud, buildings were rising far above it. The skyscraper was born. In 1916, the New York building code was revised to allow skyscraper construction to unlimited height. Engineers were challenged by the new specifications of buildings that were

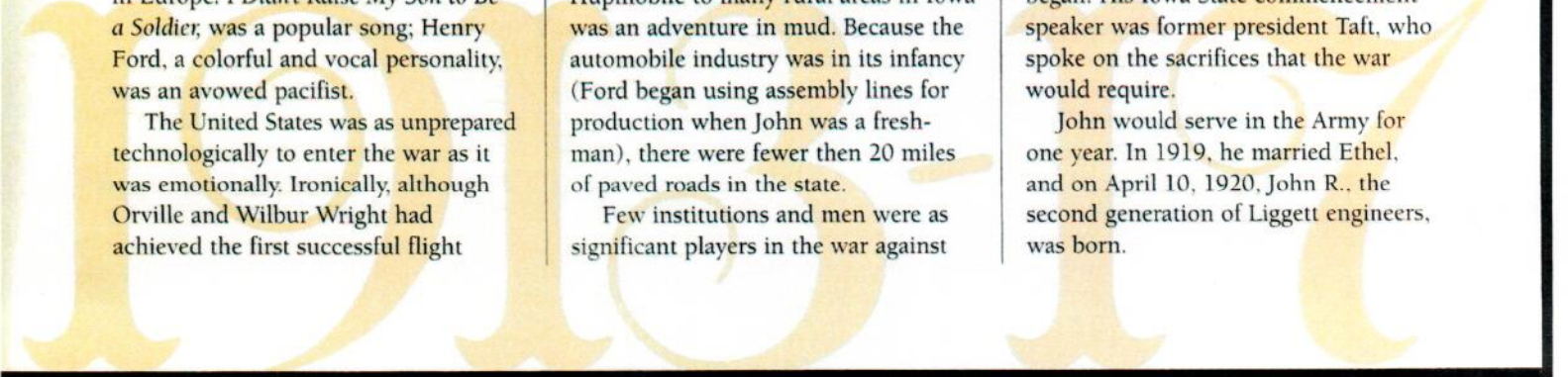
sturdier, lighter, and taller. Steel, which weighed less than half as much as masonry or stone, possessed greater tension and compression strength than the older building materials.

