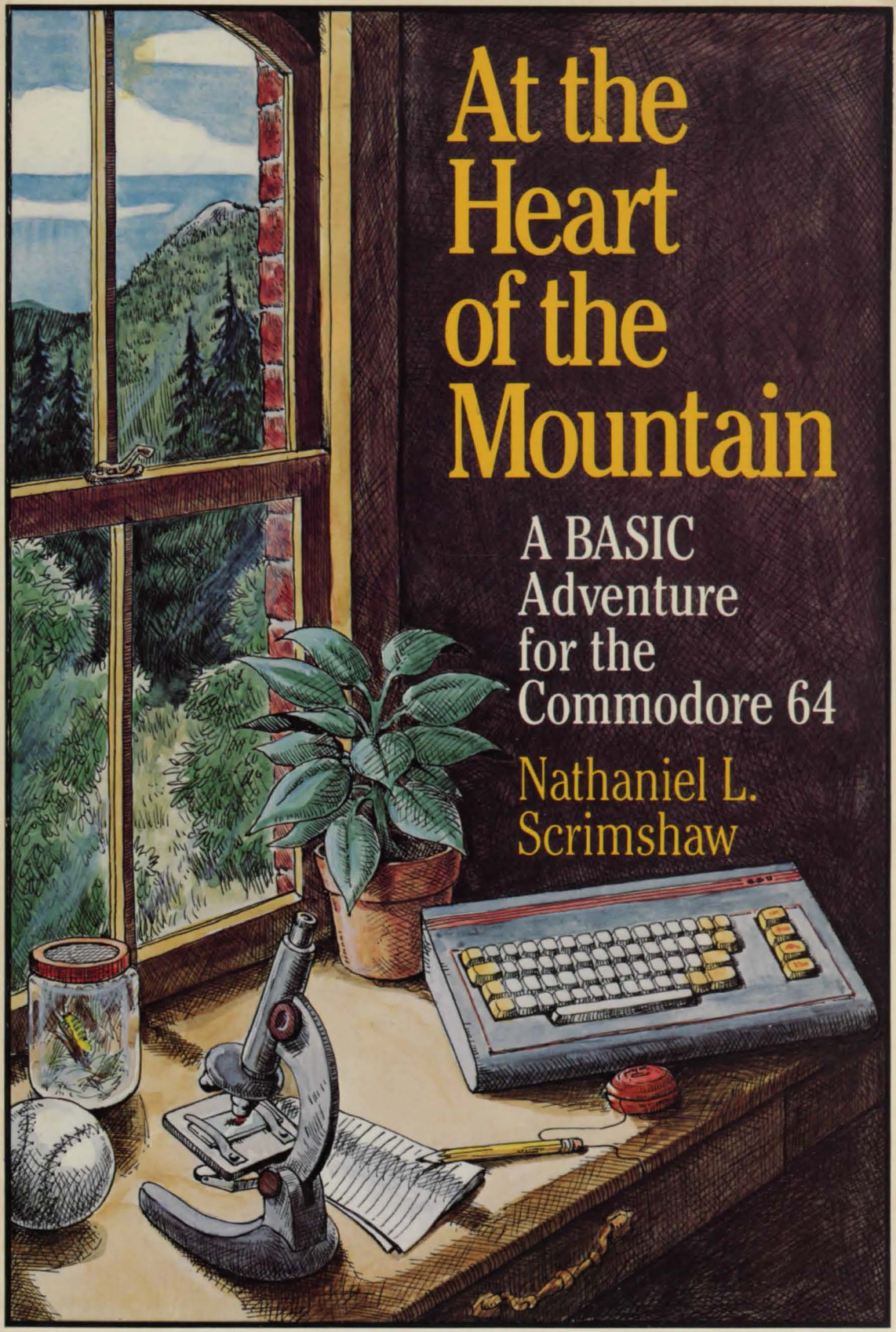

At the Heart of the Mountain

A BASIC Adventure for the Commodore 64

Nathaniel L. Scrimshaw

At the Heart of the Mountain

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Author's Preface

The valley in which this story takes place really exists in the White Mountains of New Hampshire. I have altered the geography a bit, and changed a place or two, but on the whole I have merely described the valley as it is, or rather, was. The valley I write about has disappeared, it is past, having life only in the memories of a few. The Inn burned down in 1967, and the valley floor is now covered with condominiums, the product of a resort development that occurred so quickly it seems that it happened in the blink of an eye. It reminds me of the mushrooms that appear overnight, pulpy and soft, making up in numbers for what they lack in substance. The mountains, however, are still the same, and so they shall be until a few more passes of glaciers wear away their rocky faces.

The characters in the story are entirely fictional. And while there is a Goodrich Cottage, I have made it a bit more fantastic than it actually is (although it does boast a small ruined castle in the back yard).

I hope you enjoy the book, and if you ever chance upon the valley, use your imagination and perhaps you will see the valley as it is in the pages that follow. Images have far longer lives than mushrooms, after all. By the way, there *is* a Goodrich Rock. Go there. . . if you can find it.

Introduction

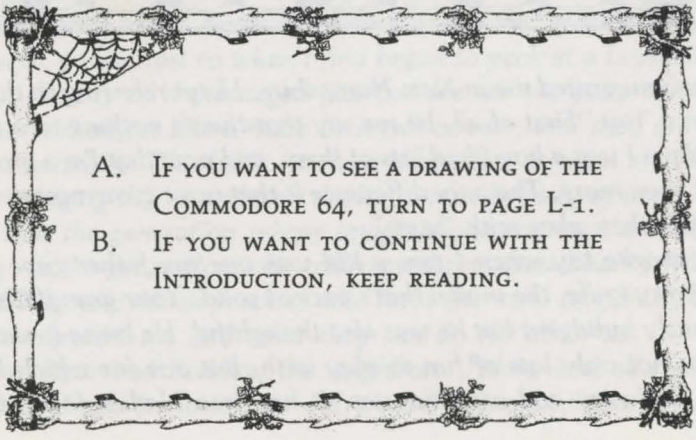
MY SWISS ARMY KNIFE
A letter from Uncle Charles

Dear Erin,

As you can see, I've got our book done. I tried to keep it pretty much as we decided to do it when we worked on it together last summer here in the Valley. I just hope my favorite niece likes it.

It has a few quirks that you ought to know about before you read it. Mainly, it branches *in much the same way a hiking trail branches when you meet a cross road. At various points in the book you, as the reader, have a choice to make. You can either continue with the story of the adventure that you and I had during the rockslide when you first came to visit me last summer, or you can branch off by reading a kind of lesson in the back of the book. These lessons are explanations of the computer analogies we use in the main course of the story.*

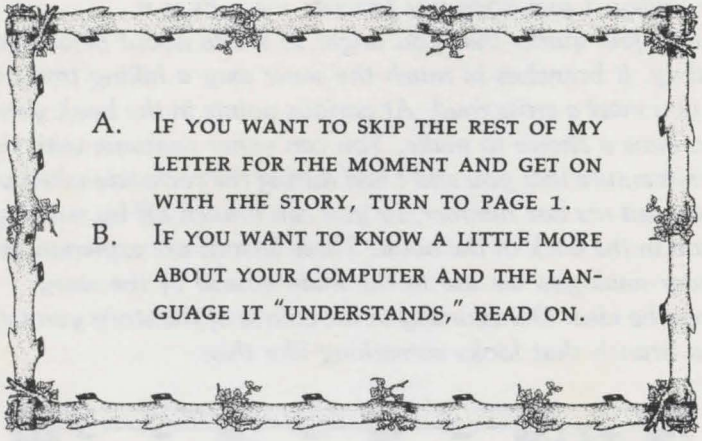
Here's the idea. Occasionally in the course of the story you will come upon a branch that looks something like this:



The choices are called a menu. *Just as you have a list of choices of what to eat on a restaurant menu, this menu gives you a choice of things to do. Not all menus in the book are the same; read each one carefully to see what choices you have. The thing to remember is that* you choose *which way to go.*

You also have the choice of how much BASIC you will learn. If all you want to do at first is read the story, then by all means get on with it. If later you become curious and want to learn a little about BASIC, then go back to a menu option and take a choice that will lead you to a lesson. Just remember, though, to do the lessons in order, just as you would read a story from the beginning, without spoiling it for yourself by looking at the ending ahead of time.

I'm going to spend most of the rest of this letter talking about what I think a computer is. You might want to skip it, though, and get right into the story. That's why you've got another menu coming up right here. Watch this!



When you visited me in New Hampshire, I kept referring to the computer as a "toy." First of all, let me say that there's nothing wrong with toys. When I was a boy I had lots of them, and now that I'm a grownup, I've got even more. The only difference is that most grownups don't call the things they play with "toys."

My favorite toy when I was a kid was one my father gave me—a Swiss Army knife, the model that's packed solid. Your grandfather was notoriously indulgent but he was also thoughtful. He knew it was a toy that was not only lots of fun to play with, but one for which I could always find new and creative uses. It had two blades, four kinds of

screwdrivers including a phillips head, a can opener, a bottle opener, a pair of scissors, a fish cleaner, a nail file, a corkscrew, a wood saw, a metal saw and even a magnifying glass. I loved that Swiss Army knife. Although the one I have and often use now is not the one my father gave me, it is the same model and I still love it. It can do countless things and it is just a single small object. It was not only fun, but it was educational—and no matter how much I thought, at the time, that something educational could not also be fun, I could not deny that this "toy" was both.

My first computer was a lot like my first Swiss Army knife. It was also a single object adaptable to countless uses. I did not own that first computer; my college did. It was a beauty. It had an 8K RAM memory, which meant that it would store 8,000 pieces of information, each of which was called a "byte"; it "spoke" a language called "FORTRAN" and what with all its noisy tape recorders and power-hungry vacuum tubes and circuits, it filled up a room the size of a helicopter hangar. The Commodore 64 computer that you use is smaller, quieter and quite a bit more powerful than my first computer. It has 64K RAM memory. Also, it "speaks" a programming language called "BASIC."

When I was a kid, not every kid had a Swiss Army knife. Not every kid had the chance to add to what he or she learned in school with a wealth of fun and education at home. But you have something that even such privileged kids did not have then: the chance to put your hands on and learn to use computers. Nobody had that then. Soon, every school from kindergarten through college will have computers for the use of its students. Already they are in many homes. Already there are colleges which require their students to buy personal computers the way they require students to buy books. And very soon, people will all learn how to use them in the same way they learn how to read.

I have watched the computer shrink in size and grow in practicality until now, in contrast to when I first began to peck at a keyboard, they are not the toy of a privileged few but are an everyday commodity, a household object like a radio or a can opener, and they are coming to be a necessity. This book marks a time when a major step is taking place, bringing this remarkable device to a wide body of users. It is my belief that the generation whose imaginations are most excitable—the young—is the generation who will reap the greatest bounty from these astounding new developments, who have the most to gain by learning what computers are and what they can do for all of us.

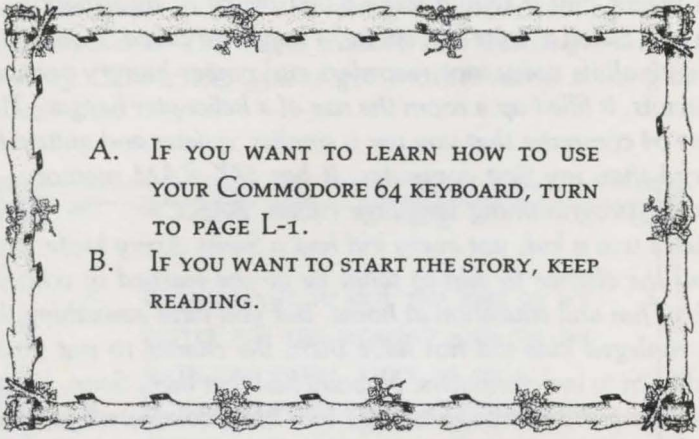
Nora, Reverend Berkley, the neighbors, Hilary and all the animals send their love. I'm sure that old wizard Solomon Snow would send

his love too, but I think he's been in hibernation since the leaves turned color. Send my love to your parents and to Sam if you see him. We're all looking forward to next summer.

Your loving uncle,

Charles Goodrich
at Christmastide
in New Hampshire

P.S. Here's another menu:



At the Heart of the Mountain

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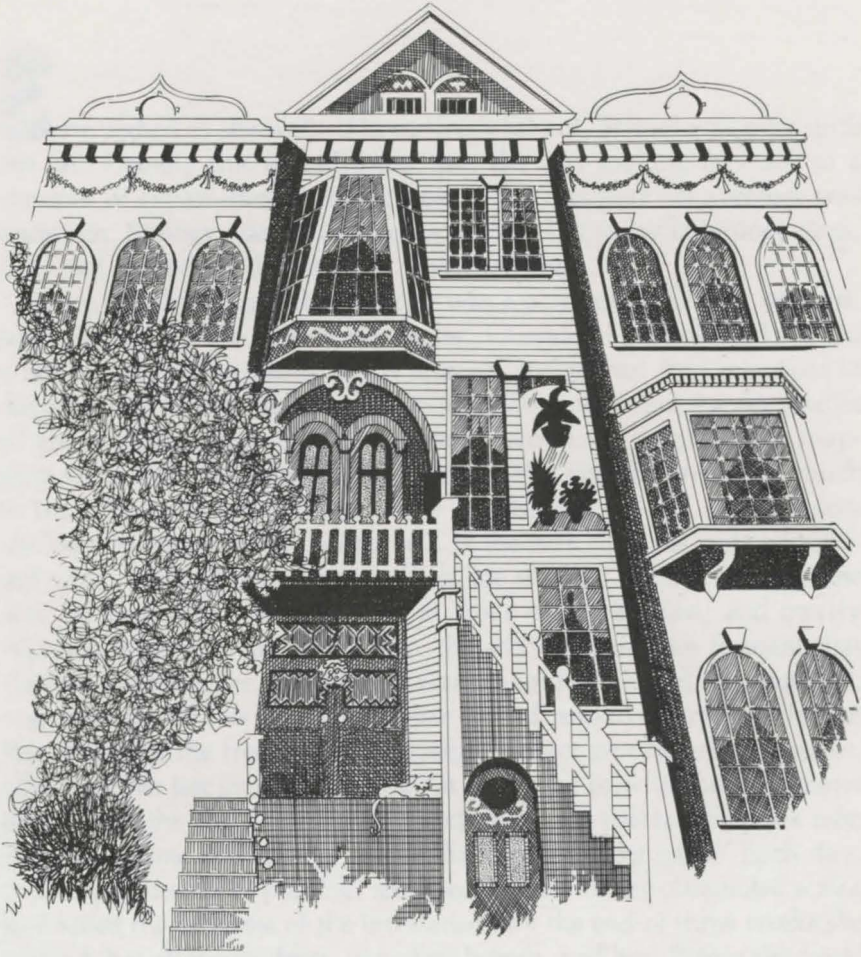


Summer In New Hampshire

 rin sighed as she walked home from school. School was over until the fall. Usually this would mean that she was looking forward to a summer of exploration in the city park, but this year her summer was uncertain. Biology was Erin's favorite subject, but today in biology class, Erin had sulked all through Ms. Byron's lesson.

Some people thought that the city was a place only for rats, pigeons, squirrels and people. Erin knew better. Outside of school she loved to walk in the park and look at the animals and plants. Erin managed to discover that if you looked hard enough you could find the deep holes of groundhogs, glimpse an occasional raccoon, or rescue a lost snapping turtle that had stumbled into traffic. Her favorite creatures, much to the dismay of some adults, were insects. She did not collect them; she liked to watch them undisturbed. In the park this was quite all right, but when she had not mentioned the lice she had noticed on John (he was the boy who sat in the seat in front of her in class) and merely watched their behavior every day, the school authorities thought that she had gone too far. All she had wanted to do, she told the principal, was measure the rate at which the lice spread, and to determine whether this related to the frequency of physical contact among her classmates, who were her test group. Every day at recess she watched her classmates play "tackle the guy with the ball," and wrote in a special notebook *who* touched *whom* and *where*, during the course of the game. Each day, as inconspicuously as possible, she checked each of her classmates' scalps and noted the progress of the infestation. By the end of three weeks she noticed that all the students, including herself, had lice. Before she could determine whether Ms. Byron had lice too, the evening janitor discovered her notebook and turned it over to the principal. Ms. Byron stuck up for her in front of the principal, saying that Erin's experiment showed "a healthy curiosity and a good sense of the methods of scientific inquiry." The principal was angry enough to spit, however, when the affair become a short segment on the local news.

Erin kicked a parking meter as she walked home from school. I don't

want to stay with my weird uncle in New Hampshire, she thought. She recalled her parents' discussion of the night before. They thought she was asleep in her bed, but as soon as she heard her name come up in a loud discussion in the living room, she opened her door a crack and listened.

"I just don't know if I like the idea of Erin staying with your brother," her father said, "he's, so . . . peculiar."

"And who doesn't have peculiarities?" her mother asked. "Besides, he is a very well-respected computer programmer. Erin might learn something."

"*Was* a very well-respected programmer," her father retorted.

"Now, David, just because he has chosen to live in the White Mountains and he is self-employed does not mean he is not respected in his field. People can do that sort of thing nowadays with computers."

"In any case," her father interrupted, "he is the most abstracted man I have ever met. Erin could be lost in the forest for a week before he'd snap himself out of the daze he always seems to be in and notice. By then she'd be half-starved and mauled by a bear. Come to think of it, she'd probably starve in any case, since he seems to eat only when he remembers he hasn't fed himself in a few days. Most likely Erin would have to collect roots and berries to stay alive."

"Now that is absurd!" Erin could hear the anger in her mother's voice. "My brother is one of the most loving, caring and responsible people I know. You have just had it in for him ever since our wedding reception when you two got into the argument about real estate development. He feels very strongly about preserving woodlands from development. It's his politics you don't like, not his lifestyle."

At this point Erin shut the crack in her door and crawled into bed. She knew that her parents had planned a trip to Europe for their twentieth wedding anniversary and that they would have to confront the subject of where Erin would go for the summer sometime. She thought about her uncle. She saw him only occasionally when he came to the city to give a lecture. His clothes usually looked a bit rumpled and smelled of wood smoke. He always brought Erin a present, something from the forest. Once he brought her something from a beaver dam, a piece of wood that the beaver had chewed to rough points on both ends. Its bark was also chewed off so that it was smooth and looked polished. Another time her uncle brought her a small round brown ball about the size of a brussel sprout. He told her it was a moose dropping. She liked these gifts, even though her father was not always pleased. He thought the moose dropping unsanitary. When her uncle told her father that in many

hunting societies hunters ate the dung of the moose and caribou when they followed their trails, her father confiscated the present. To get it back she had to promise not to eat it.

Her uncle also told Erin stories when he came down. They were very strange stories, she had to admit, but ones she enjoyed. Erin loved reading and making up stories almost as much as she liked biology. All these things she liked about her uncle.

What she didn't like was that he programmed computers. Erin hated computers. She hated computers because at school there was a group of boys who talked about nothing but computers, and what they mostly talked about were the video games Erin couldn't stand. Erin couldn't see why anybody would spend all his time in front of a television set shooting monsters, or trying to figure out new ways of shooting monsters. To her, a day in the park watching ants carry pieces of a dead caterpillar to their nest was much more interesting. And then there was that smug Kevin who sold a program to a video game company. He was the leader of the computer group. Ugh! He was so pale and skinny he looked as though he had crawled from under a rock.

Erin kicked another parking meter as she turned the corner onto her street. Erin's family lived in an old townhouse with four floors. It was one of a row of townhouses lining both sides of the street, each with a little square of yard that was a home for gardens and flowering trees. The street was also home for a line of big old maples whose branches hung over the cobblestone roadway. When she came down the street in the summer, Erin felt as if she were entering a broad, green tunnel. Her mother, who had been watching for Erin, immediately opened the door.

"You took your time getting home today," her mother scolded. Erin had made a detour through the park to inspect some caterpillars that had appeared on a patch of milkweed by the pond. She had also used the time to sulk a bit in the presence of her animal and insect friends.

Erin's mother continued, "I suppose you're excited about the summer?"

Erin felt as if she were dropping fast in an elevator. The announcement was coming, she knew it. "I guess I am," she answered weakly. Erin pulled up a chair at the kitchen table and sat down. "May I have a glass of apple juice, mother?"

Her mother said, "Of course you may," and as Erin poured out a glass added, "Your father and I were thinking it might be nice for you to spend part of the summer in New Hampshire with your uncle, the month we are away in Sweden." Changing the subject hadn't helped.

Erin was silent for a moment. "I'd rather stay here," she said.

"But why? You like your uncle, and I'm sure you would love the mountains. I spent every summer with my grandmother in that house when I was a little girl. It's beautiful in the Valley, and I assure you, there are plenty of insects. I have felt very badly that we haven't given you a chance to visit the place yet."

"I'm sure that's true, mother, it's just . . . just," Erin hesitated.

"Just what?" her mother prodded.

"It's just that I hate computers," Erin burst out.

Erin's mother laughed. "You should know your uncle well enough to realize he would never push a computer on you. Anyway, he spends most of his time wandering in the forest. I'm sure you would enjoy doing that with him."

Erin was not convinced. Kevin's superior smirk was too strongly imprinted in her mind. "I can take care of myself, mother. Why don't you go off and I'll just stay here."

"We'll talk about it at dinner, Erin," her mother sighed.

Erin knew it was no use. She knew that adults have no confidence in children's ability to fend for themselves. At dinner her parents confirmed the inevitable. She was going to New Hampshire for the summer.

The two weeks before Erin's parents were to leave passed quickly. Erin spent most of her time in the park studying the habits of gray squirrels. She tried to stretch out the days, but suddenly it was the night before her bus left for New Hampshire and her parents were helping her pack.

"It gets very cold at night sometimes. You should bring something warm," her mother said. She rummaged in Erin's closet and pulled out a gray and green plaid wool shirt. "And you'll need lots of socks, warm ones."

It didn't seem to Erin that she had much to do with her own packing. "Do I really need all those clothes?" she wanted to know.

"Better too much than too little," her mother answered.

This advice didn't make much sense to Erin. Every time she had taken a trip it seemed that the things she didn't need always got in her way.

Her father added, "We want you to have at least a few changes of clothes so you don't come back smelling like a moose."

This made Erin wonder just how a moose does smell. After she was all packed and her parents left to do their own packing, Erin curled up in her bed and began to read a book her uncle had sent to her. It was an adventure story about a boy who went to visit his grandfather in a strange house in New Hampshire. This sounds too familiar, she thought, but she started the book anyway. Soon she was caught up in the story. Erin's mother had to come in and tell her to turn off the light.

The next day she said her goodbyes, got on the bus and, entranced, she continued to read the book. That is, until a boy sat down next to her at the next stop and announced, "Hi, my name's Sam."

Erin looked up and saw a tall, dark-skinned boy. His shoulders were quite broad, but he was not stocky. His hair was dark brown, almost black. His cheek bones were high and his nose was thin-boned and straight. His eyes were deep chestnut brown.

The boy's features contrasted Erin's. While Erin was tall for her age, she was light-skinned and freckles surrounded her eyes like a mask. At school kids sometimes told her she looked like a raccoon. Her hair was strawberry blonde and her nose bobbed upward. Her eyes were a grayish blue. As Erin looked at the boy, she blushed red as a cherry. Erin blushed at the slightest thing, and when she started to blush, her blushing made her embarrassed, and so she would blush more. For some reason she blushed when she saw Sam, and of course the blushing made her blush more. "Hi," she said, looking for a paper bag to put over her head.

Sam sat down, pretending not to notice that Erin was blushing. "I guess I interrupted your reading. Sorry," he said.

Erin didn't know what to say so she looked into her book and tried to read. Sam pulled a book from a small day pack he had carried on the bus and began to read. Erin noticed that the cover read, "START-ING FORTH." This seemed like an interesting title until she saw that it was a book about computers. "Oh no," Erin thought to herself. She then had no trouble ignoring him and reading her own book.

After Erin had been reading for a while she raised her eyes and glanced out the window. She saw rolling hills covered with forest. She had never seen so much uninterrupted forest. Erin was so involved in her book that she hadn't realized how much time had gone by. She had been in the bus for six hours.

Sam noticed that Erin had stopped reading and said, "Pretty, isn't it?"

Startled, Erin answered, "Yes."

"I'm going to visit my grandmother for the summer," Sam continued. "I go up to the Valley every summer and stay with her. My grandfather's dead. How about you, where are you going?"

Erin looked at Sam. He sure didn't seem like Kevin.

"I'm going up to the Valley to visit my uncle for the summer," she answered. "I hope to study the animal and insect populations. If I can I'd also like to make a list of the wild plants in the White Mountains. That's called *Flora*, you know."

Erin knew she sounded awkward and the vicious cycle of blushing started again.

Sam looked a little surprised and said, "I see. Well, I work on the hiking trails part-time. You know, clearing trees that have fallen across the paths during the winter, building bridges and waterbars."

Erin didn't know. She had never thought about what it took to keep up a trail. She thought you just walked on them and that was enough. She wondered what a "waterbar" was. The idea of building bridges fascinated her. She imagined suspension bridges crossing great chasms and roaring rivers.

Erin wondered that Sam hadn't said anything about computers. She had to admit, Sam seemed to be a nice guy despite his reading matter.

The bus rolled over a ridge and a little town became visible. It looked like the kind of town Erin had seen only lining the tracks of an electric train set or sitting in a little crystal ball of shake-em-up snowflakes. If you put your forefinger over your view of the courthouse dome and your middle finger over the big white church steeple, you could make a "V" that would encompass the whole town.

"Hey look," Sam piped up, "see that town? That's where the bus stops. We have to get off there and get a ride into the Valley. It's about ten miles into the mountains there." Sam pointed to a notch in the hills ahead.

The forest blanketed the hills in a fresh spring green with blotches of darker green where the hardwoods mixed with evergreens. Near the tops of the mountains there was even darker green, and on some of the peaks, granite broke through the green like a rugged gray crown. As the mountains rolled off into the distance, the green turned into blue, and the mountains that were farthest off looked like the deep blue sky just before the first star appears.

"It's beautiful," Erin said as the bus pulled into the station, which consisted of a general store and a set of gas pumps.

Erin saw her uncle standing by his car near the store. Erin's uncle shared her light coloring and red-blonde hair. She noticed that he had added a bristly golden beard since she had last seen him. He looked like a Viking.

"See that guy?" Sam pointed at Erin's uncle. "He's the guy I work with on the trails." Sam looked around and said, "I wonder where my grandmother is."

Erin was surprised. "That's my Uncle Charles!"

"He is?" said Sam. "You have a neat uncle."

Erin felt proud to have an uncle who had achieved the distinction of being "neat." As the pair got off the bus and struggled with their bags, Erin's uncle called, "Erin! Sam!"

"So that's your name," said Sam.

"I guess I forgot to tell you." Erin blushed at some length.

Erin's uncle came up to the bus and helped the two with their bags. He turned to Sam and said, "When your grandmother heard I was coming in to pick up Erin, she asked me to pick you up too. Her eyes have gotten a lot worse since last summer; she doesn't like to drive too much these days."

Uncle Charles looked at both of them and said, "I see you two have already met. Well, come on. Let's be off to the Valley."

two

The Valley

 he road into the Valley followed the river that flowed out through the mountain notch. The river was still high from melting snow and spring rains. This made it appear especially true to its name, the Mad River. Sam and Uncle Charles sat in the front seat talking about what work needed to be done on the hiking trails. Erin sat in the back seat, not at all minding that she was left out of the conversation. She enjoyed looking at the rushing river and the contours of the mountains she could just glimpse through the canopy of forest along the road. At last they reached the final section of their drive along the slow river road. A valley opened out in a large, green field. Now that no trees obscured her view, Erin saw the mountains take full form. She saw through the fields, at the very end of the road, a gleam of white.

"Home again," Erin's uncle said.

Without quite knowing why, Erin felt a catch in her heart. She felt she was in fact coming home, though she had never been here before.

The road ended at the old Inn, a massive white building with a porch encircling the front half of it. The Inn was three stories high with a series of small dormer windows on the third story. Along the porch was a set of green painted rocking chairs.

"Sam," said Uncle Charles, "I'll drop you off here. Say hello to your grandmother for me. And make sure you tell her I'll be over some time tomorrow."

"Sure thing," Sam answered as he put on his day pack and shouldered a duffel bag. "Nice to meet you, Erin." Sam awkwardly balanced the bag and called out as he walked away, "See you soon."

"Goodbye Sam," Erin called back. Turning to Uncle Charles, she asked, "Where does Sam live?"

"Up there." Uncle Charles pointed to a yellow house that was about fifty yards up on the side of the ridge overlooking the green in front of the Inn. "And we live over there," he added, pointing to a white house on the other side of the field on the Valley floor. Like the Inn, this house had a porch that circled around front. The house was mostly hidden

in trees, so Erin couldn't see how big it was.

They pulled away from the Inn and went up a driveway that entered the forest. The woods were dark. A stand of old red pines shadowed everything. As they drove up in front of the house, Erin almost couldn't believe her eyes. She had never seen a house like this. What had appeared as a small wooden cottage from the field by the Inn jutted out from the back in a wondrous wing. The architecture of the wing seemed to take Erin on a journey into time. It was made of carved granite blocks. Four large, stone chimneys rose, one from each corner of the wing. The roof was made of different colored slate patterned in intricate geometric designs. What was most amazing was that at various points, half-collapsed fieldstone walls meandered out from the structure, sometimes ending a few feet from the building in a jumble of loose stone, sometimes leading to what looked like ancient rooms whose roofs had fallen in. On the far side of the wing, across the expanse of jumbled walls and open rooms, Erin could see a stone tower with slits for windows that spiralled up its side. Trees had grown through the ruin, as if to show that this place had been lost for centuries and only just found.

"This is Goodrich Cottage," said Uncle Charles. "It is a bit overwhelming the first time you see it. Your great-great-grandfather thought the Valley had everything he could want in the world except a ruined castle, so he added one to his cottage."

Erin stared at the magical house.

"Well, let's get you settled," said Uncle Charles.

Uncle Charles took as many of Erin's bags as he could carry and started walking toward the front of the house. Erin managed to get the rest of the bags and followed.

When they entered the house the first thing Erin noticed was the smell. The house smelled like old wood soaked with the smoke of generations of fireplace fires, mixed with a damp fungus smell, as if the stand of shade trees had thwarted scores of summers from drying the house completely after the wet springs. The second thing Erin noticed, much to her delight, was that in almost every corner there was a small spider's web.

"So many spiders," Erin cried. "Wonderful!"

"Those are Hilary's children," said Uncle Charles.

"Who's Hilary?" Erin asked.

"Hilary is the master weaver of Goodrich Cottage," Uncle Charles answered. "As a matter of fact, you're going to be sharing a room with Hilary."

