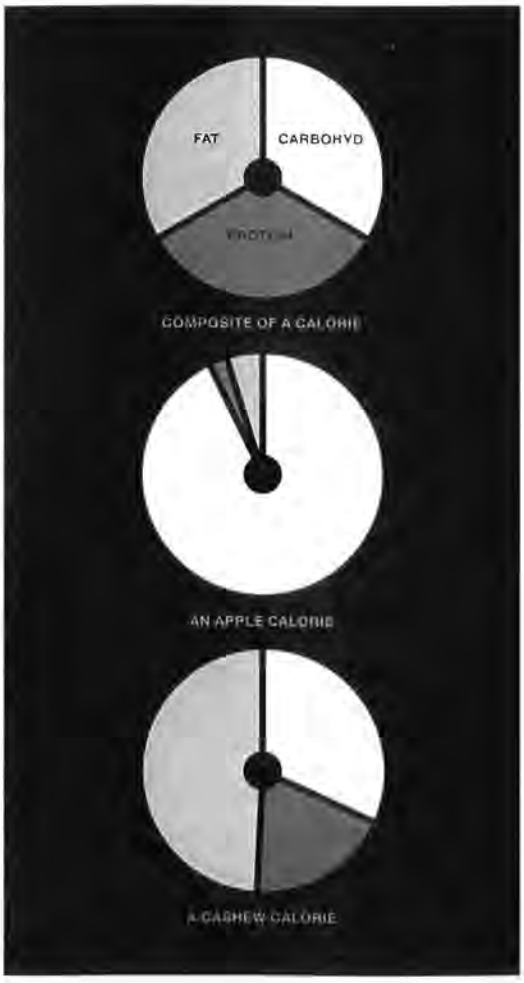
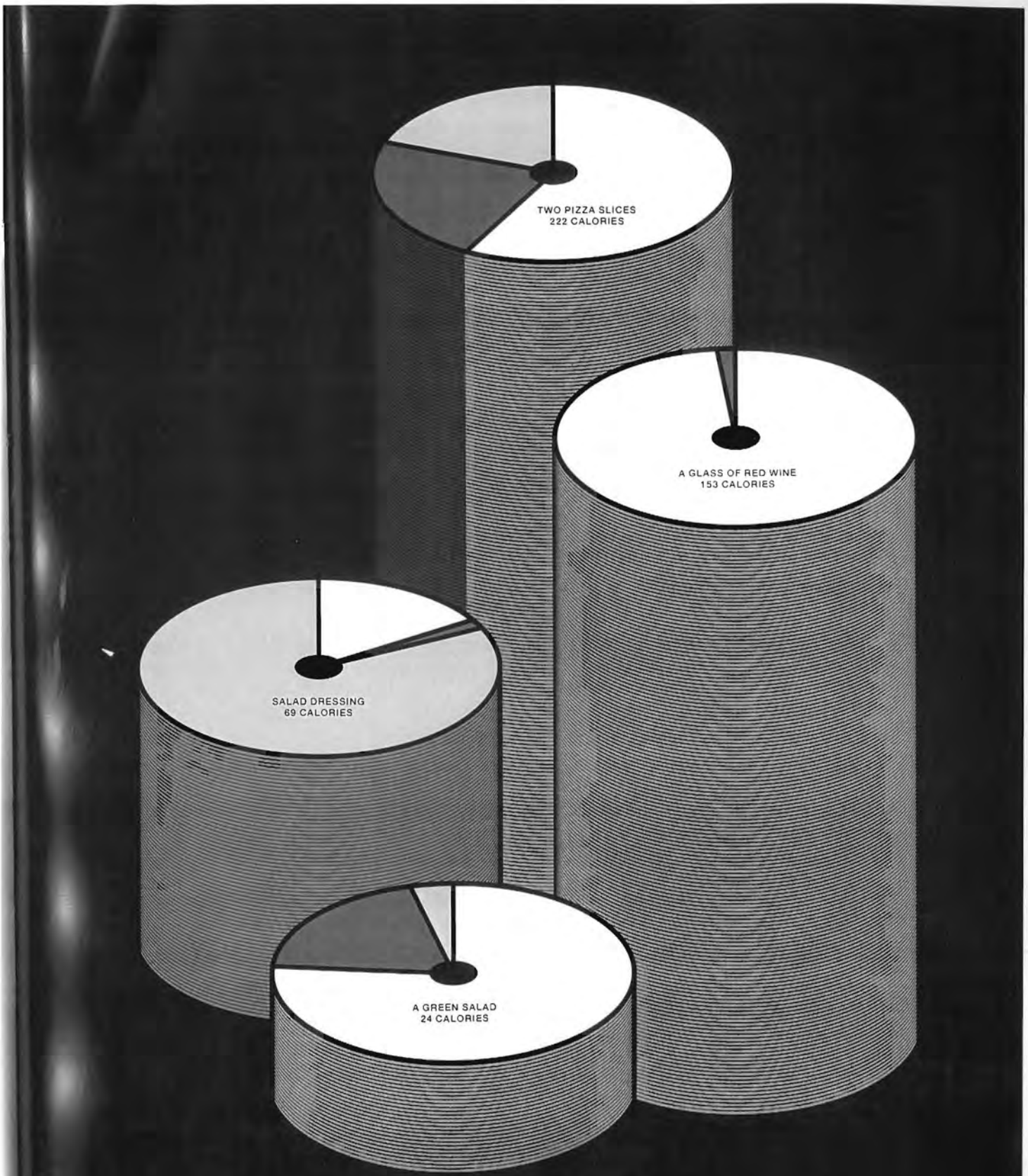
PETER BRADFORD

CAMDEN Many years ago I decided Camden, New Jersey didn't *deserve* to be mapped. *Oh Peter, be serious.* But I was. At the time I was doing a book about the city's 67 well-known examples of really bad city planning. With lots of maps and lots of colors, the book was a typically cool *professional* product aimed at the few (140) city managers responsible for planning our largest cities. But—then I saw Camden. I saw that no book could possibly show how much chaos and misery the planning had added to the lives of thousands of people. A nice book might even *sanitize* it. So, I decided to build a giant blocky model of the city instead. A narrator would walk through it, lift buildings, shift highway ramps, point at flaws, and get *angry* about such insensitivity. Closed-circuit television would broadcast the message, a printed hand-out would clarify it. Effective solution? I don't know, the project never happened. All I do know is that Camden prompted my first urge to picture the bone plain truth in graphics, and erased my comfort with anything less.

■ **CALORIES** Even a *vital* science like nutrition has conventions that obscure its simplest principles. I ask you, exactly what is a "calorie" anyway? When I diagrammed nutrition for *American Health* magazine I got a chance to ask them. I heard that utterly useless definition, heat raising the temperature of a gram of water and all that. *Yes, yes,* I said. *But, can I* hold *a calorie? Is it a lump of energy like a lump of coal?* Signs of distress. Yes, the editor said. Food fuels your body with three groups of nutritional elements—carbohydrates, protein, and fat—which are measured in energy units called calories. *You mean, a calorie is a lump of fuel with three general ingredients?* Yes, he said. *Well. So. Draw one for me.* Sigh. He snatched up a pen, drew a pie shape with three parts, and labeled the parts *carbohydrate, protein,* and *fat.* Okay, he said, that's a calorie, all flattened out. It has three parts, always those three—nothing else, ever. The only thing is, *the parts vary in proportion according to the food.* Well, that was a Very Big Reveal to me. All calories are not the same. So counting *whole* calories means much less than counting calorie parts. And our pie symbols could clearly mark the parts.

MAPPING ELEMENTS The three groups of nutritional elements in calories vary greatly in different foods. So, counting *parts* of a calorie instead of the whole makes much more sense. Divided "pies" show calorie parts and signal a meal's hazards (opposite).



