

Chapter Six

THE LONGEST CAVE

The longest cave in the world is in central Kentucky. Its limestone passages stretch four hundred miles beneath the earth in twisting patterns as intricate as the roots of the ancient hickory forests above. Inside, cavers skirt bottomless pits, pass fountains of orange stone, and discover deep, icy subterranean rivers. Between the sunlit world and the depths below, white mist swirls at ankle height, like the breath of ghosts.

Kentuckians have fought bitterly to control access to the secrets of Mammoth Cave. In the early twentieth century, hardscrabble locals conned tourists into the sinkholes on their land, spurring "cave wars" that ceased only when the National Parks Department took control, evicting landowners and installing staircases, subterranean toilets, and even a grand dining room 267 feet below ground, its ceiling encrusted with snowballs of gypsum crystal. Serious cavers now enter Mammoth's wild entrances through locked grates, using keys granted by the Parks Department. They bring with them small carbide headlamps to keep warm and light the darkness.

The earliest people to map Mammoth were enslaved, installed underground by landowners to lead tours. The first of these guides, Stephen Bishop, named its features—the River Styx, the Snowball Room, Little

Bat Avenue—and discovered the eyeless white fish that swim in its deepest waters. When Bishop was sold, along with the caves, to a Louisville doctor, he was ordered to draw a map from memory. As cave maps do, his drawing looked like “a bowl of spaghetti dumped on the floor,” but it detailed the nearly ten miles of passages that Bishop had discovered and remained the most thorough map of Mammoth’s reaches for more than fifty years. One nameless noodle, a passage forking off the subterranean Echo River, became important a century after Bishop was buried near the cave’s main entrance, his grave marked by only a cedar tree.

In Bishop’s lifetime, every landowner in Central Kentucky claimed a cave entrance; if not a natural sinkhole, then a crevice blown open with dynamite. Bishop believed that all these fragments were linked into one larger system, and his instinct was shared by generations of Kentucky cavers. At the bitter end of their remotest passages, the caves *breathe*: cold air whispers even miles below the surface, and water siphons deeper and deeper into the Earth.

Proving Bishop’s connection theory became the cause of the Cave Research Foundation, a ragtag group of caving enthusiasts who spent nearly twenty years linking the disparate caves neighboring Mammoth into a single Flint Ridge system. It was a family affair; once they were old enough, children who grew up playing in the woods surrounding the foundation’s clapboard lodge pushed past the farthest points surveyed by their mothers and fathers. By 1972, the Cave Research Foundation had surveyed nearly every Flint Ridge lead to its endpoint, sometimes with ten-hour belly crawls through womblike tunnels. The final connection, as they called it, was imminent.

The cavers believed that Flint Ridge met Mammoth past a choke of sandstone boulders at survey point Q-87, a remote spur miles from the surface, but moving the boulders with lengths of metal pipe was back-breaking work. One expedition tried an alternate route, through a vertical crevice called “the Tight Spot.” Caving humor has a nihilistic streak: the Tight Spot is a dark slit so small that only one person in the party dared enter. She was a reedy computer programmer, all of 115 pounds, named Patricia Crowther.

Pat wedged herself into the Tight Spot and came out the other end onto a mud bank. In the cool carbide light, she spotted the calling card of a previous visitor: the initials “P. H.,” engraved on the wall. Back at the surface, her party kept the discovery secret. Anyone familiar with the area would know the legend of old Pete Hanson, who had explored Mammoth before the Civil War. Those had to be his initials down there, which could mean only one thing: Flint Ridge and Mammoth were connected, in a single contiguous cave spanning 340 miles. The monumental discovery would come to be known as the Everest of speleology.

Pat returned to broach the juncture ten days later. “By the way, Pat—you’re leading this one,” the other cavers told her. Just beyond the Tight Spot, they waded into muddy water up to their chests, until only a foot of air separated the subterranean river and the dripping cave ceiling. Soaked through and caked with mud “like chocolate frosting,” they struggled to keep their headlamps dry. Eyeless crayfish skittered around their waists. When the passage opened, it revealed a wide hall, where they glimpsed the edge of a hand railing: a tourist trail in the heart of Mammoth Cave. The link was complete. Only moments before, they’d been farther afield than any cavers in history; now, weeping and falling over each other in the water, they were only a few steps away from a public restroom.