Erin and Uncle Charles ascended the stairs that were immediately in front of them as they entered the house and came up to a second story hallway. Uncle Charles brought Erin to a door that opened into a room filled with golden light. The woodwork was the color of dark maple syrup, and the wide-board floor was the color of clover honey. In one corner there was an old-fashioned pine desk that had a hinged front that opened up to reveal dozens of little drawers and cubbies. In another corner sat a matching pine bureau. At the center there was a double bed with a broad maple headboard with the carved outline of a mountain. Erin gazed out a north-facing window and realized that the mountain she saw was the same as that carved on the headboard.

Erin's uncle saw her looking at the mountain and said, "That's Mount Osceola. This is called the Osceola room because it faces the mountain.

"Everything is beautiful," said Erin.

"I'll let you unpack," said Uncle Charles. "We have about a half hour until dinner over at the Inn. We'll be eating most of our dinners there."

So much for me starving, thought Erin, recalling her parents' conversation of a few weeks back.

Erin's uncle left the room, giving Erin a chance to sit on the bed and think about the day. Meeting Sam on the bus was a happy coincidence. He seemed nice, and so far he had not mentioned anything about computers. But what was most wonderful was the house. Erin relished the chance to explore the rooms and ruins, and she loved her own room. She lay back on the bed, thought to herself that she could always unpack later, and gazed up at the ceiling. That is when she noticed Hilary. Hilary was one of the largest garden spiders Erin had ever seen. At the upper northeast corner of the high ceiling Hilary had spun a magnificent web. Some people would be horrified at having such a large spider in their room. Erin was overjoyed. For the first time Erin thought she might like spending the summer with her uncle.

A few moments later, Erin heard a loud CLANG! CLANG! CLANG! Uncle Charles poked his face through the doorway and announced, "Dinner time!"

Erin jumped off her bed and followed her uncle through the woods and across the field to the Inn. Dinner was served in a large room full of round tables, each seating five or six people. Erin's uncle led them to a table with five chairs, only one of which was occupied.

"Erin, I would like you to meet Reverend Berkley," Uncle Charles announced in a formal tone. "Reverend Berkley, my niece, Erin."

Reverend Berkley stood up from the table, offered a shallow bow, and answered, "Pleased, I'm sure."

Reverend Berkley wore a brown suit that fit his thin frame and small body without a wrinkle. His collar looked painfully stiff and made his neck look two inches too long. His thinning and graying brown hair was neatly parted in the middle and plastered against his head. It seemed that if a hair were to fall out of place, he might need a stone mason to repair it. All in all, he looked as if he belonged in another century. What a funny little man, thought Erin.

The dining room was filling with guests. Waiters and waitresses were beginning to bring dishes of hot food. The three sat down.

Uncle Charles explained the two empty chairs. "Sam and his grandmother usually sit with us, but Sam's grandmother has had some problem walking this last week and she's been taking her meals at home. I expect she'll be back with us soon, though."

Reverend Berkley agreed. "Knowing Nora," he said, "I don't expect a touch of arthritis will keep her down too long."

The food arrived: turkey with hot gravy and stuffing, mashed potatoes, peas and freshly baked bread. As they began eating Erin asked Uncle Charles "Uncle, how do you think spiders know how to spin a web?"

Erin's uncle paused a moment and then answered, "Well, not being a spider, I couldn't tell you from a spider's point of view, but I can make some guesses as to the way they know."

"Do tell us," said Reverend Berkley.

"First of all," continued Uncle Charles, "there are no spider schools that I know of, so obviously they do not learn how to spin a web. Web-building is instinctive to spiders. In other words, they know how to spin webs without having to be taught how to do it."

"I know that, Uncle, but how does instinct work?"

"Interesting question, and one that I have long contemplated," said Reverend Berkley. "The answer, however, has always eluded me."

Erin's uncle smiled, "I can't answer that question as a biologist would, but I think I can throw some light on the subject by making a simple analogy."

"What's an *analogy*?" asked Erin.

"An analogy is a comparison of two different things that somehow look similar. For instance, the analogy I want to make now is between following instinct and reading instructions. I think that instinct is like reading instructions."

"Go on, old chap, make your analogy," Reverend Berkley urged.

"If you watch a spider, you'll notice that it builds a web according to a set of distinct steps. First a spider makes a number of anchor lines, like the spokes on a carriage wheel, and then it crawls to the center and

begins to go around and around, each circle a little bigger than the previous." Uncle Charles took a scrap of paper from his pocket and wrote:

To Weave a Web

1. Weave anchor threads.
2. Weave circles around the center of the web.

"This is all quite obvious," Reverend Berkley challenged. "I do not see your point."

"My point is that a spider follows a set of instructions that it has not learned. The spider follows those instructions as if it were following some sort of pre-written program."

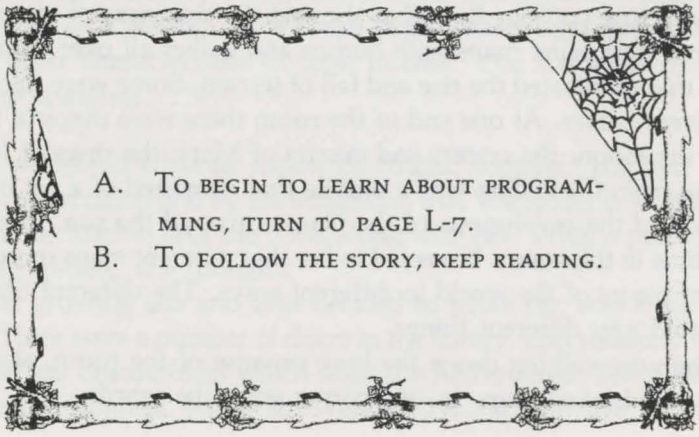
"Ah, I do see your point now," said Reverend Berkley. "It is somewhat like a program one receives at the theatre, introducing the acts and scenes of a play."

"Actually it is more like the script of a play named *To Weave a Web*, where the spider is the actor following the script," said Uncle Charles.

An idea came to Erin's mind. "Or," asked Erin, "is it also like a *computer program*?"

"Yes, in a way I think it is," her uncle answered. "A computer program is just a list of instructions written in a special language. A computer following a program, like a spider spinning a web, or," he nodded at Reverend Berkley, "an actor following a script, merely does what is written on the list of instructions. That's a very good analogy, Erin."

Instead of feeling her usual repugnance at the thought of computers, Erin felt curious. "I never thought of computers in that way," she said.



"Quite a fascinating analogy," said Reverend Berkley. "It reminds me of the time I was climbing a volcano in Central America. I had given my Indian porter a list of supplies I needed and sent him off. . ."

Erin's uncle interrupted, "I believe you told this story last night."

"Ah, yes," said Reverend Berkley, "but there was, of course, the time in Nepal. . ."

The rest of the dinner conversation was filled with Reverend Berkley's mountain climbing stories. The reverend was obviously overjoyed at having a new ear for his stories. When Erin and her uncle were leaving the dining room, the reverend called after Erin, "You really must hear of my bushwack through Oldavi Gorge."

"I suppose I will," Erin called back.

"You most certainly will," whispered Uncle Charles.

After dinner Erin's uncle retired to some far corner of the house and left Erin on her own. She decided to conduct a preliminary exploration of the house. She soon found that hallways twisted and turned in all different directions. Erin would reach the end of a hall, thinking she must have reached the end of the house, only to find a door that opened onto another strange and wonderful room. The whole house was terribly cluttered. Every wall was filled with some strange decoration that looked like it came from some distant part of the world. In one room she found the walls filled entirely with masks; masks of men with gold beards, masks of creatures from nightmares, masks of angels and devils, and masks of animals she knew and of animals she had never imagined existed. Erin hurried quickly from this room. She didn't want a thousand faces watching her.

In another room the walls were lined with maps. Erin peeked into drawers to find more maps. Some of the maps were old, some new, some with tiny contour lines that showed the steepness of mountains, and some were relief maps with bumps and gullies all over them, tiny worlds that duplicated the rise and fall of terrain. Some were filled with all different colors. At one end of the room there were maps of the far side of the moon, the craters and deserts of Mars, the rings of Jupiter. Hanging from the ceiling was a mobile that consisted of a set of rings that showed the revolutions of the planets around the sun. Erin spent a long time in this room. It seemed to her that different maps represented different pieces of the world in different ways. The different lines and colors told you different things.

As she was walking down the long expanse of the room, she came upon a hand-inked map. In one corner were the words:

THE VALLEY
A.L.GOODRICH
1888

This map portrayed a network of rivers that branched out from the Mad River like the limbs of a tree. Each of the smaller rivers had a name, even the small ones that came from the branches of branches. The mountains were named and represented by small X's, but the rivers were what gave Erin the feel of the land. Unlike the contour maps that showed the steepness of mounatins by the closeness of lines, this map gave Erin a feel for the land by showing her how the rivers flowed.

Next Erin found a library filled with all sorts of interesting books. Some of them were old and difficult to read. One whole wall was filled with natural histories, books that described the adventures of botanists and zoologists who explored different parts of the world. There were titles like, *Travels On the Amazon, Wanderings in South America, A Naturalist's Sojourn in Jamaica, The Malay Archipelago.* As she leafed through these books, it occurred to her that books were like maps. When you opened them up, you opened into a world seen in a certain way. The different words and ways of explaining things were like the different lines and colors on a map. As she was thinking of this, she came upon a book called *The Life of the Spider* by someone named J. Henri Fabre. The first chapter started:

> "The Spider has a bad name: to most of us, she represents an odious, noxious animal, which everyone hastens to crush under foot. Against this summary verdict the observer sets the beast's industry, its talent as a weaver, its wiliness in the chase, its tragic nuptials and other characteristics of great interest. Yes, the spider is well worth studying. . ."

Erin wondered what he meant by "tragic nuptials." Inspired by the dinner conversation and by the suggestion that "the spider is worth studying," she decided to take the book along with her. What a perfect place to study spiders, she thought.

It was growing late and Erin decided to make her way back to her room. There were a number of doors in the library. Erin suddenly realized that she was unsure from which door she had entered. She picked one that seemed familiar, but as she wandered along hallways, from room

to room, she realized that she had selected the wrong door. She tried to go back to the library but ended up in a cold stone hall lit by a number of kerosene lamps hanging on the wall. Ahead of her were three large oak doors. Erin was completely lost.

three

The Tower

 rin stood in the stone hallway facing the three doors. Should I try to go back? she wondered. The light from the lamps made bright spots along the walls, but left the corners dark. If I turn around and try to go back, she told herself, I'll just get lost again. Erin decided she had to choose one of the passageways and, for better or worse, follow it. She hoped it would bring her to somewhere she recognized.

Erin opened the middle door and found that it opened onto a steep stairway leading downward. The stairs were lit by the same type of kerosene lamps as in the hallway. She didn't like the idea of going down into something that looked like a dungeon, but she was determined to follow the path of whatever door she chose. At the bottom of the stairs, the passage turned sharply to the right. So did she. As she walked she thought, the house can't be this big. But on she went, until finally she came to another stair.

"This *must* lead outside," she said out loud.

The stairs were made of stone, like everything else since she had entered the hallway except for the three oak doors and the lamps. This stairway, however, spiralled instead of going straight up. Soon she noticed a small opening on the side of the wall. Fresh air streamed through, giving Erin something to breathe other than the damp, musty air of the passage. Through the opening Erin could see a tiny bit of night sky filled with stars. As she continued climbing she came to more of these windows.

After climbing for a while Erin came to an area that leveled out. She faced one door. It was then that it occurred to Erin that she must be in the stone tower she had seen from the outside. As she was thinking of this, the door slowly opened.

"I thought I heard someone out here," said Uncle Charles as he stood in the open doorway. "I'm surprised you could find this place."

"I got lost," Erin admitted.

"That's not hard to do in this house. Come on into my study."

Erin followed him into a circular room full of books. Overflowing shelves were surrounded by collapsing stacks. What Erin had mistaken

for a particularly large pile was actually a desk littered with books. Erin noticed, in the midst of this disorganization, a computer.

"This is where I usually work for a few hours every night," said Uncle Charles. "There are only two ways to get here. The first is through the tunnel and the second is through The Labyrinth."

"I got here by going through the tunnel, I guess," said Erin. "What's The Labyrinth?"

"The Labyrinth is what I call the maze of walkways and stone walls that make up the ruins around the house," Uncle Charles answered. "It's very difficult to find your way through. Anyway, I'm glad you found me. I'm afraid I got a little bit preoccupied and lost track of time."

"That's all right," said Erin. "I was exploring the house."

Erin looked at the computer monitor and noticed that printed on the screen were the words:

POPULATION MODEL
FOR SPIDERS AND FLIES
IN GOODRICH COTTAGE

This made Erin curious. The word "model" reminded her of the model of the planets she had just seen in the map room. "What's a *population model*?" she asked.

"Oh, that's just a program I was working on so that I could figure out how many of Hilary's children would be able to live in the house in any given year. It predicts the population of spiders and flies."

"How does it work?" asked Erin.

"Well, spiders need flies to eat," said Uncle Charles, "and there are just so many flies around. Inevitably, the house reaches a point where there aren't enough flies to feed all the baby spiders. I wanted to figure out how many spiders the house could hold so that I could recommend to Hilary how many eggs she could put into her egg sac without worrying about her children starving."

How can you recommend something to a spider? Erin thought, but she said, "Did you figure out how many?"

"The thing is that it varies from year to year, depending on how many flies hatch. Ever since Sarah opened the stables down the road, there have been more flies and therefore more spiders. And every year she brings a few more horses."

"That makes sense," said Erin, "since flies breed in horse manure. I suppose if you knew how many flies hatch in the spring, you could figure out how many spiders could live in the house."

"That's right," said Uncle Charles. "As a matter of fact, I am making my program using *numeric variables*."

"What's a numeric variable?" Erin asked him.

"A numeric variable is usually a letter like *s* or *f* that stands for a number. For instance, let's say that I call whatever number of spiders there are 's.' Then asking how many spiders there are is like asking, 'What does *s* equal?' or, 'What is the value of *s*?' "

"But you didn't know how many spiders there were."

"That's true. I said the number varies. That's why it's called a *variable*. In other words, the value of *s*, how much *s* equals, will change from year to year."

"How many flies does a spider need to eat?" asked Erin.

"I don't really know," said Uncle Charles. "I still have to find out from Hilary, but let's say that one baby spider needs to eat fifty flies in a summer to stay alive, then. . ."

"I see," Erin interrupted. "For every fifty flies that hatch there will be one *s*, or baby spider, that will be able to live in the house."

"Exactly. If somehow you could count the number of flies that hatched, you could predict how many baby spiders could live in the house during the summer."

"I guess you could call the number of flies some other letter, since their numbers change too."

"Yes. You might represent the number of flies hatching in any given year by the letter *f*. So the problem is, what does *f*, the number of flies that hatch, equal? It's too hard to count them as they hatch."

"I've got an idea," said Erin. "You said that since the stables were put in, there have been more flies, and that Sarah brings more horses every year."

"That's right," said Uncle Charles.

"I bet," said Erin, "that each horse produces enough manure to allow maybe a hundred flies to hatch. Why don't you just ask Sarah how many horses she plans to bring?"

"Of course!" said Uncle Charles. "I'll make the number of horses another variable, *h*, and then I'll know that for every *h*, that is, every horse, there will be a hundred *f*, or flies hatching. You've solved my problem!"

A. IF YOU WANT TO LEARN MORE ABOUT VARIABLES AND POPULATION MODELS, TURN TO PAGE L-13.

B. IF YOU WANT TO FOLLOW THE STORY, KEEP READING.

"Variables are pretty interesting," said Erin, "but I still have one question."

"What's that?" Uncle Charles asked.

"You called the program a population *model*. What do you mean by model?"

"A model is something that you make to look like something else, like a model airplane looks like a real airplane. If you build your model well enough, it acts like the thing you're copying, just as you can make model airplanes that fly."

"But your program isn't made of anything," said Erin. "A model airplane is made of wood, or metal, or something."

"A population model is made of something, it's made of numbers. It really doesn't matter what you use to make a model. What's important is that it acts like what you're trying to copy. I wanted to know how many baby spiders could live in the house, so I tried to make a program with numbers that act like the numbers of flies and spiders."

Erin again thought of the map room. She repeated to herself, "A model is something that is made to look like something else." In a way, a model is a picture of something. Just as the model of planets helped Erin to picture how the solar system works, models in general help you to picture and understand things. The population model wasn't made out of anything solid, like wood or wire; it was made of numbers. But it worked in the same way as the model of the solar system. It helped Erin picture and understand how populations work. An idea suddenly occurred to her.

"Uncle," Erin asked, "is a map a sort of model that is made out of lines and colors?"

"You might call it that," said Uncle Charles. "A map models a piece of the world. When you read a map to help you find out where you are, it's like looking at a model to understand how something works."

Erin had never thought about models in this way. It seemed odd to her that you could make a model out of lines and colors on paper, or out of numbers.

"I think it's about time to head over to the library," said Uncle Charles, pointing at the copy of *The Life of the Spider* that Erin still held in her hand, "although I see you've already made it there."

"Do you think you could show me some more things on the computer?" asked Erin.

"Yes," said Uncle Charles, "but not tonight. It's time for a little reading now."

Uncle Charles led Erin down the spiral staircase from the tower room. He paused at a doorway that Erin had not noticed when she came up earlier.

"This leads to The Labyrinth," said Uncle Charles. "Why don't we go through here since you have already been through the tunnel?"

Uncle Charles opened the door. Moonlight cut through the crack of the opening, shining on Uncle Charles. His face looked like a second moon with the cold light leaving a deep shadow on the far side of his profile. The two of them stepped into a courtyard bounded by the fieldstone walls of the ruins. Erin felt a soft layer of pine needles beneath her feet.

There were two openings in the courtyard. Uncle Charles chose one of them and led Erin through what seemed an endless number of twists, turns, courtyards, and haphazard openings in the walls. Large pines grew throughout, and often Erin and Uncle Charles had to skirt them because they grew in the middle of the path. Finally there was a courtyard that faced the stone wall of the strange wing of Goodrich Cottage. There was a door in the wall through which Erin and Uncle Charles entered. Erin found herself in the same hall where she had had to choose among the three doors.

"How did you ever find your way through that maze?" asked Erin.

"Many years of practice and a little perspective," said Uncle Charles. "Do you know where you are now?"

"Sort of," said Erin. She pointed toward the doors. "I know that the middle door leads to the tunnel, and now I know that the door on the right leads to The Labyrinth, but I was lost by the time I got here."

"I see," said Uncle Charles. He walked over to the door on the left and opened it. Inside Erin could see the library.

"You mean if I had taken that door I would have been back in the library!" said Erin.

"You certainly would have been," said Uncle Charles.

"I'm all confused," said Erin.

"You'll figure it out eventually," said Uncle Charles. "Let's read aloud a bit before bed."

They entered the library where Uncle Charles picked out a book and read a story. When he finished he said, "Time for bed, what do you say?"

Erin answered in a sleepy voice, "I say yes."

Uncle Charles took Erin to the stairs that led to the Osceola room. He left saying, "I have to put out the lamps in the tunnel. Goodnight."

"Goodnight," said Erin.

Erin made her way to her room and curled up in bed. She looked up and saw that Hilary was spinning a new web. She fell asleep watching the spider weave 'round and 'round and 'round.

four

Emerald Cascade

 rin woke up as the day did. It was early. The sun had only just emerged over the mountain ridge to pour its light through the east window. Inspired by Hilary's web directly above, Erin picked up *The Life of the Spider* and opened it. She was especially curious about web-spinning, so she turned to the chapter titled "The Garden Spiders: Building the Web". Erin found that building a web is a little more complex than her uncle described at dinner the day before, but his description was essentially accurate: spiders somehow follow a plan when they build a web. Erin skipped ahead toward the last chapter in the book titled *Geometry of Eperia's Web* (Eperia is a name for a kind of spider) where she found the following:

> "Can it then be a premeditated design on the part of the Eperia? Can there be calculation, measurement of angles, gauging of the parallel by means of the eye or otherwise? I am inclined to think there is none of all this.... The Eperia practices higher geometry without knowing or caring. The thing works of itself and takes impetus from an instinct imposed upon creation from the start."

Erin could smell eggs and bacon cooking. She quickly dressed and went downstairs into the kitchen. Uncle Charles was poking at a sizzling frying pan that he held over the old wood cookstove. It was a cold morning. Erin was glad that her uncle had used the woodstove instead of the modern gas stove. The heat from the cookstove warmed the kitchen. Erin sniffed and was blanketed by the scents of fresh breakfast and the comfortable odor of an old kitchen—the thousand things once cooked here tucked away their residue in the broad beams of the kitchen ceiling. Erin smelled old nutmeg, bringing to her mind the figure of her grandmother, whom she had never met, pushing a loaf of quick bread into the oven of the cookstove. It was as if the house held memories in the smells hidden in its nooks and crannies, waiting only for a nose to summon the images locked in timbers and dust.

Seeing Erin, Uncle Charles called out, "Today's a mountain day! Whenever the sky is as blue and the air as crisp as it is today, we drop everything else and climb a mountain." Uncle Charles flipped an egg and added, "How was your sleep?"

"Wonderful, Uncle, but I've been thinking, and doing a little research too."

"Research?"

"Yes, research. I've been reading parts of this book." Erin pointed to the copy of *The Life of the Spider* that she held under her arm.

"I see," her uncle said as he flipped another egg.

Erin sat down by the stove and warmed her hands. The kitchen had a double door, the kind that opened on both the top and the bottom. Today the top door was open, letting in fragrant morning air and bright morning sun. As Erin looked out through the opening, she noticed that one of Hilary's children had woven a web in the corner of the door. Each strand of web was covered with dew drops that glistened in a rainbow of colors. Each drop was distinct, shining in its own color and looking like a string of fiery pearls.

"Beautiful job, isn't it?" asked Uncle Charles.

"And the dew drops—" said Erin, "each one has its own special glow, its own character."

"Yes," responded Uncle Charles, "each has its own character."

Uncle Charles took the cooked breakfast off the stove and served some of it to Erin. Erin ate her food, relishing the taste as she warmed her toes on the cookstove. It seemed to Erin that food tasted better in the old kitchen than it did at home.

"You know," said Uncle Charles as they were eating, "the dew drops on the string are a lot like another kind of variable."

Erin looked up and asked, "You mean there are other sorts of variables besides numeric variables?"

"A few other sorts," said Uncle Charles. "I'm thinking of *string variables* right now."

Erin could not imagine how a *string* could be a variable. "What's that?" she asked.

"First of all," said Uncle Charles, "you should know that to the computer, a *character* means some letter, number or other symbol that the computer recognizes. For instance, 'K' is a character, and so is '5' or '?'."

"Okay," said Erin.

"A string variable," continued Uncle Charles, "is a group of characters all lined up in a string."

"Like the dew drops on the spider web," said Erin.

"Exactly," said Uncle Charles. "Each dew drop with its own particular shine is like an individual character lined up along a thread of web."

"But how do you use them?" asked Erin.

"Just like numeric variables, string variables use letters to stand for something, only with string variables the letters stands for a string of characters instead of a number. Suppose I made a variable z$. (String variables always have a '$' after the letter so that you know it's a string variable and not a numeric variable.) I can make z$ equal the name of one of Hilary's children, perhaps 'Zelda.'"

```
z$ = "Zelda"
```

"But why not just say 'Zelda' instead of z$?" asked Erin.

"It's a way for the computer to store away something that you told it. Imagine that each different thread on the spider web has dew drops that hold strings of characters, like 'Zelda,' or 'Gertrude.' The computer holds the characters in strings like a spider web holds dew drops on a thread. Each string has its own name, like 'z$' or 'q$'. When you tell the computer that z$ = 'Zelda' you're telling it to store away the group of characters Z-e-l-d-a on a string named z$. If you want the computer to remember the string of characters stored under the name z$ just ask it to:

```
Print z$
```

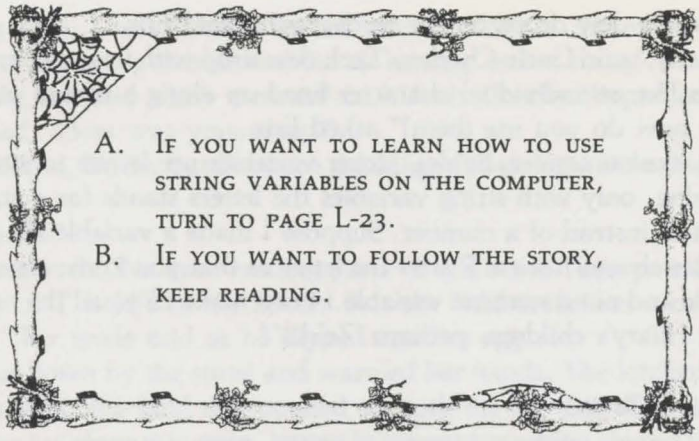
"The computer will answer you and print,"

```
Zelda
```

"Is that how the computer remembers things?" asked Erin. "By storing things away in places where it can find them later?"

"That's right," said Uncle Charles. "When people talk about a computer's 'memory' they mean the places where the computer stores information."

Erin looked up at the spider web again. She imagined all the threads of dew drops holding strings of characters. "You could store a lot of names on that web," she said.



Suddenly Sam's head and shoulders appeared through the door and he announced, "It's a mountain day!"

Uncle Charles smiled and said to Erin, "I've trained him well, haven't I?"

Erin and Uncle Charles finished up their breakfast while Sam leaned in the door. When they were all done, Uncle Charles asked, "Where shall we go?"

"How about Osceola?" said Sam. "Then we can stop by Emerald Cascade."

"All right, Osceola and Emerald Cascade it is," said Uncle Charles.

After a brief packing of knapsacks, the three set off toward Osceola. The beginning of the path passed Sam's grandmother's house.

Uncle Charles turned to Sam and said, "Let's say hello to your grandmother, what do you say?"

Sam answered, "I think she would like to meet Erin, so why not?"

The three turned up the trail that branched off of the Osceola path and led to Sam's grandmother's house. Unlike Goodrich Cottage, this house did not have odd additions. It was a well-proportioned, small two-story cottage painted a pretty creamy yellow. As they came closer, Erin noticed the beautiful gardens surrounding the house. Suddenly they came upon an old woman with her nose buried in a large bed of lilies.

"Nora," Uncle Charles called out to the broad behind that faced them. Nora pulled herself from the lilies and, still kneeling, turned to face the group. Her hair was drawn back with a red bandana. In her left hand she clutched a small spade; in her right hand she loosely held a four-pronged digging claw. Erin sniffed and smelled a strong piney, sooty odor that she recognized as an old-fashioned insect repellent. Nora

squinted at them, looking like an ancient warrior trying to determine friend or foe.

"Charles!" Nora cried, a wide smile breaking across her face. "It's good to see you! And this blonde look-alike must be Erin." Nora grasped the arm that Uncle Charles held out for her and pulled herself up. She then reached out her hand toward Erin and said, "How do you do, my dear?"

Erin grasped the long, thin hand and timidly repeated, "How do you do?" Erin felt as if she were holding a collection of sticks draped with soft, dry tissue warmed in the summer sun.

"I hear that you and I are in the same field." Nora continued to hold Erin's hand.

Erin was confused for a moment, until Uncle Charles explained. "One of Nora's university degrees is in biology. I never went in for degrees much, but Nora collects them like some people collect stamps."

Nora eyed Uncle Charles. "Still rebelling, eh? Surprised you ever learned anything." Nora's smile widened. "Well, Erin, don't let that mystic uncle of yours lead you too far astray."

Sam leaned over and whispered to Erin, "They always tease each other like that."

"If you are going to make it up and down Osceola you had better get moving," Nora said, dropping Erin's hand.

The three started off again, waving to Nora as they disappeared into the trees. At first the trail wound through a forest of maple mixed with yellow birch, then the maple trees thinned and the forest filled completely with the golden forms of the yellow birch. Branch arched toward branch, and branch spread away from branch in the tangle of green leaf and golden bough that formed a ceiling above them. The wind blew gently and irregularly, waving the green-gold mass like a rolling sea, occasionally cracking the surface to let a shaft of white light cut through like a falling shard of crystal.

Ahead of Erin, Sam and Uncle Charles examined ditches and discussed the signs of erosion on the path. Erin soon learned that a waterbar is a ditch cut across the path at a slight angle and backed by either a log or a set of stones. Its purpose is to catch water that runs down the path and to direct it off so that the path will not erode. Erin noticed that as the trail got steeper there were more and more waterbars. Uncle Charles explained that without waterbars and drainage ditches, hiking trails would soon turn into small rivers and be unwalkable. Even with waterbars some trails needed to be reinforced with rock steps because so many people walked on them and wore away the soil.

As the three continued, broad, ash-gray beech replaced the birches. The trail rose steeply for a while and then met a plateau. Huge boulders lay among the lush ferns and deep moss as if some careless giant had tossed them there.

"These are the Wadrilic boulders," said Uncle Charles, "left by the glaciers when they passed through thousands of years ago."

Erin was amazed as she and her companions made their way through the great stones. At one point a rock had split in half and the trail went right through the gap. As they walked through, Erin noticed the green-blue lichen spotted along the rough, gray rock, occasionally blemished with streaks and flecks of white quartz. From a distance this textured, mixed color fused into what Erin recognized as granite color. The soft thunder of the wind in the trees grew louder and louder until Erin realized that the sound of the trees had melted and meshed with the sound of a river. The three soon came upon a pool below a roaring cascade. The rock behind the cascade was covered with green moss.

"Emerald Cascade," announced Sam.

"From here the climb gets steeper," said Uncle Charles. "We'll take a rest here at the cascade before we continue."

Sam walked toward the edge of the pool and took a drink, scooping the water in his hands and quickly lifting it to his mouth. Erin followed Sam's example and knelt beside him to drink the cold, clear water. At the far end of the pool, the cascade spilled down the rocks, foaming white, seeming to sing a thousand songs in a thousand voices. Erin closed her eyes. She imagined a singer, a beautiful silver-haired woman who danced, her glittering silver and green dress trailing, spinning. She grasped Erin's hand, drawing her into the dance. Erin spun and the silver-haired woman tossed her up. The song now seemed deafening. Erin struggled; she was caught in the glittering dress which churned and rolled like . . . the cascade.

five

The Rains

Erin coughed. She saw Sam leaning above her. He was dripping wet. She realized that she too was soaked. Sam brushed away a bit of hair that covered her eyes and asked, "Are you all right?"

"Yes, yes, I mean, no, I'm ok, but what happened?" As her vision cleared, Erin saw her uncle standing behind Sam, looking worried.

"I was wondering about that myself," Sam answered. "You were taking a drink of water when suddenly you got this funny expression on your face. The next thing I knew you were bouncing around under the cascade. I jumped in and dragged you out."

Erin looked at Sam, whose face hovered just above her own, and said, "Thank you." This time Sam was the one who blushed.

"What did you see and hear, Erin?" Uncle Charles asked.

"I...don't know." Erin was confused and she felt she would sound silly if she told them of the silver-haired woman. But how did her uncle know she had seen or heard anything?