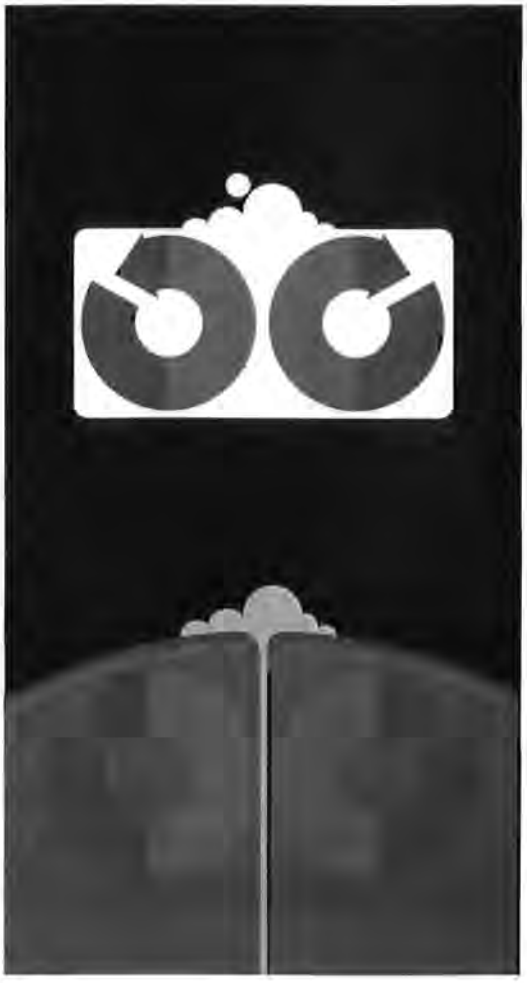


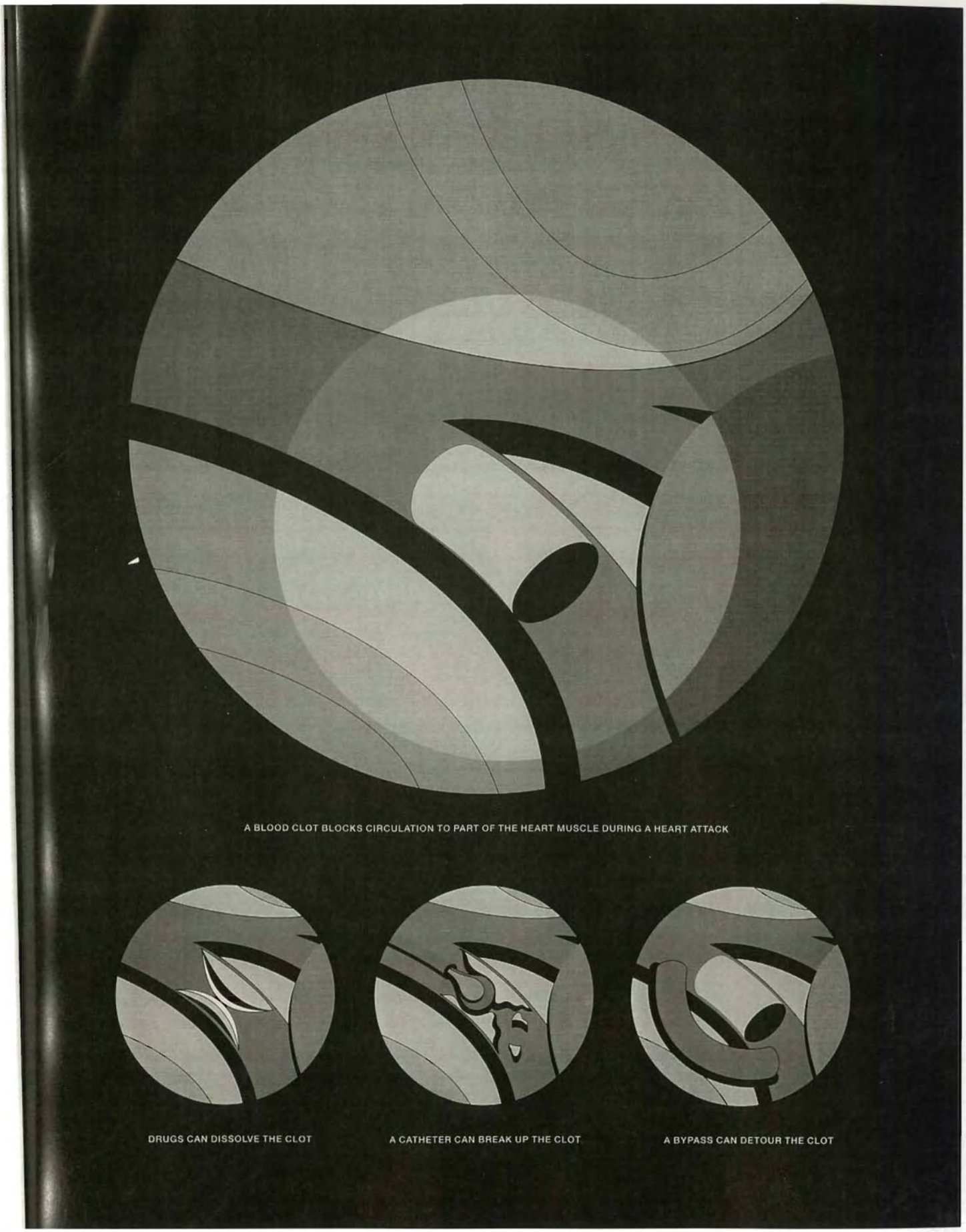
A CALORIE PORTRAIT OF A MEAL: PIZZA, RED WINE, GREEN SALAD, AND A (VERY HAZARDOUS) SALAD DRESSING

PETER BRADFORD

■ **PLATE TECTONICS** is a very young science. Constantly, with new insights and new discoveries, it seems to grow more complex every day. Far too often for me. But when I was asked to diagram a book about the subject, I suddenly had a need to know. With very long words, the author explained that the earth is covered with many thin irregular plates, which have carried the continents here and there for millions of years. Morocco was once connected to Nova Scotia, Antarctica was way over there, and so on. *Okay. But how can heavy things like continents float around like that?* He stopped. Starting again with stubborn grit, using short little words, he told me to picture the outer surface of the earth (continental crust) as a piece of paper wrapped around a basketball. He trotted off and found a world globe—this was not a basketball guy—and wrapped it with tracing paper. The paper slid easily around the globe. He described the warmth beneath the crust, and how the warm currents move like they do in a pot of boiling water, slowly circulating material under the crust to make the earth's plates separate and—*Eureka! Continents move!* I said. He was very pleased. He pushed the sides of the paper together (two plates forced together), making it rise in the center in a raggedy line. *Mountains!* I screamed. He pulled at the paper until it split open. When plates are moved apart, new surface material pushes out, sometimes violently like the volcanic eruptions happening now on the bottom of the Atlantic Ocean. *Volcanoes under water? Right now?* Oh yes. Plates slide along each other too, moving vast land masses great distances. Mexico is moving along the San Andreas fault, headed for Alaska at the same rate your finger nails grow. All because of heat. ■ How simple. Rather, how simply can be expressed a basic principle that drives an inconceivably large and invisible science. Such clear models. With tracing paper on a small globe, plate tectonics was reduced to manageable scale in my mind and my diagrams were born. Later, of course, academic conventions of word and style were laid on top, but beneath them were solid understandings. And such an easy process: play dense, get a guy to explain the basics beneath his expertise (beneath *his* crust), and let *him* do the diagram designs.

