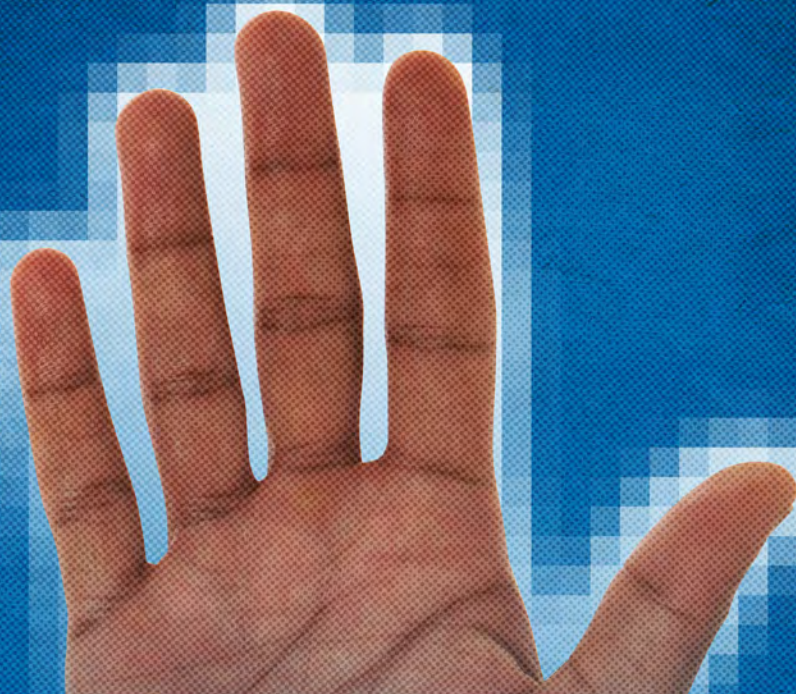# THE DEMOCRACY

MACHINE

HOW ONE ENGINEER MADE VOTING POSSIBLE FOR ALL

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GATORBYTES

THE DEMOCRACY MACHINE

How One Engineer
Made Voting Possible for All

Jon Silman

UF | UNIVERSITY *of* FLORIDA

As an African American computer scientist, <u>Juan E. Gilbert</u> understands separation and the desire to belong. The University of Florida professor spent most of his college years as one of the only black students in his field. He didn't have clear footsteps to follow.

"I was the only one like me. I was the only one who looked like me. I was isolated," he said. "It's easier to struggle when you have a community around you."

That isolation shaped him, and so he has dedicated his life's work to helping people who have been marginalized exercise this country's most empowering guarantee: the right to vote.

There's always talk about the Latino vote, the black vote, and the female vote, but what about the disability vote? What about the citizen who can't enter a polling place because of a wheelchair? What about the blind, the deaf, or the intellectually disabled? The U.S. Constitution guarantees the right to a secret ballot, yet thousands of disabled persons have never experienced what so many take for granted: making their own choices and voting without help, comfortable in the knowledge that they helped shape the future of their country by their actions.

A recent Rutgers University <u>study</u> found that when compared to the general population, people with disabilities vote

less. In fact, if they voted at the same rate as their able-bodied peers, it would translate to an extra 3 million people at the polls.

Systematic flaws involving the ballot box have plagued this country since its founding, but for voters with disabilities, the challenges are amplified.

They may have trouble reading or seeing the ballot. They may have trouble understanding *how* to vote or how to use the equipment. Many are scared, or intimidated, or embarrassed. They've never had the opportunity to vote on a machine built for them to use.

Gilbert noticed this deficit and decided to change things. What if, he asked, there were a machine that every single person could use, disability or not.

It can't be done, he was told. No way.

He didn't listen.

Gilbert is the Andrew Banks Family Preeminence Endowed Chair and associate chair of research in the Department of Computer and Information Science and Engineering at the University of Florida. He was recruited in the UF Preeminence initiative, which gives state money to the university to attract top talent to Florida. Gilbert brought a team of students with him—almost twenty, basically his own community. His work is in human-centered computing, where he focuses on how communities, especially minority communities, interact with technology.