Erin's uncle did not press her. "Well, the first thing to do is get you into a set of dry clothes. Fortunately, I always pack a couple of extra sets in case of such an emergency."

Erin's uncle took off his pack and drew out of pair of khaki shorts and a faded red T-shirt which he handed to Erin. Sam had his own extra clothes. They both changed quickly. The shorts were impossibly big for Erin, as was the T-shirt, but luckily the shorts tied around the waist with a drawstring. When she emerged from around the tree behind which she had dressed, she looked like a clown in a baggy suit.

"Do you feel up to the climb?" asked Uncle Charles.

Erin unhesitatingly answered, "Yes."

"You're sure, now?"

"I only went for a little swim." Erin was slightly annoyed that her uncle thought her so easily turned back.

"I just wanted to make sure. We'll leave the wet clothes on the rocks here to dry in the sun."

True to Uncle Charles's word, the path grew steeper. They soon passed

out of the beech forest and entered a stand of spruce and fir. As they got higher the trees grew thicker. Some of them twisted and grew stunted. In some places the tangled trees reached out to the path, making harsh scratching noises as the branches brushed the hikers' packs. The trees continued to grow shorter and more tangled until they were all squat and ragged. Erin looked over this straggling mass of growth to the purple ridges that wrinkled below the gray-green peak. They were above the timberline. Soon they passed the last struggling tree and walked among stone.

At the top of the mountain Erin looked down at the Valley. Erin could see in the forest below the small opening of the field in front of the Inn. She could see also where the Mad River made its way through the notch, and by the slight change in color of the trees, she could see where the other rivers came down the mountains. There, by the rivulets and streams, dark green stripes formed a branching network just like on great-great grandfather Goodrich's map.

Uncle Charles pointed to three sharp peaks to the east. "Those are the Tripyramids," he said.

The peaks formed a line running north to south. Erin noticed that both the north and south peaks had broad, gray scars across their slopes. "What are those gray marks?" Erin asked.

"Those are rock slides," said Sam.

"They're two of the largest slides in the White Mountains," Uncle Charles added.

Erin turned in a circle, looking at the full horizon. All around her were mountains and valleys. She felt curiously at peace. She felt the wind touch her face and push back her hair; she heard the wind touch the tops of trees and come rushing up the Valley and over the mountains.

Uncle Charles looked toward the northeast. "It looks as though we may be in for a storm," he said, pointing to a band of dark clouds. "We'd better not stay up here too long."

The three unpacked their lunches and had a quick meal. The wind was blowing harder and the black clouds were moving swiftly toward the mountaintop. Erin noticed that the rapidly advancing clouds were pulled down in hazy bands. Soon the flashes of lightning appeared among the bands, followed by long rumbles of thunder.

"Time to get off the mountain," said Uncle Charles. "This wasn't meant to be a mountain day after all."

With Sam leading, they started to make their way back down the trail. Just as they arrived at Emerald Cascade, the rain hit.

"We're all going to get a soaking today," said Uncle Charles.

They quickly gathered the clothes they had earlier laid on the rock and started down the trail at a slow jog. By the time they reached Nora's house, they were soaked to the skin.

When they entered Uncle Charles announced, "I'll get some wood for a fire," and he disappeared.

"And I'm going to change into dry clothes," said Sam.

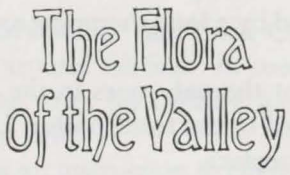
Erin found herself alone in the front hallway. Where is Nora? she wondered. As if in answer, Nora poked her face out of one of the doors in the hallway.

"Erin, my dear," she said, "why don't you come into my laboratory?"

Erin entered the door and came into the room. The laboratory had a long soapstone table with a sink at one end. Nora had all sorts of glass bottles and flasks on the shelves that randomly lined the walls. The room was on the south side of the house. Adjoining the laboratory was a greenhouse filled with plants. The door to the greenhouse was open, letting moist, fragrant air drift in. On the east wall of the laboratory was a desk with a microscope on it. Above the desk was a tall, arched window that overlooked the brook running below Nora's house.

"There's something I want to show you," said Nora.

Nora went over to the desk and picked up a large, ancient-looking book. Written on the cover in gold letters were the words:



"Sam told me you wanted to catalogue the plants in the Valley," said Nora." This *Flora* is something I've been working on since I was your age. Every summer I explore the Valley and look for new plants. In this book I have written the names of all the plants that I have found and, in addition, where I found them."

Erin opened the book, delicately turning the yellowed pages. She realized she held a lifetime's careful exploration and study. The book was filled with lists of plants and careful descriptions of where to find them in the Valley. Each entry was dated. Erin noticed that the first date was 1897.

"It's wonderful," said Erin.

Nora gazed at Erin and said, "This is the first summer I cannot walk well enough to collect the data for the year's entry."

Erin looked up at Nora. Deep, proud lines like the grain on a weathered board marked her face. As Nora continued to fix her attention on Erin, a barely noticeable sadness touched her features before she smiled and said, "I was wondering if you would like to do the field work for this year's entry."

"I would love to," said Erin. She felt as if she were being handed a sacred trust.

"If it has stopped raining, why don't you come over tomorrow?" Nora suggested. "You could help me weed in the morning and in the afternoon we can discuss the *Flora*."

Erin was excited about starting the *Flora*. "That would be great," she said.

"The only trouble with the *Flora* is this book is almost full. We need something else to store our information in," said Nora, "but we can figure that out tomorrow."

Erin carried the book back to its place on the desk.

"I've got a notebook I always carry," said Erin. "From now on I'll take notes whenever we go out into the woods."

"Thank you, Erin," said Nora. "Thank you very much." Nora put her hand on Erin's shoulder and exclaimed, "You're soaking wet!"

"We got stuck in the rain," said Erin.

"Let's get you into some dry clothes," said Nora

They were interrupted by a loud thumping and bumping coming from the front of the house.

"I can tell we are not the only ones in the house," said Nora.

Erin and Nora walked to the front parlor. Uncle Charles was there, making a fire in the fireplace.

"You never did have much respect for my rugs and floor, did you, Charles?" said Nora. Uncle Charles was standing in a puddle that was growing larger as his soaked clothes continued to drip. His sodden pack lay in a heap on the Oriental rug by the fireplace.

"Sorry, Nora. Give me a minute and I'll change into my extra clothes." With those words, Uncle Charles picked up his pack and left the room.

Sam, who had gone to change when they first entered the house, came in as Uncle Charles left. Sam held a towel with which he vigorously rubbed his black hair.

"Hi, folks," he said as he took a seat by the crackling young fire.

In a few moments Uncle Charles re-entered wearing a dry set of clothes and settled himself on the floor beside the fire.

"Sam, are you not going to offer Erin some dry clothes?" asked Nora.

"I'm afraid I've exhausted my supply of extra clothes," said Uncle Charles.

"I'm sorry," said Sam. "I should have offered you some when we first came in."

Soon Erin was wrapped in another collection of ill-fitting clothes.

When they were all settled by the fire, Sam announced, "If it rains tomorrow, we won't be able to start trail work."

"Well, you know what they say in New England," said Nora. "If you don't like the weather, wait five minutes, 'cause it's sure to change."

They all laughed. It was nice to sit around the fire and talk. Erin took the opportunity to ask Uncle Charles about something she thought of while reading *The Life of the Spider*.

"Uncle, I've been thinking. Once Hilary weaves her anchor threads, the ones you said look like spokes on a wheel, her job gets very repetitive."

"How so?" asked Uncle Charles.

"Well, what she does is go around and around spinning slightly bigger circles. I was thinking that if instinct is like a set of instructions, perhaps when she gets to the circling around part, all she has to do is follow the one instruction, 'weave circle around the center of the web,' over and over again."

"That's a very interesting observation," said Nora, "although, strictly speaking, a spider doesn't weave a circle. Spiders always weave in straight lines. The 'circle' is actually made up of many straight lines that approximate a curve."

"That doesn't affect Erin's point," said Uncle Charles. "The spider still makes a complete circle around the web. In computer languages there is a similar idea to yours, Erin. It's called a *loop*."

"What's a loop?" asked Erin.

"Most simply, a loop is an instruction to circle back and repeat some other instruction, just like you were describing.

"There's only one thing the matter with Erin's program," said Sam. "If Hilary just repeated the instruction 'weave a circle around the center of the web,' she would go around and around in the same place. The circles have to get bigger and bigger."

"That's true," said Erin disappointedly.

"Ah, but we can fix that," said Uncle Charles. "Remember when we were discussing numeric variables yesterday, Erin?"

"Yes," answered Erin.

"Let's say that spiders measure things in numbers of 'dew drops.' If Hilary had measured her web and was boasting to another spider she might say, 'My spider web is 30 "dew drops" across. What's yours?' Anyhow, if webs are measured in dew drops, then we could make the variable *d* stand for the number of dew drops in some measurement."

"How does that help with the 'weave circle' instruction?" asked Erin.

"Well, we could change the instruction to say:

1. Weave a circle around the center of the web.

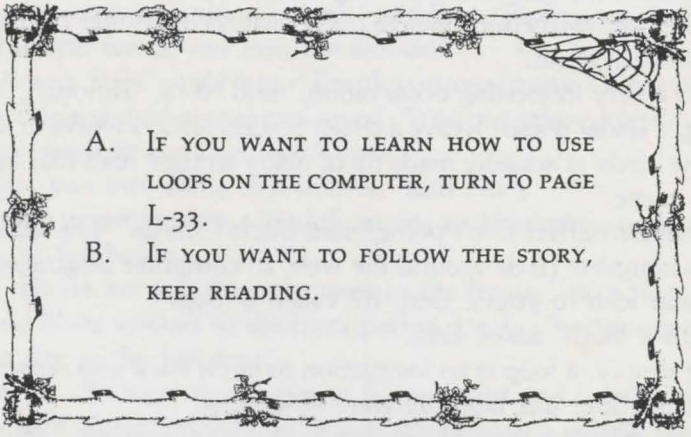
But...

2. Make sure that it is *d* number of dew drops from the center of the web.

And...

3. Every time Hilary goes around the loop, increase *d* by five dew drops."

"I understand," said Erin, "the circles will get bigger and bigger and bigger because she will start weaving them farther and farther from the center of the web."



"Uncle," Erin sighed, "I never thought this would happen, but I want to know more about computer language."

Uncle Charles laughed. "I'm not surprised, and certainly I will tell you more sometime, but I think we've had enough for the day."

"I don't know about the rest of you, but I'm hungry," announced Nora. "Can I convince you young Philosophers of Nature to escort me to dinner?"

Uncle Charles stood and put the screen in front of the fire and answered, "I, for one, would be delighted."

Nora went and gathered all the umbrellas she could find, which were two, and the four made their way down to the Inn. Uncle Charles held

out his arm so that Nora could use it as an extra support as they walked along the slippery path and shared an umbrella with her. Erin and Sam shared the other umbrella.

When they walked onto the porch, they saw Reverend Berkley talking animatedly to a group of guests. When he noticed the new arrivals, Reverend Berkley called, "Ah, Nora and company. Dinner time, eh?" Turning to his audience he said, "Sorry to interrupt the story, but my table has arrived. We'll get together after dinner."

Reverend Berkley joined the four and together they entered the dining room.

"I say," Reverend Berkley said as they sat down, "this is quite the downpour we're getting, isn't it?"

"It certainly is," answered Uncle Charles. "The rivers are already high from the rains we had last week. I'm afraid we're in for some flooding."

"At least it helps us see how well our waterbars are working," said Sam.

The rain was pounding so hard that it sounded like the roll of a bass drum.

"There was one other time that I encountered rain of this magnitude," said Reverend Berkley. "I was in the foothills of the Himalayas. It was monsoon season, you know, and. . ."

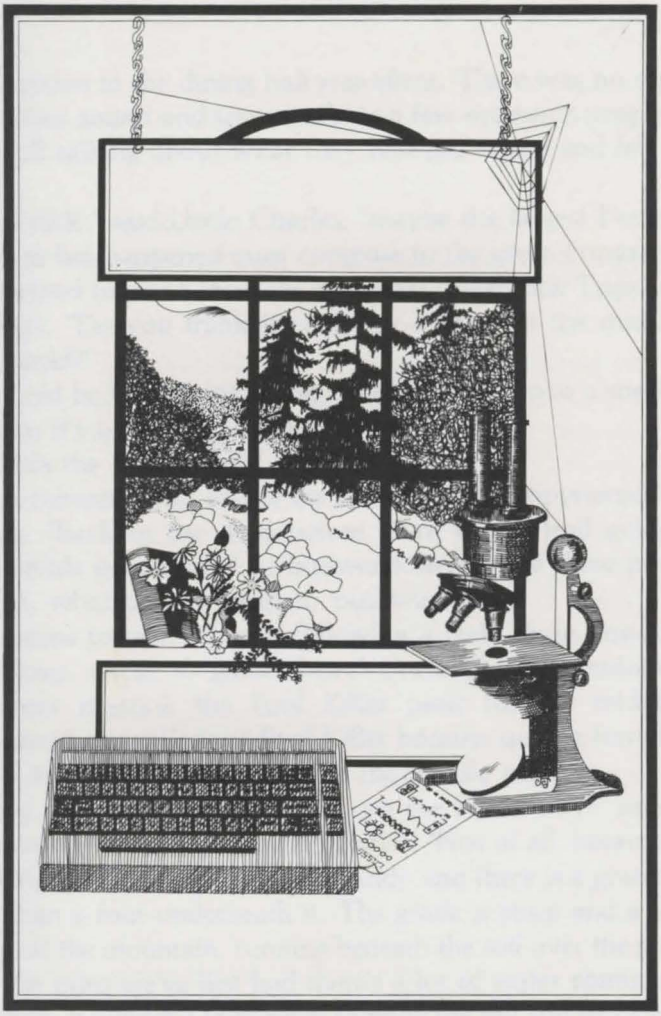
Nora looked sternly at Reverend Berkley and said, "Reverend, spare us your verbiage."

"Ah, well, I guess, another time," said Reverend Berkley who now wore an embarrassed look on his face.

"Uncle. . ." Erin began a sentence, but it was cut short by what sounded like a slow explosion. The entire Inn shook.

Sam was the first to gather enough breath to say, "What was *that*?"

six



The Fool Killer

six

The Fool Killer

 veryone in the dining hall was silent. There was no repeat of the tremendous sound and tremor. After a few moments people started to speak, all talking about what they had just heard and felt as the Inn shook.

"Rockslide," said Uncle Charles, "maybe the largest I've ever heard. Whatever has happened must compare to the great Tripyramid slides."

"It seemed to come from the northeast, where the Tripyramids are," said Sam. "Do you think it could be a slide on the middle peak of Tripyramid?"

"It could be," answered Uncle Charles, "but I have a sneaking suspicion that it's on the Fool Killer."

"What's the Fool Killer?" asked Erin.

"It's a mountain just east of the north peak of Tripyramid," said Uncle Charles. "Back in the days before there was a trail going over the Tripyramids people used to bushwack across the three peaks."

"Wait, what does it mean to 'bushwack?' "

"It means to hike without following a trail," Sam answered.

"Without a trail to guide them," Uncle Charles continued, "people sometimes mistook the Fool Killer peak for the middle peak of Tripyramid. It's called the Fool Killer because quite a few climbers got lost by hiking there instead of to the middle peak."

"Why do you think the slide is on the Fool Killer?" asked Sam.

"For two reasons," said Uncle Charles. "First of all, because the mountain is ripe for a slide. The soil is sandy and there is a granite ledge not more than a foot underneath it. The grade is steep and a lot of water drains off the mountain, running beneath the soil over the granite ledge. With the rains we've just had there's a lot of water coming down that mountain. It wouldn't take much to bring the soil and surface rock down with the water."

"And what's your second reason?" asked Erin.

"I know that mountain, and I just have a feeling in my bones. It *wanted* to slide."

After dinner Uncle Charles lit a fire in the library fireplace at Goodrich Cottage. It took the damp out of the air and made the room feel cozy. Erin curled up in a chair by the fire and read. Uncle Charles disappeared into the tower for a few hours in the early evening, emerging in time to read out loud for an hour. Tonight he chose to read "The Elephant's Child" by Rudyard Kipling. He sat in his large armchair by the fireplace, his red beard glowing redder as the firelight reflected from his face.

When he finished the story, he closed the book and looked up, not at Erin, but above her. He seemed to be looking at something far off.

"Insatiable curiosity is what I've got," he said.

"What is it that you're curious about, Uncle?"

"In general, everything. Right now I'm particularly curious about that slide."

As they went to bed Erin could still hear the heavy rain outside. Throughout the night, Erin woke and listened to it. Would it ever stop? she wondered as she lay beneath her warm covers. In the morning it was still raining.

The dull thunder of the rain on the roof was steady and oppressive as Erin got out of bed. The house was damp and gloomy, its many rooms and passages looming as an uncomfortable and confusing presence. Uncle Charles was nowhere to be seen. Undoubtedly he was in the tower. After warming her toes on the cookstove that Uncle Charles must have lit earlier, Erin decided to seek out her uncle. She went through the tunnel and up into the tower and, as she expected, Uncle Charles was working on the computer.

"Hello, Erin," he said. "I was just finishing up the population model."

Erin noticed something she had missed the other night: a large window above the desk. Through it she saw that the rain had stopped. She noticed that the whole Valley was covered with a low mist that rose and dispersed as she watched, looking like slow-motion dancers dressed in lace. As the mist continued to rise all that was left were occasional wisps drifting along the Valley floor and out through the notch. Everything glistened with wet and sun, making the Valley look brighter and somehow more real, as if the trees and mountains had hidden colors and hues that came out only now.

Erin noticed something else. When the mist was all clear, Erin saw the pattern of the maze. After a moment of study, she could see a path that would lead someone through.

"I get it now," she said.

Uncle Charles, who had started working again when Erin began to stare out the window, looked up and asked, "You get what?"

"I get The Labyrinth. I can see a path through it," she said.

"Amazing what a change of perspective can do," said Uncle Charles.

"I'm glad I didn't choose the door that led into The Labyrinth before I could see it from above," said Erin. "If I had chosen the third door the other night I'd still be wandering around in The Labyrinth."

"This conversation makes me think of a concept in logic that is also used in computer languages," said Uncle Charles.

By this time Erin had grown used to her uncle's impromptu lessons and she enjoyed them.

"How so, Uncle?" Erin was learning to prompt him along.

"In logic there is a certain kind of statement called a *conditional statement*. It's called conditional because certain conditions must exist for it to be true. For instance, you just said; '*If* I had chosen the third door, *then* I would still be wandering in The Labyrinth.'

"The statement 'I'd probably still be lost in the labyrinth now' could only be true *if* you had chosen the third door. Think of it this way. When you are in the hallway, you have three choices:

1. To go through the first door.
2. To go through the second door.
3. To go through the third door.

On the condition you choose (1), *then* you end up in the library.
On the condition you choose (2), *then* you end up in The Labyrinth.
On the condition you choose (3), *then* you end up in the tunnel."

"What does that have to do with computer language?" asked Erin.

"Let's see if I can explain using some of the concepts I've already described to you," said Uncle Charles.

"Okay," said Erin.

"Let's suppose that we used our population model to figure out that there were enough flies for fifty baby spiders to live in the house for the summer. Then Hilary will know that she should fill her sac with fifty eggs. But suppose she needs help counting the eggs? We can make a program that counts the eggs as she drops them in and tells her to stop when she has reached fifty."

"That's beyond me," said Erin.

"I don't think so," said Uncle Charles. All you have to do is first make a loop that instructs Hilary to: 'drop 1 egg in the sac.' Then we make the number of eggs in the sac into a variable, E. Now, every time Hilary

goes through the loop, the computer adds one to the value of E (the number of eggs in the sac). It would look something like this:

1. Drop 1 egg in the sac.
2. Add 1 to E (number of eggs in the sac).
3. Loop back to instruction (1)."

"So E will get bigger by one every time Hilary goes through the loop. That's how the computer counts the eggs," said Erin, adding, "Why, that's just like making Hilary's web circles bigger and bigger."

"Right," said Uncle Charles. "Now comes the part using conditional statements. I'll add to the instructions already on the list the following conditions:

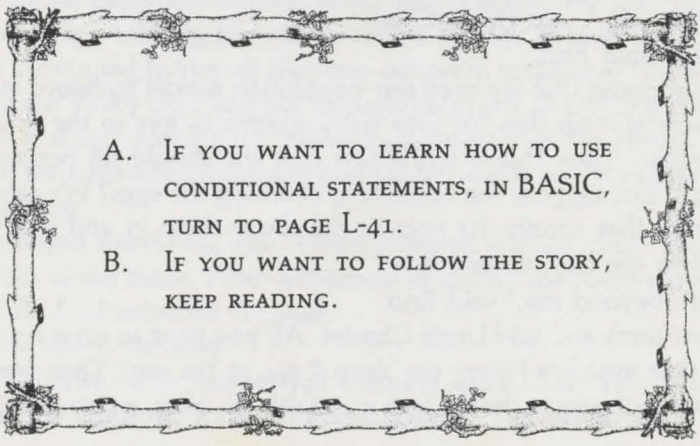
1. *If* E is less than fifty, *then* tell Hilary: 'Drop 1 egg in the sac.'
2. *If* E equals fifty *then* tell Hilary: 'Stop dropping eggs in the sac.'
3. *If* E is more than fifty *then* tell Hilary: 'Stop! Too many eggs!'"

"I understand," said Erin excitedly. "Conditional statements tell the program what to do when it has to make a choice."

"Exactly," said Uncle Charles. "Since computers can't choose for themselves, they need instructions to help them make decisions."

"But Hilary isn't a computer," said Erin.

"That's true," said Uncle Charles, "but if her instinct is like a program, then it might work the same way. If I didn't give Hilary these instructions, she still would stop filling her sac sometime. That sometime would probably be determined by some instinctive condition."



Erin looked out the window at The Labyrinth. "There sure are a lot of choices of which way to go down there," said Erin.

"That there are," said Uncle Charles.

Outside, the sun had burned away the last of the clouds. Uncle Charles opened the window, letting in the fragrances of the warming earth.

"It looks like we may make it onto the trails today yet," said Uncle Charles. "The morning has only just begun and already it's clear."

Erin heard a faint voice below yell, "Darn it, now where am I?"

Erin and Uncle Charles leaned out the window and saw Sam wandering around in The Labyrinth. He was hopelessly lost.

"Problems, Sam?" Uncle Charles called.

Sam looked up and answered, "I never could figure out this maze."

"I'll direct you," called Erin.

Erin called out instructions to Sam which eventually led him to the door to the tower. It suddenly occurred to Erin that looking at The Labyrinth from above like this was like looking at a map. She was able to see the patterns of paths that were invisible to Sam. Likewise, the view of the Valley from Osceola gave Erin a sense of overview. She was able at a glance to see the patterns of rivers, just like on great-great grandfather Goodrich's map. She had little time to ponder this point before Sam came into the study.

"That place always fools me, but I always try to make it through."

"You could sketch out the route from above and then use that as a map," said Erin.

"That's true," said Sam. "I never thought of that."

"Well, shall we take to the trails?" asked Uncle Charles.

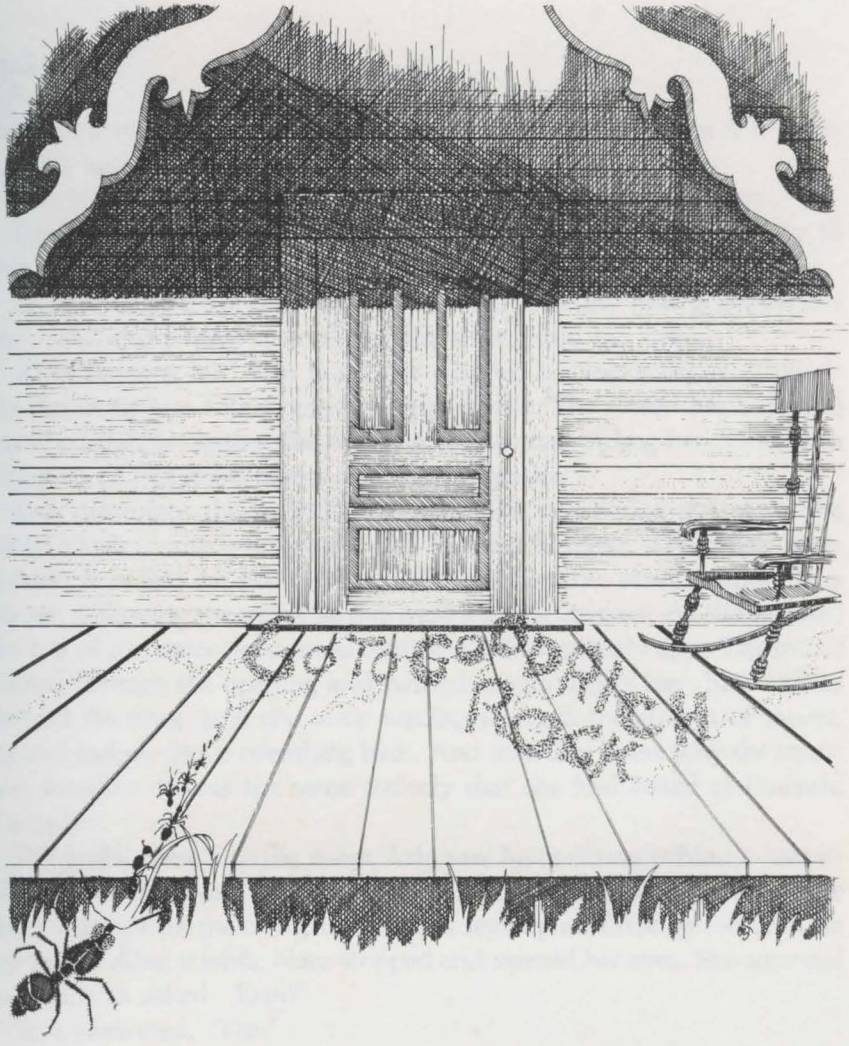
Erin remembered she had promised Nora to help her in the garden and start work on the *Flora*. "I'm going up to Nora's today," said Erin.

"Sam?" questioned Uncle Charles.

"Certainly," answered Sam. "Where to today?"

Uncle Charles paused, "How about the Fool Killer?"

seven



Trapped

 rin thought of the great rumble they had heard. "What if it starts to slide again?"

"We're going to keep our distance from the slide," said Sam.

Erin was curious about the slide also, but she was just as happy to help Nora in the garden and to start work on the *Flora*.

"Whatever you do, don't tell Nora. She'll have my hide if she knows that Sam and I went to look for the slide," said her uncle.

After the two left, Erin made her way up to Nora's house. Outside the damp air was full of green, earthy smells. She closed her eyes and breathed deeply, letting the smells seep into her, filling her mind with glimpses of imagined plants and muddy paths.

Erin came into the front hallway that led to a broad staircase. She heard music, muted, far away, and vaguely familiar. The music grew louder. It pulled on her memory. She climbed the stairs, almost in a trance, following the music as if it were a gentle current. As she reached the top of the stairs she paused, noticing a door slightly ajar. The music rushed through the opening and swirled around Erin's feet. She walked toward the door as if she were wading through the stream of music, its cool melody like a refreshing bath. And then Erin knew why the music was familiar. It was the same melody that she had heard at Emerald Cascade.

When she came into the room, Erin saw Nora sitting behind a harpsichord. Her eyes were closed and her fingers pranced up and down the keys. Erin sat on the floor, tucking her legs up and resting her chin on her knees. After a while Nora stopped and opened her eyes. She squinted slightly and asked, "Erin?"

Erin answered, "Yes."

The music made Erin remember the silver-haired woman. She had almost forgotten the incident at the cascade, thinking that what she had seen and heard were only products of her imagination. Now it all seemed real again.

"Nora," Erin asked, "if I tell you something unusual that happened to me, you won't think I'm strange or anything, will you?"

"I never make promises before I know what I'm promising, but, as you know, I have an open mind. What is it?"

Erin told Nora of what she saw and heard at Emerald Cascade. When she finished, Nora looked intently at Erin.

"And what of it, my dear?" said Nora. "It is simply that you are especially sensitive to the voice of nature. It seems to be an affliction among the Goodriches."

"Did I actually see the river? Is the river really the silver-haired woman?"

"I am not the one to tell you what you saw," said Nora. "I will say, however, that what you saw was a picture of the river that you created from the song you heard, the voice."

"You mean what I saw was just my imagination?" Erin asked in a disappointed tone.

"Don't say 'just my imagination.' Your imagination allows you to think in patterns. Without your imagination you could never picture the world."

"That still means that the silver-haired woman wasn't real."

"What is real and what is not we shall leave for the Hindu sages to decide," said Nora. "They have done more good study in that area than we could aspire to. Our task today is to weed the garden and decide what data-gathering methods you will use in the field. We must maintain certain standards for the *Flora*."

Erin was still disappointed that the silver-haired woman was not real. Nora noticed Erin's expression and added, "If it is any solace to you, the melody I was playing was something I composed while sitting by Emerald Cascade. Goodriches are not the only ones with a peculiar musical ear."

The conversation left Erin confused, but Nora would not answer any more questions on the subject. The two went downstairs and had a quick breakfast of toast and tea before they set out against the weeds. Because the ground was soft and yielding from the rain, the weeds pulled easily. By the early afternoon they had cleared most of the large garden. Erin was exhausted. She wondered how Nora, who looked so frail, could maintain the pace for hours on end.

"Not a bad job," said Nora. "I think we deserve some lunch. What do you say?"

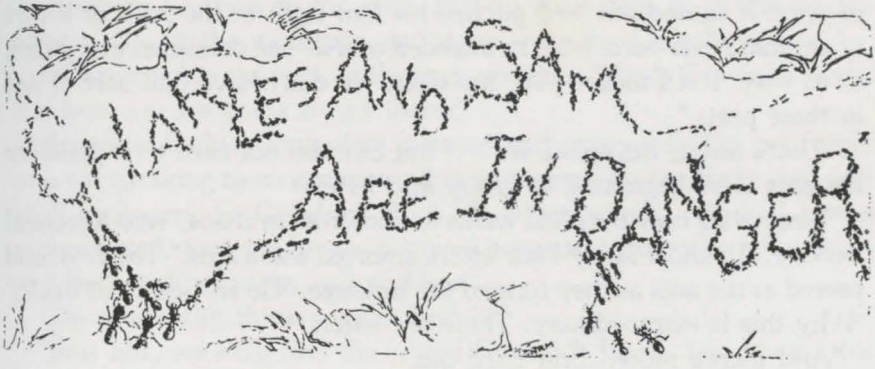
Erin was very hungry. "I'd love some lunch," was what she said.

"First, I think we ought to change out of these muddy work clothes," said Nora. "Usually it wouldn't make a difference, but today things were a bit wet. After lunch we will discuss the *Flora*."