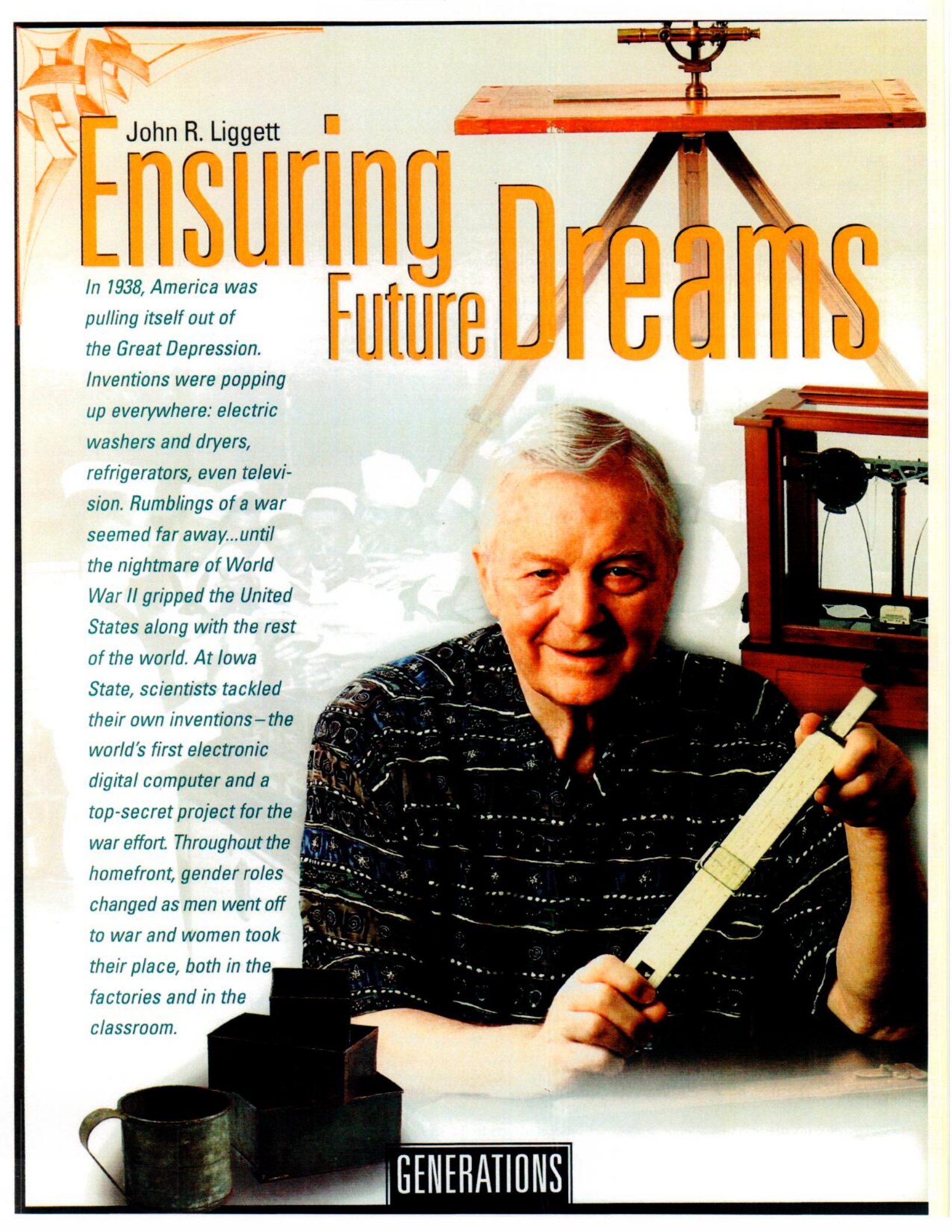
By the time John was a senior, he had passed calculus, the United States had declared war, and his dad had traded in the 1913 Hupp for a 1916 Model N Hupp. Just a month before John graduated, military conscription began. His Iowa State commencement speaker was former president Taft, who spoke on the sacrifices that the war would require.

John would serve in the Army for one year. In 1919, he married Ethel, and on April 10, 1920, John R., the second generation of Liggett engineers, was born.

“Our ancestors plowed with crooked sticks, traveled in ox carts and signaled their neighbors with fire and smoke. Our successors will farm with mechanically driven automatic machinery, travel through the air at high rates of speed with motive power unknown to us, and signal distant lands by lightning flashes. This will come through individual effort and originality, persistent concentration of mind and general business sense.”

—From a 1917 Iowa Engineer
(an Iowa State publication
authored by students and alumni)





John R. Liggett

Ensuring Future Dreams

In 1938, America was pulling itself out of the Great Depression.

Inventions were popping up everywhere: electric washers and dryers, refrigerators, even television. Rumblings of a war seemed far away...until the nightmare of World War II gripped the United States along with the rest of the world. At Iowa State, scientists tackled their own inventions—the world's first electronic digital computer and a top-secret project for the war effort. Throughout the homefront, gender roles changed as men went off to war and women took their place, both in the factories and in the classroom.

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JOHAN R. (JACK) LIGGETT staunchly maintains that his father did not pressure him to become the second generation of Liggetts to graduate in mechanical engineering from Iowa State. "As a kid, I was always mechanically inclined," he says.

As his father did before him, Jack entered Iowa State with a world war brewing—a war that would shape technology, careers, and lives. But unlike his father's freshman experience, in 1938 there was no ambivalence about the United State's role in the war. When Jack was a sophomore, the conscription bill passed, and all freshman and sophomores were required to take ROTC. "People who were not in the service had to explain," remembers Jack.

Iowa State was at the forefront of preparation for the war. Because land grant colleges had highly developed programs of technological instruction, they were strategically available as war training centers. In the summer after Jack's sophomore year, Iowa State president Charles Friley announced that the college would be in "full cooperation in measures looking toward national defense."