That machine mentioned earlier? It's called the Prime III, and it's already in use today. It's an open source voting technology, designed to be used by everyone, particularly people with intellectual and physical disabilities. It's radically changing the way people vote.

In 2008, the Government Accountability Office did a study to determine how accessible polling places actually were. The results? Forty-six percent of places had an accessible voting

system that could pose a challenge to certain voters. The study also said the Department of Justice wasn't doing enough to ensure polling places were allowing people to vote without the assistance of others.

Jim Dickson, a blind civil rights advocate, compared these systematic voting challenges to the "separate but equal" doctrine of the late 1800s, which said as long as African Americans had different facilities for things like drinking water and bathrooms, segregation was fair. That concept is preposterous to us now, Dickson said, but it's exactly what's happening in polling locations across the country. Think about it, he said, intellectually and physically disabled individuals vote on different machines and in different ways than the general public does. Sure, in some ways the needs of those voters are different, but their constitutional requirements for privacy are the same as everyone else's. As a result, people feel powerless over their voting process in a country where voting is meant to empower.

"People have died for the right to vote," Gilbert said. "I want to make it accessible for every single citizen."

Cultivating Community

As a child growing up in the 1970s, Gilbert loved science fiction. Every story seemed to have a guy in a lab coat who just knew how to fix things. The guy everyone relied on, who always knew what to do. The smart guy. He liked that.

In middle school, he was drawn to science and math—he loved the experimenting. He studied chemistry in high school, and he eventually got the bug for computer science. In his junior year at the Miami University of Ohio, a mentor told him he'd make a good professor, so off to grad school he went. His education, he said, was marked by a glaring issue—the lack

of African American students in his field. If he wanted to see change, he would have to be a part of it.

He earned his PhD from the University of Cincinnati, and he taught first at a community college, then his alma mater, and eventually at Auburn, for nine years. Then he went to Clemson University, where he was the chair of the Human-Centered Computing Department.

Gilbert talks fast. Sometimes his words sound like they're falling off a cliff. Meeting with his students, he doesn't stand at the front of the room, preferring to sit in the middle of the group, like the nucleus of a cell.

It's one of Gilbert's personal goals to see more African Americans pursuing science, technology, engineering, and mathematics (STEM). It's why he actively recruits for those fields and for his own team, and why he speaks to middle school students about studying science.

Wanda Eugene met Gilbert at Auburn University, where she was pursuing a PhD. The young Haitian American, a critical part of Gilbert's team, moved to Clemson with him in 2013, and then to Florida. She was instrumental in implementing Prime III.

Eugene didn't initially plan to be a computer scientist. She entered the workforce after earning her first master's degree in industrial engineering, but the work, she said, was unsatisfying. She was more interested in computers and how they affected the African American community. That's what drew her to Gilbert. Prior to meeting him, her experiences in college mirrored Gilbert's own. She longed for a sense of community.

"Gilbert's work is such a very different experience from what I went through," she said. "I felt isolated before. Now, I'm part of a team of students doing some impressive work."

Gilbert mentioned how the Asian and Indian communities in engineering and computer science at UF are vibrant and noticeable. He wants that for African American students. Diversity, he believes, is one of the main keys to figuring things out.

"You need diverse thought," Gilbert said. "You need diverse backgrounds. To solve problems you need diverse ideas."

For example, a part of Gilbert's research is how to better teach mathematics, with an emphasis on the students' cultural backgrounds. Traditionally, math is taught one of two ways, Eugene explains: you know what I know, and we'll start from there, or you know nothing, and we'll start from that. The idea is to understand how students might view math from their own perspectives. The project is called African American Distributed Learning Styles System (AADMLSS, pronounced "adam-less").

One of the issues, Gilbert said, is that there aren't footprints left behind from previous students. An African American STEM student will come to UF, get an advanced degree, and move on.

"Why are Asian students so successful?" he asks. "Because they have a community and support each other. They're never alone. The key to being successful in graduate school is learning from each other."

Now that he has the ability to recruit and hire, he intends to create a similar environment for African Americans.

"Now I'm the boss," he said. "If there's an African American [candidate], I'll hire two so they won't feel isolated."

Gilbert said around middle school is when kids start looking for role models, and African American children don't have enough minority scientists to look up to.