Erin looked down at her T-shirt and shorts. They were covered with dirt, and her hands were stained a dark brown. "I'll go down and change and be back soon," said Erin.

Erin ran down the trail and did not stop until she reached the front porch of Goodrich Cootage. As she stepped onto the porch, she noticed that there were hundreds of ants scurrying around. What are all these ants doing here? she asked herself. As she looked at the crawling mass she thought she saw a pattern in the ants' movement. There was a pattern! Four words emerged out of the seemingly random movement of the ants:

Erin stared at the message written by the mass of ants crawling on the porch. This is impossible, she thought. But she saw the message clear as crystal, "Go to Goodrich Rock." Suddenly the letters blurred. The ants were changing the pattern of their scurrying. A new message appeared:



"But where is Goodrich Rock?" Erin said out loud, feeling very foolish that she was talking to a collection of ants.

The ants blurred once more, but no further message followed. I've got to find help, Erin told herself desperately. Who will believe that I received a message from ants?

Without knowing what she was going to do she ran to the Inn. The first person she saw was Reverend Berkley. He was napping on the porch.

"Reverend! Reverend! You've got to help me." Erin practically leaped on Reverend Berkley, grabbed at his coat and shook him with all her might.

Startled and somewhat bewildered by Erin's behavior, Reverend Berkley asked, "My dear, what *is* the matter?"

"It's my uncle and Sam. They're in terrible danger."

Reverend Berkley stood up, spilling all the *Alpine Journal* magazines he had in his lap, and asked, "What has happened? Where are they?"

"I don't know, but they are in danger."

"What sort of danger?"

Erin felt foolish. "I don't know," she answered.

"My dear, if you know neither where they are, nor what the danger is, then how do you know anything is the matter?"

Erin did not know what to say so she grabbed Reverend Berkley's hand, dragged him off the porch and led him to Goodrich Cottage. All the way, Reverend Berkley repeated, "My dear, my dear, what is this excitement about?" Erin pulled him along without answering. When they reached the porch to Goodrich Cootage, Erin pointed at the ants that were still congregated on the porch.

"Aha, ants," Reverend Berkley said, holding onto the "s" at the end of the word so that he sounded like a snake hissing. "Ants," he repeated. "Reminds me of my missionary days in the Amazon Basin. A friend of mine, fellow missionary in fact, was completely devoured by a troop of ants. It turned out he'd pitched his tent right in the path of a sort of ant that never veers from its intended course, just consumes everything in its way. But I assure you, my dear, we don't have that sort of ant in these parts."

"That's not it, Reverend, it's . . ." But Erin did not need to explain for the ants were beginning to group into letters.

"Fascinating how the mind wants to find order in chaos," said Reverend Berkley. "I almost fancy I see letters amongst these ants." The reverend peered at the ants as they formed the message: "Go to Goodrich Rock." "Why this is extraordinary. There *are* letters!"

"And there's more!" Erin cried out.

As if on cue the ants spelled out the rest of the message: "Charles and Sam are in danger."

Reverend Berkley turned to Erin and said, "I see your point, my dear, but you really shouldn't worry. You must realize that this is a dream. The question we might consider, though, is who is dreaming this dream. Is it you or I? I suppose it is possible that we may both be dreaming, but then how is it that we are sharing this dream?"

"Reverend," Erin interrupted, "I am *not* dreaming!"

"Well, then, that answers that. I am the one who is dreaming. What an extraordinary dream."

"You are not dreaming either. You must help me find Goodrich Rock!"

"Well, if you insist, my dear, it might make for an exciting dream. I am afraid, though, that I do not know where Goodrich Rock is, and it is on none of the current maps. I do recall, however, hearing your grandfather speak of it. Apparently it was discovered by your great-great grandfather and for some reason he never made a trail to it."

"How are we going to find it, Reverend?"

"Have you considered asking the ants? Anything can happen in a dream you know."

"I've already tried that. They seem only to be able to give that message." Suddenly it flashed through her mind that she had seen the name Goodrich Rock somewhere before. Then she remembered: it was on her great-great grandfather's map in the map room. "Follow me, Reverend," Erin called as she ran into the house.

Erin wove her way in and out of the hallways and rooms. Reverend Berkley trotted close behind. Finally they arrived in the map room.

"I say," said Reverend Berkley, "this house is quite a labyrinth. I shouldn't like to get lost in here."

They faced the large old map. Amid the branches of streams and brooks near Osceola, Erin saw in small letters the words "Goodrich Rock." There were no trails to the spot, and no trails near it. It was on the eastern side of the mountain, far away from the Osceola path.

Erin pointed to the spot on the map and said, "Here's Goodrich Rock, but how are we going to get there?"

Reverend Berkley looked at the map and answered, "Do not forget you are speaking to an experienced mountaineer, on or off the trail. We shall bushwack to Goodrich Rock. In other words, we shall tramp without trail, foot the forest as nature presents it: unbothered by boot and backpack, pristeen and pathless."

"Do you really think we can find it?"

"Fear not, we shall find the fabled Goodrich Rock. You know, this

is quite the most exciting dream I've had in a fortnight."

"It's not a dream, Reverend!"

"Yes, yes, wouldn't be a decent dream unless everybody in the dream thought it real. Turning to our task, there is one problem."

"What's that?" Erin was worried.

"Well, you see," answered Reverend Berkley, "we cannot lug this great, old map into the forest with us, and I will need something to refer to. In any case, I find this map difficult to read because it has no contour lines."

Erin had an idea. "Why don't we take one of the smaller contour maps and compare it to this one? Then we can mark where we think Goodrich Rock should be on the smaller map. We can take it with us, and it will be easier to read because it has contour lines."

"Splendid idea," said Reverend Berkley. "I wish I had thought of it myself, although I suppose I did since this is my dream. Let's get started."

Erin brought out a contour map from the drawer and they compared it to the old map. When they were satisfied that they had found where Goodrich Rock should be on the contour map, they marked a small "X" on the spot and printed next to it: "Goodrich Rock."

"This is sort of like translating a book from one language to another," said Erin.

"It is, isn't it?" answered Reverend Berkley.

When they were through Erin wanted to run off into the forest immediately.

Reverend Berkley was more practical. "Even if this is a dream, we must be sensible. We may have to spend the night out, so we shall need sleeping bags, extra clothes and some food. If they are hurt we will need first aid supplies, and it is always prudent in such situations to have some mountaineering gear. I shall supply the needed items other than your sleeping bag and clothes. I will meet you on your front porch in twenty minutes." With these words Reverend Berkley left the room.

A few moments later he returned and sheepishly asked Erin, "Could you please direct me out of this contorted mansion?"

Erin led him out and proceeded to gather up a sleeping bag, clothes, and boots. Exactly twenty minutes later Reverend Berkley returned wearing gray corduroy knickers with white wool socks that emerged from huge mountaineering boots. On his back he carried a tremendous pack stuffed full, and tied to the outside of it was a coil of rope and an ice axe. This outfit was crowned with a small hat that had feathers sticking out of one side, the sort of hat one might expect to find on Robin Hood.

In contrast Erin had fit her sleeping bag and clothes in a lightweight pack. Instead of boots she wore sneakers.

"Shall we be off?" suggested Reverend Berkley.

Erin answered by charging ahead.

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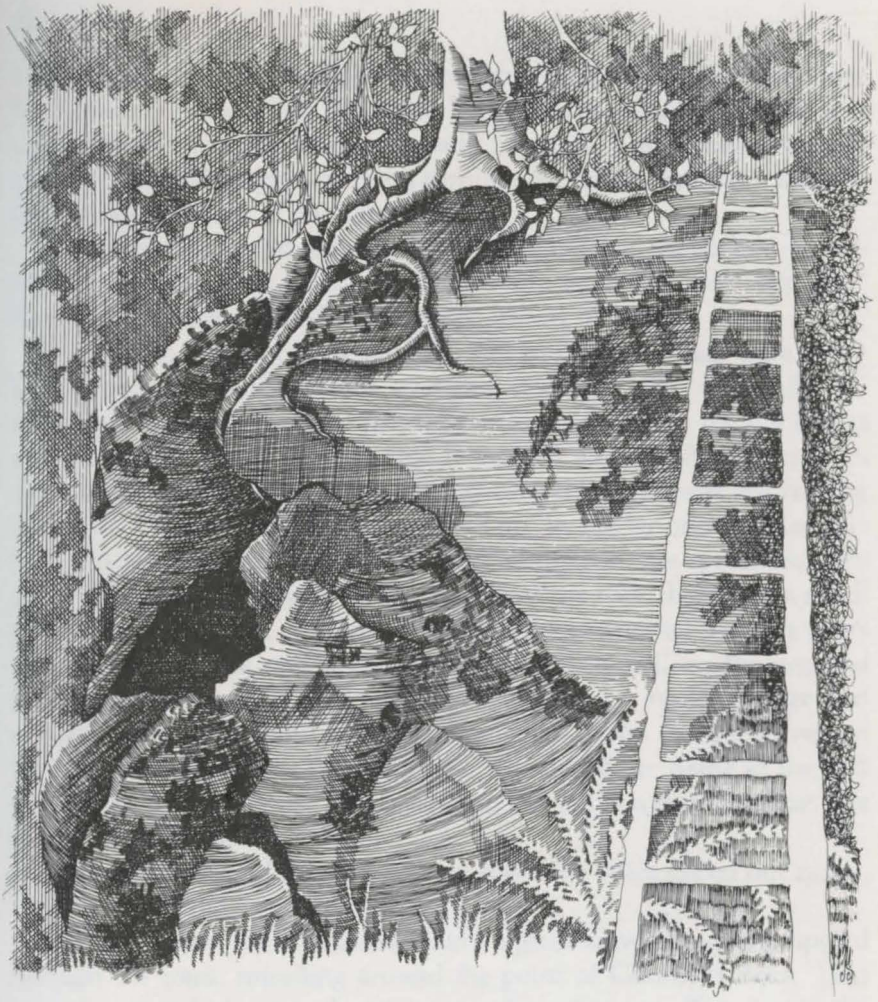

Goodrich Rock

Erin and Reverend Berkley entered the forest and began their hunt for Goodrich Rock. With Reverend Berkley occasionally stopping and consulting the map, the two made swift progress. The reverend seemed to have no problem guiding them through the forest. Erin was amazed that he was so sure of his direction.

"If I am correct," said Reverend Berkley, "and our translation is adequately accurate, then Goodrich Rock ought to be just over that rise." Reverend Berkley pointed at the slope ahead of them.

Erin ran on ahead. Surely enough, not more than a half mile away Erin found a tremendous rock emerging from the side of the hill. On one side it was at least forty feet tall; on the side facing the hill it was partially buried in the slope so that it was not so high. Erin noticed an old, wooden ladder on the short side. Reverend Berkley was just coming into sight. Without waiting, Erin rushed up the ladder onto the flat surface. On top Erin could see the Inn and all the cottages spread out like a tiny make-believe village. In the middle of the rock there was a small yellow birch growing. The tree was stunted and gnarled from its years of struggling to live on the small patch of sandy soil on the exposed rock. Its golden bark curled and flaked, giving it a rough texture and a mixed color. The wind blew, or seemed to blow, for the leaves on the trees rustled, and to Erin's surprise, she heard her name in the soft rush of the jostled leaves. Like a whisper carried in a gentle breeze, she heard: "Erin, Erin."

Erin looked around, but she saw no one. The voice called out again, "Erin, it is we the trees that speak."

As if to support the impossible claim, a great wave of rustling rippled through the trees, spiralling around the point of Goodrich Rock. Leaf tapped against leaf. At each contact a voice called out, "Erin," until the sound seemed to be a million voices, each voice just following the next so that the call was a perpetual echo cascading through Erin's mind. Erin put her hands to her ears in order to block the sound; it was as if each voice wanted to hold her attention and pull her in a different direction.

"I am sorry." The voice was one again, and seemed to come from the soft rush of the yellow birch's rustling leaves. "We cannot all speak together to you."

How can this be happening? thought Erin. She turned to the birch and asked, "Who are you?"

"As I told you, it is we, I, the forest that speaks to you."

"But how can a tree speak?"

With the wind through the trees the forest sighed. "This place that you call Goodrich Rock is a place where all beings can speak in a common voice. You, the Human Being, can speak to me, the Forest Being."

Just then Reverend Berkley pulled himself onto the rock. "I have been listening from just below the ledge," he said. "This is really a capital dream; it poses all sorts of theological questions."

"Hush up, Reverend," whispered Erin. Turning to the birch she said, "Is it you who sent the message through the ants?"

"It was all of us, all of the forest beings," sang the birch.

"This is really quite fantastic, you know," said Reverend Berkley, "there are tree spirits, more properly called *dryads*, inhabiting this dream. Wonderful pagan imagery."

Erin interrupted Reverend Berkley's musings, "Where are my uncle and Sam? What danger are they in?"

The yellow birch answered, "Charles and Sam were exploring a cave that opened up after the slide on the Fool Killer. The cave is now blocked by a large stone that fell during a small second slide. They are trapped inside the cave."

"What can we do?" said Erin desperately.

"You must go to the Fool Killer and find a way to move the stone, and you must do it quickly, for the mountain is angry. It is not finished with its destruction. The mountain will slide again, and this time it will bury the cave forever."

"Then we must go right away," said Erin.

"Yes, you must make haste." The trees all rustled into a sigh. "We, I, warned your uncle not to explore in that area after the rains; but, as usual, his curiosity was stronger than his caution. The mountain is angry now and he has gotten in the way of that anger."

"I have often had that feeling myself about a particular mountain," said Reverend Berkley. "Once I was climbing in Peru. We were led by Inca Indians, and. . ."

"We don't have time for a story, Reverend. We must try to rescue my uncle and Sam."

"I suppose you are right," said Reverend Berkley. "Well, let's get on with it."

Suddenly two brown shadows flashed in front of Erin and Reverend Berkley. Standing before them were two animals that looked like thin, medium-sized dogs.

"I'm Elsa," one of the dogs said.

The other said, "I'm Moka."

"Oh my!" exclaimed Reverend Berkley, "they don't bite, do they?"

The leaves rustled in a way that sounded like laughter. "No, Reverend, they don't bite. Elsa and Moka are coy-dogs, part dog and part coyote. They will be your guides during your journey."

Reverend Berkley, who had noticed Elsa scratching her ear, leaned toward Erin and whispered, "I do hope they don't have fleas."

The birch continued: "Outside of Goodrich Rock, you will not be able to speak to Elsa and Moka, or to any of my brothers and sisters. You will have to rely on what you know of the forest languages. Elsa and Moka's mother was a dog. From her they learned about the ways of human beings and to understand some of the human language. They will help you as well as they can."

"How is it that at Goodrich Rock we can all speak to each other?" asked Erin.

"That is difficult for me to say to you. It is something that goes beyond a saying, a speaking of it. I can only give you a picture.

"When the light of the world shines on Goodrich Rock, it becomes a rainbow of colors. These different colors are like the different beings in the world. Each being, like each color, has its distinct differences. Hawks are not mice, and mice are not trees. But all colors share something in common: they are light. All beings share something in common: they are Being. The world shines on Goodrich Rock and a rainbow of colors emerge and disperse. In the same way, all colors meet at Goodrich Rock as the common light. Goodrich Rock is the common light for all beings. Here we may speak to each other in the illumination of the common light of our shared Being."

For a moment there was silence, then the birch continued: "You must hurry. Elsa and Moka will take you over Scaur Ridge to the Fool Killer. Once you reach the height of land, the forest is filled with dense spruce. Elsa and Moka have numerous hunting trails through thick underbrush. They will take you through. Time is of the essence. The mountain is gathering its forces to slide again. Hurry!"

With the birch's last word, Elsa and Moka leapt off the rock. Erin

and Reverend Berkley quickly climbed down the ladder and met the coy-dogs at the base of the Rock. Elsa and Moka immediately trotted off into the forest. Erin and Reverend Berkley followed. Even though it looked as if the coy-dogs were just moving at a fast walk, Erin and Reverend Berkley had to jog to keep up the pace. Before long Erin felt a cramp in her side. Reverend Berkley was also visibly tired. He panted and puffed, occasionally encouraging Erin by saying, "Keep your chin up. Keep up the pace. We can do it."

At first they ran up and over a ridge that was covered with tremendous ancient yellow birch. Erin thought of the stunted little tree on Goodrich Rock. These trees around me must be part of what spoke to me, she thought. She felt secure; she was among friends.

When they reached the top of the ridge, Erin felt as if she were going to collapse. Only the fact that they were now going downhill kept her going. It annoyed her that Elsa and Moka looked as if they were sauntering along at a leisurely pace.

I suppose if I had four legs, it would be easy for me too, she thought. Suddenly Erin tripped and tumbled down the slope, knocking her knee on a rock.

"Are you all right, Erin?" Reverend Berkley asked her.

Erin held her leg and closed her eyes as pain pulsed through her knee. "No, I'm not all right!" she yelled angrily.

Elsa and Moka had stopped a few yards ahead and were looking back anxiously. Erin was angry that they made her run so much, angry that she had tripped, angry that Reverend Berkley asked stupid questions. Then her anger melted and she began to cry. "I'm sorry, I'm sorry," she sobbed. "It's just that I have a cramp, and my knee hurts."

"No need to explain, my dear. Exhaustion and bad temper go together. What you need is your second wind. Just give a little push and you'll reach your extra reserves. Take it from an old path runner."

Elsa and Moka trotted up to Erin and licked at her tears. They almost smothered her with their kisses.

"For goodness sake, give the girl some air," cried Reverend Berkley.

The coy-dogs' tongues tickled, and soon Erin was laughing. She hugged the animals and buried her face in their musty fur.

"Not the cleanest way to dry your face, but I suppose one need not worry about contracting diseases in dreams. I wouldn't want to get mange, though; I have little enough hair as it is." Reverend Berkley took off his hat and rubbed his pate.

Erin got up. A sharp twinge of pain flashed in her knee as she tried to put her weight on her injured leg.

"It looks like I've hurt my knee badly, Reverend."

"This looks to be a problem," said Reverend Berkley. "Can you walk at all?"

Erin took a few tentative steps. Pain flashed in her knee with each step, but she was able to endure it. "I can manage," she said.

"Scaur Ridge is quite a bit higher than what we've just gone over. It doesn't look like you'll be able to make it. There is, however, a shorter way to go that isn't half as steep. We could go through Lost Pass and the beaver swamps, although with the rain we just had, it may prove impossible."

Elsa and Moka seemed to understand what Reverend Berkley suggested, for they looked up at him and shook their heads.

"It is a bit wet through there, but I'm afraid Erin's knee won't last the extra miles and steeper grade. It's our only chance."

The two coy-dogs continued to shake their heads no. Then Moka put her nose to the air and sniffed, let out a small "yip" which prompted Elsa to raise her nose into the air also. The two then looked up at Erin and Reverend Berkley and nodded.

"I can't imagine what changed their minds," said Reverend Berkley, "but I think this alternate route will be less rough on your knee. I just hope we don't get stuck in the swamp."

The four began to move again, this time at a slightly slower pace. Erin's knee continued to ache, but the pain subsided as she established the rhythm of a fast walk. When they reached the bottom of the small ridge, they started to climb again, but this time it was a gradual grade. They soon left the stand of old birches and entered a forest of tall spruce. Erin found that she no longer felt winded, and her cramp had disappeared long ago. She felt curiously light and full of energy. The ache in her knee was persistent but it did not bother her too much now. She noticed the pain as she noticed the muscles in her legs tensing and loosening, and as she noticed her lungs bringing in and pushing out air. This must by what Reverend Berkley means by second wind, she thought.

After a time the terrain leveled off. Erin noticed that the ground was spongy under her feet. The forest grew thicker and darker, and deep green moss covered the exposed roots of trees. As they went farther, there were long expanses of solid moss that stretched beneath the forest like narrow lawns. In the distance Erin saw a silver and blue glint that looked like the sky opening out over a cliff. When they reached the spot Erin was surprised to realize that what she had taken for sky was the reflecting surface of a still pond. Rising from the middle of the pond was a collection of sticks shaped into a rough dome that Erin recog-

nized from a book as a beaver lodge.

"Now, how are we going to get around this?" exclaimed Reverend Berkley.

Suddenly Elsa and Moka howled.

"No need to despair," said Reverend Berkley, looking at the coy-dogs. "I'm sure we will find a way around."

"Hush," said Erin. She noticed an interruption in the surface of the water. Near the lodge two ripple lines in a V-shape were slowly moving toward them.

"What are you peering at, Erin?" Reverend Berkley whispered.

"Look." Erin pointed to what she could now see was a swimming beaver. The small brown face appeared as a lump with eyes, followed by a larger lump that was the beaver's body. Suddenly the beaver changed course, veering to the right. Erin heard a clap that sounded like a firecracker. The beaver had slapped its tail on the water, a warning to intruders.

"Doesn't seem too friendly, does he?" observed Reverend Berkley.

Elsa and Moka yapped at the beaver. The beaver veered again, returning to a direct path toward the shore. When he was near the shore, he stopped and looked at Elsa and Moka. Elsa sounded a gutteral, growling noise and then pointed her snout at Erin and the reverend. The beaver looked up at the two humans and slapped his tail on the water again. After a few minutes filled with yaps, growls and slaps, the beaver came out of the water to face Erin and Reverend Berkley. Before Erin could blink, Elsa and Moka had disappeared.

"It looks like we have a new guide," said Erin.

"It certainly does," said Reverend Berkley. "I hope his temper improves. That tail looks like a dangerous weapon."

Erin looked at the beaver and asked, "What's your name?"

The beaver walked toward a log, turned around and gave it a hard slap with its tail.

"For heaven's sake, don't make him angry," said Reverend Berkley.

"I don't think he's angry," said Erin. "I think that's his name."

"If that's the case, I'm afraid we don't have the anatomy to answer him."

"I think I'll call you 'Slapstick,'" said Erin to the beaver.

The beaver slapped the ground and started around the pond and into the forest. Erin and Reverend Berkley followed. Throughout the woods around the pond were smooth damp paths that led in and out of the pond. There were many pointed stumps scattered around, and occasionally a felled tree blocked their way. After they had circled most of the pond, they came to a dam of sticks and mud.

"A very impressive piece of construction, Mr. Slapstick," said Reverend Berkley.

Slapstick slapped the edge of the dam, climbed on top of it and started to waddle across. He paused, looked back at Erin and Reverend Berkley and slapped again. This prompted them to climb up onto the dam and continue to follow. Slapstick led them along beaver paths, through shallow marshes, to numerous beaver ponds. As the humans passed the ponds, other beavers would slap their tails on the water. Slapstick always answered by slapping a muddy section of earth. Erin lost count of the number of beaver ponds they passed. They were obviously traveling up a stream that the beavers had turned into a chain of ponds. The paths between the ponds branched in many directions, making it seem as though they were traveling through a maze like The Labyrinth. Erin was glad that they had such an able guide. Reverend Berkley continued to be impressed by the workmanship and prattled to Slapstick about this or that section of dam. Occasionally he called out to a beaver swimming beside them in the pond, "Good show, old fellow. The engineering boys at MIT could learn a lesson from you."

After an hour or so of this sort of terrain they came to a portion of land that was slightly higher and drier. It was only an island, though, and beyond stretched a long open swamp. In the middle of the island stood what looked like an oversized beaver lodge. It was a domed hut of sticks and mud. From a small hole on top of the hut there poured white smoke that hovered under the trees.

Suddenly a deep voice called, "I've been expecting you."

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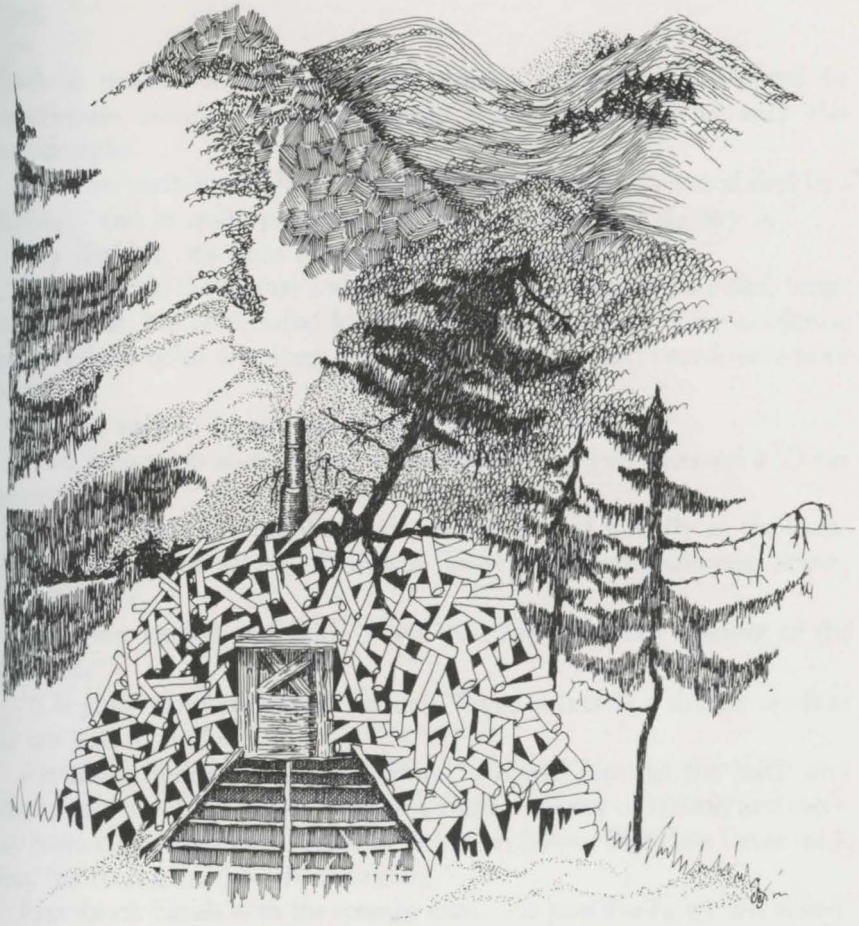


Solomon Snow

 rin could not tell where the voice came from. It seemed to reverberate among the dense spruce and hang in the air with the woodsmoke.

"Who on earth would live in this wilderness?" asked Reverend Berkley, adding, "and in quite primitive accommodations, if I do say so."

"Jay Berkley, it's been a long time," said the voice.

From behind the beaver lodge walked a large, heavily bearded, long-haired man. He wore what looked like a tattered and filthy academic gown whose color was long faded away. His hair and beard were pure white.

"I don't believe I have made your acquaintance, sir."

"You forget too soon, which is probably why you received a 'D' on your exam."

Reverend Berkley squinted his eyes and peered intently at the man. After a minute he asked, "Professor Snow? Professor Solomon Snow, is that you?"

The man smiled and said, "Have you kept up your reading of the *Kabbala*?"

"It *is* you!" cried Reverend Berkley. "Even if it is in a dream, it's fine to see you again."

Reverend Berkley ran up to Snow, clapped him on the back and vigorously shook his hand. "Erin, you must meet my old friend and mentor from divinity school, Professor Solomon Snow. Best class I ever took was his course on Jewish mysticism."

Erin shook hands with the strange man. "Do you live here?" she asked.

"I have for twenty years," Snow answered.

"So that's what became of you. A few years after I graduated I heard you had disappeared into thin air. Rumor had it that you'd gone off to climb some mountain no one had ever heard of. Mount Analogue, I believe it was. And here you are instead, residing in a mud house in one of my afternoon dreams."

"Don't flatter yourself, Jay," said Snow. "We are not all mere products of your dreaming."

"Yes, yes, of course," said Reverend Berkley. "No use spoiling the fun now."

"Professor Snow, sir," said Erin.

Snow interrupted and said, "Call me Snow."

"Snow, sir, we're trying to rescue my Uncle Charles and a boy named Sam. They were trapped in a cave by a rock slide."

"Yes, I know, pup. I received word through the network, and I have arranged transportation to the slide. But first come into my house while I gather my things."

"Are you coming with us, old chap?" asked Reverend Berkley.

"Of course I am," said Snow. "Charles and I may not see eye to eye on all matters, but he is my dearest friend. And Sam is my only chess partner this side of the wilderness. Can't lose him, can I?"

Snow began to make his way to the hut. Erin and Reverend Berkley followed. In order to enter the hut all three had to stoop over as they passed through the door. Inside it was dark and very smoky. On one side of the hut there was a mud fireplace that seemed to billow out as much smoke as it carried up the chimney. On the other side of the hut there was a low cot. Between the fireplace and cot sat a crude, circular table surrounded by four stumps. There were no windows. The only light came from the fire and a small oil lamp on a table. Snow started to rummage underneath the cot as Erin and Reverend Berkley gazed around the hut.

"Have a stump," Snow called out from underneath the bed.

After Reverend Berkley seated himself on a stump, he continued to look around and asked, "I say, what happened to your library? I was always impressed by your collection."

Snow's muffled voice came from under the cot, "Ah, here they are." Snow emerged holding a well worn pair of leather oxford shoes and one tattered sock. "Haven't worn them in years. I wonder where my other sock is?" Snow looked over to the table. "You were saying, Jay?"

"Your library? Have you forsaken it for this life in the swamp?"

"No, I still have my collection."

"But where are your books?" said Reverend Berkley, gesturing to the empty walls and sparse furnishings.

"It's a rather involved story," said Snow, "and we hardly have the time."

"Just tell us a bit while you're putting on your shoes," said Reverend Berkley.

"Well, when I first came here I brought all my books," said Snow as he struggled to put on his left shoe. "It took five strong bears twelve trips to bring them all. Then I found myself here, surrounded with books

and only this small lodge that the beavers built for me to house them."

"Sounds like a dreadful situation. What did you do?" asked Reverend Berkley.

"It was my beaver friends who found the answer," said Snow. "One by one each family came around and took one book to its lodge. Before I knew it, all the books were stored."

"What if you want to get a particular book from a lodge?" asked Erin.

"That was the one problem," said Snow, "I had no way of knowing where any of my books were."

"Sounds like a rather inconvenient system," said Reverend Berkley.

"It was, but then Charles gave me an idea," said Snow. "You see, the beavers have built their ponds all along the river that flows from the swamp. This forms a line of ponds that starts from here and stretches down the river. I have labeled the ponds with address numbers that correspond to the pond's position on the line. Look, I've got a map here." Snow pulled a scrap of birch bark off the wall and put it on the table. Drawn on the birch bark were a series of ponds. Written on the space of the pond was a number and a book title.

"The address for this pond is '5' because it is the fifth pond from the swamp," said Snow, pointing to the fifth pond down.

Erin noticed that the words beside the number in the box spelled out the title *The Odyssey*. "Why do you have the book title in there?" she asked.

"Because that's what book I have at that address."

"And how would you retrieve this book?" asked Reverend Berkley.

"First I read down this map until I find the book I want. When I find the book, I look to see what number pond it's in. In this case, *The Odyssey* is in pond number five, so next I find a resonant piece of mud and slap five times to get *The Odyssey*. The beavers all know their addresses and they bring me whatever I have stored in their lodges. The books are packed in waterproof satchels, so I need not worry about them getting wet."