Riding to base camp in the back of a park ranger’s pickup, they looked up at the stars, bright in the summer sky. Lying “in the open truck bed, with the treetops filing past overhead and falling away behind into the darkness,” they contemplated their feat in silence. The long drive reinforced its magnitude: had they really traveled these seven miles underground? Their final passage, through the Tight Spot and beyond what would come to be known as Hanson’s Lost River, joined an unmarked line on Stephen Bishop’s hand-drawn 1839 map. After hamburgers and champagne at dawn, they slept.

“It’s an incredible feeling,” Patricia wrote in a journal account of the trip, “being part of the first party to enter Mammoth Cave from Flint Ridge. Something like having a baby. You have to keep reminding yourself that it’s really real, this new creature you’ve brought into the world

that wasn't here yesterday. Everything else seems new, too. After we wake up on Thursday I listen to a Gordon Lightfoot record. The music is so beautiful, it makes me cry."

The new creature Patricia felt she had brought into the world had always been there, slumbering in the darkness of geologic time. What she'd given birth to that day was not the *cave* but the *map*—not the thing, but its description. By wedging herself into the Tight Spot and bringing her lamplight to the darkness, she moved an earthly place into the symbolic Cartesian plane. Or at least that's how she might have seen it, being the party's mapmaker.

Back home in Massachusetts, Pat and her husband Will ran a "map factory," tracking the cartographic data each Cave Research Foundation expedition surfaced. Both being programmers, they brought considerable technical sophistication to mapmaking. As Pat described it, the couple typed raw survey data from "muddy little books" into a Teletype terminal in their living room, which was connected to a PDP-1 mainframe computer at Will's workplace. From this data, they generated "plotting commands on huge rolls of paper tape," using a program Will wrote—Pat contributed a subroutine to add numbers and letters to the final map—which they "carried over and plotted using a salvaged Calcomp drum plotter attached to a Honeywell 316 that was destined to become an ARPANET IMP."

The Crowthers' maps were simplified line plots, but they represent some of the earliest efforts to computerize caves, a leap in technical sophistication made possible by the hardware to which they had access: a PDP-1 mainframe and a Honeywell 316, a sixteen-bit minicomputer, both far beyond consumer-grade. Will Crowther's employer was Bolt, Beranek and Newman (BBN), a Massachusetts company that specialized in advanced research. In 1969, BBN was contracted by the U.S. government to help build the ARPANET, the military and academic packet-switching network that spawned our present-day Internet. A few years after they used it to plot their cave maps, the Honeywell 316 minicomputer was repurposed and ruggedized to become an Interface Message Processor, or IMP—what we now call a router. These routers

formed a subnetwork of smaller computers within the ARPANET, shuffling data around and translating between primary nodes, a vital component of the Internet then and now.

Will was one of the strongest programmers at BBN, and his tight, frugal code expressed his fastidious manner. A lifelong mountaineer, he taught Patricia to climb the vertical faces of New York's Shawangunk Mountains, and was known to hang from his office door frame by his fingertips while deep in thought. Will was a caver, too, and the couple spent all their vacations deep underground. "I get cold when he's not keeping me company," she wrote in one caving diary. "There's quite a draft here; the cave's breathing."

Will didn't come along on the final connection trip. He'd been at Patricia's side on earlier surveys, pushed to his limit in the underground wilderness. But the final survey fell in early September, right as their daughters, Sandy and Laura—aged eight and six, respectively—were headed back to school. One of the Crowthers had to stay home, buy the girls their books and school clothes, take them to the dentist, and register them for classes. Will knew how much the expedition meant to Patricia. She had, after all, found the lead, what cavers call "going cave," and she was dying to see it through. He told her to go ahead. He'd take care of the girls.

When Pat came home, deeply moved by the experience, Will was waiting for her. They stayed up late, holding each other and talking about the connection. When Will fell asleep, Pat crept to the Teletype terminal in the living room and entered, as quietly as she could, the bearings of the survey they'd made in Kentucky. She ran a coordinate program, and the data spooled into her hands in the form of a long paper tape. In the morning, Pat and Will brought the tape to his office, and she watched the BBN computer plot the link she'd made, beneath the earth, between two vast and lonely places. "Now I can sleep," she wrote.

Caving is unforgiving. Until the late 1960s, anyone entering Mammoth would have passed the glass-topped coffin of Floyd Collins, a country caver who died pinned by a boulder. Cavers become enveloped by the earth, their every move constrained by walls and ceilings of rock.