By 1940, it was clear that the country's colleges could not produce enough engineering and science graduates to meet the critical needs of the national defense. The federal government, collaborating with engineering departments, initiated short, intensive courses that would train students to perform specific industrial jobs. The 227 colleges that participated in the program, including Iowa State, offered more than 31,000 engineering courses to more than 1.3 million people.

The military was a visible presence on campus. Military courses took up residence at Friley Hall and other dormitories, and fraternities housed "non-Greeks," including 220 veterinary students. The Engineering Extension Service conducted short courses on safety, civilian defense, conservation, and war production.

On Dec. 7, 1941 the Japanese

bombed Pearl Harbor, and the next day the United States formally declared war. The days were uneasy ones for Iowa State students, who didn't know when they might be called to serve. Classes were held continuously, through week-ends and holidays.

The war machine of Jack's era bore little resemblance to that of his father's. A military that had only six planes at the beginning of World War I now had 296,000. In one day, Allied forces used as much petroleum as they had used for the entire previous war. Engineers and engineering education responded to the needs of the war with new research and new applications. More sophisticated electronics gave birth to radar and navigation systems. Aeronautical and mechanical fields researched high speed aerodynamic structures, gas turbine engines, new fuels and lubricants, and

new ways to forge, press, and test high-tension metals.

There was much speculation among the students as to the exact nature of the research being conducted at the modest building just east of what is now Hamilton Hall. The building (which looked a little like the old Pammel Court temporary housing units) was used to research and produce pure uranium, to be used for the atomic bomb. The magnesium used in the refining process caused frequent explosions and small fires. Most of these were minor—causing the building to glow and appear to expand. Part of the famous Manhattan Project, Iowa State was, for a time, the nation's leading producer of uranium and would be named as one of the four outstanding university atomic bomb projects in a report by the Secretary of War.



1938-42

Ensuring Future Dreams/continued

In spite of the dark times, Jack's memories are of the camaraderie of his TKE fraternity brothers, football, and the sounds of the big band. The Glenn Miller Orchestra was the music craze of the time, and people gathered around their radios on Tuesday, Wednesday, and Thursday evenings to hear the orchestra's music.

New dreams

"How soon will we have television in our homes?" asks a writer in the May 1940 edition of the *Iowa Engineer*. By the time Jack was a junior, television's pictures had changed from black and green to black and white, and students speculated that "a new art has blossomed out... Some day an 'angel' will buy some television time to advertise his product; the art will find itself and become a paying industry."

To help the dream along, Iowa State's Electrical Engineering Department constructed a television laboratory in 1940 to teach students the mechanics of the new communication device. The laboratory would blossom into a full-fledged television studio and transmitter building in 1949.

In 1939, an ISU physics professor named John Atanasoff began work on a revolutionary machine. Frustrated at the time it took to solve algebraic equations, Atanasoff created a machine the size of a small desk, using 300 vacuum tubes, rotating drums, and cards. It would be 58 years before the world fully credited the Iowa State professor with inventing the first digital electronic computer.

Jack Liggett was inducted into the Army on June 1, four days before he was to graduate. "I had to report to Fort Des Moines every day before noon," he remembers. "When I asked my officers for time off to graduate—when I said the least we could do was allow my parents to watch me walk across the stage—they agreed."

For the next two years, Jack used the applied mechanics he had learned at Iowa State to develop tanks for combat landing. He married Betty on July 8, 1943. On July 15, 1947, John M., the third generation of Liggett Iowa State engineers, was born.

If you don't have a slide rule, are you still an engineer?

"Slide rules inducted!" moaned an article in the January 1942 issue of the *Iowa Engineer* (Iowa State's monthly magazine written by engineering students and alumni). So

many slide rules were being used by the military effort that students and other civilians were left empty handed.

"Because of the lack of rules," the article reads, "many students entering engineering problems courses for the first time this quarter are faced with the possibility of taking a slide rule course minus a slide rule."

► Engineering students of the early and mid-1900s worked in the machine shop and the foundry to cast metal items. The manhole covers the students made were used throughout the campus, and some of them are still used today.



