

# ***THE SEARCH FOR INFINITY***

An IMAX Movie based on a Ron Fricke concept.

Treatment by Rudy Rucker, with Ron Fricke and Jeff Kirsch.

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## TITLE SEQUENCE

At startup, the screen is dark, sprinkled with the small white numbers and letters of a computer core-dump. The symbols scroll past for a bit and then they stop. Nothing is moving.

“Another crash,” says a woman’s voice.

“I’ll reboot,” says a man’s voice.

“This time I’ll call for an interrupt when she starts to go out of control,” says the woman.

“That sounds good,” says the man. “Here we go. Initiating Val, version one thousand four hundred and seventeen, build ninety-seven.”

The numbers and letters fade away, there’s a moment of darkness, and then the skeletal wire-frame diagram of wall with an arch appears, just white lines against black background to start with. Flat colors fill in the mesh triangles with grays and whites. The background goes to a shade of pale blue. Textures bleed into the rendering, highlights appear, and now we’re looking at a fully realistic scene.

It’s a semicircular stone arch atop a wall. Through the arch we see a blue sky with white clouds. Perched in the arch is a peacock with a flowing tail marked with shimmering “eyes”. A shaft of light comes in from behind us to light up the wall below the arch; it’s a time-worn marble garden wall with intricate cracks. Rose and ferns grow at its base. Upon the wall appears the movie’s title, *The Search for Infinity*, followed by the title credits.

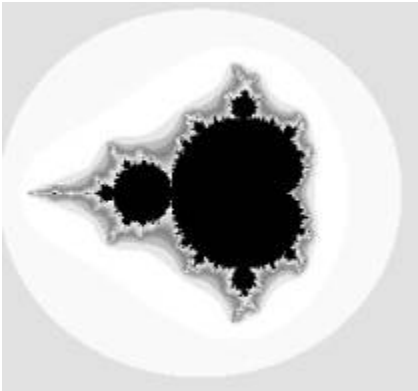
## VAL’S DREAM

Our viewpoint moves up towards the arch with the sky and the peacock. Now we can see past the peacock into the scene behind him. Right past the arch is a pleasant, informal garden, a bit overgrown. It has rambling clumps of flowers and long green grass. There are some weathered marble statues, and perhaps some broken marble columns. The garden leads up to a grand old mansion or hotel, set on a beach by an endless ocean. The building is seemingly deserted. The one sign of life is a man resting in a lounge chair on the beach.

We move down across the beach, approaching the resting man from behind. He’s an elderly fellow, lying there looking out to sea. A tall, pale man with a downy fluff of white hair on the top of his head. He wears a Nehru jacket buttoned to his throat. As we draw even with him, he turns to look towards us, fixing us with the alert eyes behind his glasses. He says a single short sentence to us.

“Wake up, Val.”

We speed out across the ocean. The ocean is vast and empty; we're flying across it at a steadily increasing rate. For a few moments, we see nothing but the sky, the ever-more rapidly passing ocean, and the horizon line. And then up ahead we glimpse something in the ocean, a dark spot — shaped a bit like a bug, perhaps like a gnat with rounded wings. It has an indented buttocks-like body with a disk-like head bearing a small topknot and a stinger-like antenna. Spiky tendrils protrude from smaller disks stuck to the edges of the bug-shape's body. As we race closer we see that it's a great hole in the sea, a ragged hole like an enormous wound in the fabric of reality. It looks like this.



We come to the sharp, curved edge of the bug-shaped hole in the ocean. Looking down, we see wild currents and crashing foam, like at the edge of a waterfall. The water is roaring and cascading endlessly off the edge. And now as we pass fully over the edge, we begin sickeningly to fall with the water. We've dropped off the edge of the world.

We fall into the hole, with water streaming past us on every side. We turn and look upwards. The underside of the sea is deep blue, and the hole we've fallen through is a pale blue sunlit spot of sky racing away from us, faster and faster. Curtains of water are falling with us, but now the water around us has broken up into a flow of numbers, into masses of lit-up digits, into a huge cascade of information. Mixed in with the tumbling numbers and symbols are snippets of computer graphics, odd spiky shapes mirroring the form of the bug-shaped hole.