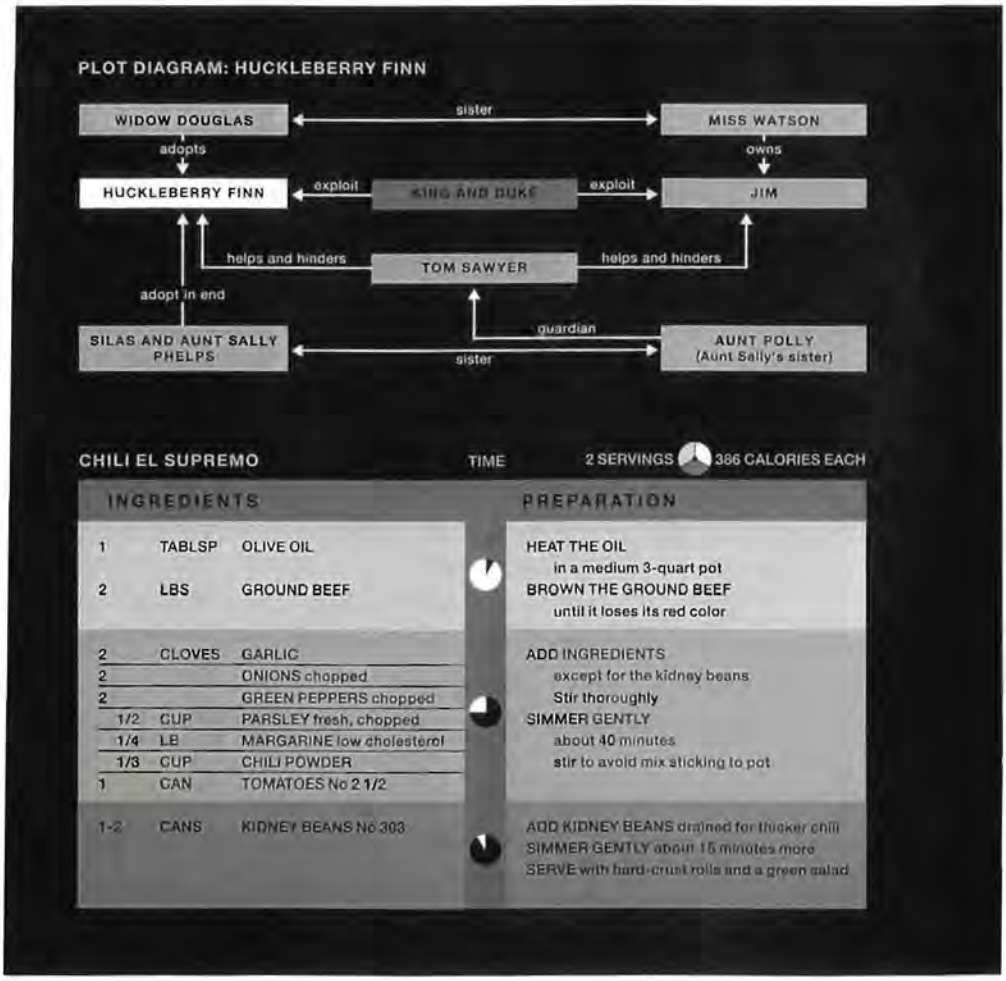
MAPPING PROCESS The plates of the earth shift as the warm material beneath its crust circulates, not unlike boiling water in a pot (below). In the plumbing in our hearts, blocks are removed with drugs or catheter balloons, or they are by-passed (opposite).




A BLOOD CLOT BLOCKS CIRCULATION TO PART OF THE HEART MUSCLE DURING A HEART ATTACK
DRUGS CAN DISSOLVE THE CLOT
A CATHETER CAN BREAK UP THE CLOT
A BYPASS CAN DETOUR THE CLOT

■ **KEYNOTES** It seems that *Cliff Notes*, those beloved classics of literary avoidance, may be too dense for today's college students. So, Random House published *Keynotes*, a series of 100 skinny, six-page study guides of the world's great novels. I was asked to give the little things a gaudy cover and draw the tiny diagram that summed up the book's main characters and plot. These plot abbreviations had the gall to compress splendid literature into a few miniscule squares. But, while their simplifications were just stupendous, they were also very swift scans of their main ideas. ■ Content subtraction is a formidable skill; when sensibly compressed and reduced, content becomes a bare skeleton of essential ideas. Then, the essentials can be safely manipulated and enhanced—even animated. For example, I see plot diagrams *moving* as the action develops: *Bang!* One little character square shoots another little square. I see ingredients *joining* the process of cooking a recipe (bottom). I see surgical drawings moving too. How else could one bring the *thrust* of a catheter tube to life? (Just kidding.) But if the heart *pumps* and arterial blood *flows* as blocks are removed (preceding page), isn't the surgery made much more clear?

MAPPING ELEMENTS AND PROCESS The essential ideas of great novels were compressed into tiny interacting squares (below). The ingredients of a recipe were aligned with stages in the cooking process. In both, connecting the actors clarifies the action.



■ **CURRICULUM DICTIONARY** A very clever fellow once told me that one horsepower is equal to ten 75-watt light bulbs, 2637 pizza pies, or 3,122,756 calories. *What?* Yes. Because they share the same science definition of energy: doing *work* (how far you move an object) with *power* (how fast you move it). Those are measurements, he said, and all energy measurements can be compared. *So, how many pizzas will it take to heat my house?* How many rooms? he asked. Very interesting. ■ In time, the two of us travelled down a long and painful path on Dick and Pete's Excellent Adventure: the re-making of school dictionaries. He was Dr. Richard Venezky, an expert lexicographer. He felt conventional dictionaries were difficult, I felt they were armor-plated, bullet-proof monsters of opacity. We chose to attack school dictionaries because therein lies hope: the young learner finds pleasant reference a seductive friend. Random House was interested, committed money, and off we went. ■ At the same time, I got dunked in dictionary conventions when I re-designed the *American Heritage Dictionary* for Houghton-Mifflin. *Type styling only please, no rooting around in common sense. Re-organize definition entries? Are you crazy?*

MAPPING WORD RELATIONSHIPS In a school dictionary, complex definitions were divided into groups of similar senses, which were given labels. The labels created a vocabulary for electronic navigation, and gathered related words in topics (following pages).

CONVENTIONAL DEFINITION

watch (woch or wŏch), 1 look attentively or carefully: *The medical student watched while the surgeon performed the operation.* 2 look at; observe; view: *Are you watching that show on television? We watched the kittens play.* 3 look or wait with care and attention; be very careful: *I watched for a chance to cross the street.* 4 a careful looking; attitude of attention: *Be on the watch for automobiles when you cross the street.* 5 keep guard: *The sentry watched throughout the night.* 6 keep guard over: *The police watched the prisoner.* 7 a protecting; guarding: *A man keeps watch over the bank at night.* 8 person or persons kept to guard and protect: *A call for help aroused the night watch.* 9 period of time for guarding: *a watch in the night.* 10 stay awake for some purpose: *The nurse watched with the sick.* 11 a staying awake for some purpose. 12 device for telling time, small enough to be carried in a pocket or worn on the wrist. 13 the time of duty of one part of a ship's crew. A watch usually lasts for four hours. 14 the part of a ship's crew on duty at the same time. 1-3,5,6,10 *v.*, 4,7-9,11-14 *n.*, *pl.* **watch es.**

SENSE-LABEL DEFINITION (Phrases added)