The war calls women to engineering

For months, the *Daily Student* had speculated on the nature of these strange birds—young women who would soon arrive on campus for a crash course in aeronautical engineering. And then on Feb. 15, 1942, 100 Curtiss-Wright cadettes swarmed into the Memorial Union, where they would live for the next 10 months.

Iowa State was one of seven colleges to participate in a program created by the Curtiss-Wright Airplane Company. World War II was draining men from the work force at exactly the time when trained engineers were needed to keep factories operating. Assembly lines that cranked out planes, tanks, and weapons were critically short-handed.

Curtiss-Wright recruited and paid all expenses for 700 young women to receive intensive training that would prepare them to work in airplane factories. At Iowa State, the women represented the third largest group trained as part of the war program. The 40-hour-per-week program was rigorous, and the problems the students tackled were related to real data from current production operations.

"It is hard to believe that we are part of the war effort, as we still lead a normal college life and enjoy a care-free existence," wrote Cadette Jean Louise Ritter in her memoirs. "However...we learned it has been impossible for Curtiss-Wright to hire the usual quota of men for their engineering department, so we are being trained to take their places. We did not realize that the situation is so acute, that we are to be the aero engineers of the year."

The cadettes at Iowa State and the other colleges became national media darlings, with numerous local reports and a feature story in *Life* magazine. Although it was to be many years before women gained permanent respect in the engineering field, their brief sojourn at Iowa State College in 1942 was positive and necessary.

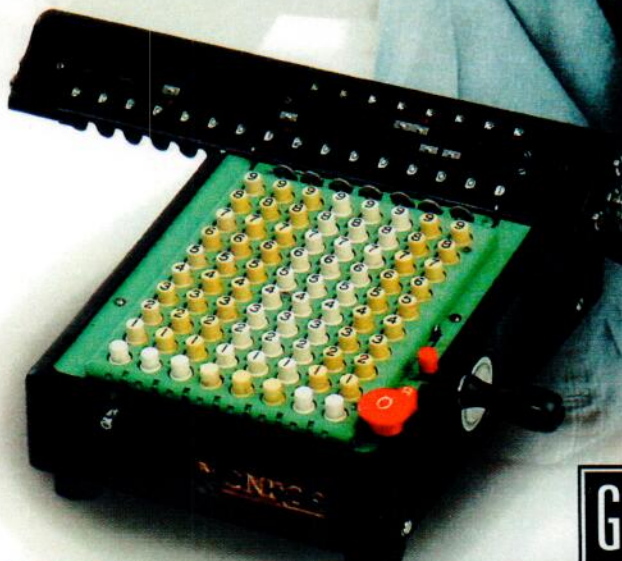
A note to readers: Would any ISU alumni who were Curtiss-Wright cadettes please contact Dr. Amy Sue Bix, ISU assistant professor of history, who is researching the topic? She is interested in memories and experiences and can be reached at 515-294-7266, abix@iastate.edu, or at 603 Ross Hall, Iowa State University, Ames, IA 50011.



Values ^{and} Technology at an Impasse

John M. Liggett

In the sixties, the country was embattled in social, political, technological, and cultural turmoil. America's youth rebelled against the government, the war machine, and their parents. Leaders were gunned down; women and minorities were fighting for their rights. The discord of the decade was set against a backdrop of peace, love, and rock'n'roll. But in the midst of the turbulence, Iowa State stood solid.