"But they see me and they say, 'Oh. You do exist! Maybe I should do this.' It's important to break down their stereotypes."

He wants kids to think about African Americans when they think about scientists, so Gilbert had a camera crew follow around his team for a YouTube documentary.

"They get a chance to see us in public," he said. "Then they can say, 'Oh. A scientist isn't what I originally thought.'"

STEM education is extremely important because it applies to the future of the human race and nearly every aspect of political progress, he said. Scientists change the world for the better by solving the complex problems of our age.

Gilbert's vision of community traces back to his family's community garden in Ohio. His father taught him to care for the crops and how to cultivate the food and share with those in need.

It was the same thing with fishing, he said. Every Sunday, he'd go out with his family and spend hours catching and cleaning fish, then have a fish fry.

He learned from these experiences: you help someone if they need it because it's the right thing to do, and you don't take what you have for granted. If you cultivate relationships and stick together as a community, everyone will benefit.

From Clemson to UF

The University of Florida Department of Computer and Information Science and Engineering Dean Cammy R. Abernathy leapt at the chance to snatch Gilbert away from Clemson through the Preeminence Initiative.

The initiative is an almost-billion-dollar enterprise to establish UF as one of the nation's best public research universities. As of November of 2014, UF had made 61 hires and plans to roughly double that number.

Gilbert made bringing his team a condition of joining UF, and after interviewing them Abernathy agreed. She praises Gilbert as a collaborator who brings people together and bridges interdisciplinary divides.

"Human-centered computing is an area we knew we wanted to expand," Abernathy said. "It's attractive because it encompasses that interface between computers and fine arts, or education, or social sciences."

"We need people who say 'Why can't we do this?'" she said. "He's not shackled by the previous notions of what's possible and what isn't."

Thanks to Gilbert, Abernathy said she anticipates an uptick in African American recruitment in the college—maybe even on the whole campus.

For Gilbert, the opportunity to come to a state where voting issues are so prevalent was a main motivator. He is excited by the prospect of testing the Prime III in real-life Florida venues.

Voting in America

The earliest voting in the United States, according to sources culled by the Smithsonian National Museum of American History, was by voice or paper ballot. The ballots were known as "party tickets," and although the government regulated the size and thickness of the paper, the political parties of the time controlled the printing and distribution of it. Fraud was prevalent.

In the early 1900s, with the population rapidly expanding, the government took control of voting from the political parties and introduced measures to fight voter fraud, such as the ballot box to prevent tampering with votes, and also what is known as a "blanket ballot" with all candidates on one sheet.

By the 1920s, voters were using gear and lever machines in booths with curtains. The machine, according to University of Washington Professor Kathy Gill, was created to prevent fraud, but inadvertently facilitated it.

"The machine's reliability rested, in part, on the honesty of

the election officials," she wrote. "The election officials had to 'zero' out the counters before any vote. More troublesome, when the gears stopped counting (and they did get jammed, accidentally or on purpose), no one knew."

Gill said that in 1960, "when upstart John F. Kennedy defeated Richard M. Nixon by just one tenth of one percentage point (0.1%), about half of the estimated 65 million ballots were cast on mechanical lever voting machines."

The punch-card system, which involved sliding a card into a device and using a stylus to punch holes through it, was common in the 1980s and was prevalent all the way through the year 2000. Around this time, a new type of technology utilizing computers and touch screen voting also entered the landscape.

The infamous 2000 presidential election changed everything. George W. Bush beat Al Gore by a slim margin. Some of the dispute centered around the physical properties of the punched cards—were the punches dimpled, or were there "hanging chads" from an incomplete puncture?

The confusion and subsequent attention to the issue led to a complete overhaul of the voting system—the first in many years. The Help America Vote Act (HAVA) passed in 2002 with the purpose of kickstarting sweeping reforms of the process.

Tucked away inside the legislation are some provisions specifically for people with disabilities: "Improving the accessibility and quantity of polling places, including providing physical access for individuals with disabilities, providing nonvisual access for individuals with visual impairments, and providing assistance to Native Americans, Alaska Native citizens, and to individuals with limited proficiency in the English language."