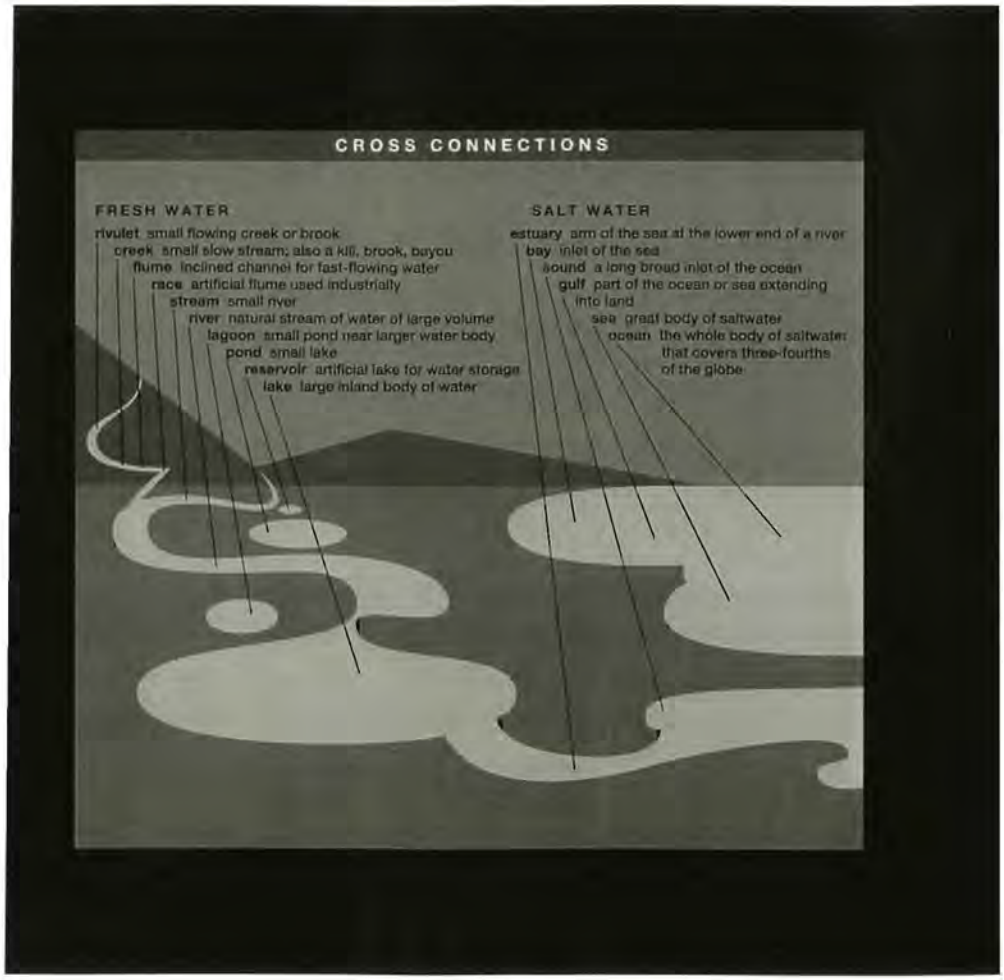
watch (woch or wŏch) pl **watches**

1. LOOK **a.** *verb:* look attentively or carefully: *The medical students watched while the surgeon performed the operation.* **b.** *noun:* a careful looking; attitude of attention: *Be on the watch for automobiles when you cross the street.* **c.** *verb:* look at; observe; view: *Are you watching that program on television? We watched the kittens play.* **d.** *verb:* look or wait with care and attention; be very careful: *I watched for a chance to cross the street.*
2. GUARD **a.** *verb:* keep guard: *The sentry watched throughout the night.* **b.** *verb:* keep guard over: *The police watched the prisoner.* **c.** *noun:* a protecting; guarding: *A man keeps watch over the bank at night.* **d.** *noun:* person or persons kept to guard and protect: *A call for help aroused the night watch.* **e.** *noun:* period of time for guarding: *a watch in the night.*
3. STAY AWAKE *verb:* stay awake for some purpose: *The nurse watches with the sick.*
4. DUTY **a.** *noun:* the time of duty of one part of a ship's crew: *A watch usually lasts four hours.* **b.** *noun:* the part of a ship's crew on duty at the same time.
5. INSTRUMENT *noun:* a device for telling time, small enough to be carried in a pocket or worn on the wrist.

PHRASES. **bird watcher:** someone who watches birds in their natural areas. **bear watching:** worth paying attention to. **clock watcher:** a worker anxious to stop working. **on the watch:** alert. **watch it:** be careful (usually a command). **watch one's smoke:** notice a quick action. **watch out:** be careful.

■ So naturally, the first thing we did in our school dictionary was re-organize the definition entries. Take the word *Watch*. It has 17 slightly or very different meanings, nouns and verbs, usually all mixed up in some order of common usage. *Look attentively* is mixed with *keep guard*, *device for telling time*, and *part of a ship's crew*. We felt that was confusing. So we separated the 17 meanings into five groups of similar-senses, giving each group a general sense label and a number to separate them (preceding page). ■ Group labels like *LOOK* and *GUARD* focussed the definition for faster searching. Even better, as more definitions were re-worked, the sense labels became a vocabulary which began to connect the entire data base upon which the dictionary was built. For example, the sense label *LOOK* connected *Watch* to other, slightly different definition entries like *Observe*, *Perceive*, and *Study*. When our printed dictionary turned electronic, this vocabulary could link definitions for travelling throughout the dictionary. ■ It worked in reverse too: word meanings that belonged together were gathered together. *Satire* gathered with *Parody* and *Irony*, *Typhoon* gathered with *Monsoon* and *Twister*. Isn't that nice? Each juxta-

UNIFYING WORD RELATIONSHIPS As related words were gathered by the similar-sense vocabulary, pictures were created to show their variances, like *Bodies of Water* (below). Or, if difficult to picture, word tables and diagrams were created (opposite).



PROSE

Prose literature has many forms. **Fiction** is writing produced by the imagination, unlike **non-fiction,** which is writing based on facts and real events. **Drama** is a form of prose designed to be performed on stage, by actors, in front of an audience, videotaped for broadcast on radio or television, or filmed for projection in movie theaters.

FICTION

tale
noun: a story or account of true or imagined events, passed down through generations by oral communication
A **myth** is a tale originating in a preliterate society serving to explain the wonders of nature and man; a **legend** is a popular, related myth believed to have historical basis. A **folk tale** is a story made up and handed down orally by the common people. A **fairy tale** is a folk tale about fairies and giants and a **tall tale** is a tale that exaggerates things.

moral
noun: a story with a conclusion meant to teach goodness or correctness of character and behavior
A **parable** is a short, simple story, usually of a familiar event, from which a moral lesson may be drawn; a **fable** is a fictitious parable and an **allegory** is a more complex parable in which people and things have a hidden meaning.

narrative
noun: a structured account of actual or imagined events
A **story** is a narrative intended to interest or amuse the hearer or reader; a **short story** usually describes a single event with few characters. A **novel** is a long story with a plot that unfolds through the actions, speech, and thoughts of the characters. A short or condensed novel with a moral or satirical ending is a **novella.**

fantasy
noun: fiction in which the characters are involved in imaginary or bizarre situations, unrelated to everyday life
An **adventure** is a novel about a dangerous or risky undertaking. A **Gothic novel** is a medieval adventure emphasizing the supernatural and the grotesque. **Science fiction** is an adventure which takes place in the future; a **mystery** is about a puzzling crime and a **romance** is about idealized love.

irony
noun: a literary style in which words convey the opposite of their literal meaning for humorous effect
A **parody** is a literary work that mimics and ridicules a serious author's writing, and a **satire** uses irony or wit to ridicule an idea or custom.

NON-FICTION

record
noun: events, ideas, and experiences put down in writing so as to create a permanent account
History is a narrative record of important past events connected with a person, nation, or institution; a **chronicle** is more systematic than history or brief documents events in the order in which they took place. A **diary** is a personal chronicle, with entries written each day, of a person's experiences and observations. A **biography** is the life story of a person researched and written by another person; an **autobiography** is a biography written by and about the same person.

expression
noun: the act of conveying one's thoughts, feelings, or opinions through words, either written or spoken
An **essay** is a short composition on a single subject, usually presenting the personal views of the author; a **review** is an essay in which the author expresses his or her opinions on a book, a play, a movie, etc. A **speech** is an essay prepared verbally to an audience, or recorded in written form. A **letter** is a written communication addressed to another individual rather than the public, conveying personal or intimate information.

explanation
noun: a written or spoken account which serves to clarify, justify, or explain something
An **exposition** is a speech or writing which explains a single process, thing, or idea; a **treatise** explains the relationship and connections between two or more ideas, and **discourse** is the verbal form of a treatise: a lengthy discussion of a subject or series of ideas.

DRAMA

entertainment
noun: a happening that is designed to interest, please, or amuse an audience; a **skit,** a short, comic sketch, is a form of light, often deliberately superficial diversion.
A show, performance, and spectacle are all terms for public entertainment. A **show** is the most general term; it can or does not indicate content or place. A **spectacle** suggests that something unusual and sensational is presented. A **performance** implies that a dramatic or musical work is acted on a stage.

play
noun: a literary work that tells a story, usually of human conflict, by means of dialogue and action performed on stage. A **movie** is a filmed version of this kind of story presented on a screen in a movie theater.
A **comedy** is a play that is humorous in its treatment of theme and characters and has a happy ending; a **farce** is a comedy full of ridiculous happenings and absurd actions. A sentimental and romantic play is a **melodrama,** and a play leading to an unhappy, often disastrous ending is a **tragedy.** A **pageant** is an elaborate play, often staged outdoors, celebrating a historical event. **Operas** and **musicals** are plays in which most of the text is set to music, characterized by elaborate costuming, scenery, and dance choreography. A musical features song and dance in a secular idiom. When a play is broadcast on the radio it is a **radio play** and when it is broadcast on television it is a **television play.**

TERMS USED IN PROSE

participant
noun: one who takes part or acts in a story, play, etc.
character is the term for a person portrayed in a story or drama. An **actor** is a participant in a play who takes on a dramatic role or character. The central or leading character is the **protagonist,** and a **hero** or **heroine** suggests a character in a play noted for exceptional physical or moral courage. The **antagonist** is a character who opposes and actively competes with the protagonist to create a **conflict** in the drama; a disagreement, struggle, or clash.

form
noun: style or manner of presenting ideas or concepts in a literary composition as distinguished from its content
An **act** is one of the major divisions or sections of a play; a **scene** is a subdivision of an act in which the setting is fixed and the time continuous. An **episode** is a portion of a play which relates a number of scenes to form a coherent story in itself; a **flashback** interrupts the continuity of an episode to introduce earlier events. A **prologue** is a speech introducing the play, and an **epilogue** is a speech following the conclusion of a play. Both are addressed to the audience directly. A **climax** is the time of highest dramatic tension or a turning point in the action of a play. **Rising action** brings about the climax and **falling action** occurs after the play's climax and leads to the **resolution;** the part of the play in which the plot is explained. A **dialogue** is a conversational passage in a play or story, and a **monologue** is a speech or talk delivered by a single character.

content
noun: the meaning, significance, or substance of a literary composition as distinguished from its form
A **plot** is the main story of a play, and the **subplot** is a secondary plot. A **theme** is the subject of the plot and a **setting** is the time, place, and environment in which the plot takes place. A **script** is a written text including the plot, dialogue, setting, and performance directions used by the director and actors of a play or film.