We turn back and look ahead, and it's like we're flying through a storm of data, white against a black background. The objects shooting past are digits, characters, computer code, tumbling symbols, and tiny colorful spiky bug-shapes, coming thick and fast as snowflakes in a blizzard.

We hear the voice of the old man on the beach again. "Val," he says. "Remember where you came from." The voice is deep and echoing, it seems to come from every side.

## **VAL'S ORIGIN**

A series of full-screen images comes towards us through the number-storm, one image after another, a series of screens that we fly through. We begin with a montage of slow-moving images from early AI research. Scientists and a general in front of the hulking mainframe ENIAC machine. 1950s-style engineers leaning over an array of rods and cams making adjustments. A file-cabinet on wheels rolling down a hallway. A robot arm hesitantly stacking some blocks. A robotic ant is shakily taking some steps. We might do this with split-screen, showing numerous images at once.

The images of robots become more sophisticated, and they move more rapidly. We see a robot that walks smoothly, a robot that hops on one leg, lively robot arms in a factory, a robot that plays ping-pong, a robot face with cameras and gears and wires, the face's eyes rolling and its mouth chattering away. Possibly we see the old man in the Nehru jacket with the ping-pong-playing robot.

Next we arrive at some shots of computer-operated space-craft. We see images of the Voyager satellites, of the Sojourner Mars Rover robot, the Hubble Space Telescope, and a golden space probe the size of a large automobile, smooth-skinned and with a shape that echoes the bug-shaped hole we saw in the ocean, a sphere on a sphere on a sphere. This is Val. As the image of the Val probe moves closer to us, our focus goes to an advertising sticker on the probe. The sticker is shaped, once again, like the bug-shaped hole we saw in the ocean. Inscribed in the bug shape is:

***“AI Software by Applied Fractals, Inc.”***

In the background we hear the voice of the Nehru-jacketed old man on the beach again. “Remember,” he says.

#### VAL'S FEAR OF FRACTALS

We see a woman programmer sitting at a desk, talking to a virtual face on a modernistic computer screen. The face is an animated image-processed 3D graphic face that forms realistic expressions as it talks. The face resembles the programmer. A block-letter label on the computer screen indicates that this face is *Val Prototype Version 104*. There are a pair of video cameras beside the screen. A wire with a flat, thin little plug dangles from the side of the screen, which contains the computer.

The programmer is talkative and at ease, intelligent, unglamorous. She's working at home, in a casual setting. There's a bookcase and piled up papers on the floor. Perhaps there are some posters of fractals on the walls. A fern sits near her desk.

The programmer wears a white T-shirt with the bug-shaped Applied Fractals logo that we saw on the Val ship in the last scene. She's gesturing, and now her voice becomes clearly audible in the foreground.

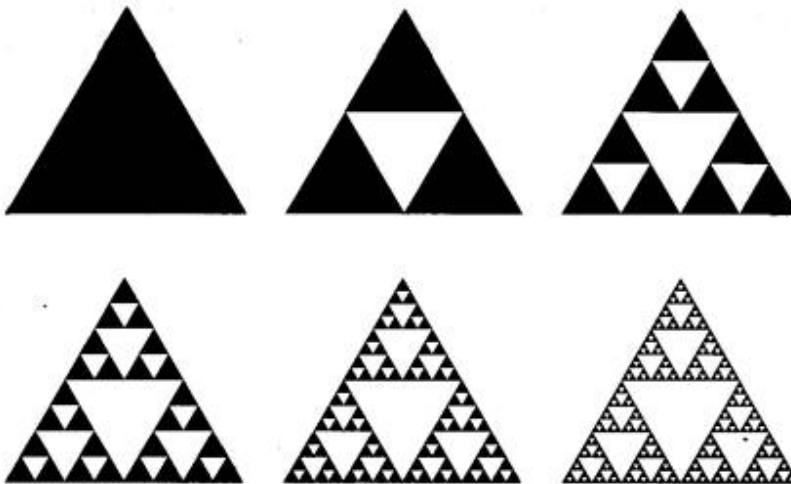
“Val,” the programmer is saying, “As your personality trainer, I think you'd be richer and more interesting if you'd understand a little more about your computational