GENERATIONS

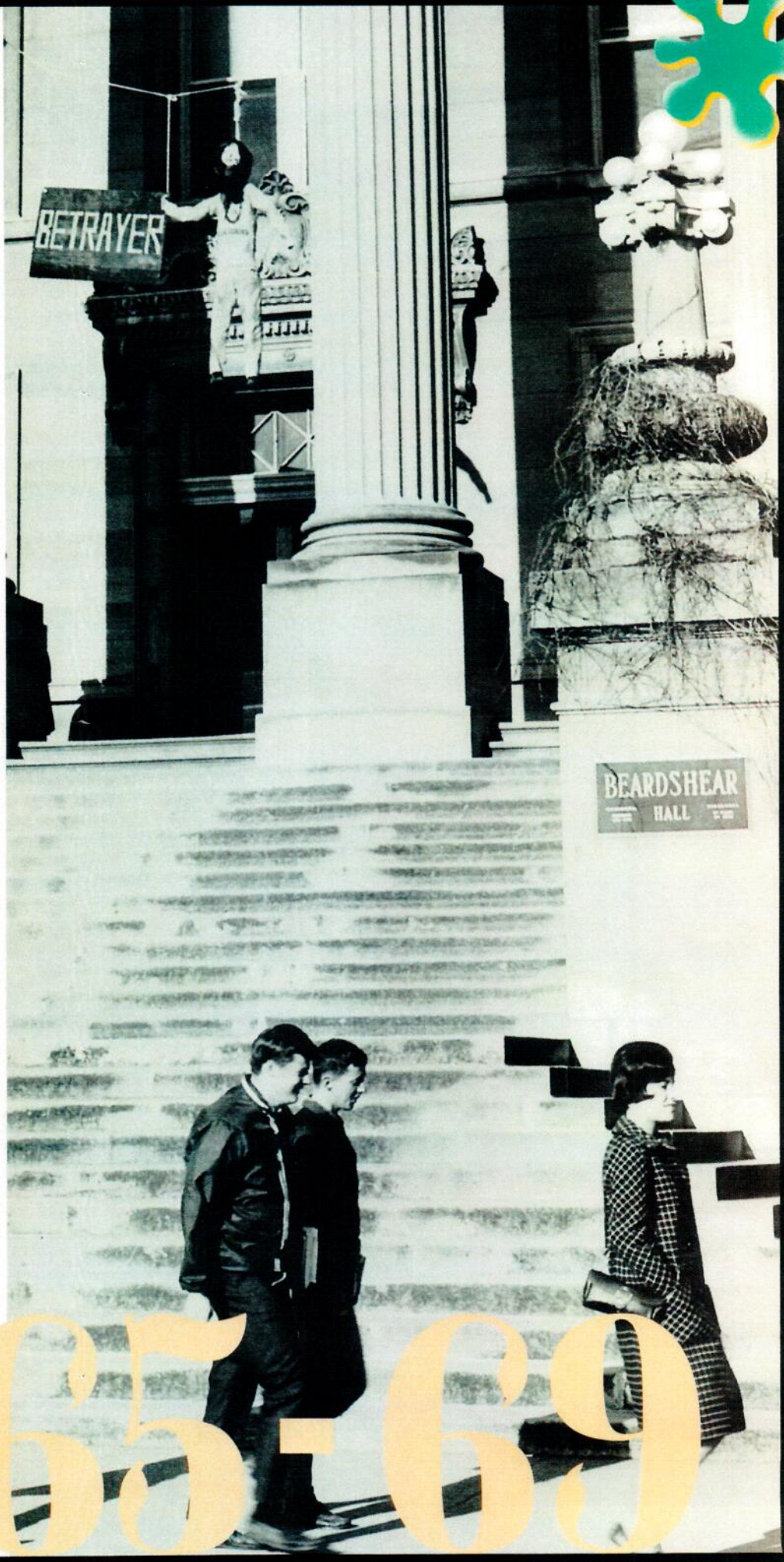
DID JOHN M. LIGGETT choose to come to Iowa State and major in mechanical engineering so that he could become the third generation of his family to do so? Well, not exactly. He came, he says, because Iowa State had such a rotten football team. He wanted to play football, knew he wasn't a top-notch player, and thought he might have a chance to play with Coach Clay Stapleton's losing Cyclones.

Like his father and grandfather before him, John Liggett's Iowa State years were at a time when the country was embroiled in war. When John arrived in 1965, the country was in turmoil over its undeclared war in Vietnam. The throng of students that arrived on campus in the '60s was the largest in history, and the college student had become the icon of the century. America now had more college students than farmers.

At a time when many other campuses were burning with anti-military and anti-establishment passion, John Liggett's Iowa State was relatively calm. The students' response to Martin Luther King's assassination in 1968 was a silent vigil, and demonstrations against the war were few and far between. "ISU was not on the leading edge of protest," remembers John.