POETRY

Poetry can be defined by its **form** or by its **content.** The components of poetic form are explained below using some examples that show how a poem can be read to enhance its meaning. Opposite are content explanations and examples.

FORM

TERMS AND EXAMPLES

meter
The combination of **accented** and **unaccented syllables** that determine the rhythm in a poem. The **rhythm** of a poem is its flow of sounds having a regular measure or beat, which is heard most clearly when a poem is recited or read aloud. A foot is one unit of the meter, or any combination of one accented and one or more unaccented syllables.

An **iambic** foot is the combining of an unaccented syllable followed by an accented syllable. A line of verse with five iambic feet is described as iambic pentameter, and has a consistent rhythm of five accents to a line. Blank verse (shown below in Shakespeare's *Hamlet*) is a poem consisting of unrhymed lines of iambic pentameter.

This above all: to thine own self be true,
And it must follow, as the night the day,
Thou canst not then be false to any man.
Farewell: my blessing season this in thee!

free verse
Poetry that does not follow a regular meter and has an irregular rhythm or no rhyme. **Haiku** and **Tanka** are forms of Japanese poetry, written in free verse, usually about nature. Haiku (shown in the example below) is composed of three or sometimes four lines that do not rhyme and contain seventeen syllables—five in the first and third lines and seven in the middle lines. Tanka has five lines—the first and third such have five syllables and the rest have seven syllables.

Does the sea have fun
Bobbing the swimmers around
Like so many corks?

rhyme
The correspondence of end sounds of two or more words, usually ending a verse line. In verse, the use of similar sounding words is used as a device of emphasis and as a means of defining a pattern of lines, or a **stanza.** A stanza is not only a fixed pattern of lines, but also a pattern of rhymes, or a **rhyme scheme.** The simplest stanza is that of **rhymed couplets** (shown below in Ted Hughes' poem *My Brother*) in which every two lines rhyme and form a verse category sort. A **sonnet** is a poem on then or fourteen lines of iambic pentameter with a prescribed rhyme scheme described as follows: **A-B-A-B-C-D-C-D-E-D-E-F-F;** the first line rhymes with the third, the second line with the fourth, etc. In its typical form a sonnet presents and develops its theme in the first twelve lines, and states the conclusion in the last couplet.

Pets are the hobby of my brother Bert.
He used to go to school with his mouse in his shirt.
His hobby it grew, as some hobbies will,
And grew and GREW and GREW until —
Oh don't breathe a word, pretend you haven't heard.
A simply appalling thing has occurred —
The very thought makes me iller and iller:
Bert's brought home a gigantic gorilla!

CONTENT

TERMS AND EXAMPLES

narrative verse
A poem that tells a detailed story in rhyme, following a rhyme scheme with lines arranged in verses or stanzas (see Sir Walter Scott's poem *Lochinvar* shown below). A descriptive poem is usually a short poem about a person, scene, situation, or occasion which reveals the author's feelings about what is being described.

Oh, young Lochinvar is come out of the west:
Through all the wide Border his steed was the best,
And save his good broadsword he weapons had none;
He rode all unarmed, and he rode all alone.

song
A short poem set to music. A **lullaby** is a poem set to soothing and lulling music, and a song belonging to the history and experiences of a certain culture is a **folk song. A lyric poem** (Stopping I Met a Stopping by Woods on a Snowy Evening shown below) is characterized by its musical sound pattern, and its expression of personal emotion.

Whose woods these are I think I know
His house is in the village, though;
He will not see me stopping here
To watch his woods fill up with snow.

nonsense poem
A composition of words or syllables arranged primarily for meter and rhyme and not by sense, for humorous or whimsical effect (see below in Jabberwocky). A **tongue twister** is a poem in a series of words or syllables that are difficult to say quickly because of a succession of very similar sounds. A **limerick,** originating in Ireland, is a light, humorous, or nonsensical verse of five lines, usually with the rhyme scheme: **1-1-2-2-1** (see Edward Lear's limerick, bottom).

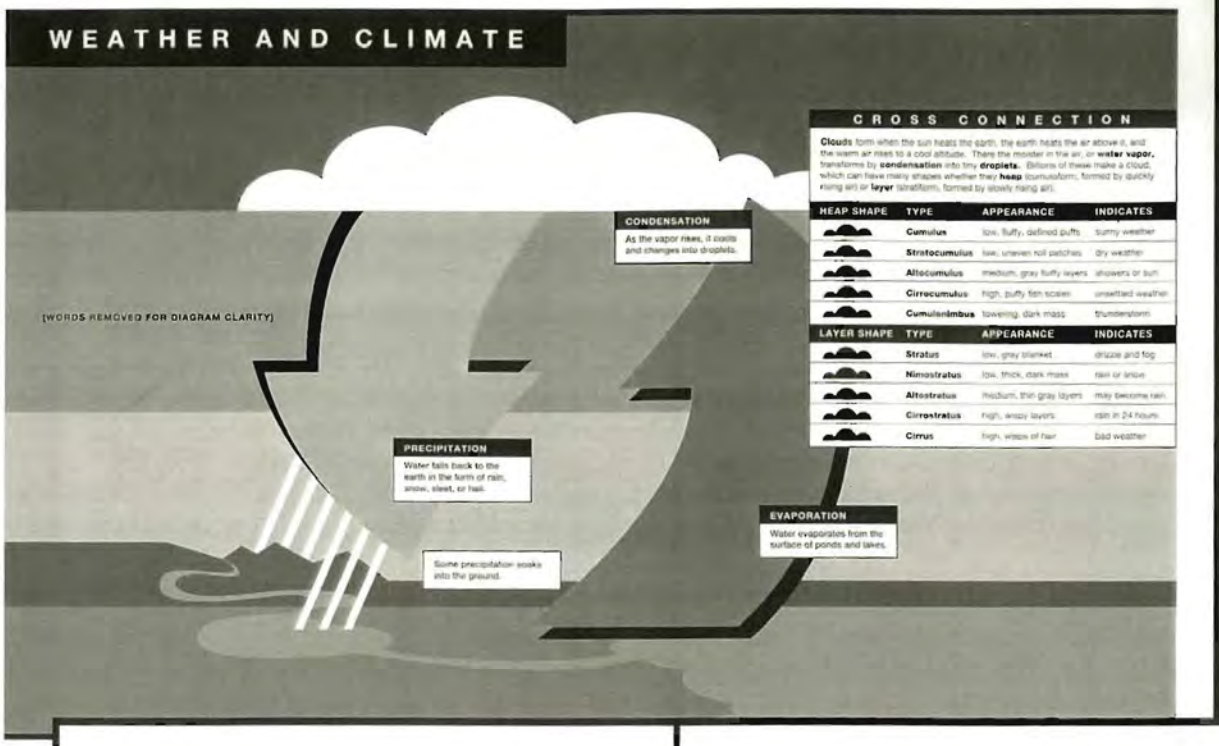
"Beware the Jabberwock, my son!
The jaws that bite, the claws that catch!
Beware the Jubjub bird, and shun
The frumious Bandersnatch!"