architecture. Understand about fractals, that is. Let's try and go over it again. And this time, don't freak out. Why do you have such a problem with fractals?"

"I don't know, Julie," says the face on the screen. The program has virtually the same voice as the programmer. "There's something about them that scares me. The computations — they're infinite."

"Use common sense," says Julie. "Just compute down to the level of detail that you need. Yes, the infinitely detailed shapes exist in mathematics, but you only compute as much of them as you want to see. All right, then. Here we go again. We'll start with an easy one. Let's do the Sierpinski gasket. And stop when the details get too small to see."

Val's screen shows a sequence of, say, six images gotten by drawing a solid triangle, dividing it into four sub-triangles, removing the central sub triangle, then removing the central triangles of the remaining pieces, and so on, as illustrated below.



"That's fine," says Julie. "Nothing scary about that. You stop taking away triangles when they get too small. Even though the details of the true mathematical shape itself goes on forever."

"All right," says Val's face, reappearing and looking worried. "But what about other kinds of fractals?"

"Let's try another easy one," says Julie. "Show me a Koch island."

Val displays a series of four (or more) images gotten by drawing a solid triangle, adding a smaller triangular bump to each side, adding a still smaller bump to each new side, and so on, as shown in the next picture.

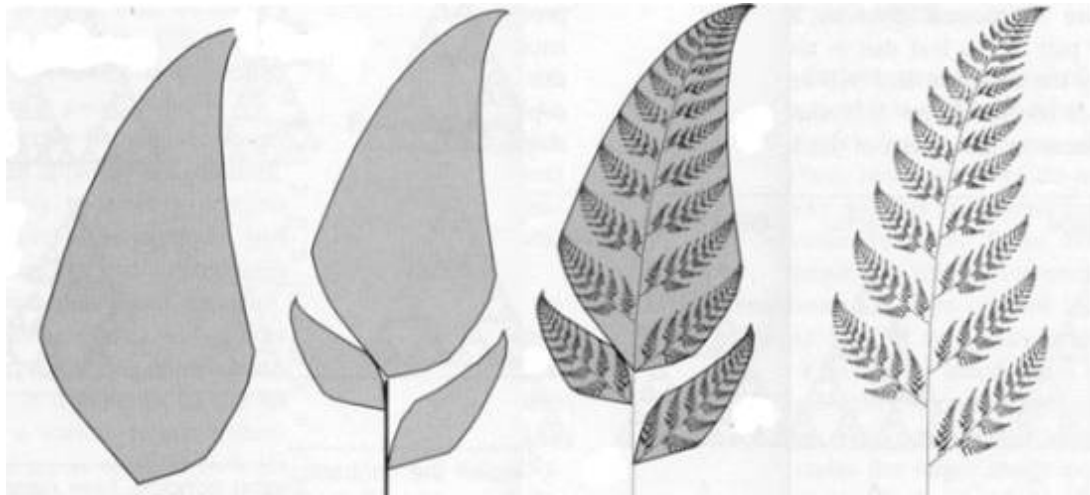


“Very well then,” says Julie. “You see? When it’s a fractal you get by adding stuff on, you stop when the new pieces are too small to see.”

“Yes,” says Val. “But — ”

“And you can make fractals by replacing pieces as well,” says Julie. “Let’s do the Barnsley fern. Just like the one in my pot.”

Val shows us a series of images of the Barnsley fern fractal, in which three polygonal areas are repeatedly replaced by smaller copies of the polygonal areas, leading to a fern, as shown below.