John joined with the largest student body in ISU's history to participate in a GSB student election, electing the rebellious, long-haired, Don Smith as student body president. "People treated his election kind of like Minnesotans do their governor today. It was a way to step out of the main stream and do something mildly anti-system," he says. But not all students appreciated Smith's leadership style, and on one occasion he was dubbed "betrayor" and hung in effigy at Beardshear Hall.

Unlike his father and grandfather, John did not join ROTC. "I didn't like button polishing, and I had too many other things to do," he remembers. Although John decided not to go out for football after all, he joined both the varsity basketball and tennis teams. He sang in Cardinal Keynotes, and like



Values and Technology/continued

his father and grandfather, pledged TKE. Leaving *We Shall Overcome* and *Blowing in the Wind* to other groups, John played string bass in an 11-piece dance band that cranked out the cheerful, brassy music of his father's day—big band.

An address by ISU president Robert Parks, now in his third year at Iowa State, called for a “new humanism” on campus. Charging that there was a division in science and culture, he said, “Science dominates our cosmology, but

it is not a part of it...We must adopt a cosmology which will permit intelligent social decisions on the consequences of...modern warfare, industrial use of nuclear power, and automation...”

Military industrial complex

Parks' call for a science that “permits intelligent social decisions” reflected the era's disillusionment with technological growth. The “military industrial complex,” which was seen as saving the country in John's father's time, was now perceived as threatening personal freedoms and was seen as a stock phrase for what ailed America. The moon walk in 1969, rather than being considered the beginning of an era, was viewed as the end of one—the climax of space research.

Was it possible that only one generation ago, television advertisers of the future were dubbed “angels” who would save the fledgling new television industry? Television and its ubiquitous advertisers were now seen as potent social forces—and not very good ones. Churches and parents formed groups to monitor the violence and sex on TV; minorities began researching and publicizing television's negative stereotypes.

Nuclear power had also fallen into disfavor, and public protests and demonstrations frequently accompanied new reactor openings. But once again, ISU seemed immune. Ahead of its time, in 1959 Iowa State had installed one of the first university-operated reactors in the country. For 10 years, the reactor had quietly served as a teaching and research laboratory for engineering

► “Most of an engineer's calculations can now be done on computers, so students must learn how to use them.”

— 1969 BOMB



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students, who measured power output and conducted radiation experiments. The reactor's 30-year tenure at ISU would be a peaceful one.

In an attempt to make engineers and scientists more responsive to social needs, engineering schools like Iowa State now required that students take broad, general education classes, in addition to specialized, technical subjects. In fact, the numbers of classes that mechanical engineering students were required to take had escalated so much that it now (unofficially) took five, instead of four years to graduate. John Liggett recalls that in 1969, he was only one of a handful of mechanical engineers in his class of 200 to graduate in four years.

Students who, in John's father's time, had forged gears and manhole covers were now seldom required to "get their

hands dirty." "I remember the curriculum being intensely theoretical," recalls John.

Shirt pocket power

When John was a freshman, an ISU graduate by the name of Thomas Whitney—a young engineer working for Hewlett Packard—developed a new device that displaced the slide rule as the engineering student's constant companion. First called the "pocket electronic calculator-slide rule" and quickly shortened to "pocket calculator," the invention took colleges by storm. The manual that accompanied it informed the user that he was in possession of something extraordinary. Under the section labeled Shirt Pocket Power, the manual read, "Our object in developing the HP-35 was to give you a high precision portable electronic slide rule.

We thought you'd like to have something only fictional heroes like James Bond, Walter Mitty, or Dick Tracy are supposed to own."

It was the dawn of computer-assisted machine design, and John Liggett was among the group of graduates to enter the job market with knowledge of FORTRAN and the ability to use the computer to solve machine design problems. "It was an interesting time; when I went into the job market, I had more knowledge of computers than the people I was working for."

The summer between his junior and senior year, John and his new wife, Shelly, moved to Pammel Court. John was drafted shortly after he graduated, but high blood pressure earned him a deferment. Ian, the fourth generation of ISU engineers, was born June 23, 1980.



Technology Responds to a Shrinking Planet

Ian Liggett

Today's Iowa State students are the kids who grew up playing warp-speed video games, watching MTV, talking on cell phones, and surfing the Internet. For them, there has never been life without technology. It's everything they do, everything they see, everything they know. Clearly, technology will continue to shape their lives and the lives of future generations of Iowa Staters.