"Fascinating system," said Reverend Berkley.

"As I said, Charles gave me the idea. Apparently you can store information in a computer in a similar way."

Erin suddenly had an idea."That's how we can store the entries to the *Flora!*" said Erin excitedly.

"What on earth are you talking about?" asked Reverend Berkley.

"Nora and I are updating her *Flora*," said Erin, "but we don't have any more room in her book. If I can store the information in a computer program, then we'll have a place to store this year's *Flora*."

"I think it's time we started on our rescue mission," said Snow.

Snow is right, thought Erin. We need to find Sam and Uncle Charles. "What transportation did you 'arrange' for us?" she asked.

"You'll see," said Snow as he slipped on a right shoe without any sock.

Snow led them out of the house, faced the swamp and made a sound like a sick cow. A moment later three large horse-like figures lumbered from the center of the swamp toward Snow's hut. As they came closer Erin was awed by the size of the ungainly creatures.

"Why, look," said Reverend Berkley. "We're being visited by moose."

They were much larger than horses. When they finally stopped the three moose stood five feet from Erin. The top of Erin's head reached no farther than the bottom of the broad moose chest. The moose antlers reached into the sky like giant gnarled and twisted hands.

"All aboard," Snow hollered as he raised Erin onto the massive shoulders of one of the moose. Snow and Reverend Berkley managed to mount their own steeds by climbing partway up spruce trees. Soon they were slogging their way through the swamp.

"Quite a stench these beasts exude," remarked Reverend Berkley.

"They feel the same about you, Jay," said Snow.

Erin had also noticed the pungent odor rising from the coarse fur of the moose.

"Now I know what a moose smells like," Erin said out loud.

"What ever inclined you to wonder?" Reverend Berkley asked her.

"Never mind, Reverend," she laughed.

When they were part-way to the swamp, the moose increased their pace to travel at a steady gallop. Erin was surprised that the huge, gangly creatures could go so fast.

After a while they slowed. Erin could see dense forest ahead.

"It's best we go on foot from here," said Snow. "I'm afraid our steeds would only increase our chances of getting tangled in the trees."

The moose brought them to the edge of the forest. Snow was right. Erin had to duck and hold tightly in order not to be swept off the moose's back.

"I say! I say!" Erin heard Reverend Berkley calling frantically. "Someone help me!"

Erin turned and saw that Reverend Berkley had not fared as well as she. He was clinging to the uppermost branches of a spindly fir. Snow, who had swung himself off the moose by grabbing a tree and climbing down, went to the base of the reverend's tree and called up, "Climb down, you silly fool. Are you waiting to wake up from your presumed dream or what?"

"I hadn't thought of that, but it is a good suggestion. Never before have I endured saddle sores while dreaming, without a saddle no less. Interesting point: saddle sores without a saddle. I must consider the logical implications of this paradox."

Snow sighed and turned to Erin. "I see he hasn't changed in twenty years."

While Reverend Berkley continued to muse on saddleless saddle sores, Snow took hold of the tree and shook it. It wasn't long before Reverend Berkley came flying out.

"I say, that wasn't too kind, now was it?" said Reverend Berkley as he rubbed his behind. "You've added bruises to my sores."

Erin, who was still on the moose's back, followed Snow's example and grabbed onto a tree to climb down. When she tried to bend her knee, she found that it would move only a few inches and that it ached terribly. The long ride had given it a chance to stiffen and swell. She made it down the tree, though, and was able to limp over to Snow and Reverend Berkley.

"I am not the only one who has sustained injury on this venture," said Reverend Berkley, looking at Erin. "It seems your knee has taken a turn for the worse."

"It doesn't look like you'll be able to make it with that knee," said Snow.

Erin was angry at herself for falling. "You go on. You have to."

"I don't think your uncle would appreciate it if we left you behind," said Reverend Berkley.

"On that I agree," said Snow.

Just then Elsa and Moka came loping out of the woods, their tongues dragging like small red flags.

"You have made it around, my friends," said Snow.

Elsa and Moka trotted toward them, carefully avoiding the looming figures of the moose, and sat down.

"Perhaps Elsa or Moka could carry me," said Erin.

"While I'm sure they would be willing, I'm afraid they're not big enough," answered Snow.

"It looks as though we're stuck," said Reverend Berkley.

"Don't give up so easily," said Snow. "There is someone who may help us yet." Snow cupped his hands, raised his head and gave a raspy, high-pitched howl.

The moose immediately started and went crashing into the forest toward the swamp. Elsa and Moka crouched low and growled.

"Where did your learn to do that?" asked Reverend Berkley. "It's really quite the most horrid noise I've ever heard."

Snow repeated the cry. Elsa and Moka backed into the shadows of the forest.

"Now we wait," said Snow.

"For what?" asked Erin.

"Those two seem to know," said Reverend Berkley, pointing toward Elsa and Moka.

Snow said nothing. He just sat and watched the edge of the forest.

The three humans and two coy-dogs sat and waited silently, for what Erin didn't know. The sound had sent a shiver through her. Minutes passed. Erin grew anxious. We must reach the Fool Killer before it slides again, she knew.

Suddenly, without a sound, a cat emerged from the forest. Elsa and Moka snarled, the hair at the backs of their necks rising. It took a moment for Erin to realize that it was no ordinary cat. It was a mountain lion.

"Oh my," exclaimed Reverend Berkley.

The lion was not still. It paced back and forth eyeing the humans with distrust, hissing at the coy-dogs.

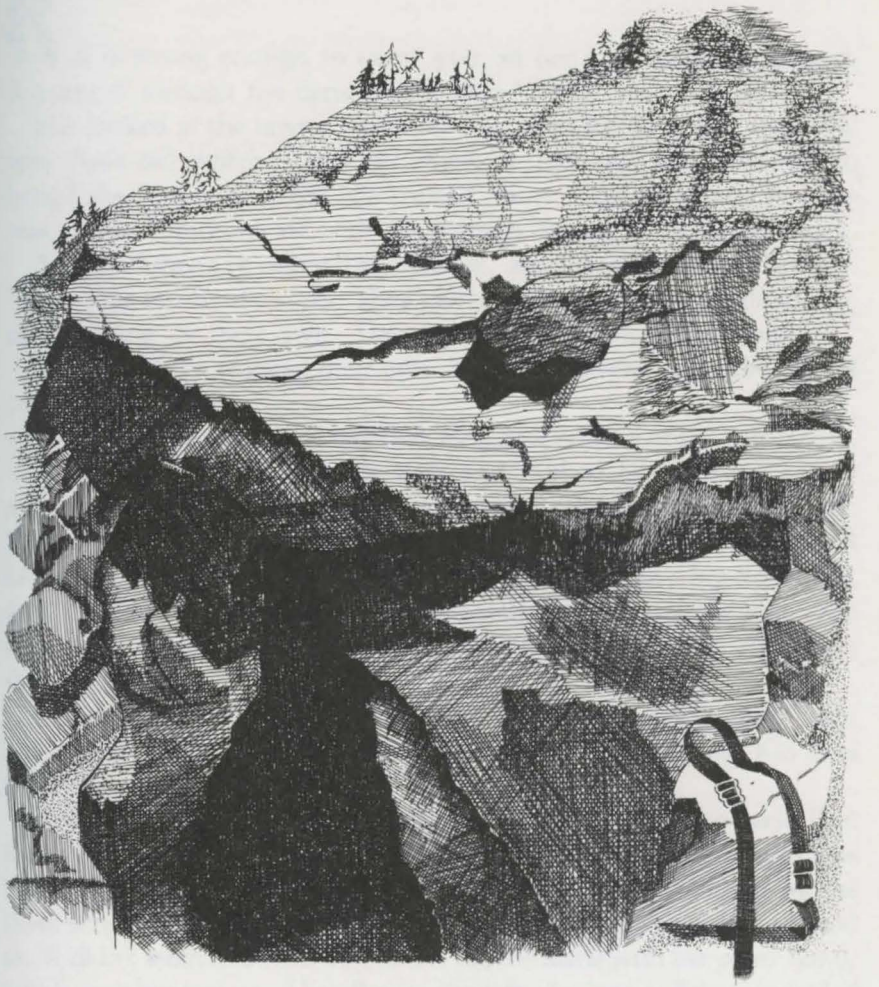
Snow stared into the lion's eyes and hissed, "Hassassah."

The cat snarled. Snow repeated, "Hassassah," and then added, "sah-hah-sagh."

The cat sat down and calmly started to wash itself. It licked its paws and rubbed them behind its ears, seeming to ignore Snow. After a moment of bathing, the cat stretched, looked at Snow, looked at Erin and Reverend Berkley, and let out a tremendous snarl that let its fangs show. Elsa and Moka backed further into the forest. Reverend Berkley closed his eyes and began pinching himself and muttering, "Enough is enough for one afternoon's nap."

Snow smiled and then said to Erin, "She's agreed to carry you."

ten



The Slide

Kai is strong enough to carry you on her back and low enough to make it through the dense forest here," Snow said to Erin.

Erin looked at the tawny mountain lion who stared at her with oval eyes. Kai's tail twitched and her whiskers quivered. Erin admitted to herself she was scared, but she trusted Snow. Erin wondered how he was able to communicate with the animals outside of Goodrich Rock.

"I'm glad I shan't be riding that creature," announced Reverend Berkley. "Never was too fond of cats. They never want to cooperate, always insist on being on their own. They're not half as faithful as dogs."

Elsa and Moka wagged their tails. Kai gave Reverend Berkley a cool cat-look and hissed.

"Well you'd better appreciate that she's cooperating now," said Snow.

Kai licked her paw one last time and rubbed her face before she sauntered over to Erin. Erin's heart pounded. She sat completely still. When Kai reached Erin, she bowed her head, rubbed her neck against Erin's shoulder and purred. Why she's no different than a big house cat, thought Erin. She reached out and scratched Kai under the chin. Kai responded by purring even louder and circling around to rub Erin's shoulders again.

"Now that you have been introduced, it's time we get moving," said Snow. "Just crawl on Kai's back and hold on as best you can. Kai likes to go fast, so hold on tight."

Erin got on the lion's back and grasped the fur around her neck. Erin found that it was not very thick so that she had no grip. Kai's skin was loose, which made Erin think of how mother cats carry kittens by the loose scruffs of their necks. Erin took a handful of neck skin and held on. It didn't seem to bother Kai so she did the same with her other hand, which gave her two good handles for the ride. As soon as Erin was settled Kai sprinted into the forest. From behind, Erin could just hear Reverend Berkley calling, "We shall meet you at the slide. . ."

Erin felt as if she were riding a scudding cloud. Kai bounded over flooded streams and logs, darted through tangled trees. For the third

time today Erin's nose came close to the fur of a wild beast, and for the third time Erin breathed in a rich, unique smell. In what seemed like no time they reached the top of a ridge that looked over a raging river.

A little while later Elsa and Moka emerged from the forest. They kept away from Kai, who was lounging by a tree.

Erin walked over to the coy-dogs and said, "I still love you."

Elsa and Moka sniffed suspiciously at Erin, their tails tucked between their legs. After they were satisfied that she was not Kai in disguise, the pair wagged their tails and asked to be petted. Quite a while afterwards Reverend Berkley and Snow arrived.

"This is the river that runs beneath the slide," said Snow. "The start of the slide shouldn't be more than half a mile up."

As they contemplated the river, the woods grew darker. By now the afternoon was drawing to a close; the sun was sinking behind the ridges to the west.

"However close we are, we don't have much time until it gets dark," said Erin.

"Nor do we have much time until the mountain slides further," offered the reverend. "I don't want to sound gloomy, but if that dryad was right, we're probably standing right in the path of the next slide."

"Let's hurry, then," said Snow.

Erin remounted Kai and they were off again. This time Kai stayed with the group. Soon they came to the base of the slide. Erin could hardly believe her eyes. Never before had she seen such destruction. Rising two thousand feet above them was a half mile wide reddish-brown slash. To the sides of the slide, and piled at the bottom where they stood, were jumbles of trees and rocks. Some of the trees had roots that still clung to elephant-sized boulders. Others were piled like a collection of sticks, their roots spreading out into the sky like skeletal fingers reaching from the earth, still holding clumps of mud.

"This is even larger than the great North Slide," murmured Reverend Berkley.

"How do we find them in this mess?" asked Erin.

"*We* will not," answered Snow. He put his hands together to form a hollow chamber, then blew into the hollow, making a deep whistle like that of a recorder. By moving his fingers he changed the notes. He played a song that started with a low note and rose evenly to a high note, then dropped quickly back down to the low note, followed by two long, low hoots. Erin recognized it as the song of the mourning dove.

"How many animal languages do you speak?"

"As many as the number of animals I have met," answered Snow.

"He always was good with languages," added Reverend Berkley.

The return call came soon, followed by a mourning dove in the high branches of one of the trees.

"She won't come closer because of Kai," said Snow, "but we don't need her closer."

Snow hooted a more intricate variation of the song, which prompted the bird to fly off.

"She's searching for signs of them," explained Snow.

"What if she can't find them?" Erin asked.

"Let us hope she does," said Reverend Berkley.

They waited anxiously amidst the boulders, sand and uprooted trees. Finally the mourning dove returned, calling in its sorrowful voice, but fortunately bringing welcome news.

"She has found them!" cried Snow.

"How far up the slide are they?" asked Reverend Berkley.

"Not far," said Snow, "but far enough that it will be dangerous."

Erin felt helpless with her hurt knee. She was glad that Kai was with her, giving her some sense of movement and power.

"It will be quite a task just getting through these boulders and fallen trees," said Reverend Berkley. "After that, when we reach the point where all the debris has come from and things are relatively clear, the trick will be to avoid sliding down the loose soil and rock."

"You make it sound hopeless," said Erin.

"I'm merely trying to outline the facts as I see them, and this is one area where I do have some expertise."

"Let's begin by getting through this mess at the base," said Snow.

With Snow's suggestion, the four humans and three animals began to make their way through the destruction. The animals progressed far more quickly, being able to crawl easily through criss-crossed trees. Kai was the quickest because she could leap from one fallen tree trunk to another. Soon Erin and Kai reached the point where the slide appeared as a clean slash in the mountain face. Erin looked up at the towering slide. It was so steep and sheer that it gave the illusion of being a cliff. It was very difficult to tell the difference between soft sand and solid granite ledge because of their similar texture and wet color. The mourning dove was flying above, circling around a point. . . then Erin saw what she was looking for: a bright blue speck partway up the slide. "Uncle Charles's pack!" she cried aloud.

Kai immediately bound up the slide.

"Wait! Wait for the others!" Erin cried, but Kai continued to run up the slope. As she ran she loosened bits of sand and rock that sent mini-

slides slipping down. Erin realized that if it were not for her speed and light foot, they would have ended up going down with one of the small slides. In a matter of seconds they reached the blue pack. It was sticking out of a small crevice, held up by a walking stick.

"Sam! Uncle Charles!" Erin yelled.

Out of the crevice came Uncle Charles's voice. "Erin? What are you doing here?"

"Are you and Sam all right?"

This time Sam's voice answered. "We're fine. No injuries. Just in a jam, that's all."

"It's very dangerous up here," said Uncle Charles, "You should get away from the slide."

"And leave you up here?"

As they spoke Erin heard a deep rumble.

"It's sliding again. Get away Erin!" cried Uncle Charles.

Erin looked above her and saw a moving wall of boulders and sand. The whole mountain shook. Suddenly, the large granite boulder that blocked the cave that trapped Sam and Uncle Charles heaved and started to roll down the mountain.

They're free! thought Erin. But then she realized there was no place to go. It was only a matter of seconds before the mass of tumbling rock would reach them.

"Get in!" yelled Uncle Charles, "Quickly!"

For a fraction of a second Erin was confused. Then she realized the only choice she had was to join them in the cave. But what about Reverend Berkley, Snow, Elsa and Moka? Everything seemed to be moving in slow motion. The rumble was deafening. She tasted the gritty, gunpowder-like granite dust in the air.

Erin yelled to Kai, "In the cave!"

Whether Kai understood the human words or just followed her own sense of self-protection, Erin didn't know. Whatever it was, Kai jumped into the opening. As Kai jumped, Erin turned and looked down the slide. Below she saw the figures of two men and two coy-dogs standing still and looking up. Then there was a great roar and darkness. She rolled off Kai's back and found herself held tightly in someone's arms. The cave was flooded with granite dust. Erin started to gag.

"Breathe through my shirt," Sam called. "It will filter out the dust."

It was Sam who held her, and whom she held. Erin followed his advice and buried her face in his thick cotton shirt.

A long time after the rumbling stopped, the dust settled. There was no light at all.

"Erin, Sam," said Uncle Charles, "are you all right?"

Erin lifted her head from Sam's chest. "I'm all right," she said.

"Me too," said Sam.

Kai snarled.

"We haven't forgotten about you, Kai," said Uncle Charles.

"You know Kai?" asked Erin.

"For a long time. Snow introduced me to her. I suppose it was Snow that introduced you to her also."

"That's right. How did you know?"

"He's the only one around who can speak to the animals in their own languages."

"What I want to know is how we are going to get out of here," said Sam.

Out of the darkness came a croaking voice, "The impatient froglet gets no dinner, no dinner."

"What was that?" asked Sam.

"Oh ho, impatient froglet wants to know what I am."

Erin noticed a dim, yellow glow toward the back of the cave. The glow grew brighter until the cave was filled with a soft yellow light that came from what looked like a piece of quartz. Holding the quartz was the toad-like figure of an ancient woman. She was dressed in dripping wet green rags that looked like stringy moss.

"I seep, froglet, seep. I seep from the cracks in the stones and run down walls, I seep through sand. The ocean is my mother, the rain my father, a storm my conception."

"It's good to see you again," said Uncle Charles.

"You see, froglet, and you too fishy," the woman pointed a damp, white finger at Erin. "He knows. He knows. Once before he traveled this path, and it was not meant that he travel it again. Now he brings froglets and fishies, or are these only dinner for the furred one?"

"I realize I was forbidden to come again to this place, but we are trapped."

"And why are you trapped, ducky? Is it because you were curious. You were looking to return. The mountain did not take kindly to your first visit, and it does not want you now, but enough of this chatter. You are under my protection for the moment. Let us go."

Erin was confused by the conversation. Evidently her uncle had been here before, but when? And why?

"Follow me, duckies," the old woman croaked.

The light showed that the cave ended just in back of the old woman. Erin wondered where they were going. The old woman walked steadily

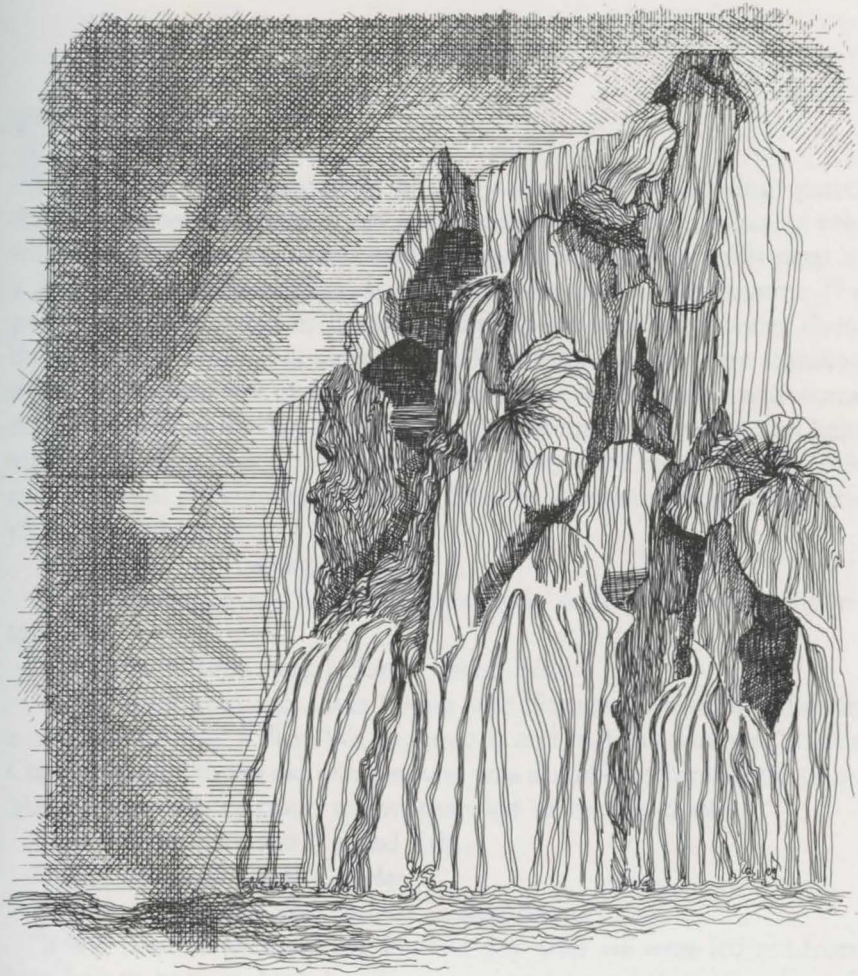
toward the back of the cave. As she reached the wall, she turned and said, "We shall share form for a moment. Do not be afraid, just follow." Then she walked into the wall, which seemed suddenly unclear. Erin could almost see through it. It was not like a rock wall at all.

Erin hesitated and stepped into what had been solid rock. Then she realized the rock was still solid. It was *she* that was no longer solid. Erin seemed to separate, finding small spaces that she conformed to and pockets of sand that she spread through. She was divided, yet together, moving between granite slabs and tightly packed granite chips. She felt the rock with a sense that was not quite touch, not quite smell and not quite taste. Somehow it was all three senses, and at the same time, not like any of them at all.

"We have passed through," said the old woman.

Erin blinked. They were standing in a large cavern.

eleven



The Heart of the Mountain

The cavern was illuminated by the same kind of glowing quartz that the old woman held in her hand, except that here the quartz was embedded in the ceilings and walls. They were standing ankle deep in a dark pool that spread across the entire expanse of the cavern. The pool appeared to be fed by the slow dripping and seepage of water along the wall. The water was so cold that Erin felt as if she were standing in ice. On the far side of the cavern Erin saw a wall covered with some sort of circular emblems. As her eyes grew accustomed to the dim light she realized they were not emblems at all. They were faces, all with their eyes closed as if they were sleeping. The old woman walked across the room toward the faces.

"Where are we?" whispered Sam.

Uncle Charles paused before he answered, "At the heart of the mountain."

"And you've been here before?" asked Erin.

"Once. I was your age. I was hiking with Nora and we stumbled upon a cave on the Fool Killer. We explored it and met this woman," Uncle Charles pointed to the old woman who was shambling through the pool. "As she did with us now, the woman led us to this cavern."

"Nora's been here too?" asked Erin.

"Yes," answered Uncle Charles.

"Where is the cave you found?" asked Sam.

"It was the one we were just in. The day after we were led out from here I went back to look for the cave, but I found that a small rock slide had hidden the entrance. I was not supposed to find this place again, you see."

"And that is why you were so curious after the slide," said Erin.

"That's right," said Uncles Charles. "I guessed that the slide had opened up the cave again."

"You said you weren't going near the slide," scolded Erin.

Uncle Charles shrugged and said, "Insatiable curiosity."

By this time the old woman had reached the far side of the cavern where the mysterious faces slept. Then she did something that Erin could hardly believe. She brought her hands up to her head and gently touched her temples. As if she were washing, she brushed her hands down her face. Suddenly her face was gone. She had no features, there was just a halo-like shining above her shoulders. In her hands she held what looked like a round silk cloth. She carefully hung the cloth on the wall. Then Erin saw that the cloth on the wall was a face, the face of the old woman.

"How did she do that?" asked Erin.

"She is water. Water has many forms, many faces," said Uncle Charles.

The faceless water reached up, took down another face and brought it upward, drawing it around the milky luminescence above her shoulders. Standing before them was a tall, dark-haired woman with ivory-white skin. She was draped in a gown that was the color of mouldering leaves. "I am Dusky Pool," she announced.

"Yes, I remember you," said Uncle Charles.

"And I you. I forbade you to return here. But no matter, the prohibition was to protect you from the mountain. You are under my protection now."

The conversation carried across the large space of the cavern. Uncle Charles had not needed to shout because even a whisper could be heard from one end to another.

"Come closer," said Dusky Pool.

Kai immediately ran forward, splashing across the shallow water. Erin's uncle stepped ahead. Erin felt for Sam's hand and grasped it. Together they followed, Erin limping, the pain in her knee growing worse.

When they were a few steps away, the woman looked at Erin and said, "There is a part of me that has met you before."

With those words she turned, and as before she pulled off her face and hung it in its place. And as before she reached and took another.

"Erin," said the silver-haired woman.

"It's you!" cried Erin, "you're real!"

The silver-haired woman laughed, her voice ringing like tiny icicles falling on glazed snow. "I am Emerald Cascade. You may call me Emera."

"I really saw you the day we were hiking!"

"Yes, we met. I am sorry I pulled you into me. I mistook your Being. Like your uncle, your Being is sensitive to the forms of other beings that are close to you."

Emera turned, saying, "I must go now, but perhaps we shall meet again."

Emera performed the ritual changing of faces again. This time the old woman returned.

"You are not the only inconvenience, duckies," said the hag. "There are other fishies that floundered today. Yes! I picked up more fishies. Perhaps, at last, some dinner for the furred one, eh?" The old woman scratched Kai under the chin, then walked to the wall and faded away.

Erin looked at the place where the old woman had been. There was only the dark of the rock. The cavern was silent except for the constant sound of dripping. It seemed as if the dripping pounded in time with the throbbing in her knee. All energy seemed to drain away from her. Without thinking she squeezed Sam's hand.

Sam gave her a reassuring squeeze back and asked, "What is it?"

"It's—it's my knee. It hurts so much."

"Let me see that knee," said Uncle Charles.

Erin tried to raise her knee, but now even the slight bending shot pain through her leg. Uncle Charles bent down and saw that Erin's knee had swollen to the size of a small melon.

"You've really hurt yourself," said Uncle Charles. "Make sure you support her, Sam."

Sam put his left arm around Erin's waist and pulled her right arm so that it rested on his shoulder.

Just then the old woman returned from a different side of the cavern, followed by Reverend Berkley, Snow and the coy-dogs.

"What an extraordinary experience!" Reverend Berkley exclaimed. "I say, look! It's Erin and company. What luck." Reverend Berkley began to stride toward them mumbling, "It's rather wet, isn't it? Reminds me of the time..."

Before he could finish his sentence he stepped from the shallow water into a deep pool. For a moment all that was visible was his hat floating on top of the water. Then he popped up like a buoy.

Erin started laughing, for a moment forgetting her pain. Sam, Uncle Charles and Snow joined her.

"A wet froglet, you be," cackled the old woman.

Reverend Berkley stood up to his neck in the cold, black water, waving his arms back and forth. "My goodness, it's like ice in here." Reverend Berkley gasped and shivered with the cold. "I say, I say, that, was a, a nasty trick."

"Duckies must be careful. Many places drop down beneath this pool, yes they do. Duckies must only go where they are told."

"Will, will some, someone help me, me, me out of here?" chattered Reverend Berkley.

Uncle Charles walked out to where he was close to Reverend Berkley, carefully feeling out each step so that he would not go off the ledge. When they were close enough, Uncle Charles reached forward and pulled Reverend Berkley up.

"Thank you, old man. Frightfully cold in there, you know. I must be having a fever dream. That's it, a fever dream! And now I'm going through the chills."

Erin rushed over and hugged the soaking Reverend Berkley.

Reverend Berkley gave Erin a stiff embrace and said, "It is awfully good to see you. I'd thought you'd been buried alive."

The old woman led Snow and the coy-dogs around the deep section and brought them below the wall of faces. Erin hugged them all in turn, receiving a bear hug from Snow that took her breath away and a thorough washing of her face by Elsa and Moka.

"I'm glad to see everyone's all right," said Uncle Charles. "I would like to know how you managed to avoid getting buried in the slide."

"We would have been buried if it weren't for her," Snow gestured at the old woman.

"Yes," said Reverend Berkley, still shivering with cold, "a most fantastic thing happened. First, first we saw, saw Erin by the bl. . . bl. . . blue pack, and then we noticed the, the, the slide coming toward us. I must confess, I was badly scare, scared. It was too, too, too late to attempt a scramble to safety. All, all of a sudden, an, an opening in the rock appeared and this ma. . . ma. . . matron," Reverend Berkley pointed at the old woman, "ushered us in. She left us for a while in the da. . . dark passage, and then returned to bring us here." Reverend Berkley finished his story with a great, "Ahh*choo*."

While Reverend Berkley was talking the old woman changed faces and she was again the black-haired Dusky Pool.

"I would like to thank that woman," said Reverend Berkley, sniffling. "She has a strange way of expressing herself, but she is quite literally a life-saver." Reverend Berkley turned and saw Dusky Pool. "Well, hello, madam," he said. "You haven't seen a small elderly lady here somewhere, have you? I can't imagine where she's gone off to."

Erin whispered, "That's her, she's just in another form. She's water."

"Really!" exclaimed Reverend Berkley. "First dryads, now protean water nymphs. Isn't it amazing!"

Dusky Pool turned to Erin and said, "I see pain in your face."

"It's my knee. I hurt it running in the forest."

Dusky Pool bent down and with cupped hands brought up some water.

She took a few steps toward Erin, knelt in the pool and grasped Erin's knee with both her hands. The water seemed to seep into her knee, making it feel frozen. Then, curiously, she felt a glowing warmth. When Dusky Pool took her hands away, Erin's pain had subsided and the swelling was all but gone.

"You will feel less pain and you will be able to complete your journey home, but only time can heal you."

"Thank you, Dusky Pool," said Erin.

Dusky Pool turned to face Uncle Charles. "The mountain is jealous of you, you speak to all beings through Goodrich Rock. It sees in your efforts an attempt to return to the Old Time, the time before Being divided into its many forms. In that time animal, plant, and stone were one. Then they were shattered like a fragmented crystal, and became what is called the world."

"Like the Tower of Babel," murmured Snow.

"Like what?" asked Sam.

"It's an old story," said Snow, "and one that has always seemed special to me. It begins in a time when all men spoke the same language. There weren't such things as English, Spanish, Hebrew. Everyone could understand each other. The people in the world decided to build a tower to heaven. When they were partially finished, they suddenly found that they could no longer understand each other. They all spoke different languages. And so they stopped building the tower. No one could agree on what to do because they could not communicate with one another."

"But people can learn other languages," said Erin.

"That's right, but often they don't. In my life I have tried to learn as many languages as I could. First human languages, and then animal languages. It seems such a tragedy that we do not understand each other."

"You might say that Snow and I have taken different paths to get to the same place," said Uncle Charles. "At Goodrich Rock I can speak to any creature without knowing its language. The Rock changes what is incomprehensible to me and makes it comprehensible. Goodrich Rock *translates* for me. Snow instead will learn the language and can speak and understand it without translation."