They eat very little—candy bars and canned meat—and carry their waste with them back to the surface. They have no sense of time. Emerging, they may be surprised to see the moon. As the Crowthers' friends Roger Brucker and Richard Watson wrote in *The Longest Cave*, their account of the connection trip, "The route is never in view except as you can imagine it in your mind. Nothing unrolls. There is no progress; there is only a progression of places that change as you go along."

Making the route visible is the central pursuit of serious caving. The Cave Research Foundation had a group doctrine: *no exploration without survey*. A map is the only way to see a cave in its entirety, and making maps is caving's equivalent of summiting mountains. It's also a survival mechanism. To stay safe, cavers map as they go, "working rationally and systematically to locate known passages." It's no wonder the hobby attracts computer programmers. Code is a country populated by the fastidious. Like programmers, cavers may work in groups, but they always face their challenges alone.

Not long after the connection trip, Patricia and Will's marriage deteriorated. They divorced in 1976, after a separation that left Will "pulled apart in various ways." Caving without Patricia in the company of their mutual friends in the small Cave Research Foundation community "had become awkward." Alone and surrounded by their maps, including an extensive survey of the Bedquilt section of Mammoth they'd made together in the summer of 1974, he consoled himself with long Dungeons & Dragons campaigns and late nights coding at home. When Sandy and Laura visited their father, they usually found him hard at work on a long and elegantly structured string of FORTRAN code. He told them it was a computer game, and that when he was done, it would be theirs to play.

The novelist Richard Powers once wrote that "software is the final victory of description over thing." The painstaking specificity with which software describes reality approaches, and sometimes even touches, a deeper order. This is perhaps why Will Crowther felt compelled to make one last map. This one wasn't plotted from his wife's

muddy notebooks but rather from his own memories. Translated into seven hundred lines of FORTRAN, they became *Colossal Cave Adventure*, one of the first computer games, modeled faithfully on the sections of Mammoth Cave he had explored with Patricia and mapped alongside her, on a computer that would form the backbone of the Internet.

Colossal Cave Adventure—now more commonly known as *Adventure*—doesn't look like a game in the modern sense. There are no images or animations, no joysticks or controllers. Instead, blocks of text describe sections of a cave in the second person, like so:

You are in a splendid chamber thirty feet high.
The walls are frozen rivers of orange stone. An
awkward canyon and a good passage exit from the
east and west sides of the chamber. A cheerful
little bird is sitting here singing.

In order to interact with this cave, players type terse imperative commands, like `GO WEST` or `GET BIRD`, which trigger fresh onslaughts of description. *Adventure's* puzzles are an endless shuffle of magical inventory: to pass the snake coiled in the Hall of the Mountain King, you must unleash the bird from its cage, but you can't `GET BIRD` if you're in possession of the black rod, because the bird is afraid of the rod, and in turn, the crystal bridge will not appear without a wave of the rod, and all the while you are in a maze of twisty little passages, all different—or worse, all alike.

This would have been familiar to Will's colleagues from the ongoing Dungeons & Dragons campaign they sometimes played after work. In D&D, a game with no winnable objective, a godlike "Dungeon Master" describes scenes in detail, prompting players at actionable decision points. But Will wrote the game for his young daughters. After the divorce, Sandy and Laura came to expect that they'd play computer games whenever they visited their father. According to a researcher who interviewed members of the Cave Research Foundation, "Another caver who

was with the Crowthers on an expedition in the summer of 1975 reports that one glance at 'Adventure' was enough to identify it immediately as a cathartic exercise, an attempt by Will to memorialize a lost experience."

Once he'd finished coding, Will saved a compiled version of the game on a BBN computer and left for a monthlong vacation. It might have stayed there, untouched and unremembered, save for the Crowther girls, had his computer not been connected to the new computer network his company had helped to build. By the time Will finished his vacation, *Adventure* had been discovered by people across the ARPANET. Where Patricia linked caves, Will linked nodes, and *Adventure*, a mental map of the long expeditions they took together, traveled wherever those links were forged.

Adventure was a phenomenon. The game was as unforgiving as caving itself. It was maddening to navigate—a "harrowing of Hell," proposed one writer who tried it—and addictive to play. Productivity in computer science labs ceased every time *Adventure* made landfall on a terminal. An *Adventure* devotee at Stanford, Don Woods, modified the code further by adding fantasy elements—an underground volcano, a battery-dispensing machine—to Crowther's austere descriptions. *Adventure's* journey into the earth is now considered a foundational text of computer culture. Hundreds of players took their chances on it, then thousands, each scribbling their own hand-drawn maps of the subterranean world Will described.