Access for Voters with Disabilities

Jim Dickson, the legally blind civil rights advocate, fought to

make sure HAVA had those provisions. Around the same time, he met Gilbert. Dickson was working on voting accessibility issues with the American Association of People with Disabilities. Gilbert was working on making Prime III a reality.

"The disability community took the position that if any legislation was going to be passed," he said, "it had to offer the opportunity for us to vote privately and independently."

Some people with disabilities had never cast an actual secret ballot. Former Connecticut senator Chris Dodd appointed Dickson to be on the Board of Advisors to the U.S. Election Assistance Commission, established by HAVA, in order to address this problem.

"[Dodd] got right away the following fundamental principles: One, that everybody should vote on the same device, and two, that it shouldn't be on a 'disability ghetto' machine. HAVA requires an accessible machine in every poll, and [Gilbert] saw right away that unless everybody's voting on the same machine there was going to be all kinds of problems with the segregated machine."

Gilbert started designing and testing the Prime III on hundreds of people with all kinds of disabilities. This was different from, say, the for-profit election companies, Dickson said, because they didn't test on as many people, especially not on people with disabilities. Gilbert, he said, set out to test on many people, with the help of a federal grant.

The United States has thousands of different election jurisdictions, with many different rules. In Florida, each county can buy whatever type of system they want.

"Unfortunately, some election officials are putting their heads in the sand and pretending they don't know the equipment is going to break," Dickson said. "It's irresponsible and in the long run it's going to wind up costing more."

Even if new equipment were bought today, he said, it would

still need to be tested and certified, which could take years. This illustrates some of the potential roadblocks Gilbert faces.

"It's like bringing a new prescription medicine to the market," Dickson said. "You can't just build it. It has to be built to standards, and tested to the standards all the states and counties have."

These stipulations and restrictions, he said, highlight how important Gilbert's contributions have been.

"He has demonstrated that you can have accessible voting that is secure and affordable," Dickson said. "Much less expensive than previously thought. He's also established the principle that everyone needs to vote on the same device."

A First-Hand Look at Voting with a Disability

Nancy Ward is an intellectually disabled woman who first voted back in 1968 with the help of her parents, she said, who explained what to do, how to vote. But Ward is capable of selecting the candidate she prefers; it's navigating the voting machines on her own that has been the problem.

Ward is a member of the national organization, Self Advocates Becoming Empowered, which works to help people with disabilities become more self-sufficient.

"I've gone to vote and I've had to have poll workers help me," she said in a recent phone interview. "They've gotten so frustrated that they wouldn't help me because I wasn't understanding. And you know when they get frustrated it becomes a vicious cycle and I get frustrated, and I start crying. And now I'm sitting there crying and they don't know what to do with me. I need someone to come and help me calm down. But in a polling place, that's not the easiest thing to do."

Up until her experiences with the Prime III, she didn't know anything about which candidates were running, or what issues were in contention. No one, she said, had ever bothered to explain the information in a way she could understand. So she just voted the way her parents told her to. Now, things are different. She feels more informed, and, in turn, more confident about the process. Prime III, with its user-friendly instructions that include pictures of all the candidates, has helped put her at ease.

"I was able to make my own choices and able to find out about the candidates and learn how to be able to do it myself," she said. "I didn't know I could do that."

Perhaps the most telling example of Ward's newfound independence was her decision to switch parties, which caused a small family rift.

"It was really because I was able to be independent, and not feel like people were telling me how I had to vote, and who I had to vote for, and what issues I needed to vote for," she said. "When my mom found out I switched from Republican to Democrat she said, 'your grandfather is rolling over in his grave,' but that just shows how much I was influenced before Prime III."

She used it for the first time at a conference in Minneapolis for Self Advocates Becoming Empowered, where Gilbert tested the machine. A member of his team videotaped her speaking about the experience, and her excitement was obvious.

"A lot of times people with disabilities have things tested for them," Ward said. "And then they're asked to test it after it's already made. In this case, you guys gave us the opportunity to test it ourselves. And that was really cool."

Ward smiles.

"That was very cool, to be able to do it independently."

She waits a moment before she speaks, as if she's collecting her thoughts. Asked how it felt to vote on her own, Ward's eyes welled for a moment.

"It makes me very excited," she said and paused, "to be able to do it by myself. And not to have somebody to have to explain it to me."