Erin thought for a moment and then asked, "You've been teaching me about computer language. Is the language I've been learning actually the language that the computer understands?"

"As a matter of fact no," said Uncle Charles. "A computer language is more like a translator, more like Goodrich Rock. A computer understands a language called *machine code*. Instead of letters and words,

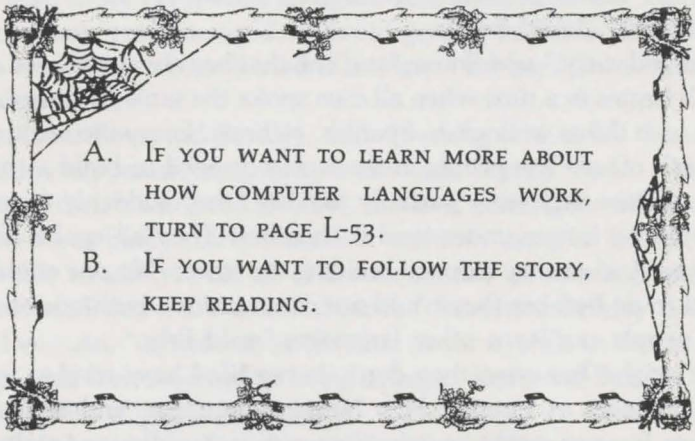
machine code is all numbers. It is very difficult for most people to talk to the computer in this language of numbers. A computer language tries to use words and ideas that people can more easily understand, and then translates these words and ideas into machine code, the language that the computer understands."

"And I suppose," said Snow, "that what I do is more like speaking to the computer in machine code."

"That's right," said Uncle Charles. "You talk directly to the animals, which is like talking directly to the computer."

"Still," said Snow, "the problem of Babel is there in computer languages. If I am correct, there are many different computer languages, many different ways of translating, if you will."

"That's true," said Uncle Charles. "No one has decided what is the best way of translating, so we have a multitude of computer languages."



"You people indulge in intellectual conversation in the strangest places," said Reverend Berkley. "I, for one, am cold. This dream is definitely growing uncomfortable. Not that I don't appreciate the fine company of this gracious lady; however, I am beginning to doubt that this is my dream at all. Who, may I ask, is dreaming this dream, and why does he, she or it insist on having me drenched and standing in frigid water?" Reverend Berkley looked accusingly at everyone.

Dusky Pool, who had listened quietly throughout the talk, started laughing. "Human beings are like the salmon that swim from the sea to their first homes, the tiny streams in the mountains: you strive and strive, for what reason you know not, but you must forever strive to some end."

They were all silent.

"Now it is time for you to leave," said Dusky Pool. "At the bottom of one of the pools there is an underground stream. The rapids will take you through. Again you shall share one of my forms."

Dusky Pool turned and drew down another face.

"I see how she does it," said Reverend Berkley. "Why that collection of masks surpasses yours, Charles."

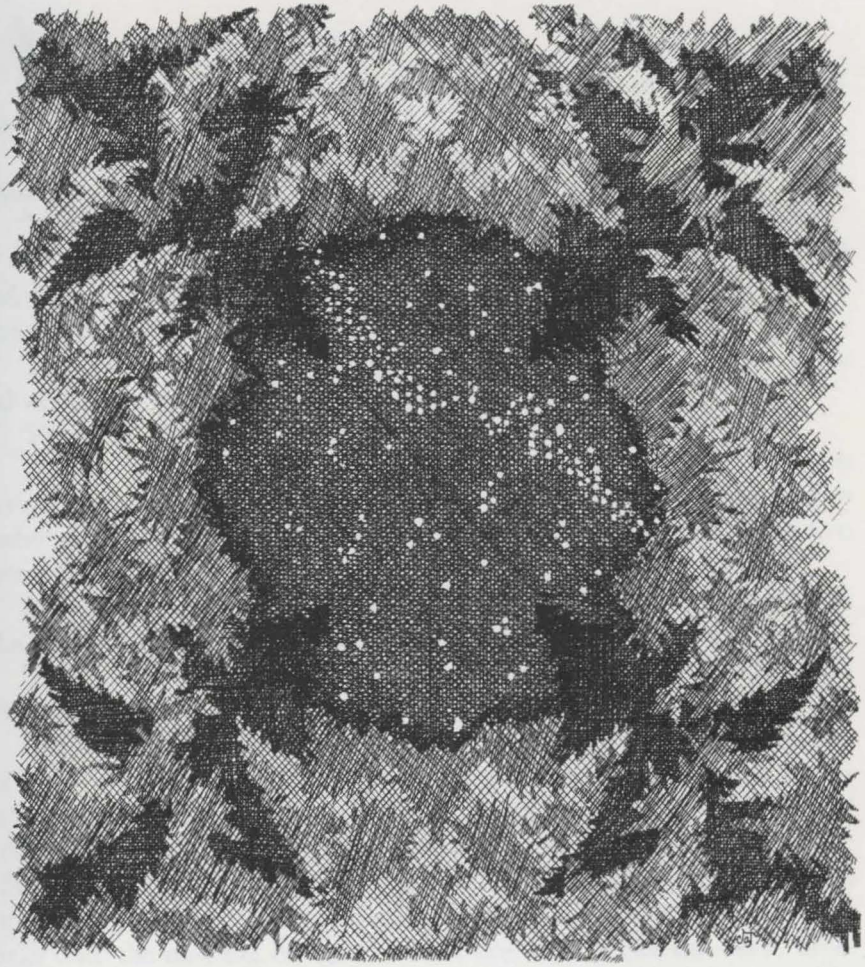
Snow gazed at the faces. "So this is the heart of the mountain."

Now a new woman stood before them. She was lean and barely clothed in white shreds. Her skin shone as if she had just completed a great exertion. She flashed in front of them and said one word: "Follow." She dove into a section of the pool. Erin felt herself drawn into the water, as if some powerful current had swept her off her feet. Her body stretched and rolled, falling over ledges, squeezing in narrow openings. She tossed, she was thousands of tiny bubbles frothing, rolling. It began in darkness, but soon she burst forth into light. She felt as if she were running as fast as she could, faster even, but she was running without legs, breathing without lungs. . . and then it stopped.

Erin, along with the rest of them, was standing waist-deep in a pond near the mouth of a river. The coy-dogs and Kai immediately paddled to the shore. It took the humans a moment to comprehend where they were before they waded out of the pond.

"We must set up camp quickly," said Uncle Charles.

twelve



Campfire

Uncle Charles found a flat area a few yards from the pond, just in the woods.

"We'll need some firewood," said Snow. "I'll go collect some. Reverend, will you join me?"

"I suppose so. Anything so that I may get these beastly clothes dry."

Snow then let out a loud yap, followed by a raspy growl. Elsa and Moka immediately ran off into the forest. Kai curled up underneath a tree and promptly fell asleep.

"See? What did I tell you? Cats never want to pull their load. They always insist on being different."

"Reverend, let each one be his own," said Snow.

The two walked off together, Reverend Berkley muttering, "Have you ever had to clean out kitty litter? I knew a fellow in the Belgian Congo who had thirty-nine cats. . ." Reverend Berkley's voice faded as the two moved farther into the shadows of the forest.

In the meantime, Uncle Charles laid out a small circle of stones. Soon he had a kindling fire snapping happily in the middle of the circle.

"Erin," said Uncle Charles, "I want you to rest that knee. Sam, you make sure she does. I'll take care of the fire."

Erin and Sam walked down to the edge of the pond and leaned against a tree. The water was still. The air rang with the high-pitched chirps of peeper frogs. Erin and Sam gazed across the water. The stars and sky were reflected in the smooth surface of the pond. Erin looked up. Before she came to the Valley, she had never seen a night sky without the dulling glare of streetlamps and house lights. Here in the forest there was only the dancing red glow of the fire. Above her the deep, blue-black sky seemed bottomless. Across the depth, the stars glistened like salt spilt on a shroud.

"All that's happened—it seems impossible," Erin said to Sam.

"That makes me think of something your uncle told me when I first started working on trails with him."

"What's that?"

"We came on a section of trail that was completely washed out. It had become a small stream. So I told your uncle, 'We can't fix that, it's *impossible*!' He looked at me and asked me why I thought it was impossible. So I told him all the reasons why we couldn't fix the trail. I'd been working on another trail crew for the National Forest Service and I thought I knew everything about trails.

"And what did he say after that?" asked Erin.

"He agreed with all the reasons why the trail couldn't be fixed. Then he asked me: 'What would it take for it to be possible to fix the trail?'"

"That's funny, since he agreed with you that it was impossible."

"I thought so too, but I tried to think of a way. Finally I told him it would be possible to fix the trail if we changed the course of the stream, but I knew that was more work than we could do, that we would need a bulldozer or something."

"And then what happened?"

"He looked at me and said, 'maybe.' Then we walked about half a mile up the stream, I mean the trail, until we reached a point where the trail was suddenly fine, no erosion at all. Your uncle pointed to a spot where a stream that had flowed across the trail had gotten clogged. This made it change its path so that it had started flowing down the trail. All we had to do was clear out the clog and the stream started flowing on its old stream bed, no bulldozers needed."

"You must have felt pretty dumb."

"I did. Your uncle told me that people often think things are impossible because they assume that the world is a certain way, and so things seem impossible. He said that I was right when I said that to fix the trail we needed to change the course of the stream. But I assumed that to change the course of the stream we needed to dig a whole new channel. For that we would have needed bulldozers. As it turned out, all we needed to do was clean out the clog."

Erin thought about what Sam had just said. Everything that had happened seemed impossible, but that was because she had always assumed that people couldn't talk to animals, trees and rivers. And, Erin realized, she had always assumed that she hated computers, before she ever knew what they were.

"Later on," Sam continued, "when your uncle started teaching me how to program computers, I would sometimes get stuck and say, 'This is impossible!' Then I would remember the time on the trails, which made me try to think of my program in a new way. It usually worked."

They watched the stars for a little while longer, then returned to the camp. The fire was crackling and waiting for more fuel. Erin noticed

Reverend Berkley scribbling furiously by the light of the fire. She also noticed that he was using the notebook she always carried with her for field notes. Just then Elsa and Moka emerged from the forest with smooth beaver logs clutched in their jaws. Waddling behind them were two beavers with similar loads. Erin recognized one of the beavers as Slapstick. The two coy-dogs dropped their logs at Uncle Charles's feet, grinning and wagging their tails as they panted. The beavers also dropped their burdens and rose on their haunches.

"Thank you," said Uncle Charles.

"You're welcome," answered Reverend Berkley, "but, really, any decent chap would do the same."

"He's not talking to you," said Erin, feeling slightly annoyed that Reverend Berkley had not asked her whether he could use her notebook.

"Ah, yes," said Reverend Berkley, noticing the congregation of animals. "By the way," he added as he saw Erin, "I hope you don't mind that I borrowed your pencil and pad. Mine was all wet. I noticed you had wisely wrapped yours in a plastic bag. I must take notes on this fabulous dream, although I suppose this notebook will disappear when I wake up. Drat!"

"Erin," Uncle Charles called across the fire, "I did mean to thank you and the reverend."

Erin looked up and blushed, but no one could tell because everyone's face glowed red. "It was really everyone else, every*thing* else, the forest, the animals, and the faces of water."

"I know that it was team effort, but I thank you for your part on the team." Erin's uncle turned to Reverend Berkley, who had given up writing and seemed to be snoozing. "Thank you, Reverend Berkley."

Reverend Berkley opened his eyes and mumbled, "Same dream, is it?" He tried to close his eyes again, but Elsa came over and licked him on the face to which he replied, "That's enough, old girl. Yes, I love you too. That's enough now."

They all laughed, including Reverend Berkley.

"Erin," Uncle Charles asked, "did you see Emera the day we climbed Osceola?"

"Yes I did," she replied.

"So that's why you fell in the water," said Sam.

"But, Uncle, I told Nora about what happened and she said it was just my imagination."

"Nonsense," cried a voice from the forest. Out of the darkness came a moose carrying a hooded and cloaked figure. "Don't just stand there and gawk. Somebody help me down from here."

Uncle Charles helped Nora down from the moose and made a comfortable spot for her by the fire. When she was settled, Nora announced to the group, "I've been worrying my bones apart about you."

Erin realized she had forgotten to tell Nora where she was going. "How did you find us, Nora?" Erin asked.

"Don't think you're the only one who's got connections in the forest. My bones are too brittle to climb Goodrich Rock, but there are other ways to tap its power. And let me set the record straight, young lady. I told you that through your imagination you made a picture of Emera from her song."

"What's the difference?" asked Erin.

Erin's uncle interrupted, "Since this is one area where Nora and I agree, perhaps I can explain. Human beings tend to be picture-thinkers. When they explain things, they often use images. For instance, when you say that someone has 'a face of stone,' you don't mean that the person's head is actually made out of rock. You mean that he never smiles, or that he scowls, making it *seem* that he is as hard and unmoving as a rock."

"Isn't that called a *metaphor*?" asked Erin.

"That's right. Essentially what you do when you use a metaphor is take two different images, like the image of a face and the image of a stone, and you bring them together as if they were the same. So you say, 'the man had a face of stone.' A person's face cannot be made of stone, but you can picture it as if it were."

"Does that mean that the song *reminded* me of a woman singing, the flowing water *seemed* like a flowing dress, and that's why I saw Emera? Were we all just imagining the faces of water?"

"So you have been to the heart of the mountain," mused Nora.

"Yes," answered Charles, "all of us."

"Erin," said Snow, "it is not that you did not see the faces of water, it is that you saw them as only human beings can: you saw them as mixed images, metaphors if you like. Kai, Elsa and Moka, did not see what we saw. Just as each animal speaks a different language, each animal also sees the world in a different way."

Erin was confused. "What about computers? How do they see the world?"

"Computers don't *see* anything. They just follow instructions," said Uncle Charles.

"Your ability to mix images and make new pictures is something that you can do and a computer cannot," said Nora.

"What a computer can do," continued Erin's uncle, "is follow instructions, like Hilary's instinctive web-spinning program. And you can make

models on computers, like the population model, which in a way is a kind of picture. But it is you who designed it, not the computer."

"And a computer is a useful tool for storing and retrieving information, like my beaver ponds," said Snow. "Although computers are not nearly as companionable as beavers."

"What people forget," said Uncle Charles, "is that computers are only tools, not image-makers, not picture-thinkers. Very simply, computers have no imagination. That's what you provide."

Reverend Berkley closed the discussion: "That is the only statement in all you have you said for the past ten minutes that I understand. And let me compliment you, Erin, for the wonderful job you did in imagining that lovely lady in the cavern. Although I supposed it was my imagination since this is my dream. Oh dear, this does present a philosophical problem. It reminds me of an essay by William James entitled 'Does Consciousness Exist?' There he argued. . ."

"Spare us your verbiage, Reverend," Nora proclaimed. Elsa and Moka howled in assent as the beavers slapped the ground. Kai hissed.

"Ah yes," said Reverend Berkley meekly. "Well, I suppose another time then."

The group was quiet. Erin looked at the human and animal faces that formed a glowing ring around the dancing fire. The faces hung in the backdrop of the black night. It almost seemed to Erin that she was at the heart of the mountain again. But all these faces she knew, they were the faces of her friends. She knew that at the end of the summer she would return to the city. How could she explain what had happened to her friends and parents? She knew she couldn't. Her adventures and new friends she would hold secret.

Maybe by morning the good reverend would stop wondering when he would wake up. Erin barely noticed Sam putting a blanket around her shoulders. In her dreams she was already imagining the next summer in New Hampshire.

Introduction to Manual

BASIC stands for "Beginner's All-purpose Symbolic Instruction Code," and is a language that was developed in 1970 by Dr. John Kemeny of Dartmouth College right here in New Hampshire. Dr. Kemeny studied at Princeton University under Professor Albert Einstein, and later served as president of Dartmouth College and as a member of issues. He is one of America's most gifted scientists. His language, BASIC, is one I will introduce, in part, to you as I introduce you to the computer itself. You will see that in the BASIC language, you can find all sorts of new and exciting things to do with your adaptable little toy, the computer.

Happy programming,

Charles Goodrich

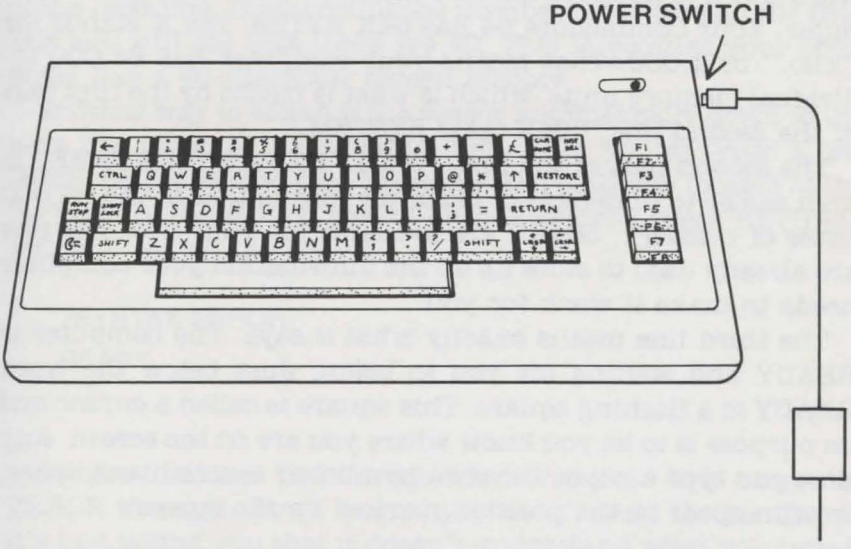
Introduction to Manual

ONE

Getting Started

Let's begin learning about our computer and its keyboard. Before we start, however, make sure that all the wires are connected properly. If you're not quite sure about this, ask someone who already knows about the computer.

The next step is to turn on your T.V. or monitor. It's always a good idea to turn on the viewing screen before you turn on your computer.



Now you're ready to turn on the computer. Flip the switch on the right side of the computer to the ON position. You should now see a red light in the upper righthand side of the keyboard. When the light is on, you know that the computer is running.

Watch your monitor and soon you will see the Commodore 64's title screen.

```
    ****COMMODORE 64 BASIC V2****
 64K RAM SYSTEM 38911 BASIC BYTES FREE
 READY
```

The purpose of this title screen is to tell you about the computer. The first line lets you know that your computer's name is Commodore 64, and that it uses the computer language called BASIC. BASIC is a special language that was developed to help teach people how to use computers, and it's very easy to learn, as you'll soon see.

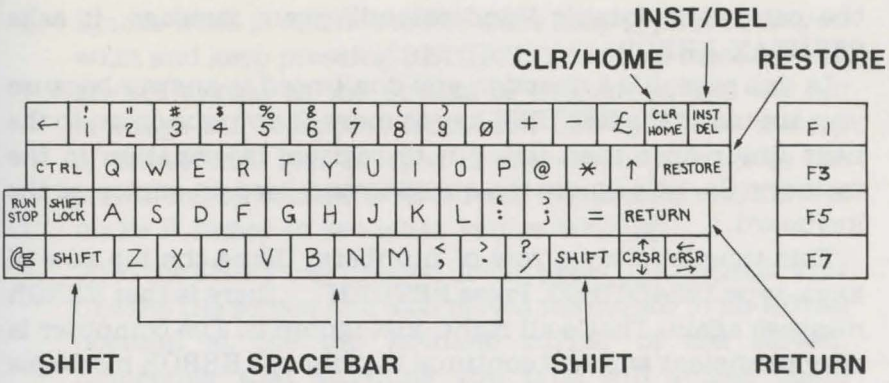
The second line tells you about your computer's memory. A computer stores all kinds of information in its memory. Some computers have very large memory spaces so that many people can use them at the same time. Home computers such as yours have smaller memories, although for a home computer the memory in your Commodore is quite substantial. We use the word BYTE to describe the individual memory unit of the computer. Your Commodore 64 has 64K BYTES. The K stands for "kilo," or 1,000. That means your computer has 64,000 individual memory units, which is what is meant by the first part of the second line, "64K RAM SYSTEM."

The second part of the line, "38911 BASIC BYTES FREE" is even easier to understand. It simply means that of the 64,000 bytes of memory, 38,911 are available for your use. The rest are already used to store up all the information your computer needs to make it work for you.

The third line means exactly what it says. The computer is READY and waiting for you to begin. Just below the word READY is a flashing square. This square is called a *cursor* and its purpose is to let you know where you are on the screen. Any time you type a letter, number, symbol or even a blank space, it will appear in the position marked by the cursor.

THE KEYBOARD

We use the keyboard to communicate with the computer. As you can see, the keyboard is loaded with letters, numbers, symbols and special-use keys. For now, let's explore only the characters marked on the top of the keys. They are generally arranged like the keys of a regular typewriter.



Try typing a row of letters; for instance, QWERTYUIOP. As you type the letters, notice how the cursor moves across the screen, one space at a time. Now continue to type letters. Eventually, you will reach the end of the line. If you keep typing letters the cursor will automatically jump down to the beginning of the next line. If you count the numbers of letters on the first line you will see that there are 40. This is because your computer has a 40-character screen display.

Another way to advance the cursor automatically down to the next line is using the RETURN key. After you've typed a few letters on the second line, press the RETURN key located at the far right of the second row of keys. After you press RETURN, you will see on the screen:

```
?SYNTAX ERROR
READY
□
```

Congratulations! You have just received your first computer ERROR message. Don't worry, you didn't hurt the computer, it's just telling you that it doesn't understand what you typed. BASIC is a lot like English in that it has certain rules for spelling and grammar and QWERTYUIOP just doesn't make any sense at all. The reason that you received the error message has to do with the RETURN key.

The RETURN key automatically moves the cursor to the next line, but it does something even more important. It tells the computer to store into its memory what you have typed. Because

the computer doesn't "understand" your message, it asks ?SYNTAX ERROR.

In this case, it's a question you don't need to answer because you are using the RETURN key to move the cursor down to the next line rather than using it to register information in the memory. So, let's ignore the question and keep on exploring the keyboard.

This time let's try a row of numbers. Using the top row of keys, type 1234567890. Press RETURN . . . there is that ERROR message again. That's all right, just ignore it. The computer is very persistent and will continue to print out ERROR messages until it understands what you have entered. Computers may be sophisticated technological machines, but they're somewhat less intelligent than your average tree toad. They can't tell when someone is just learning about a keyboard.

Did you notice when you typed the row of numbers that the zero has a line through it? The line is to remind you that Ø means zero and not the letter O. It is a common mistake to type the letter O when you actually mean Ø or to type Ø when you mean the letter O. On a typewriter the mistake might go unnoticed, but when you start programming the computer must receive *exactly* the right information.

Another very important key on your keyboard is the SHIFT key. Look at the keys with numbers on them. You will see that there are symbols above the numbers. To make these symbols appear on the screen, press either one of the SHIFT keys and while holding it down, type the number keys 123456789. On your screen, you will see:

```
! " # $ % & ' ( )
```

As you can see, the SHIFT key allows you to type the upper character of a key that has more than one character on its top face. For more practice using the SHIFT key, try these examples. Press SHIFT *and* : ; , . /. On your screen, you will see:

```
[ ] < > ?
```

By now, your screen is getting rather cluttered with letters, numbers, symbols, and ERROR messages. There are three common ways to deal with this problem.

1. Ignore what is on the screen. Just keep typing what you want and keep pressing RETURN. Your new message will always appear at the bottom of the screen and the old message will disappear from view line-by-line at the top of the screen. This method is convenient but leaves the screen messy and difficult to read. The second method will make it easier to see what you're writing.
2. With the SHIFT key pressed down, press CLR/HOME. This CLeaRs the screen and also moves the cursor to its HOME position at the top lefthand corner of the screen. Remember that anything you type will appear there because the computer always prints at the location of the cursor.
3. The third method for clearing the screen can be used when you get the scary feeling that you've broken the computer. Perhaps you leaned your elbow on the computer and everything went crazy. DON'T WORRY. Any time the screen is displaying something you don't understand or isn't what you want on the screen, you can press the keys [RUN/STOP] and [RESTORE] at the same time. The screen will then return to its original state with the message READY for you to begin again.

Have you already pressed a key by mistake and wondered how to correct the error? Fortunately, the INST/DEL key makes correcting typing mistakes a simple task. Type in the short sentence, "HILARY WAVES BATS." Use the space bar, which is the larger long key at the very bottom of the keyboard, to create the empty space between words. On your screen you will see the sentence printed:

HILARY WAVES BATS.□

The only problem is that Hilary doesn't wave bats, she weaves webs and, nominally, makes little Hilarys. Let's concentrate on her talents as a seamstress. Press INST/DEL and see what happens. The cursor moves back one space and the period disappears. Press INST/DEL again. This time the "s" disappears. Press INST/DEL eight more times and you will see:

HILARY W

Now type "EAVES WEBS." The sentence that now appears makes more sense (for a spider):

```
HILARY WEAVES WEBS.
```

When you want to erase a whole word or words, it will be faster if you hold INST/DEL down continuously. Then, the cursor will move left, erasing letters and spaces until you take your finger off the key. Notice that we said letters *and* spaces. That's because a space counts as a character, just the same as letters, numbers, and symbols.

Now you know quite a bit about your computer keyboard. We'll tell you more about some of the other keys and symbols a little later, but you know enough already to write your first program.

A. IF YOU WOULD LIKE TO RETURN TO THE STORY, TURN TO PAGE 1.

B. IF YOU WOULD LIKE TO CONTINUE LEARNING ABOUT YOUR COMPUTER AND WRITE YOUR FIRST PROGRAM, KEEP READING.

TWO

Introduction to Programming

Let's write our first program. This is going to be easier than you might think. Turn on the computer if you have not already done so. Now, go to the keyboard and type the word NEW. After you've typed NEW, press the RETURN key. Your screen now looks like this:

```
NEW
READY
□
```

By typing NEW, you gave the computer an instruction. When you pressed the RETURN key, the computer performed its task. What do you think that task was?

NEW tells the computer that you are going to begin a NEW program. When the computer receives this instruction, it clears its memory of all old instructions. Now you can write your NEW program without writing over an old one. NEW erases the old program and gives you a clean slate.

Now, let's write our program. Type in the following line exactly as it appears below. When you are done, press the RETURN key so that the line will be stored in your computer's memory. If you make a typing mistake just erase it using the INST/DEL key and make your correction.

```
1Ø PRINT "UNCLE CHARLES"
```

Make sure you use the quotation marks because they are very important. When you use the word PRINT in a program, you are instructing the computer to PRINT out whatever message

is between the quotation marks. In this case, the message is UNCLE CHARLES. If you have trouble finding the quotation marks on the keyboard, they are located on the same key as the number 2. To get the quotation mark, just hold down one of the SHIFT keys and the number 2 key at the same time.

Well, believe it or not, you just wrote a program. Would you like to see it in action? Just type the word RUN and press the RETURN key. If all went well, your screen now looks like this:

```
10  PRINT "UNCLE CHARLES"
RUN
UNCLE CHARLES
READY
□
```

You just wrote a program that told your computer to PRINT the name UNCLE CHARLES. You see, a program is simply a set of instructions. We give each instruction a number which is called a line number. In this case we used the number 10. By giving our instructions a number, the computer can keep track of the order it's supposed to follow when executing the instructions. In this case we only used one instruction:

```
10  PRINT "UNCLE CHARLES"
```

What happens when we want the computer to perform more than one instruction? To find out, let's add another line to our program. First, however, let's clear the screen by holding down the SHIFT key and the CLR/HOME key at the same time. Now your screen is blank, but don't worry, the computer has your program in its memory. You can see your program again by instructing the computer to print out your program's line list. Just type the word LIST and press the RETURN key. Now your screen looks like this:

```
LIST
10  PRINT "UNCLE CHARLES"
READY
□
```

Let's add our new line:

```
2Ø PRINT "VISITS GOODRICH COTTAGE"
```

When you have finished typing the new line, remember to press the RETURN key. Now your program has grown to two lines. Notice that our new line has a different line number. We used the number 20 this time. When you ask the computer to RUN this version of the program, it will know to perform our earlier line first and then our new line. That's because it always performs the instruction with the lowest line number first, and then moves to the line with the next lowest number. Let's see how the program works by typing RUN and pressing the RETURN key:

```
RUN
UNCLE CHARLES
VISITS GOODRICH COTTAGE
READY
□
```

As you can see, Line 1Ø was printed before Line 2Ø. Whenever you are assigning line numbers to your instructions, it's always a good idea to space out the numbers. Some people use the numbers 10, 20, 30, 40 and so on. Others leave even bigger spaces by using 100, 200, 300, and 400. We leave the space so that we can always have room to add lines anywhere in the program. For example, let's say we want to have our program print the following lines:

```
ERIN GOES WITH HER
UNCLE CHARLES
WHEN HE
VISITS GOODRICH COTTAGE
```

How do we go about adding the new lines to our program? First, let's clear the screen of our old lines by pressing the SHIFT and CLR/HOME keys at the same time. Remember that this only clears the screen and not the memory like the command NEW.

In this case, we are adding to an old program and *not* beginning a NEW one. Let's call up our program out of memory by typing LIST. Our screen now looks like this:

```
LIST
10  PRINT "UNCLE CHARLES"
20  PRINT "VISITS GOODRICH COTTAGE"
READY
□
```

We can now add our new lines. Type in the following lines exactly as they appear below. Remember that if you make a mistake, all you have to do is use the INST/DEL key to erase the error. Also remember to press RETURN after each new line.

```
 5  PRINT "ERIN GOES WITH HER"
15  PRINT "WHEN HE"
```

You have now added two new instructions to your program. Even though they were not added in the order they are to appear, the computer knows the order by the line number and has already stored this information in its memory. If you want to check this, type LIST. You will then see your program listed in its proper order.

```
LIST
 5  PRINT "ERIN GOES WITH HER"
10  PRINT "UNCLE CHARLES"
15  PRINT "WHEN HE"
20  PRINT "VISITS GOODRICH COTTAGE"
READY
□
```

If we had numbered our first two program lines with the numbers 1 and 2:

```
 1  PRINT "UNCLE CHARLES"
 2  PRINT "VISITS GOODRICH COTTAGE"
```

we would not have had the room to add our new lines. This is why we always leave space for new lines.

Now, let's RUN our program in its final form. Just type RUN and press RETURN.

```
RUN
ERIN GOES WITH HER
UNCLE CHARLES
WHEN HE
VISITS GOODRICH COTTAGE
READY
□
```

Congratulations, you've just written your first program. Let's review what you have just learned about writing a program.

REVIEW

1. A program is a group of instructions that tell your computer what to do.
2. Each instruction has its own line and line number.
3. The computer performs the instructions in the order of the line numbers, from the lowest number to the highest.
4. We use the word NEW to clear the computer's memory of any old instructions.
5. We use the word LIST when we want the computer to list out the program that is currently in its memory.
6. When we want to register a line in memory, we always press the RETURN key.
7. We use the word RUN when we want the computer to perform the instructions that make up our program.
8. The word PRINT is used as an instruction in a program when we want the computer to PRINT out a message.
9. Any message to be PRINTed out must be enclosed with quotation marks.