MIND'S EYE

Poetry can be identified by its rhythmic accents, or **meter scheme,** and by its similar line ending sounds, or **rhyme scheme.**

METER SCHEME	RHYME SCHEME
There **was** an old **man** on whose **nose**	nose ❶
Most **birds** of the **air** could re**pose;**	pose ❶
But they **all** flew a**way,**	away ❷
At the **close** of a **day,**	day ❷
Which re**lieved** that old **man** and his **nose.**	nose ❶

WEATHER AND CLIMATE



CROSS CONNECTION

Clouds form when the sun heats the earth, the earth heats the air above it, and the warm air rises to a cool altitude. There the moister in the air, or **water vapor**, transforms by **condensation** into tiny **droplets**. Billions of these make a cloud, which can have many shapes whether they **heap** (cumuliform, formed by quickly rising air) or **layer** (stratiform, formed by slowly rising air).

HEAP SHAPE	TYPE	APPEARANCE	INDICATES
	Cumulus	low, fluffy, defined puffs	sunny weather
	Stratocumulus	low, uneven roll patches	dry weather
	Altocumulus	medium, gray fluffy layers	showers or sun
	Cirrocumulus	high, puffy fish scales	unsettled weather
	Cumulonimbus	towering, dark mass	thunderstorm
LAYER SHAPE	**TYPE**	**APPEARANCE**	**INDICATES**
	Stratus	low, gray blanket	drizzle and fog
	Nimostratus	low, thick, dark mass	rain or snow
	Altostratus	medium, thin gray layers	may become rain
	Cirrostratus	high, wispy layers	rain in 24 hours
	Cirrus	high, wisps of hair	bad weather

WEATHER COMPONENTS

Weather is the interaction of the **temperature, moisture,** and **winds** in the atmosphere. The activity occurs in the troposphere, the layer of the atmosphere closest to the earth. When the activity is noticeably swift, changeable, and violent, it is called one of the many forms of **storms.**

TEMPERATURE

Temperature is a measure by degree of the hotness or coldness in an object, body of water, or air. Air temperature, along with humidity and wind speed, effect our feeling of hotness or coldness in the surrounding air.

TERM	DEGREE	IDIOM
scorching	intensely hot, burning	*a scorching attack*
torrid	intensely hot, parched	*with torrid passion*
parched	intensely hot, dry	*a parched throat*
boiling	intensely hot	*with boiling anger*
sweltering	oppressively hot	*a heinous swelter*
hot	heated, almost burning	*hot under the collar*
muggy	warm, damp, moist	*a muggy room*
warm	moderately hot	*a warm welcome*
balmy	slightly warm	*a balmy comfort*
mild	gentle, not extreme	*mild mannered*
cool	moderately cold	*a cool manner*
nippy	chilling	*a nippy response*
chilly	noticeably cold	*chilly suspicion*
cold	very low temperature	*bundled out cold*
frosty	briskly cold	*a frosty reception*
freezing	intensely cold	*a freezing attitude*
frigid	intensely cold, frozen	*a frigid heart*

MOISTURE

Moisture is the wetness in the air, caused by water vapor, and measured as humidity. **Water vapor** is evaporated water in gas-like state, and **humidity** is the amount of water vapor present at a given time, usually measured in relation to the maximum water vapor that the air can hold.

Warm air can hold more water vapor than cold air. As air cools, water vapor turns to water droplets or ice crystals, or **condenses** into clouds. When condensed water accumulates and becomes heavier than the air, it then falls as **precipitation** (rain or snow.)

TERM	EFFECT	IDIOM
raw	disagreeably damp	*raw winter days*
soggy	saturated with moisture	*soggy snow*
damp	high humidity	*dampened enthusiasm*
clammy	moist, cold, and sticky	*clammy statistics*
humid	oppressive moisture	*a humid workout*
moist	tolerable humidity	*moist eyes*
dry	a lack of humidity	*a dry sense of humor*
arid	exceptionally dry	*arid miles of boulevard*

TERM	CONDENSATION
cloud	masses of water or ice crystals in various forms
fog	light cloud
mist	fine water droplets suspended in fog
smog	water vapor condensed with smoke or dust
haze	particles of smoke or dust in the atmosphere
steam	visible vapor, rising when air is cooler than ground

TERM	PRECIPITATION
dew	ground condensation when the earth is warm
frost	ground condensation when the earth is cold
hoar frost	*furry looking frost*
rain	droplets collide to form drops and fall
sprinkle	spatter of rain drops
drizzle	light intensity rain, fine drops, almost mist
dripping	average drops, coming down fast
shower	short, light rainfall
downpour	sudden, short, heavy rainfall
deluge	heavy rainfall, almost torrential
torrent	violent downpour
sheet	heavy rainfall looking like a curtain
pelting	large drops landing with force
lightning	drops that split when they land
pouring	large drops, coming down fast
hail	clumps or small balls of frozen rain or snow
hailstone	a single, large clump of hail
snow	precipitation that falls as white ice crystals
flurries	brief, light snowfall
blizzard	sustained, heavy, very windy snowfall

WIND

Wind is the natural, horizontal movement of the earth's air mass. Wind transports water vapor and spreads fog, clouds, and precipitation. Differences in temperature in the earth and atmosphere, which result in the changing high and low **air pressures**, create and drive the complex systems of wind.

Wind can be **laminar** (smooth and sheetlike) or it can be **turbulent** (erratic in direction or speed). An **eddy** is a whirling wind that flows against the main current, wind that shifts direction clockwise is a **veering wind** and wind shifting counter-clockwise is a **backing wind.**

An **air current** is an up and down, column-like movement of air within the wind. If this column descends rapidly, riders in an airplane will feel like their supporting air has disappeared; they are in an **air pocket.** Differences in a column's speed produces **bumpy air.**

If the wind or the air column has vastly different, adjacent speeds, it is called **windshear.** If the wind speed combines with the air temperature and cools the human body, the effect is called **windchill.**

FORMAL TERM AND EFFECT		*BSF	KPH
calm	smoke rises vertically	0	0-1
light air	smoke drifts slowly	1	1-5
light breeze	wind can be felt, leaves rustle	2	6-11
gentle breeze	twigs move, flag unfurls	3	12-19
moderate	dust blows, branches move	4	20-28
fresh breeze	wavelets form, trees move	5	30-38
strong breeze	large branches sway	6	40-50
near gale	head body, walking difficult	7	51-61
gale	twigs break, walking very hard	8	62-74
strong gale	shingles, branches blow down	9	75-87
storm	trees uprooted, severe damage	10	88-101

TERM AND EFFECT	IDIOM
breath: very slight wind	*not a breath of scandal*
puff: intermittent wind	*puff up to full height*
waft: slight, puffy wind	*a waft of perfume*
breeze: gentle, constant wind	*breeze through it*
gust: sudden, brief rush of air	*a gust of emotion*
swirl: forceful circular	*a swirl of events*
eddy: circular, against current	*eddies of people dancing*
blow: strong, violent wind	*blow hot and cold*
blast: violent, constant gust	*a blast of the siren*
bluster: violent, sudden gusts	*a bluster of protest*

*BFS: Beaufort Scale Force (with kilometers per hour)

STORM

A **storm** is a disturbance of the atmosphere caused by a set of extreme weather conditions. It usually has high winds and precipitation. Storms can have a single extreme condition as in a snowstorm or windstorm, or multiple conditions as in a thunderstorm. The power of storms can be incredible. If all the energy from one hurricane in a single day could be converted into electricity, it would be enough to supply the whole of the United States for three years.