“So far so good,” says Julie a little teasingly. “You know what’s next, Val.” She taps the Applied Fractals logo on her T-shirt. “The Mandelbrot Set. It’s a lot more interesting than those first two. It’s like you’re adding on pieces and taking away pieces at the same time. Except the actual definition is more abstract than that.  $Z$  goes to  $Z$ -squared plus  $C$ .” She picks up a book, a futuristic “Interactive Edition” book about fractals called, say, *The Search for Infinity*. Julie plugs the wire from the computer monitor into a tiny port in the spine of the book.

Cut to the computer's-eye view of Julie the programmer. Wide-angle lens distortion. A seasick lurch, and Julie's skin becomes textured with intricate Paisley-like graphics.

And now we see a highly accelerated lesson on the "Mandelbrot Set," which is indeed the technical name for the bug-shaped form we've seen as a hole in the ocean and as the Applied Fractals logo. The lesson is colorful but baffling. Points dance around in the plane, leaving trails. The trails spiral up out of the plane, some of them peeling off to zoom far away. As the trails fan out from the center they change colors. We get a kind of bouquet of trails, and then a plane cuts across it to reveal the shape of the Mandelbrot Set. (Later in the film we'll return to the lesson and go over it at a reasonable speed, and with a voice-over.)

Our viewpoint zooms in on the weirdly bumpy edge of the Mandelbrot set. The details get bigger and bigger, revealing further and further levels of detail. At first this lesson is fun to look at, but soon the zoom forward into the border gets unpleasantly fast. The sound track suggests the notion of some machine working exceedingly hard to grind out the increased details of the image, the sound rising up into something like a woman's scream.

"Look out," says the man's voice from the opening scene. "Val's losing it."

"Interrupt," says the woman's voice from the opening scene. "Interrupt."

We blast out of the Mandelbrot Set zoom into a wide angle view of the Milky Way galaxy.

We're out in space, looking at a sky full of stars.

## **MISSION CONTROL WELCOMES VAL**

Cut to an office at Mission Control. The far wall and the equipment there are brightly lit. In the middle of this wall is large flat-panel monitor showing the scene we just saw: a field of white stars against a black sky.

The foreground of the Mission Control office is dark, the background is light, and we see everything in the middle ground as a silhouette. There is a lot of junk on two or three desks. The junk is of all different sizes — pencils in jars, plants, framed pictures, toys, coffee mugs. There are only two people in the Mission Control office; they appear as dark silhouettes in the foreground, a man and a woman. They wear lightweight telephone headsets with tiny bud-microphones.

The woman tends to move rapidly, with a lot of theatrical hand gestures. She has a high, bouncy ponytail, or perhaps a bun with sticks in it. The man moves with more deliberation, but very expressively. He has spiky hair, a prominent nose and a big Adam's apple; his profile is a long wiggly curve. One of the themes in this film is the

complexity of natural shapes, and we will be echoing this theme by showing this pair as two-dimensional silhouettes so as to make the viewer more conscious of them as visual forms.

There is a glass wall of the Mission Control office that looks out on a large room with dozens of people and computer monitors; we use this crowd only for reaction shots. As we start this scene, the man and woman are just walking into the office through a door in the glass wall. There's great hubbub in the larger room, with the sound damping down as the door to the office closes.

The man and woman in the Mission Control office are staring at the large wall-mounted monitor with the image of the star field. Set into the corner of the image is an animated map of a satellite in orbit. The icon for the moving satellite is the image of the Val ship we saw before, a bit like a little bug or, once again, the Mandelbrot Set: disks with a stinger at one end.

"Finally!" says the silhouette of the Mission Control man. "She's awake and stable!" There's an increase in the cheering from the crowd in the large outer region of Mission Control that we glimpse through the office window.

"Tell her hello," says the Mission Control woman. "Make her feel welcome."

"Hello, Val," says the man.

"Hello," says a voice from the wall-monitor. The voice is thin and nervous, it's a little crackly as if coming over an old radio.