It must have been strange for Pat. By the time she encountered *Adventure* firsthand, at a Cave Research Foundation meeting in Boston sometime in 1976 or 1977, she was Patricia Wilcox, having married the leader of the 1972 expedition. Will's computer game proved a delightful oddity for the experienced cavers in their circle, and indeed for anyone who knew Mammoth well. In Boston, the foundation spent much of their meeting playing *Adventure*. Because they played the more popular version supplemented by Don Woods, who had embellished sections of the game, Patricia didn't immediately recognize the cave it described. She told a researcher in 2002 that it was "completely different from the real cave."

Except it wasn't: Mammoth cavers who tried *Adventure* found they needed no maps. It was so accurate they could navigate it from memory. As the game spread, *Adventure* players who made pilgrimages to the real Mammoth Cave could scramble down the twisting passageways secure in their knowledge of the game's virtual map. A former coworker of Will Crowther's, recalling the topographical data stored on the computers at Bolt, Beranek and Newman, noted in 1985 that "Adventure's Colossal Cave, at least up to a point (or down to a point) is the same as the one in Kentucky, and the description and geology of the first few levels are consistent and accurate." That has been proven. In 2005, a group of researchers visiting the "source cave," the Bedquilt section of Mammoth, was able to document clear parallels between the cave's geology and Crowther's descriptions.

Like the fluorescein dye with which speleologists trace the course of underground streams, *Adventure's* version of caving culture stained the entire network. Cavers seek connections, which they discover through systematic survey, collective effort, and a willingness to forge ahead into the darkness, knowing full well that when the end appears, it may be a small place, a crack in the rock so tight only the wind can broach it. The game is a set of instructions for re-creating Mammoth; those instructions explode into pencil passageways, antechambers, and pits. *Adventure* can be won only with a map, just as caves are survived only by those who know the way back out. Steven Levy, in his history of computer culture, compares *Adventure* to the craft of programming itself, writing that "the deep recesses you explored in the *Adventure* world were akin to the basic, most obscure levels of the machine that you'd be traveling in when you hacked assembly code. You could get dizzy trying to remember where you were in both activities."

I'm telling you the story of the Mammoth Cave, of Stephen Bishop and Patricia Crowther and her husband Will, heartbroken as he memorialized their adventures in code, as a way of reminding you that every technological object, be it a map or a computer game, is also a human artifact. Its archaeology is always its anthropology. In fact, the most famous archaeologist to study Mammoth, Patty Jo Watson, inferred an

entire agricultural economy from the grains digested by the corpses preserved in the cave's constant temperature and humidity. To understand a people, we must know how they ate. To understand a program, we must know its makers—not only how they coded but for whom and why.

A half dozen turns into *Adventure*, a magic word appears on the cave wall. The real Mammoth Cave contains its share of carved messages—Patricia discovered the most important—but the “word” that shows up in *Adventure*, “XYZZY,” is Will's invention. He added it for his sister, Betty Bloom, who came to stay with him after the divorce. She was one of *Adventure*'s original playtesters and a famously impatient sort. When typed, the magic word transports the player elsewhere in the game in a quick jump-flash, skipping the tedious steps along the way. According to Bloom, XYZZY, which Will pronounced “zizzy,” was a family password. His daughters were told to use it if they ever got lost or needed to identify themselves. It is the original cheat code.

The first academic to seriously consider *Adventure* was a woman, Mary Ann Buckles, who compared the game with folktales, chivalric literature, and the earliest uses of film, arguing that the growing cultural importance of computer technology that *Adventure* represented would lead to a democratization of computer use “analogous to the democratization of reading that characterized the spread of printing.” The literary critic Espen Aarseth, writing about the genre of forking digital literature that *Adventure* catalyzed, called it “a mythological urtext, located everywhere and nowhere.” *Adventure* created a genre of adventure games, which mutated from text interfaces to visual ones while retaining Crowther's strange and compelling interplay of second-person description (There is a shiny brass lamp nearby) and imperative command (Get lamp). This developed into a textual physics used in virtual spaces all over the early Internet. In time, even people with no knowledge of cave adventures came to talk this talk.