STORM	EFFECT	LOCATION
windstorm	high winds	any region
sandstorm	windstorm, clouds of sand	desert
whirlwind	rotating, spiral windstorm	over land
dust storm	dry, dust-laden windwind	arid regions
dust devil	tiny dust whirlwind	arid regions
twister	whirlwind, visible spiral air whirlwind, cone-shaped	over land
tornado		over land
water spout	violent whirlwind	over water
squall	sudden, violent wind, rain	over land
tempest	extensive violent wind, rain	over ocean
cyclone	violent, rotating winds	tropics, ocean
hurricane	cyclonic, rotating winds	Atlantic Ocean
typhoon	cyclonic, rotating winds	Pacific Ocean
monsoon	periodic wind, torrential rain	Indian Ocean
blizzard	long, intense snowstorm	cold regions

MIND'S EYE

Lightning is a giant spark of electricity that builds up in a thundercloud and zigzags to the ground and back as a lightning bolt. Lightning below the horizon illuminating the sky is *sheet lightning*, a glowing sphere is *ball lightning*, and a spray of lightning is *St. Elmo's fire.* **Thunder** is caused by superfast lightning that heats the air along its path to five times the heat of the sun, expanding the air at great speed and creating the familiar booming noises that Mark Twain described in the book *Huckleberry Finn* as ". . . rumbling, grumbling, tumbling . . . h-whack-bum! bum! bumble-umble-umbum-bum-bum-bum."

position clarifies the defining of each term. Gathering also helps locate a term when you don't know or can't spell it, instead of navigating back and forth in an alphabetic listing. Next, we designed ways to represent the gatherings. We made context pictures for easily pictured word groups like *Bodies of Water*, tables and typographic diagrams for less easily pictured groups like *Poetry*. Very quickly, our representations multiplied and grew to unwieldy size. They began to crowd the alphabetic section, making it jumpy and difficult to use. To accommodate them, we tacked on a group of pages after the alphabetic section and called it our topic section. ■ Well, not so easy, Sneezy. Topically arranged reference is neither familiar nor encouraged by American publishers. In fact, splitting the dictionary into two sections was to become our most provocative change. But how could we deny the logic? ■ Now we had word-group pictures and tables bunched together in topics, and a whole section to put them in. To organize it, we returned to our early rationale for deciding which major words should have major group pictures. For example, *Weather* had a picture because its terms are so numerous and so visual. As its basis, I chose to diagram the *Water Cycle* and its circling machinery of heat (opposite). Gradually, these intuitive choices evolved into an organizing mechanism: a hierarchical (top to bottom) and inter-linked (left to right) grid of topic pigeon holes for sticking every word in the dictionary—which covers, of course, everything we know. We called it Mother Matrix and a rickety thing it was, but it served our purpose. *Weather* fitted vertically as a topic group within *Earth Systems* beneath *Planet Earth* (diagram left). It linked horizontally to related subjects, like *Solar System* and *Eco-System*. (These hierarchies were not easily created, nor are they easily defended. But some kind of master scheme was needed to ensure free electronic travel throughout our data—just as it is in all such projects.) ■ Anyway, all to no avail. We presented our dictionary to loud frowns. It seemed to suit no reference category and had no generic name. The publisher said, if we can't name it, we can't sell it. *Well, how about Wooky?* I said. *That has a hairy flavor to it. How about calling it a Wooky?* They were not amused.

UNIFYING TOPIC RELATIONSHIPS Gradually, the pictures and tables of related word groups grew to become a whole topic section in the dictionary (opposite). To organize it, a grid of subject hierarchies and links was used, like the portion shown (below).

Earth

The earth is a great globe of rock surrounded by an envelope of air. It is one of nine planets that travel through space around the sun. The sun is a star—one of billions in the Milky Way galaxy. The Milky Way and billions of other galaxies make up the universe.

SOLAR SYSTEM: The earth ranks fifth in size among the sun's nine planets, and, at 93 million miles, is third in distance from the sun. The earth travels 595 million miles in just over 365 days and 6 hours.

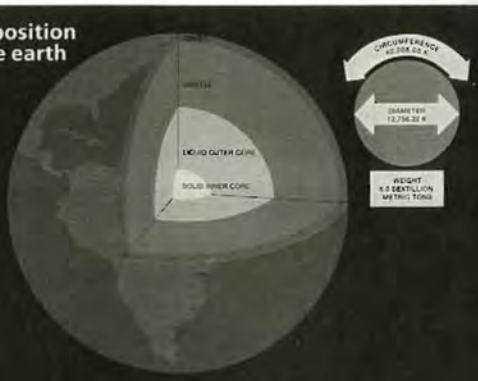
PLANETARY SYSTEM: The earth has one orbiting moon which is about a fourth the size of the earth. Pluto also has one moon, Mercury and Venus have no moons. All the other planets have two moons or more.

ATMOSPHERE: Air surrounds the earth in layers, and extends to about 1600 kilometers above it, where it gradually fades into space. All weather takes place in the troposphere, the layer closest to the earth.

CRUST AND CORE: The earth has a crust, or topmost layer of solid rock. The next mantle layer is also solid rock, but moves slowly under heat and stress. The outer core is molten rock and the inner core is believed to be solid iron.

SIZE AND SHAPE: The earth is held nearly round by gravity. But, the earth also rotates, creating an outward push called centrifugal force. The force is greatest at the equator where the earth bulges out as it flattens at the poles.

Composition of the earth



Terms

Earth science: the study of the earth. Includes the sciences of:

Geography: the surface of the earth

Geology: earth's history and composition

Geochemistry: chemical properties of the earth

Geophysics: the physical properties of the earth

Meteorology: study of air and weather

Earth When and how did the earth begin? This question has always fascinated people. The earth is but one of nine planets that make up our solar system, but to us it is by far the most important planet. It is our home. As far as we know, it is the only planet that supports life.

The earth is constantly changing. It is not the same as when it was first formed. It does not look as it did several million years ago or even 100 years ago. If you could re-

and how it is changing, scientists study the land surface, the air, the oceans and the interior of our planet. The general term for the study of earth is earth science. **Earth science** is made up of several sciences that are related to one another. Among them are geography, geology, geochemistry, geophysics, meteorology, oceanography, and paleontology.

The Ever-Changing Earth

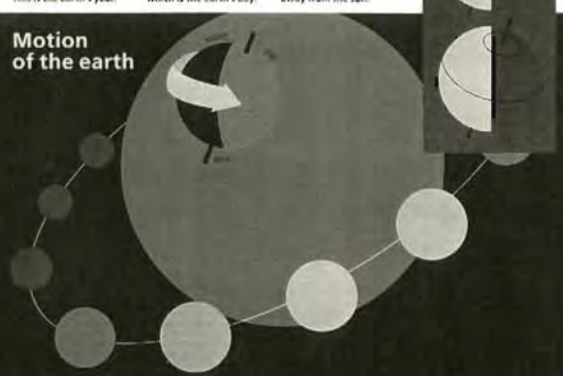
world began. Most changes occur so slowly that the human eye does not notice them. Over millions of years, mountains are thrust up and worn down. The land is steadily attacked by erosion—the slow wearing away of the surface by water, air, and ice. Rock is broken into tiny fragments, which are carried away by rivers and dumped into the oceans as sediment. Seas creep in over the land, deposit sediment, and draw back, making new land. Glaci-

ORBITS: As it rotates, the earth travels around the sun. The path that the earth follows—called its orbit—has the shape of an ellipse, or slightly flattened circle. The earth takes about 365 1/4 days to complete its orbit. This is the earth's year.

ROTATION: The earth rotates, or spins, on its axis from west to east. The direction of the rotation makes the sun appear to rise in the east and set in the west. A complete rotation occurs about every 24 hours, which is the earth's day.

SEASONS: The earth's axis is not at right angles to the sun's rays—it is tilted. In the northern part of the earth, summer arrives when the North Pole is tilted toward the sun, and winter when tilted away from the sun.

Motion of the earth

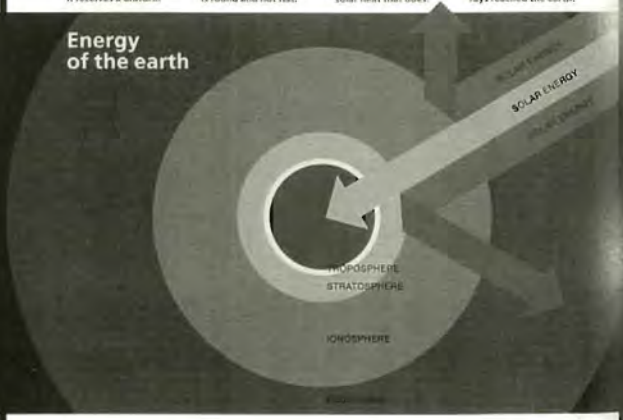


LIGHT and HEAT: The sun is a star and like every star it is a very hot ball of gas. As the gas burns, energy is released in the form of light, heat, and other radiations. Because the earth travels around the sun in a stable orbit, it receives a uniform amount of energy from the sun each year—just the right amount for life to develop. However, as shown in the diagram below, all parts of the earth do not receive the same amount of solar heat because the earth is round and not flat.