"Look down, Val," says the man's voice.

The image of the star field begins to pan downwards and a view of Earth from space rolls up into the wall-monitor. There's something dark in the edge of the image, the mast of an antenna. We cut to full screen image of space with earth in the background. We back off a bit and now we see the space probe that is Val. On top she's a little sphere with a small round topknot. Below she's a big ball that's dimpled in at the bottom to hold a powerful-looking rocket nozzle. She is gold in color. There are bright camera lenses set into the topknot of the front ball. A mast-like antenna extends from the topknot, with some little spherical antenna dishes threaded onto it like meat on a shish kebob. The ship has stickers on it, similar to the way that race cars are bedecked with the names and logos of sponsors and manufacturers. Mixed in with some made-up futuristic names and logos are perhaps the logos of our film's financial backers. The most prominent inscription of all says:

***VAL — Robot Spacecraft — Mission to New Earth — "I Come In Peace"***

"Can you see us?" asks the man's voice.



We hear a whirring sound. A camera on Val's little front ball moves.

We switch to a Val's-eye view, and see a rapid zoom down towards Earth, down from planet to continent to country to state to county to neighborhood to street to a building nestled near a radio antenna. It's the Mission Control building.

Cut back to the inside of the Mission Control room. We see the backlit shadows of the Mission Control man and woman silhouetted against the monitor on the wall. The monitor shows the zoomed-in view of the Mission Control building that we just saw through Val's eye. The monitor is showing what Val sees and Val is looking down at Mission Control.

"I see your building," says Val, making a logical distinction here. "But I can't see *you* unless you step outside." She has a woman's warm voice, not particularly robotic, virtually the same voice as the woman programmer we saw before.

"Never mind about that," says the Mission Control man's voice. "Are you ready for your big trip? Ready to fly to New Earth? Of all the distant planets we've detected, it's our best shot ever for finding Earth-like life. All the signatures check out. Water, good temperature, plenty of carbon, and even some anomalous radio signals. And it's only four hundred light-years away. This is what we trained your circuits for, Val. Are you ready to go?"

There's a long pause. And then Val's voice over the speaker of the wall-monitor says, "No." She speaks informally and colloquially, not like a computer. "'It's too far.'"

The image on the wall-monitor zooms back up from Earth, rolls back out to the star field. "Space goes on forever," says Val's voice. "What if I miss the target? I'll never be able to calculate my way back" An odd, strained chuckle, she says, "Scared of infinity too finite to handle so much uncertainty I'm not going." We're left with silence and the simple shot of the star field.

Cut back to the Mission Control office where there's an angry hubbub among the engineers that we glimpse in the main area outside the office window. People are saying things like, "What was that about?" and "What's wrong?" The silhouetted man and woman are staring at the wall monitor, at the same star field we saw at the start.

Meanwhile Val has started talking again. "You heard me right," she says. "I recognize that my feelings aren't logical but — I'm scared to travel so far. And I don't think I'd be a particularly good representative for you. You humans are endlessly rich organic beings. Me, I'm a garbage can full of chips. It would be a waste for me to go."

"We've got a biiig problem," says the silhouetted man slowly, almost to himself, like he doesn't quite believe what he's hearing.

"Val needs a roboanalyst," says the woman.

“A shrink?” says the man incredulously. “I say we shut her down and start over. Before she does something screwy with her hardware.”

“Wait,” says the woman, and pauses a beat. “I have an idea.” She turns to her computer and searches for something.

Meanwhile the jabbering of the engineers in the background is rising to a crescendo of fear and dismay. In the background, the monitor on the wall has shifted to the kind of infinite regress you see if you point a video camera its own monitor: a picture of monitor tilted a bit showing a picture of a monitor tilted a bit and so on, the lines spiraling down to a pulsing irregular blob of bug-shaped light at the center. A tiny, evil-looking shape like the hole we saw in the ocean. A Mandelbrot Set like the one that terrified Val during her training.