Adventure has been remembered, celebrated, canonized, satirized. Crowther, who never made another game, is now considered interactive fiction's J. D. Salinger. But the domestic context from which *Adventure*

emerged bears exploring, too: Will Crowther wrote the code after divorcing the woman with whom he'd mapped the cave *Adventure* emulates. It was playtested by his sister, for whom he invented the game's “magic word.” It was created for the daughters he saw only on weekends and holidays and because he missed Patricia, or at the very least because she had instilled in him a love of the enveloping darkness.

Patricia Crowther had been a FORTRAN programmer at the Haystack Radio Observatory when she graduated from MIT. Like many technical women at the time, she left the computing industry behind to raise her children—and to cave, naturally. When she returned to work in the late 1970s, everything had changed. She went back to school, enrolling in all the undergraduate computer science courses the Indiana University of Pennsylvania had to offer, eventually taking a job as an instructor. In her classes, which were often attended by hundreds, she remembers seeing plenty of female students, but they would be the last generation of women to enter the field in substantial numbers. In the generation after Grace Hopper and her contemporaries, the professionalization of “software engineering” marked a sea change in the gender demographics of computing. By 1984, the number of women pursuing computer science degrees in the United States began to dive, and it has kept diving to this day, a decline unrivaled in any other professional field.

The Honeywell 316, the microcomputer at Will's workplace that would become a router on the early Internet, has one more claim to fame. Honeywell made a model for women: with a built-in pedestal and a cutting board, it sold in the Neiman Marcus 1969 Christmas catalog as the Honeywell “Kitchen Computer.” It cost ten thousand dollars, came with an apron, and took two weeks of programming classes to learn how to operate, but the catalog picture shows a woman in a long floral dress unpacking a basket of groceries on top of the computer as though it were an extension of her kitchen counter. “If she can only cook as well as Honeywell can compute,” the copy says, implying that the computer has “more authority, power and intelligence than its female user.” And on her home turf to boot.

As Patricia's ex-husband's game grew in popularity, it was men who congregated around networked terminals to play it late into the night. It was men who scribbled cave maps on notepads lit by the electric glow of the screen. It was men who emerged dizzy in the light of day from each long crawl. And for all that Patricia accomplished, in the many tellings of the *Adventure* story, she has remained a background figure. Although she mapped and charted the subterranean world Will popularized with his game and made a physical leap into the unknown that few would even consider, her presence is a spectral outline of what might have been. She has been hidden in plain sight. The same could be said about many women in the early network era.

It's fitting that the networked century's inaugural collective experience would be *Adventure*. It's a story about how intimately people influence software, and how wide its impact can be. And caves were always virtual worlds, the first places where human beings experienced the ontological disembodiment we now so strongly associate with projecting ourselves on-screen. By flickering firelight or by the shudder of a CRT monitor, we see beyond the real. Symbols applied to raw granite, to canvas, to code: all of it lights up the darkness.

There's a lamp in the cave. Do you know what to do?

GET LAMP

Good. Now hold it tight, we'll need to take it with us. We'll take it through the twisting passages until they open wide to the other side and we can finally see the writing on the wall, a scrawl a hundred years old. It's our magic word, our cheat code, our jump cut through the night. You can barely read it in the carbide light: *Even when women were invisible, it never means they weren't there.*

Chapter Seven

RESOURCE ONE

It's raining in California. Levee-busting rain, water rushing to the ground like a lover kept away by drought. In the Marin Headlands, north of San Francisco, the brackish tidal plains are throbbing, egrets buzz the grasses, screeching, and I'm waiting by a flooding bus stop, raindrops on my glasses. Sherry Reson pulls up in an old Camry, opens the driver's side door just enough to poke a mop of curly hair out, and waves.

She drives me up the road to her place, a slate-gray bungalow weathered by the wind. On the way, she briefs me excitedly about the group she's gathered, which we find perched around her dining room table, eating spongy feta, broad beans, and spinach salad from wooden bowls. As I divest myself of my wet outer layers, they look up cheerily from their conversation. They've been catching up. Only recently have they reconnected with one another, but forty years ago, alongside a hundred other dreamers, hippies, and iconoclasts, they all lived together in a technological commune in San Francisco called Project One.

They'll explain to me that Project One was a mustard-yellow warehouse South of Market. Inside its eighty-four thousand square feet of interlinked habitations, they slept in hand-built bays one hundred feet wide and gathered for community meetings on the fifth floor that often