The smile returns.

"So. It was very important and very empowering," she said. "And I do have the disability but [also] power now for the voting. And I'm very excited about that."

Prime III: From a Challenge to a Reality

In 2003, Gilbert was at a conference, in a session about electronic voting. He listened to an expert say electronic voting was not possible because of security issues. Gilbert and his team started discussing the possibility of a secure machine that any single person, regardless of impairment, could use to vote. Such a machine did not exist. At that time, experts thought it couldn't be done—there were too many variables, too many things to figure out. That challenge sparked something in Gilbert, and the idea was born.

"Let's go to the lab and let's do it," he said to his team.

It had to be fully accessible, he said. No way around that. He knew "separate but equal" wouldn't work. In the beginning, many scoffed at the idea. This, Gilbert said, is a natural reaction to new products that challenge the status quo. He's not the type of man to give in to doubts. He had his plan, his vision.

"We will have change in voting in America," he said.

He started with $93,000 from the National Science Foundation that funded his research assistants and eventually won a $4.5 million grant that formed the Research Alliance for Accessible Voting, from the United States Election Assistance Commission.

He wanted real people to test a prototype on, so he went to the Alabama Institute for the Deaf and Blind. He expected it to

go smoothly, but it didn't—not at first anyway. The machine was a touch screen, with a headset and microphone that offers audible and visual instructions to serve both blind and deaf testers.

There were problems with the initial iteration, but Gilbert said one person "kept coming back and back. She said, 'I'd do this all day if I could.'" That encouraged him to keep trying. Blind testers seemed to have the most trouble, so when Gilbert and his team went back to add new data and make changes, the team put on blindfolds and turned the machine around. That, he said, put them on the right path.

A common misconception about the way the machine works is how it listens. It's not a speech recognition–type software, even though that's what they started with. What it does is wait for a sound. That way, you can just blow into the microphone to make your voting choice, similar to a "sip and puff" device that a quadriplegic might use. It doesn't matter if you can't speak clearly, or if it's noisy around you.

"It's language independent," he said.

That feature was one of the hardest to perfect and also a huge breakthrough for the team. At first, they had trouble with the microphone in noisy areas—it would pick up all the background noise. Gilbert and his team struggled with this until they realized there was only a small amount of time each person needed to make a choice.

They decided that 1.5 seconds per choice would be sufficient, so for that time, the Prime III cancels out noise around it and "listens" for input from the user.

"Everyone can use this thing," he said. "My ATM is more complicated."

One of the hardest features to develop was the way the program spoke to a user. Should someone touch and not listen? Should they only listen at first? How do we prompt them?

"One of the most natural things we do is converse. Our brains are wired for language. . . . But conversational systems are hard to design."

Figuring out that problem was a eureka moment, he said. Another was when they coded it for use in browsers, which essentially made it hardware independent, meaning an election official can buy touchscreens and upgrade old equipment. And, because of the federal funding Gilbert received, his software is open source, meaning anyone can take it and change it if they like, or simply use it, free of charge.

Ease is the goal, especially for a human-centered computing professor. He doesn't want people to think about the countless hours and the science and the money and travel spent to make it happen.

Previously, election officials were tethered to companies that provided the machine. Now, they can download the software themselves and run it in-house. Essentially, they can have more autonomy and control over the voting process.

A typical session with the Prime III starts with a simple sheet of white printer paper. The distinction of paper is mentioned because as Gilbert puts it, many election ballots are printed on specific stock paper, which can run as much as $1 a page. Costs for paper can easily breach $400,000, and that's in a smaller county. The paper is placed in a printer next to a touchscreen where the voting area is located. The voter puts on a pair of headphones. The machine says to the user, "to start voting, say vote." "Vote," the user replies.

The interface tells the user what races are available, and the user can even just vote by party line, or give a name. You can speak or tap the screen. When you're done, the machine tells you a summary of all your choices. Then it prints a ballot for you.

The ballot lists the contests and the person voted for, "so

there's no ambiguity," Gilbert said. The voter puts it into a ballot box and it's later scanned. Another option the Prime III allows for is home voting. A voter fills out all choices from a home computer, and the machine prints out a Quick Response, or QR code. The paper with the code is brought to the precinct, and the Prime III's scanner reads it and brings up the ballot in Prime III's review screen. The voter can change options or simply review them and then print them.