10. It's always a good practice to leave space between our line numbers. Then we will always have room to add new lines at a later time.

A. IF YOU WANT TO RETURN TO THE STORY, TURN TO PAGE 17.

B. IF YOU WANT TO LEARN MORE ABOUT BASIC PROGRAMMING, KEEP READING.

THREE
Variables

In this lesson we will build a program based upon Erin's population model. The lesson is divided into two parts.

In Part I you will learn the skills necessary to build the population model program. In Part II we'll put all these ideas together to construct the program.

PART I

What we're going to do is learn how to use the computer to figure out how many eggs Hilary can put into her egg sac without worrying about her children starving for lack of food. To do this, we'll build a computer program based upon Erin's *population model* for the relationship of the number of spiders, flies and horses living around Goodrich Cottage. Before we can build this program, however, we'll first have to learn a few more things about our computer and how we can make it work for us.

PLAYING THE NUMBERS GAME

Your computer is absolutely super at helping you work with numbers. It is fast and accurate and knowing just a few simple rules turns your computer into a handy desk-top calculator.

You can use the PRINT command along with the symbols for addition (+), subtraction (−), division (/), and multiplication (*), to turn your computer into a calculator.

You'll notice that the addition sign (+) and the subtraction sign (−) are located on the top row of keys on your keyboard just to the right of the zero.

The computer uses the asterisk (*) instead of the common (x) for its multiplication sign. The asterisk (*) is located on the far right-hand side of the third row of keys.

Finally, the computer uses the slash (/) as its division sign. The slash (/) is located on the far right-hand side of the bottom row of keys. It shares the key with the question mark (?).

Now you're ready to try a few calculations. Let's try addition first. Go to your keyboard and type the line below. When you are done, press RETURN. The computer will then respond with the answer to the problem.

(You type)	PRINT 22 + 43
(Computer's response)	65
	READY
	□

Pretty fast, wasn't it?

Now let's try subtraction. The method is the same; only the sign changes. Don't forget to hit RETURN.

(You type)	PRINT 54 – 36
(Computer's response)	18

Multiplication and division work the same way. Here are some examples for you to try.

(You type)	PRINT 63/9
(Computer's response)	7

(You type)	PRINT 27*4
(Computer's response)	1Ø8

It's just that easy to make the computer work for you. But there is always one very important idea to keep in mind. The computer is your *helper* and *not* a substitute for *knowing* how to do the math on your own. Knowing how to work with a computer is a wonderful skill but knowing an answer isn't worth anything if you don't understand the question.

VARIABLES

Besides working with numbers on a computer, another con-

cept we'll have to understand to build our population model program is *variables.* As you will recall, Uncle Charles explained to Erin that a *numeric variable* is a letter that stands for a number. You can think of a variable as a handy way to store information in the computer's memory.

The variable's name is used by the computer to identify a location in its memory that contains certain information; like how many horses live at the stable down the road. Variables play a very important role in programming a computer because a simple name like "H" (for horses) can represent a great deal of numeric information.

Often, the number information in the program will vary. One year there might be 100 horses and the next 107. By using the same variable name "H" we can use the same program each year without having to change it. That's because even if the number information changes the variable name remains the same.

If you are having a problem understanding this concept, don't worry about it. Learning new ideas takes time. Remember how many times you fell off your bike before you got the idea how to balance on two wheels? Well, you got it eventually and then riding was easy. It's the same way here.

Let's build a little program to help you understand variables. Here is the situation. You own a stable that has 100 horses. Each year you plan to add six more horses to your stable. You want to write a program that will show you how many horses you will have in each of the next three years.

The element of this situation that will *vary* from year to year is the number of horses. That means that we will have to assign a variable name to the number information that deals with the horses. Let's give it the name "H" because "H" is the first letter in "horse."

We know that we are starting out with 100 horses. With this knowledge, we can write the first line of our program. First clear your screen with the SHIFT and CLR/HOME keys. Next type the word NEW to clear the memory of any old programs. Then press the RETURN key to register the NEW command.

Now type the first line:

```
10  LET H = 100
```

You just told the computer to assign the variable H (for horses)

the number 100. Whenever we want to assign a variable name to a number we use the word LET. This is called *initializing* the variable because it gives the variable its *initial* or *starting* value.

Now that we have initialized the variable "H" we can write the next line of our program. We know that the first year we are going to add six horses to our stable. That means we will have 100 + 6. We can also say we will have H + 6 because we LET H = 100. With this knowledge let's write our second line.

```
2Ø  H=H+6
```

In this second line H = H + 6 we can see the real value of variables and how they work with changing information. The starting value of H was 100, but now, it is 106. That is because we gave a new value to our variable by using the equal sign. H = H + 6 tells the computer that the intial value of H (100) has now changed because we bought more horses. The new value is H + 6 (100 + 6).

Now we add the next line to our program which will PRINT how many horses we will have in the first year.

```
3Ø  PRINT "YEAR ONE" H
```

Let's see if our program works for year one. On a new line, type RUN and press RETURN. If all went well, your screen looks like this:

```
1Ø  LET H=1ØØ
2Ø  H=H+6
3Ø  PRINT "YEAR ONE" H
RUN
YEAR ONE 1Ø6
```

In Line 3Ø we told the computer to PRINT the message YEAR ONE and also to PRINT H. The computer printed 106 instead of the letter H. That's because H stands for a piece of variable information, in this case the number of horses in our stable the first year.

We can do the same procedure for years two and three by adding the following lines to our program.

```
40  H=H+6
50  PRINT "YEAR TWO" H
60  H=H+6
70  PRINT "YEAR THREE" H
```

Now when we RUN our program, we get the following:

```
RUN
YEAR ONE 100
YEAR TWO 112
YEAR THREE 118
READY
□
```

So you see, each year the numeric information changed. The value of our variable changed from 100 to 106 to 112 to 118 even though the name remained the same (H for horse).

INPUT

Besides knowing how to work with numbers and variables, there's one final command that you should know about before we build our population model—the INPUT statement. Using the INPUT statement is an easy procedure to learn and it will enable you to add a very interesting and useful element to your programs.

The INPUT statement allows you to enter the values from the keyboard while the program is RUNning. When you use INPUT in a program, the action pauses while you enter a number from the keyboard. This number is then assigned a variable name.

Here is an example of one way to use the INPUT statement.

```
NEW
10  PRINT "HOW MANY HORSES DO YOU HAVE"
20  INPUT H
30  PRINT H
RUN
```

When you RUN this program, the computer will respond:

```
HOW MANY HORSES DO YOU HAVE
?
```

The computer will wait until you answer its question. All you have to do is type a number and press RETURN. The computer will then assign the number you entered into the variable name appearing after the INPUT statement, in this case H.

Since we have 100 horses we type in the number 100 and the computer then PRINTs out the value we assigned by following the instruction on Line Ø. We can use the INPUT statement to rewrite the program that printed out the number of horses we would own for each of the next three years.

It looks like this:

```
1Ø PRINT "HOW MANY HORSES DO YOU HAVE"
2Ø INPUT H
3Ø H=H+6
4Ø PRINT "YEAR ONE" H
5Ø H=H+6
6Ø PRINT "YEAR TWO" H
7Ø H=H+6
8Ø PRINT "YEAR THREE" H
```

PART II

As you will recall, Erin was trying to figure out how many eggs Hilary the spider could lay this year without having to worry about her children going hungry. Uncle Charles guessed that each baby spider would need to eat 50 flies in order to live through the summer. Erin figured that each horse in Sarah's stable would produce enough manure to breed 100 flies. Later she went down to Sarah's stable and found out that Sarah had 12 horses.

Using this information we can construct a program that will compute the number of eggs Hilary should lay.

In this particular model, we have two variables whose values may change from year to year. They are the number of horses at the stable and the number of eggs Hilary should place in her sac. Let's assign each of these a variable name. We'll use H for horses and E for eggs.

The first part of the program will use an INPUT statement to enter the number of horses.

```
NEW
1Ø  PRINT "HOW MANY HORSES ARE THERE IN T
HE STABLE THIS YEAR"
2Ø  INPUT H
```

You will notice that the message in Line 1Ø spills over to a new line. That is just fine. You can use up to two full lines for any line number. The computer will automatically carry it over for you. Make sure, however, that you do not exceed two lines because anything over the second line will not be registered in your computer's memory.

Now that we've built the horses into the program, we have to turn our attention to the eggs. You remember that each baby will need 50 flies and that each horse will help produce 100 flies. With this knowledge, we can write our second section of the program.

```
3Ø  LET E = H*1ØØ/5Ø
```

This line means that the number of eggs (E) equals the number of horses (H) times 100 (because there are 100 flies per horse), divided by 50 (because each baby will need 50 flies).

In the final section of our program, we must instruct the computer to PRINT the number of eggs Hilary should lay. We can do this as follows:

```
4Ø  PRINT "HILARY SHOULD LAY"
5Ø  PRINT E "EGGS THIS YEAR"
```

Your program should now look like this:

```
NEW
1Ø  PRINT "HOW MANY HORSES ARE THERE IN T
HE STABLE THIS YEAR"
2Ø  INPUT H
3Ø  LET E=H*1ØØ/5Ø
4Ø  PRINT "HILARY SHOULD LAY"
5Ø  PRINT E "EGGS THIS YEAR"
```

Try to RUN your program. When the question "HOW MANY HORSES ARE THERE IN THE STABLE THIS YEAR?" appears, enter the number 12. Your computer should then respond with:

```
HILARY SHOULD LAY
24 EGGS THIS YEAR.
```

If this does not happen, then there is probably a mistake in your program. Computer programmers often call these mistakes *bugs*. If you've got a bug in your program, then you'll have to *debug*. In this case we don't mean erasing the spiders and the flies. The best thing to do if you have a bug is to go over the program step by step until you have found your mistake. Make sure you have all the quotation marks in the right place and that you have included all the blank spaces. Finally make sure that all the words are spelled correctly. If you find a line with a mistake, simply retype the entire line, including the line number. The computer will automatically replace the old line with the new line. If you didn't have any bugs, then congratulations. If you did, don't worry—it happens to everyone.

Now, let's put the finishing touch on the program. The first thing we are going to do is clear the screen, only this time we are not going to just press the CLR/HOME and SHIFT keys before we RUN our program. We are going to build a screen-clearing command into our program. This can be accomplished in the following manner:

1. Assign a line number to your instruction.
2. Type PRINT.
3. Type a quotation mark.

4. Press the SHIFT key and the CLR/HOME key. When you do this, a little heart character will appear on your screen. This is the symbol for the CLeaR/HOME instruction in a program.
5. Type an end quotation mark.

This is how the line looks when you add it to your program:

```
5 PRINT "♥"
```

By adding this as the first instruction of your program, you will cause the screen to clear each time the program is RUN.

Now you have a professional-looking population model program and Hilary has her answer: 24.

REVIEW

1. The computer uses these four signs for mathematical operations:

   \+ addition
   \- subtraction
   * multiplication
   / division

2. A *numeric variable* is a letter assigned to a number.

3. *LET* is the word we use to *initialize* a variable in a program.

   Example: 1Ø LET Z=5

4. Variables are used when number information varies during the course of a program.

5. The INPUT statement is used when we want to have information entered from the keyboard into a program while the program is RUNning. It is usually preceded by a PRINT statement.

   Example:
   ```
   2Ø PRINT "HOW OLD ARE YOU"
   3Ø INPUT A
   ```

6. A *bug* is a problem in your program that prevents it from running the way you'd like. The process of finding and removing the mistakes is called *debugging*.

7. You can clear the screen as part of your program by typing the following:

```
10 PRINT "♥"
```

The heart character is the result of pressing the SHIFT and CLEAR HOME keys at the same time after you have typed the quotation mark.

A. IF YOU WANT TO RETURN TO THE STORY, TURN TO PAGE 26.

B. IF YOU WANT TO LEARN MORE ABOUT BASIC PROGRAMMING, KEEP READING.

FOUR

Strings

As you will recall from our story, Erin noticed that one of Hilary's children's webs had dew drops clinging to its strands. At breakfast Uncle Charles compared the rows of dew drops on the strands to characters in a *string.*

You may not have known this, but you have been using strings in almost all of your programs. When you have been typing messages, you have been putting quotation marks around them. In programming, *the message between the " and the next " is referred to as a string.*

Actually, a string does not have to be a message made up of letters. A string may include numbers and symbols as well as letters. Strings can even include blank spaces.

On your particular computer, the Commodore 64, a string can be as long as two lines. That means that you can enclose a message in quotation marks that will fill up as much as two full lines on your screen. (Note that this includes your line number and the PRINT statement.)

You will remember that spaces count as characters. Therefore, the string "SAM" not equal the string "SAM ". Even though it reads the same if you instruct the computer to PRINT "SAM" or PRINT "SAM " its effect will be different when you try to combine your message with another string.

Putting messages together and controlling the way they appear on the screen is called *formatting text.* There are a number of ways you can approach formatting your PRINT statements. One way is to use the semi-colon (;). The semi-colon is used when you want to combine strings that appear on different lines of your program. Always place the semi-colon after the last quotation mark of your PRINT statement.

Try this program to demonstrate the difference between the string "SAM" and "SAM ".

```
NEW
1Ø  PRINT "SAM";
2Ø  PRINT "AND ERIN"
RUN
```

(the result):

```
SAMAND ERIN
```

If you retype Line 1Ø so that your program looks like this:

```
1Ø  PRINT "SAM ";
2Ø  PRINT "AND ERIN"
RUN
```

(the result):

```
SAM AND ERIN
```

The semi-colon and the blank space become even more important when we are using longer messages. Try typing this program. It will give you some more practice at using these formatting tools. It is also good typing practice because it contains all the letters of the alphabet.

```
NEW
1Ø  PRINT "THE QUICK BROWN FOX JUMPS OVER
 THE LAZY DOG.";
2Ø  PRINT " THAT WAS ONE LUCKY FOX."
RUN
```

(the result):

```
THE QUICK BROWN FOX JUMPS OVER THE LAZY
DOG. THAT WAS ONE LUCKY FOX.
```

Notice that we placed a space at the beginning of the second line of Line 1Ø. Even though the computer carried the line over to the next, it is important to type this space because if we don't, the words "OVER" and "THE" will be combined (OVERTHE).

Also notice that we used a space at the beginning of the second

sentence on Line 2Ø. By placing a space here, we are formatting our text so that the two sentences do not run together.

STRING VARIABLES

In the last chapter, you learned about numeric variables. As you will recall, a numeric variable is a letter assigned to a number. Well, there is a second type of variable that is used for strings. It's called a *string variable.*

To let the computer know that the variable we are using is for a string rather than a number, we placed a dollar sign ($) after the variable name. To make the dollar sign, press the SHIFT KEY and the four (4) key at the same time.

So, if you use the variable name "A" or "X" the computer will expect a number. If you use the name "A$" or "X$," it will expect a string. Since the computer recognizes that the variables "A" and "A$" are very different, you may use both these variable names in the same program.

Try typing this program. It demonstrates how to use a string variable. You may clear your screen with SHIFT and CLR/HOME if it's getting crowded.

```
NEW
1Ø  LET A$ = "EMERALD CASCADE"
2Ø  PRINT A$
RUN
```

(the result):

```
EMERALD CASCADE
```

In this program, we LET the variable A$ be equal to the string "EMERALD CASCADE." Another way to say this is that we initalized the variable A$, and gave it the value "EMERALD CASCADE."

One important point to remember about the difference between numeric and string variables: a string variable can be assigned a number, but a numeric variable can never be assigned a letter or a string. If you try to assign a string value to a numeric variable, the computer will not accept it. Instead it will return a "?TYPE MISMATCH ERROR" message. To see what we mean,

try these two sample programs.

```
NEW
10  LET A="TWO"
20  PRINT A
RUN
```

(the result):

```
?TYPE MISMATCH ERROR IN 10
```

```
NEW
10  LET A$="2"
20  PRINT A$
RUN
```

(the result):

```
2
```

The one thing you must remember when using a number in a string is that the number must be enclosed in quotation marks. If it is not, the computer will not accept it. Here is an example of the *wrong* way to use a number as a string.

```
NEW
10  LET A$=2
20  PRINT A$
RUN
```

(the result):

```
?TYPE MISMATCH ERROR IN 10
```

Using INPUT with String Variables

You can also use strings along with the INPUT statement. The only real difference in using strings, as opposed to numbers,

with an INPUT statement is the use of the dollar sign ($). When we used numbers, we typed INPUT H. When we use strings, however, we type INPUT H$.

Type this program:

```
NEW
1Ø  INPUT H$
2Ø  PRINT H$
```

When you RUN this program, you will see a question mark appear on the screen. Because you have used H$, the computer expects you to INPUT a string in response to its question. Since the computer already knows it's a string, you don't have to enclose your string in quotation marks.

Try typing EMERALD CASCADE. The computer responds by PRINTing the value you just INPUT from the keyboard. In this case, "EMERALD CASCADE." If you like, RUN the program several times. Each time INPUT a different string. You can do this because a *string variable,* like a *numeric variable,* can deal with varying information. In fact, that's the very reason we use it.

One of the fun things about using the INPUT statement with strings is that you can program the computer to ask specific questions. You can then take the information that you have INPUT from the keyboard and use it further on in your program. Here is a program that will do just that, only there is one problem—the program has a few text formatting problems. Let's type the program and RUN it to see what happens. Then, we'll debug it. (Note: the apostrophe that appears in Line 1Ø in the word HILARY'S is produced by pressing the SHIFT KEY and the 7 KEY.)

```
NEW
1Ø  PRINT "DO YOU HAVE A NAME FOR HILARY'
S FIRST CHILD?"
2Ø  INPUT N$
3Ø  PRINT "HILARY WILL NAME HER FIRST CHI
LD";
4Ø  PRINT N$
RUN
```

When you RUN the program and it asks the question, DO YOU HAVE A NAME FOR HILARY'S FIRST CHILD?, you may choose any name you wish. We are going to use the name ZELDA for our example.

After entering the name "ZELDA," the screen will look like this:

```
DO YOU HAVE A NAME FOR HILARY'S FIRST CH
ILD?
?ZELDA
HILARY WILL NAME HER FIRST CHILDZELDA
```

Can you locate the text formatting problems? There are two. The first appears as a result of the instruction in Line 1Ø. When the computer prints the string, the word "CHILD" is broken up into two lines:

```
DO YOU HAVE A NAME FOR HILARY'S FIRST CH
ILD?
```

We can correct this by retyping Line 1Ø so that it reads as follows:

```
1Ø  PRINT "  DO YOU HAVE A NAME FOR HILAR
Y'S FIRST CHILD?"
```

By adding two spaces after the first quotation mark, we have shifted the whole string over two spaces. This also improves the way the line looks because it indents the beginning of the sentence.

The second mistake is the result of our instruction in Line 3Ø. By placing the semi-colon at the end of the string, we instructed the computer to connect the first string to the string that appears on the next line. This is why the words "CHILD" and "ZELDA" appear together as CHILDZELDA.

We can solve this problem in a similar way. All we have to do is to retype Line 3Ø. This time, however, we'll add a blank space to the string after the word CHILD. Our new Line 3Ø will look like this:

```
3Ø  PRINT "HILARY WILL NAME HER FIRST CHI
LD ";
```

Now, when we run our program, the screen display will look like this:

```
 DO YOU HAVE A NAME FOR HILARY'S FIRST
CHILD?
? ZELDA
HILARY WILL NAME HER FIRST CHILD ZELDA
```

Now that we have the program debugged, let's add two final touches that will improve the way the program looks.

First, let's LIST the program and see it as a whole. Type LIST and press RETURN.

In its present state, our program looks like this:

```
1Ø  " DO YOU HAVE A NAME FOR HILAR
Y'S FIRST CHILD?"
2Ø  INPUT N$
3Ø  PRINT "HILARY WILL NAME HER FIRST CHI
LD ";
4Ø  PRINT N$
```

First, let's put a screen clearing command into the program. As you will recall, this is accomplished by placing a SHIFT:CLR/HOME inside quotation marks. The screen will show the heart character when you do this. Add this line to your program:

```
5  PRINT "♥"
```

The final touch is accomplished by using the PRINT statement to PRINT blank lines. This will improve the way the text looks on the screen. All you have to do to make a blank line is to use the PRINT command with no string or quotation marks. Add these lines to your program to see what we mean.

```
 7 PRINT
 8 PRINT
15 PRINT
25 PRINT
```

Now when you RUN your program, the screen will clear and, starting on the third line of the screen, you will see:

```
 DO YOU HAVE A NAME FOR HILARY'S FIRST
CHILD?

?
```

Notice that there is now a blank space between the question and the line where you enter your response. The blank was the result of your PRINT instruction from Line 15. The two blank lines at the beginning are the result of the PRINT instructions from Lines 7 and 8.

To see what Line 25 does, enter your name selection. Your final display will then look like this:

```
 DO YOU HAVE A NAME FOR HILARY'S FIRST
CHILD?

? ZELDA

 HILARY WILL NAME HER FIRST CHILD ZELDA
```

Using strings and formatting text are two important parts of writing programs. The program is a lot like HILARY'S WEB. The different lines are like the individual strands. The strings are like the patterned dew drops.

REVIEW

1. A message that occurs between the " " is referred to as a *string*.

2. A string can fill up to two lines of the screen. This includes the line number and the PRINT statement.

3. Blank spaces count as characters in a string.

4. Strings can be made up of characters that are letters, numbers or symbols as long as they are enclosed in quotation marks.

5. One way to connect strings from different lines in the program is to use the semi-colon (;) after the final quotation mark of the first line.

   Example: 1Ø PRINT "SAM ";
   2Ø PRINT "AND ERIN"
   (result) SAM AND ERIN

6. Strings can be assigned a variable name. When assigning the name, we add the dollar sign ($) to the letter.

   Example: 1Ø LET A$ = "EMERALD CASCADE"

7. A string variable may be assigned a number as its value but a numeric variable may never be assigned a letter as its value.

8. The INPUT statement may be used with a string variable.

   Example: 1Ø INPUT N$

9. Controlling the way strings appear on the screen is called *formatting* the *text.*

10. A *bug* is a problem that occurs in a program when it is running. This problem may cause the program to RUN improperly or to produce effects that are not desired. *Debugging* is the process of working out the problem.

11. You can use a PRINT statement without a message to produce a blank line in your screen display.

    Example: 1Ø PRINT

A. If you want to return to the story, turn to page 34.

B. If you want to learn more about BASIC programming, keep reading.

FIVE

Loops

In this section, we are going to use programming loops to build a model of Hilary's web. Our model will enable us to tell Hilary how many circles we would like her to weave into her web. It will also tell us how many dew drops wide the web will be at each complete circle.

Before we build this program, however, a little background on loops would be helpful.

THE FOREVER GOTO LOOP

A loop does just what the word implies; it creates a circle of instructions within a program. Loops are a lot of fun and can create very dramatic effects. The easiest kind of loop to understand is the forever GOTO loop. We say "forever" because the loop RUNs continuously and will not stop unless you tell it to—not unlike the Reverend Berkley telling dinner stories.

Whenever Nora got tired of the reverend's stories, she had a sure-fire way to turn him off. All she had to do was say, "Reverend, spare us your verbiage!" You can do the same thing with your computer. When you've had enough, just tell it to stop by pressing the RUN/STOP key. The RUN/STOP key is located on the far left-hand side of the second row of your keyboard.

Now that we know how to stop him, let's build a program based around the Reverend's typical dinner conversation.

```
10  PRINT "♥"
20  PRINT "REVEREND BERKLEY LIKES TO TELL
STORY, ";
30  PRINT "AFTER STORY, ";
40  GOTO 30
```

Before you RUN this program, make sure all your work is correct. Check all your blank spaces and punctuation since they are very important to the final text format. When everything checks out, RUN the program for a big surprise. Oh yes, don't forget to press the RUN/STOP key to turn him off.

If all went well, you got a screen display that looked like this:

```
REVEREND BERKLEY LIKES TO TELL STORY, AF
TER STORY, AFTER STORY, AFTER STORY, AFT
ER STORY, AFTER STORY, AFTER STORY, AFTE
R STORY, AFTER STORY, AFTER STORY, AFTER
STORY.....ETC.
```

Here is a line-by-line description of how this program works:

Line 1Ø clears the screen with a SHIFT:CLR/HOME instruction.

Line 2Ø PRINTs the message "REVEREND BERKLEY LIKES TO TELL STORY. " Notice the blank space after the message. Also notice the semi-colon at the end of the line. This is a string connecter; you learned about this earlier. The semi-colon connects this message with the one in the next line.

Line 3Ø PRINTs the message "AFTER STORY. " Once again, notice the blank space and the semi-colon.

Line 4Ø is the most important line in the program because it creates the loop. The GOTO command does exactly what you would expect. It tells the computer to GO TO the Line 3Ø. Whenever the computer encounters a GOTO instruction, it will go directly to the line number that follows the command. So GOTO 15Ø sends the computer to Line 15Ø while GOTO 25 sends it to Line 25.

Now that you know what each line does, can you figure out how the loop works? It's easy; after the computer PRINTs "AFTER STORY," it receives an instruction to GOTO Line 3Ø and PRINT "AFTER STORY" again. After it executes Line 3Ø, it then moves back down to Line 4Ø and receives the GOTO 3Ø instruc-

tion once more. This process repeats over and over and over, forming a forever GOTO loop.

If you would like to have some fun with this program, you can ConTRL the speed of Reverend Berkley's stories by pressing the CTRL key while the program is running. The CTRL key is located at the far left-hand side of the third row of keys. The CTRL key has many uses. One of them is to slow down a program while it is running. Try RUNning your program and pressing the ConTRL key a few times to see what we mean.

The GOTO instruction has many other uses besides forming loops. We'll learn about some of them a little later. For now, however, let's learn another way to create a loop in a program.

THE FOR-NEXT LOOP

Another way that you can create loops is by using the FOR-NEXT instruction. Unlike the forever GOTO loop, this kind of loop does not RUN forever. That's because the FOR-NEXT loop has a built-in counter. This counter lets us loop exactly the number of times we want.

To demonstrate this counter, let's write a program that uses a FOR-NEXT loop. In this program, we'll use the variable name "C" to represent the "Counter."

```
NEW
10  FOR C=1 TO 5
20  PRINT "THIS IS LOOP NUMBER ";
30  PRINT C
40  NEXT C
```

Why not RUN the program and see what happens. You should get the following screen display:

```
THIS IS LOOP NUMBER 1
THIS IS LOOP NUMBER 2
THIS IS LOOP NUMBER 3
THIS IS LOOP NUMBER 4
THIS IS LOOP NUMBER 5
```

Here is how our program works:

Line 1Ø does a lot of work because it is here that we set up our counter. FOR C = 1 TO 5 means that FOR the variable C (our counter), we assigned the values 1 through 5. This line defines the loop.

Line 2Ø PRINTs "THIS IS LOOP NUMBER." You've seen this kind of PRINT statement before. Also note the semi-colon.

Line 3Ø PRINTs the value of the variable C. As you can see when you RUN this program, the value of C varies. The first time through the loop, the value is 1; the second time it is 2, all the way up through 5.

Line 4Ø is the final part of the loop. Each time the computer comes across the NEXT C instruction, it does three things: First, it increases the value of the counter C by one. Second, it sends the computer back to the line with the FOR instruction to start the loop again. Third and finally, when the computer has performed the loop five times as defined by the FOR instruction, the computer leaves the loop like a runner scooting off a track after a race.

Let's use a FOR-NEXT loop to recreate our Reverend Berkley program. This time, however, we'll only let the Reverend tell his story sixty-three times. In this program, we'll call our counter "S" for stories.

```
NEW
1Ø PRINT "♥"
2Ø PRINT "REVEREND BERKLEY LIKES TO TELL STORY, ";
3Ø FOR S=1 TO 63
4Ø PRINT "AFTER STORY, ";
5Ø NEXT S
```

Now when you RUN your program, you'll get a full screen's worth of the Reverend.

Are you beginning to see how the FOR-NEXT loop works? All you really have to do is define your loop with the FOR state-

ment, outlining the number of loops you want. In this program, we wanted 63 loops so we said FOR S = 1 TO 63.

The next step is to write the instructions to be included inside the loop. In our program it was a simple PRINT statement "AFTER STORY."

Finally, you must end the loop with a NEXT statement. It's a good practice to include the name of the loop counter with your NEXT statement; that's why we used NEXT S instead of just plain NEXT. This way, if you use more than one FOR-NEXT loop in a program, you will know which NEXT refers to which FOR.

One final but important rule about FOR-NEXT loops: any time you use a FOR, you must use a NEXT. Also, any time you use a NEXT, you must use a FOR. If you don't, the computer will get confused and give you a "FOR WITHOUT NEXT" or "NEXT WITHOUT FOR" error message.

WEAVING THE WEB WITH FOR-NEXT

Now we are ready for our web-building program. One very important element which we have to work into this program is that as Hilary's web grows in its number of loops, it gets wider and wider. That's what Sam was telling Erin when he reminded her that if Hilary just went around in circles, she wouldn't really get anywhere. The circles of Hilary's web have to get bigger and bigger instead of going around and around in the same place.

Therefore, we are going to have to make the loop in our program change each time Hilary adds another loop to her web. That's just fine becaause things *can* change within a loop each time the computer goes through it.

The next question we ask is "What is it that is going to change?" And the answer, of course, is the size of the loop. As we learned from Hilary, spiders measure their loops in dew drops. So, we'll assign the number of dew drops a variable name, since it is going to vary while the program is running. We'll name our variable "D" for "dew drops."