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AN LIGGETT could have chosen just about any place to go to college. A National Merit Scholar, he was wooed by both Ivy League schools and state universities. So why Iowa State? Like the generations before him, he independently denies that he was carrying on a family legacy. A young man of few words, Ian uses just two to summarize his feelings about ISU: "Good people."

Of the four generations of Liggetts at ISU, the educational experience of Ian and of his father represent the greatest differences. If his father was just learning to use the computer, Ian can not imagine life without it. Stern instructions to yesterday's consumers to not "fold, spindle, or mutilate" delicate computer punch card are meaningless to today's cyber-savvy student. Students today who can register for classes with a few keystrokes, shake their heads in disbelief at photographs of their parents, waiting to register for classes in a mile-long lines that snaked their way from a packed State Gym.

Iowa Staters on line

The student of 1999 may begin his day by using his personal computer to check the weather forecast. Good chance of rain? No problem. Today, he need never leave his dorm room. He returns an e-mail message to a friend, listens to a hot new tune over the net, and plays a game of Tomb Raider III. After a jelly doughnut, he begins his day in earnest. He listens to and watches his thermodynamics instructor deliver his most recent lecture via the computer. He is baffled by one of the problems, and e-mails a question. Next stop is to his biology instructor, who has posted the results of yesterday's test on the Web. Hopefully, he checks his English class syllabus, to see if there has been a last-minute class cancellation.

After a Mountain Dew, he visits his own personal web page. He adjusts an item on his resume, and posts an invitation to friends to come to a weekend party.

Technology is no longer something to be switched on or off; it is the very landscape in which daily lives are lived.

New realities

The one-dimensional computer images of today's student may some day be as anachronistic as computer punch cards. Iowa State is a leader in developing three-dimensional virtual reality computer laboratories that simulate real-life interaction and experiences. ISU's C2 virtual reality room projects images on the floor and three walls. User control devices allow students and faculty to wander through the columns of the Parthenon, work on a tractor design simultaneously with colleagues across the world, or construct and observe a multi-dimensional dataset.

New challenges

But as old boundaries disappear, new limitations evolve. Today's engineer works with an awareness that thousands of strands connect the global web of a shrinking planet. The ripples of technological triumphs and defeats are felt worldwide. Fuels are limited. Pollution threatens. Food is scarce.

ISU engineering education and research are responding in ways that cross disciplines. Building materials are made from animal wastes, human vaccinations are

produced from the proteins found in genetically altered grain. If yesterday's student measured the heat generated from the resident nuclear plant, today's student measures the heat produced from switchgrass and corn. "Biodiesel," a word unknown in Ian's father's day, may be tomorrow's fuel solution. Iowa State is a world leader in researching this renewable, nontoxic, and biodegradable fuel, which is produced from soybean oil and animal fats.

Yesterday's technologies that

constructed weapons of destruction are today being deconstructed. ISU, once a leader in producing nuclear energy fuel, is today a leader in diffusing it. Don Bullen, ISU associated professor of mechanical engineering, was recently appointed by President Clinton to serve on a review board to dismantle nuclear weapons and safely dispose of nuclear energy by-products.

In Ian's father's day, students interviewing for engineering jobs were often asked if they had any objection to working for a company whose technology might be used for weapons or defense. Issues of weapons research and defense were heavily debated in the press and on campus. "Today, many defense-related industries have diversified their businesses and turned to other domestic production, and graduates are finding jobs in other areas," says Howard Shapiro, professor of



▲ Virtual farmer: ISU's Gary Lindahl, assistant scientist at the Virtual Reality Application Center, simulates tractor design.

mechanical engineering and vice provost for undergraduate programs.

As the fourth generation of Liggetts finishes his first year at ISU, the country is deeply mired in another undeclared war. And how does Ian feel about the United States' use of sophisticated air weaponry to bomb Kosovo? He doesn't have an opinion, he says. Isn't sure.

He knows only that his future is bright. The world can't get enough engineers. When it comes time to enter the job market, dozens of companies will come calling. The future is his.