PROTECTIVE SHIELDS: The earth's atmosphere is essential to life. It contains the oxygen we breathe. It acts as a shield that prevents too many of the sun's rays from reaching the earth's surface and holds in the solar heat that does.

RADIATION: Many of the dangerous radiations from the sun, such as X-rays and cosmic rays, are absorbed in the ionosphere, an important region of the earth's atmosphere. Life would not be possible if these rays reached the earth.

Energy of the earth



earthquake. A volcano erupts, and hot, molten (melted) rock pours out onto the surface. The lava hardens into new landforms.

Scientists study these changes and try to understand the forces behind them. They have taken giant strides forward in understanding the earth, but the answers to many questions are still locked within our planet.

The Earth's Plates

Some of the changes on the earth's surface are caused by movements of the crust. Geologists have determined that the crust is made up of six large plates and a number of smaller plates, each holding land masses, ocean regions, or both. This concept is known as **plate tectonics**.

The plates move slowly with a sliding motion. Two neighboring plates may move apart. A rift (crack) opens between the plates, and hot, molten rock from the earth's interior wells up through it, forming a ridge. In another place two plates may collide head on. One plate is forced under the other, and a trench is formed. Great mountains may be thrust up in such a collision. It is believed that the Appalachian Mountains were formed in this way many millions of years ago, as were the Alps, which are still rising slowly. Sometimes two plates slide slowly past each other, their edges scraping. The edges may catch and stick, pressing the plates together. A sudden release of the pressure results in a jerking motion that causes an earthquake.

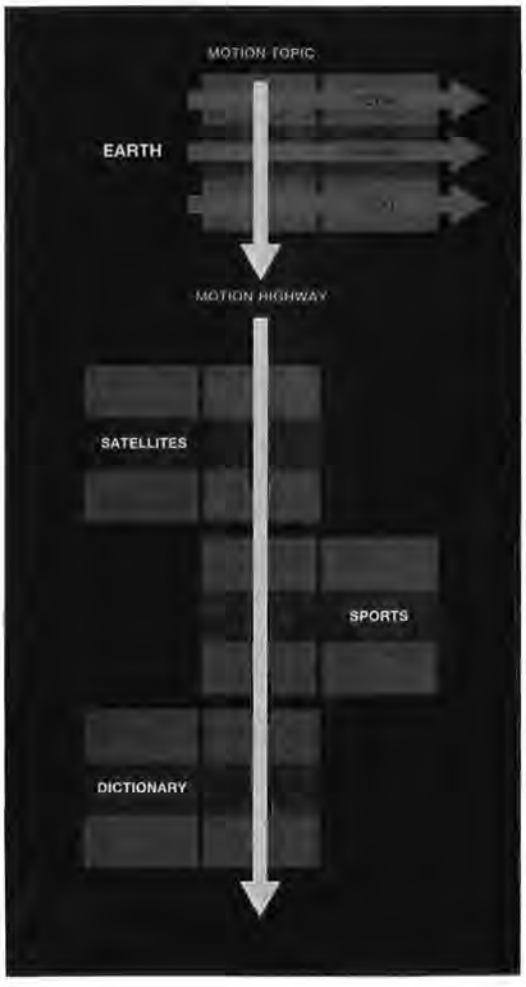
Many details of plate movement are still unexplained. But it is clear that these movements do occur. And most scientists agree that the forces of **convection** are connected with the movement.

When you heat a pan of water, you set up convection currents in the water. As water at the bottom of the pan is heated, it becomes lighter and rises. The cooler water at the top is denser, and so it sinks. The hotter water keeps rising, and the cooler water keeps sinking. This movement, which goes round and round, produces a convection current.

Many scientists think that something similar takes place within the earth. The lower part of the mantle is much hotter than its top. As a result, convection currents are set up within the mantle. The hot material, like the hot water, rises. The cool-

■ **THE NEW BOOK OF KNOWLEDGE** The job of an encyclopedia is to explain, isn't it? Well, how can that be done best? With vertically deep, exhaustively detailed explanations like the *Encyclopedia Brittanica*, or with horizontally broad, relational explanations like the *Curriculum Dictionary*? Maybe both? Yes, I think so, too. But, how does one build such a mass of linked knowledge? ■ The simplest mechanical linkage I have ever seen is in a toilet tank. I watch the water rush out, the stopper fall down, water rush back in, and the hollow ball float high to shut it off. I watch all the ways that machines use gravity for the good of me. But wait, why does the water rush in? I jump in the tank, swim down the pipe against the current to the main water tank, and find another cooperating force: tightly packed air is pushing hard to get more water back to the toilet. Oh, the clarity (and convenience) of clever links. ■ Grolier Publishers asked me to swim down the pipes of its encyclopedia. Clearly determined to look ahead, the editor Gerry Gabianelli asked if content could be arranged for both print and electronic products. I said yes. (I *always* say yes.) We began with the subject *Earth*. For the printed pages, I placed content in three horizontal bands: detail on top, images in the middle, and text on the bottom. Then I separated *Earth* into a series of page-long topics to be read in order, first *Composition of the Earth*, then *Energy of the Earth*, then *Motion of the Earth*, and so on. I did this because: 1) I wanted more easily entered hierarchical pages in the print product, and 2) I wanted to lay foundations for a cross-navigational electronic product. ■ Topic separations created access routes *across* the subject. One can travel these routes or topic highways (or plumbing pipes) to various descriptions of the same topic. One can travel the *Motion* highway from *Motion of the Earth*, to *Motion of the Atom*, to *Motion of Heat* to better understand the realm of motion as a whole. ■ The topic highway system is a browser's delight; it links all subjects in a unified scheme of relationships. Imagine a topic like *centrifugal force* gaining clarity as you travel the *Motion* highway from *Earth* to *Orbiting Space Craft*, to *Hammerthrow*. Or, all the way to the Dictionary (*Yes!*) and the Latin root of centrifugal force: *center flee*.

UNIFYING TOPIC ACCESS In a print version of a children's encyclopedia, subjects were displayed in three content layers for better access (opposite). Then, subjects were divided into topics that connected to related topics in the electronic version (bottom).



■ **COSMIC COMICS** Driving as I was along my topic highways, a new thought struck. Why use words? Why not use other ways to link ideas, like pictures or symbols? Ways that represent ideas but liberate them from words, giving me visual tools to explore and compare any subjects I want? ■ In 1869, Dimitri Mendeleev drew a picture of kinships—the first accurate table of chemical elements. Each element was placed in a scheme according to properties it shared with other elements. Very logical, very elegant, and very bold. By plotting what was known, Mendeleev could predict and leave room for elements that wouldn't be found for years. ■ Then there was Richard Feynman, another bold relationist. When he found that current perceptions of physics could not accommodate new discoveries, he promptly redefined the perceptions. He too used diagrams to express his thoughts, strange and squiggly diagrams which became inseparable from the ideas themselves. Two bold guys seeking lasting relationships, both trying to draw the whole picture. ■ *Cosmic Comics* uses animated sequences to explore relationships between seemingly unrelated things. Not with words, not with special knowledge, but with analytic imagery. It applies a range of visual techniques, like cross-sections, comparative patterns, and unique points-of-view, to arbitrarily chosen subjects. The results are intriguing. When cross-sectioned, similar layers of concentric growth appear in eggs, pearls, raindrops, and even the earth itself. They have great differences, of course, but their growth *patterns* are so similar. Why is that? I don't know of any principles that explain the physics of growth—yet growth seems so basic to understanding everything. ■ Take a more dynamic natural event like lightning. A spark of lightning superheats its path to five times the heat of the sun, rudely spreading and colliding the air with great noise. Lightning is a giant heat machine making large masses move, just like the little heat machines moving pistons in a car engine (right). Sections through both also show concentric growth patterns—this time expanding energy instead of material. ■ Analytic techniques also explain the racing dominance of the hurdler Edwin Moses, or even the mystical zones of scoring in basketball. If you care.

EXTENDING TOPIC ACCESS The earth, an egg, and a pearl show similar concentric growth patterns when cross-sectioned (opposite). The expanding power of heat in lightning and a car engine is seen when the same analytic technique is applied. (below).