Erin figured out that each loop in Hilary's web was five dew drops wider than the one inside it. With this knowledge, we can begin to write our program. First, we'll clear the screen and then we'll initialize our dew drop variable to the number 5 since the first loop is going to be five dew drops wide.

```
10 PRINT "♥"
20 LET D=5
```

The next step is to decide how many loops Hilary is going to weave into the web. Let's pick lucky seven so we can catch a lot of flies. To make the web seven loops wide, all we have to do is write the following instruction. Here, we'll use the variable name W for Web.

```
30 FOR W=1 TO 7
```

Now, we will add a series of instructions to include in the loop. You can think of these instructions as the material that makes up the individual strand that forms each circle. Actually, these PRINT instructions will help us see just how to put together a loop. Here they are:

```
40 PRINT "THIS IS LOOP NUMBER";
50 PRINT W
60 PRINT " HILARY'S WEB IS NOW";
70 PRINT D;
80 PRINT "DEW DROPS WIDE."
```

Now that we have completed a loop, we'll have to get ready for the next one which will have to be five dew drops wide. To accomplish this, let's add the following line to our program:

```
90 LET D=D+5
```

This line changes the value of the variable D by increasing it by 5. Since the D stands for dew drops, our next loop will be five dew drops wider. Let's call for our NEXT loop with the final instruction in the program.

```
100 NEXT W
```

Your program should now look like this:

```
10 PRINT "♥"
20 LET D=5
30 FOR W=1 TO 7
40 PRINT "THIS IS LOOP NUMBER";
50 PRINT W
60 PRINT " HILARY'S WEB IS NOW";
70 PRINT D;
80 PRINT "DEW DROPS WIDE."
90 LET D=D+5
100 NEXT W
```

After you have checked all the lines to see that they are correct, RUN your program. This is what you will see:

```
THIS IS LOOP NUMBER 1
 HILARY'S WEB IS NOW 5 DEW DROPS WIDE.
THIS IS LOOP NUMBER 2
 HILARY'S WEB IS NOW 10 DEW DROPS WIDE.
THIS IS LOOP NUMBER 3
 HILARY'S WEB IS NOW 15 DEW DROPS WIDE.
THIS IS LOOP NUMBER 4
 HILARY'S WEB IS NOW 20 DEW DROPS WIDE.
THIS IS LOOP NUMBER 5
 HILARY'S WEB IS NOW 25 DEW DROPS WIDE.
THIS IS LOOP NUMBER 6
 HILARY'S WEB IS NOW 30 DEW DROPS WIDE.
THIS IS LOOP NUMBER 7
 HILARY'S WEB IS NOW 35 DEW DROPS WIDE.
```

Well, there is your web. I'm sure you'll agree that FOR weaving webs, computers are NEXT to spiders. Hilary follows the instructions of her instincts; the computer follows the instructions of its programmer; YOU!

Now, let's take this program one more step. As it stands now, Hilary can only build one size web. It will always have seven

loops. Can you think of a simple way to change this program so that we can vary the size of the web each time we RUN the program?

THE INPUT FOR-NEXT WEB WEAVER

Here is the answer: use the INPUT instruction. Add these two new lines to your program.

```
12  PRINT "HOW MANY TIMES WOULD YOU LIKE HILARY TO GO
AROUND HER WEB"
15  INPUT T
```

Now retype Line 3Ø:

```
3Ø  FOR W = 1 TO T
```

By adding these new lines to our program, we can vary the size of our web. By using the INPUT statement, you can use a variable *before* you enter a loop to tell the computer how many times you want it to loop. Being able to control your program in this way makes it much more flexible. Different situations require different solutions just as different locations require different size webs.

Now, when you INPUT a value from the keyboard, that value will be assigned to the variable "T." We picked T because it stands for the number of **T**imes we are going to loop. We then define the loop in Line 3Ø with FOR W = 1 TO T. This line makes the web loop as many times as the number INPUT from the keyboard.

Your program should now look like this:

```
1Ø  PRINT "♥"
12  PRINT "HOW MANY TIMES WOULD YOU LIKE HILARY TO GO
AROUND HER WEB"
15  INPUT T
2Ø  LET D = 5
3Ø  FOR W = 1 TO T
4Ø  PRINT "THIS IS LOOP NUMBER";
```

```
50 PRINT W
60 PRINT " HILARY'S WEB IS NOW";
70 PRINT D;
80 PRINT "DEW DROPS WIDE."
90 LET D=D+5
100 NEXT W
```

Check your work and when you are satisfied it is correct, RUN the program. When the computer asks, "HOW MANY TIMES WOULD YOU LIKE HILARY TO GO AROUND HER WEB?" just enter a number from the keyboard. Your web will then grow to whatever number of loops you have selected.

We'll learn more about loops and some of their many other uses a little later.

REVIEW

1. A loop creates a circle of instructions within a program.
2. The RUN/STOP key is used to stop a program while it is running.
3. GOTO instructs the computer to GO TO the line number following the command.

   Example: GOTO 30 instructs the computer to GO TO Line 30.
4. GOTO can be used to create a continuous loop.

   Example:
   ```
   10 PRINT "HELP, I'M CAUGHT IN A LOOP"
   20 GOTO 10
   ```
5. The CTRL key can be used to slow down a program while it is running.
6. FOR-NEXT is another kind of loop. The FOR part defines the number of times the program will loop. The NEXT part keeps track of the loop counter and defines the end of the loop.

   Example:
   ```
   10 FOR Z=1 TO 5
   20 NEXT Z
   ```

7. You must always use a NEXT statement when you use a FOR statement. Also, you must always use a FOR statement when you use a NEXT statement. If you do not, the program will not RUN and you will receive an error message.

8. A FOR-NEXT loop differs from a forever GOTO loop because with a FOR-NEXT loop, you can define the number of loops.

9. Variables inside of a loop may change each time through the loop.

   Example:
   ```
   10 LET D=5
   20 FOR W=1 TO 7
   30 D=D+5
   40 NEXT W
   50 PRINT D
   ```

10. You can use a variable *before* you enter a loop to tell the computer how many times you want it to loop. This is done with the INPUT statement.

    Example:
    ```
    10 PRINT "HOW MANY TIMES DO YOU
    WANT TO LOOP"
    20 INPUT T
    30 FOR W=1 TO T
    40 NEXT W
    ```

A. IF YOU WANT TO RETURN TO THE STORY, TURN TO PAGE 44.

B. IF YOU WANT TO LEARN MORE ABOUT BASIC PROGRAMMING, KEEP READING.

SIX

Conditional Statements, Branching Statements and More Loops

Computers are very good at accomplishing tasks, but only when they have a complete set of instructions in the form of a program. One thing that computers cannot do is make decisions on their own. For this reason, whenever we have a situation where a number of possible choices are available, we have to use *conditional logic*.

To help you understand what conditional logic is and how we use it in programming a computer, let's construct a program around the idea of Erin's choice of doors. As you will recall, Erin was in a hallway which had three doors. Two of the doors led to routes to the tower (the tunnel and The Labyrinth) while the other led directly to the library.

Let's consider the two doors that lead Erin to the tunnel and The Labyrinth. In programming, we can express this choice using the IF-THEN statement. IF Erin chooses door one, THEN she will be in the tunnel, or, IF she chooses door two, THEN she will be in The Labyrinth. We have to make sure to give the computer instructions for both possibilities.

The program below illustrates one possible way to build this program. This short program will introduce you to three new concepts; the IF-THEN statement, the use of the colon (:), and the END statement. Here is the program:

```
1Ø PRINT "[♥]"
2Ø PRINT " YOU ARE IN THE HALLWAY."
3Ø PRINT "WHICH DOOR DO YOU CHOOSE"
4Ø PRINT "1 OR 2"
5Ø INPUT D
6Ø IF D=1 THEN PRINT "YOU ARE IN THE TUNNEL":END
7Ø PRINT "YOU ARE IN THE LABYRINTH":END
```

Lines 1Ø-5Ø set up the first part of the program. There is nothing new here. We clear the screen in Line 1Ø for a series of PRINT statements that follow.

Lines 3Ø-4Ø ask the question "WHICH DOOR DO YOU CHOOSE, 1 OR 2?"

Line 5Ø sets up an INPUT statement. We used the variable name D for doors.

At this point, the computer is going to have to make a choice. IF you select door 1, THEN the computer will have to tell you that "YOU ARE IN THE TUNNEL." IF you choose door 2, THEN the computer must tell you that "YOU ARE IN THE LABYRINTH." All of this work is accomplished in Lines 6Ø and 7Ø.

```
6Ø IF D=1 THEN PRINT "YOU ARE IN THE TUNNEL":END
7Ø PRINT "YOU ARE IN THE LABYRINTH":END
```

USING THE COLON

In these two lines (6Ø and 7Ø), we will find all of our new concepts. In all of our previous programs, we have only used one instruction for each line number. Sometimes, however, we will want to use more than one instruction in a line. When this situation arises, we use the colon (:). The colon (:) tells the computer that the first instruction is complete and the next instruction is beginning. You may use as many instructions as you like for each line number. The only rules you have to follow are:

1. A colon (:) must separate each instruction.

2. You can only use up to two full lines of instructions per line number.
3. A colon (:) should not appear after the last instruction in the line.

THE END STATEMENT

The second new concept we find in these lines is the END statement. Whenever the computer encounters an END statement, no matter where it is in the program, it will END the program. You will notice that there are two END statements in this program, one on Line 60 and one on Line 70. Even though there are two END statements, the computer will use only one of them. That's because of the conditional logic built into the program.

THE IF-THEN STATEMENT

The conditional logic we are speaking of is the IF-THEN statement, the final new concept in Lines 60 and 70. An IF-THEN statement sets up *conditions* for the direction of the program. It works in the following way: whenever the computer encounters an IF statement, it checks the possibilities that follow it in the statement. IF that condition is true, THEN the computer will follow the instruction that immediately follows to the right of the THEN statement. IF, however, the condition is not true, THEN the computer ignores all of the instructions that follow the THEN statement and immediately skips to the next line number.

Let's see how this works in Lines 60 and 70 of our program.

```
60  IF D=1 THEN PRINT "YOU ARE IN THE TUNNEL":END
70  PRINT "YOU ARE IN THE LABYRINTH":END
```

First, let's explore what happens if you enter "1" for "door 1." The first thing the computer will do is check the condition of the statement that follows the IF statement in Line 60. Since we entered the number 1 and that number was assigned to the variable D by the INPUT statement in Line 50, the statement D = 1 is true. IF D = 1 is true (which it is), THEN the computer will perform the instructions to the right of the THEN

statement. Thus, the computer PRINTs:

YOU ARE IN THE TUNNEL

After PRINTing the message, it reads the colon (:) and knows that there is another instruction on the line. That instruction is to END the program, which is exactly what the computer does. Since the program ENDs, the computer will never get a chance to perform the commands on Line 7Ø.

Because the program has ENDed, it is necessary to RUN it again to see what happens if we explore door 2. Type RUN and enter 2 when the computer prompts, "WHICH DOOR DO YOU CHOOSE, 1 OR 2."

This time, the computer will perform in exactly the same way as it did before until it comes to Line 6Ø. This time, however, when it checks the condition of the statement following the IF statement in Line 6Ø, it will perform differently. Can you figure out why?

When the computer checks IF D = 1, it will see that this statement is false. This is because we assigned D the value of 2. Since D does not equal 1, the computer will ignore everything that follows to the right of the THEN statement on Line 6Ø and skip down to Line 7Ø.

At Line 7Ø, it receives an instruction to PRINT "YOU ARE IN THE LABYRINTH."

After PRINTing the message, the computer reads the colon (:) and knows that there is still another instruction on the line. Once again, the instruction is to END the program.

By using the conditional logic of the IF-THEN statement, we were able to give the computer the necessary information to deal with either one of our two possible choices. In this way, the computer was never in the situation of having to choose for itself. We built a program with a series of instructions that covered both possible conditions.

Another way to build this program is with the IF-THEN statement combined with the GOTO statement. This time we are going to use GOTO as a *branching* statement rather than as a looping statement.

BRANCHING STATEMENTS

As you will recall from an earlier section, we defined a program as a series of instructions to the computer. Each instruction has its own line number so that the computer will follow the correct order in performing the instructions. There are, however, a group of instructions that allow us to jump around the number lines. These instructions are called *branching statements* because they allow us to branch from one section of the program to another. The easiest to use of all these branching statements is GOTO.

The correct form of the GOTO statement is:

```
10 PRINT "HI THERE"
20 GOTO 10
```

When the computer reads the above instruction, it wil GO TO Line 10 and perform the instruction we have written for Line 10, in this case, PRINT "HI THERE."

Let's use GOTO to construct another program where we have to choose a door.

```
10 PRINT "[♥]"
20 PRINT "  YOU ARE IN THE HALLWAY."
30 PRINT "WHICH DOOR DO YOU CHOOSE"
40 PRINT "1 OR 2"
50 INPUT D
60 IF D=1 THEN GOTO 80
70 PRINT "YOU ARE IN THE LABYRINTH":END
80 PRINT "YOU ARE IN THE TUNNEL":END
```

As you can see, the first five lines (10-50) are the same as our original program. Once again, Line 60 is the pivotal line of the program.

```
60 IF D=1 THEN GOTO 80
```

To see how this line works, RUN the program and type "1" in response to the question "WHICH DOOR DO YOU CHOOSE, 1 OR 2."

Now, when the computer gets to Line 60, it will check the condition of the statement following the IF statement. Since the condition is true (D does equal 1), the computer will perform the instruction to the right of the THEN statement. Thus, it moves directly to Line 80, skipping over Line 70. At Line 80, it receives the instruction to PRINT "YOU ARE IN THE TUNNEL," and then a second instruction to END the program.

Now, let's see what happens when we enter door 2. RUN the program a second time. This time, type "2" in response to the question "WHICH DOOR DO YOU CHOOSE, 1 OR 2?"

This time, when the computer arrives at Line 60 it will again check the condition of the statement that follows the IF statement. Since the condition is false (D does not equal 1, it equals 2), the computer ignores the instruction that follows the THEN statement on Line 60 and skips down to Line 70.

At Line 70, it receives the instruction to PRINT "YOU ARE IN THE LABYRINTH" and a second instruction to END the program. Notice that the computer never made it down to Line 80.

So you see, in this approach to solving the problem, we used the branching GOTO combined with the conditional IF-THEN. By using the GOTO we were able to branch off to the part of the program that supplied the correct instructions for the situation. Once again, the computer was never asked to choose for itself. We told it to use Line 80 if door 1 was chosen; otherwise, use Line 70.

CONDITIONAL LOOPS

So far, we have learned about two kinds of loops. The first we called the "forever GOTO loop" because it looped around and around and never stopped. The second was called the FOR-NEXT loop. As you will recall, the FOR-NEXT loop enabled us to define how many times we wanted the computer to go through the loop.

But what happens when we don't know ahead of time how many loops we will need? What happens if a certain condition has to be true before the loop is to stop. For a situation like this, we need a third kind of loop. It's called a conditional loop.

To illustrate how a conditional loop works, let's build another

program to help Hilary with her egg laying. As you will recall from our population model program, Hilary had to lay 50 eggs. Hilary's new problem is that at any given time, she can lay between one and seven eggs in her egg sac. She needs help in figuring out when her egg sac has been filled to 50. Let's construct a program to help her.

In the first part of this program, we'll use a series of PRINT statements to outline what we are going to do in the program. Go to your computer and type in the following lines:

```
NEW
 1Ø  PRINT "♥"
 2Ø  PRINT "  HILARY WANTS TO FILL HER EGG SAC WITH"
 3Ø  PRINT "EXACTLY 5Ø EGGS AND NEEDS YOUR HELP."
 4Ø  PRINT "  SHE CAN PUT BETWEEN 1 AND 7 EGGS IN AT A
TIME BUT SHE CAN NOT TELL";
 5Ø  PRINT "  WHEN HER SAC IS FULL."
 6Ø  PRINT
```

To check your work, try RUNning the program as it now stands. Your screen display should look like this:

```
HILARY WANTS TO FILL HER EGG SAC WITH EXACTLY 5Ø
EGGS AND SHE NEEDS YOUR HELP.

SHE CAN PUT BETWEEN 1 AND 7 EGGS IN AT A TIME BUT
SHE CAN NOT TELL WHEN HER SAC IS FULL.
```

The next step is to figure out a way to put between 1 and 7 eggs in the sac. We'll also have to keep track of how many eggs there are in the sac. This means that we are going to need two variables. We will call the number of the eggs already in the sac "S," and we'll call the number of eggs that she lays at any given time (between 1 and 7) "E."

REM STATEMENTS

When using more than one variable in a program, it sometimes gets a little difficult to keep track of what is going on. One way

to get around this is to use the REM statement. A REM statement is just a little reminder that you can put into a program. To use a REM statement, all you have to do is type REM and then a message. Whenever the computer sees a REM statement, it knows that it is just a reminder and not an instruction. Therefore, the computer will ignore any REM statement you put into a program.

Let's use REM statements to help us set up the next part of the program.

```
7Ø  LET S=Ø:REM NO EGGS IN SAC TO START
```

Make sure to use the colon in between the two parts of the line. Also make sure to type the word REM or the computer will not know that the message is just a reminder.

Our next step is to create a way to place the eggs in the sac. This is easy—all we have to do is use the INPUT statement. Let's add these lines to the program.

```
8Ø  PRINT "HOW MANY EGGS SHOULD SHE PUT IN THE
SAC (BETWEEN 1 AND 7)"
9Ø  INPUT E:REM NUMBER OF EGGS JUST LAID
```

After we add between 1 and 7 eggs to the sac, we have to update the variable S. This means that we have to add the number of eggs just laid (E), to the number of eggs already in the sac (S). We should then have the computer PRINT out the number of eggs currently in the sac. We can do all this by adding these next two lines to our program.

```
1ØØ  LET S=S+E:REM THE NUMBER OF EGGS IN THE SAC
PLUS WHAT SHE JUST LAID
11Ø  PRINT "HILARY'S EGG SAC CONTAINS" S "EGGS"
```

The final step in our program is to build in the conditional logic to deal with three possibilities.

1. IF there are less than (<) 50 eggs, THEN we have to tell Hilary to lay more of them.
2. IF there are exactly 50, THEN we have to tell her she has completed the job.

3. IF there are more than (>) 50 eggs, then we have to tell her to stop because there are too many.

We can do all this work by adding the following lines.

```
120 IF S<50 THEN GOTO 80
130 IF S=50 THEN PRINT "THAT'S JUST RIGHT":END
140 IF S>50 THEN PRINT "STOP THAT'S TOO MANY!":END
```

By adding these lines, the computer now will be able to deal with all three possibilities. IF there are less than 50 eggs, THEN it will loop back to Line 80 and we can add more. IF there are exactly 50, THEN it will PRINT "THAT'S JUST RIGHT" and END the program. IF we make a mistake and add too many, THEN the computer will tell us "STOP THAT'S TOO MANY" and END the program.

Here is what our final version looks like. Check it against yours for any mistakes. When you are satisfied that all is correct, RUN the program and see what happens.

```
10 PRINT "♥"
20 PRINT " HILARY WANTS TO FILL HER EGG SAC WITH"
30 PRINT "EXACTLY 50 EGGS AND SHE NEEDS YOUR HELP."
40 PRINT " SHE CAN PUT BETWEEN 1 AND 7 EGGS IN AT
A TIME BUT SHE CAN NOT TELL";
50 PRINT " WHEN HER SAC IS FULL."
60 PRINT
70 LET S=0:REM NO EGGS IN SAC
80 PRINT "HOW MANY EGGS SHOULD SHE PUT IN THE
SAC (BETWEEN 1 AND 7)"
90 INPUT E:REM NUMBER OF EGGS JUST LAID
100 LET S=S+E:REM NUMBER OF EGGS IN THE SAC
PLUS WHAT SHE JUST LAID
110 PRINT "HILARY'S EGG SAC CONTAINS" S "EGGS"
120 IF S<50 THEN GOTO 80
130 IF S=50 THEN PRINT "THAT'S JUST RIGHT":END
140 IF S>50 THEN PRINT "STOP THAT'S TOO MANY!":END
```

REVIEW

1. The colon (:) is used when we want to use more than one instruction on a line.

   Three rules to follow when using the colon are:

   a. The colon must be used between each instruction.

   b. You can use up to two full lines of instructions per line number.

   c. A colon should not be used after the last instruction.

2. The END statement is used to END the program. The computer will END the program immediately after encountering the END statement no matter where it is in the program.

3. The IF-THEN statement is used when you need to build conditional logic into a program—whenever a number of conditions are possible. Here is the correct form for an IF-THEN statement.

   ```
   2Ø IF D=1 THEN PRINT "HELLO"
   ```

   Whenever the computer encounters the IF statement, it checks to see if the statement following the IF is true. IF it is, THEN the computer performs all the instructions to the right of the THEN statement. IF it is false, THEN the computer ignores the instructions to the right of the IF statement and skips to the next line.

4. Branching statements allow you to skip around the numbered lines. In other words, you can branch from one section of the program to another. GOTO is an example of a branching statement.

5. Conditional loops are used when you want to have a loop in your program but do not know ahead of time how many loops you will need. Usually a certain condition must be true to break out of the loop. Conditional loops use the IF-THEN statement. Here is an example of a conditional loop that uses branching statements.

```
10 LET S=0
20 PRINT "THIS IS A CONDITIONAL LOOP"
30 S=S+1
40 IF S=5 THEN GOTO 60
50 GOTO 20
60 PRINT "THE END":END
```

6. The REM statement is a reminder. It helps you keep track of what is going on in your program. The computer ignores REM statements which means it does not treat them as instructions. To correctly use a REM statement, you must type the word REM before your reminder message. Here are two examples:

```
10 REM THIS IS EXAMPLE ONE
20 PRINT "HILARY":REM THIS IS EXAMPLE TWO
```

A. IF YOU WANT TO RETURN TO THE STORY, TURN TO PAGE 52.

B. IF YOU WANT TO LEARN MORE ABOUT BASIC PROGRAMMING, KEEP READING.

SEVEN

Computers and Language

In this lesson we will examine how a computer works and learn more about its language.

BASIC, the language that comes built into your Commodore 64, was developed at Dartmouth College during 1963-4. It stands for *B*eginners *A*ll-purpose *S*ymbolic *I*nstruction *C*ode. When you run a program the computer translates the BASIC statements into its own language called *machine code*. The symbols change but the *meaning* of your program is preserved.

Even though almost all home computers use BASIC, a program written for one computer will rarely work on another. Fortunately, the fundamental ideas are shared: variables, loops, conditionals, and more are common to all forms of BASIC. Often programs just need minor changes to run on some other computer.

The version of BASIC that your Commodore uses sits inside a part of its memory called ROM or *R*ead *O*nly *M*emory. It is called Read Only because you can read information that is stored in ROM but you can't store any new information. If Solomon Snow stored his books in a ROM pond, he would never be able to add more books to his library. When you turn on your computer the tiny *microprocessor*, the main control center activates and looks into its ROM to remember what kind of computer it is. Apple and Atari computers and the Commodore 64 all have the same microprocessor, therefore, the same machine language, but their Read Only Memories are different and so these three computers have very different "personalities."

Inside the 64's ROM there is a machine code program that every one sixtieth of a second checks to see if any key has been pressed, if the screen should be changed and a small host of

other housekeeping details. Also, there is a part of ROM that contains a machine code program to interpret BASIC statements into into equivalent machine code programs. A simple program line such as:

```
10 PRINT "HI"
```

will translate into a fairly long machine code program that might begin:

```
10010100
00111001
10011000
00111101
10100001
00110110
   .
   .
   .
```

and so forth for altogether too long.

Machine code programs generally work more quickly than equivalent BASIC ones, but BASIC, as you may notice, is easier to read.

When you type RUN and press RETURN, the version of BASIC in your computer's ROM will look for the lowest numbered line and then translate that line into a single machine code program similar to the above. It will then run that program. The Commodore 64 then goes on to the next BASIC line and translates it into machine code and runs that. Somewhat like an inch worm the computer goes back and forth between machine code and BASIC. Breaking up the execution of a program into small steps is slow but the programs are thus easier to change and expand.

There is another kind of memory that your Commodore 64 has: RAM, or *R*andom *A*ccess *M*emory. Unlike ROM, RAM is erased when you turn off your computer. The advantage is that you can use it to store information while your computer is on. Remember that you can't store new information in ROM. The

translation program that resides in ROM uses RAM as a scratch-pad while it is doing its work. Each piece of RAM has an address, like the books in Solomon Snow's library.

The POKE statement allows you to put something in RAM. Address 53281 is where the 64 looks every 1/60 of a second to see what color the screen should be. If you type in:

```
POKE 53281,1
```

and then press RETURN; the screen will turn white. By typing POKE 53281, you tell the computer to go to the place in its memory where it stores the background color. By typing a comma (,) and then a one (1), we tell the computer to change the color to white. (1 is the POKE code for white—if you want to see your cursor better press CONTROL and 1 at the same time.

Address 53272 is where the 64 checks for character shapes. Try this—it will jam your computer so be ready to flick your 64 on and off to clear the jam.

First, type a lot of symbols onto the screen, such as QWERYOUP.

Then find an empty line and type:

```
1Ø POKE 53272,7
```

Now press RETURN, and then run your program.

When you get tired of the show turn your computer off and then on again. When you turned the computer off your intervention in address 53272 was forgotten and your screen display returned to normal.

In each of the above two examples of BASIC at work, a machine code program residing in ROM translated (or *mapped*) the BASIC line into equivalent machine code programs.

The fact that POKE addresses in different computers vary is still another reason it can be difficult translating programs from one version of BASIC to another. The Babel thickens when you consider the multitude of other computer languages besides BASIC. Here are a few of the more important:

- LOGO
- FORTRAN
- ADA
- C
- FORTH
- LISP
- COBOL
- Pascal

There is, as yet, no Goodrich Rock that will translate all the different computer languages. Nor is there a computer that understands simple English. Even so, the computer allows us to understand more about the world we live in. Erin has learned that computers can help her and be interesting as well. We hope that you have too!

A. IF YOU WOULD LIKE TO RETURN TO THE STORY, TURN TO PAGE 98.

B. IF YOU WOULD LIKE SOME HELPFUL HINTS, KEEP READING.

EIGHT

Helpful Hints and Shortcuts

By now, you are probably getting pretty good at using your Commodore 64 computer. In this section we'll give you a number of helpful hints and shortcuts that will make your programs easier to type and more interesting to look at.

HINT 1: ABBREVIATIONS

Up until now, you have been typing your instructions using special BASIC words like PRINT and LIST. There are abbreviations that you can use to save time and effort. Here are some of the most common:

PRINT

The abbreviation for PRINT is the question mark (?).

```
10 PRINT "HILARY"
```

is the same as

```
10 ? "HILARY"
```

The nice thing about abbreviations is that when you LIST your programs, the full spelling of the word will appear. Try typing in a PRINT program using a question mark in place of PRINT. Then LIST your program to see what we mean.

LIST

The abbreviation for LIST is L and SHIFT I. It looks like this: L 

GOTO

The abbreviation for GOTO is G and SHIFT O. It looks like this: G 

For a complete list of abbreviations, check the appendix of the *User's Guide* that comes with your computer.

HINT 2: BACKGROUND AND BORDER COLOR

Thus far, all of our programs have used the blue screen that automatically appears when you turn on your computer. It is very easy to change the background and border colors. Here are the colors you can choose.

Ø	BLACK	8	ORANGE
1	WHITE	9	BROWN
2	RED	1Ø	LIGHT RED
3	CYAN	11	GRAY 1
4	PURPLE	12	GRAY 2
5	GREEN	13	LIGHT GREEN
6	BLUE	14	LIGHT BLUE
7	YELLOW	15	GRAY 3

To change the background color to black, type:

```
POKE 53281,Ø
```

By typing POKE 53281, you tell the computer to go to the place in its memory where it stores the background color. By typing a comma (,) and then a zero (Ø, we tell the computer to change the color to black. You can use the number next to the color on the above chart to select any one of 16 colors.

Thus POKE 53281,2 changes the background color to red,

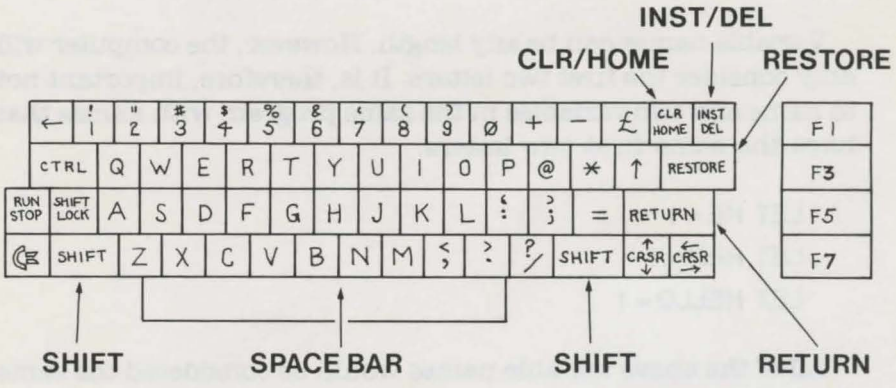
while POKE 53281,8 changes it to orange.

We can use a similar procedure to change the border color. Actually only one number is different. The border color memory number is 53280.

Thus, POKE 53280,9 changes the border color to brown, while POKE 53280,5 changes it to green.

HINT 3: PRINT DISPLAY COLORS

You can also change the color of the letters on the screen quite easily. Simply hold down the CTRL key and press a number key between 1 and 8. This will change your PRINT display to the color indicated on the key you press. You can get eight additional colors by pressing the COMMODORE key and one of the number keys. The COMMODORE key is the first key of the first row on the lefthand side of the keyboard. It looks like this: C=



Try a little experiment with some of these color changes. Type a few lines with each of the 16 colors. Then change the background colors.

HINT 4: INITIALIZING VARIABLES

Up until now, we have used the LET statement to initialize variables.

```
10 LET A=5
```

Although this is the common way to initialize variables, it is not necessary to use the word LET.

So, A = 5 is just as acceptable to the computer as LET A = 5.

HINT 5: NAMING VARIABLES

Thus far, we have only given our variables simple letter names like A or A$. We can, however, expand these names so that they reflect their individual function. For instance, instead of using the variable name D for doors, we can use the variable name DOOR.

```
LET D = 1
```

is just as acceptable as

```
LET DOOR = 1
```

Variable names can be any length. However, the computer will only consider the first two letters. It is, therefore, important not to name any two variables in the same program with names that have the same first two letters.

```
LET HE = 1
LET HER = 1
LET HELLO = 1
```

All of the above variable names would be considered the same because each uses the same first two letters (HE).

Another important rule when expanding variable names is never to include a BASIC word as part of the name. For example, SUBLET is illegal because it uses the BASIC word LET. ENLIST, IMPRINT, POGO and RUNNER are illegal because they contain the words LIST, PRINT, GO, and RUN respectively.

The rules for naming and expanding string variable names are the same as numeric variable names. The only difference is that a dollar sign ($) must appear after the name. Thus CHOICE$, PLAYER$ and NAME$ are all legal variable names.

We are interested in knowing what you do with your Commodore 64 computer and with the knowledge you've gained from our little story. If you have any interesting programs or descriptions of unusual purposes to which you've put your computer, please write to us at this address: Erin & Uncle Charles, c/o Birkhauser Boston, 380 Green St., Cambridge, Massachusetts 02139. Happy adventuring!

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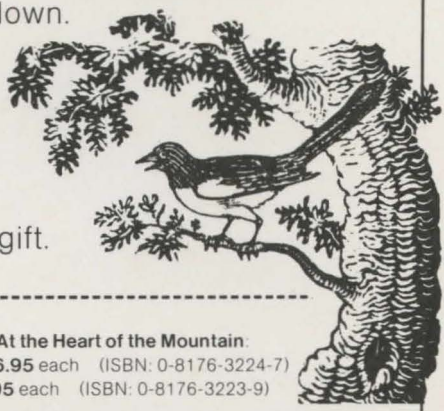

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