One of the major issues the general public has with computer-based voting is the notion that data might be manipulated, stolen, or recorded incorrectly. Gilbert knows this, and although he stresses how serious a problem security is in voting, it's why he has the machine print out your ballot with paper. The paper allows you to not only review your vote—to make sure it's correct—but it's the ballot of record. Essentially, Prime III is a sophisticated ink pen in that it allows everyone to privately and independently mark their ballot.

Testing in New Hampshire

In November 2014 the Prime III was used in New Hampshire in three polling locations. Assistant Secretary of State Tom Manning handled most of the logistics, including purchasing and testing.

He said finding machines that were accessible for voters with disabilities has always been a priority. In 2005, the state asked companies to bid on a machine to comply with HAVA conditions; New Hampshire bought a machine with a telephone system that allowed voting through a hotline.

"[People] weren't crazy about that particular system," he said. "We promised when we saw a better system we would pursue it. There just hasn't been that many options."

What really sold him on the Prime III was the open

architecture of the software. He liked the idea of not being married to the company that makes the hardware.

That meant two things: more voter confidence because of the transparency and an ability to adapt to specific regional needs.

Manning purchased Dell tablet computers and set up docking stations connected to standard printers. For the first time in many years, voters in precincts with the Prime III wouldn't have to rely on someone else to vote.

The phone and fax machine combo, Manning said, cost more than $230,000 a year to lease.

"With this software we save ourselves quite a bit of money," he said.

Manning said he's still perfecting the Prime III for New Hampshire's needs, but people with disabilities who tried it out said they liked it. Next election, he'll put the Prime III in more precincts.

A Day in the Life

I visited Gilbert on a recent day in November. His office—located at the Computer and Information Science and Engineering building, near the famous "french fry" sculpture on campus—was still decorated with the occasional cardboard box here and there. But the view was phenomenal, with sun streaming in through large windows, and a clear line of sight to Century Tower and Turlington Plaza.

"I'm still moving myself in," he said. "But I do enjoy the atmosphere."

In the morning, he sat in a conference room with some of his team, on the same floor as his office, for a meeting with a man from the Massachusetts Institute of Technology's Lincoln Laboratory. The man's name is Bill Kindred, and he's the manager of diversity and inclusion at the lab. He was in Florida for

a conference, and he drove to UF to invite Gilbert personally to speak at the National Society of Black Engineers. The two went back and forth, talking about this student and that one, and they emphasized how small the community of African American engineers and scientists really is.

Gilbert, Kindred explained after the meeting, is well known and well respected around the country, and he knows students who get to see the man speak are more inclined to pursue science and related fields.

After a short break, Gilbert, on his phone, spoke with an official at the nursing school at the University of Cincinnati. He wanted to persuade her to use another one of his projects, called Applications Quest, a software that helps choose candidates for jobs and admissions.

"Let's say you have 50 spots for 200 candidates," he explained. "The software would compare them by attributes in a spreadsheet, and put them in groups or clusters. It will recommend the candidates who are the most unique or special, in a way people can't do, in a fraction of the time."

Later, he met with a computer science student asking for advice. He listened carefully to the student's concerns and asked about his future. The student had employment offers from Intel and Microsoft, but he wanted to do more research. Gilbert suggested he consider becoming a postdoctoral scholar, so he could continue to do work he was passionate about. Maybe, Gilbert said, you could consider staying in academia.

The next stop was a meeting with his team about progress on various projects, including the Prime III. Now that he's at UF, getting a pilot program for the Prime III in a Florida election is a top priority. Also, he had some data from some previous elections that still needed to be analyzed. Some of his students wanted to know when their credits would transfer.

The last part of Gilbert's day was spent talking about patents

with a woman who worked at the UF Innovation Hub, where he laid out some of his plans for upcoming projects, including the workings of his voting machine and its implications for the future.

What's next? He'll keep working and keep trying to tug the world closer together. He'll keep researching and pushing the boundaries of what is possible. He'll keep doing what he loves.

This book may be available in an printed edition.