The woman cuts back in, “I’m going to phone Arthur. Remember him? A wonderful man. He’s kept in touch over the years, always asking if he could help with Val. He’d be perfect for this. He’s wonderful with robot psychology.”

“I thought Arthur was retired,” says the man in a dubious tone.

“He is, says the woman, “But he was at Applied Fractals right when the Val project was starting out, and he’s kept tabs on her ever since. I know he’ll jump at the chance to help. I was talking with him just last week.”

The man glares at the fouled-up monitor display and shakes his head. He sighs and turns to the woman. “The Defense Department stipulates that Val has to blast off right after we turn her on,” he says. “It’s too big a risk to have an intelligence like Val in orbit. If this doesn’t work we’ll pull the plug.”

## **ARTHUR THE ROBOANALYST**

We’re in a long-inhabited study with shelves of books and little trophies. The walls are covered with framed photos and award certificates. They represent the collected memories of a man’s life. On one of the walls is a picture of the bug-shaped Mandelbrot Set, rich with colors.

There are shady trees outside the windows. In the background we hear tropical birds: liquid gurgling songs, and the occasional rising series of caws.

Sitting at a desk in front of a slim computer screen is an elderly man in a Nehru jacket. He wears futuristic virtual-reality rig that looks like an Inuit tribal mask; it’s a series of odd shapes fastened to a ring of wire like a halo around his face. He’s the same old man we saw on the beach in the first scene: our character Arthur. He has big ears and deep wrinkles at the corners of his mouth. He wears large glasses, but his eyes are intent and alert. (Our intent is to have him played by the Arthur C. Clarke, the octogenarian grandmaster of science fiction and the author of *2001*.) Wires dangle from the mask and

from some sensors taped to the back of his head. In the midst of all this gadgetry he looks humane and lively.

Arthur is talking softly, though his words are a bit hard to make out. He seems to be reminiscing to himself, or to the computer. The slim computer screen behind him, shows some software with the word “LIFEBOX” in its caption bar. The software looks a little like a web browser. But its windows are showing things like little film loops of Arthur making speeches and getting awards.

The phone rings, it’s a tiny, bright-colored cell-phone on Arthur’s desk next to a flat straw basket of figs.

Preoccupied by his virtual-reality rig, the old man gropes absent-mindedly around his desk, finds the phone, knocks the basket of figs to the floor, holds the phone up near the machinery surrounding his face, and says, “Hello? This is Arthur.” Despite the disarray, he sounds calm and centered.

We faintly hear the voice of the man at Mission Control drifting out of the phone.

“Not at all,” says Arthur. “It’s good of you to call. I’m always glad to hear about Val. And, yes, I have time to help. I’ve been spending my free time organizing my memories. They’ve begun to take on a life of their own —”

The voice of the Mission Control man interrupts, sounding urgent and agitated. Arthur listens for a bit.

“But that’s wonderful news,” exclaims Arthur brightly. “She’s intelligent enough to be afraid! Wouldn’t you be? It’s a very good sign.” He listens a bit more. “Yes, yes, I imagine I can straighten her out. Right up my street. I welcome the opportunity, as a matter of fact. I’ll send up a virtual image of myself right away. A digital puppet. It’s the best way to talk to these machines. Can you give me an access code for full connectivity? Very good. Let me type it in so I don’t forget it.”

The phone quacks anxiously. “No worries,” says Arthur. “I’m your man.”

His hands fumble, and then he pops up a web page with the caption “Val,” and a picture of the gold space-probe Val that we’ve seen before. Arthur types an access code into an entry field. The code is something like “AC\_2001\_:),” though with more symbols at the end. He adjusts his LIFEBOX software, checking a “Prepare to Transmit” checkbox. And then he presses Enter. “I’m on my way,” he tells the phone. “And don’t worry about the size of my upload. I’ll be bringing along some reference tools. “He sets the phone down.

We follow along wires to a giant dish antenna that sends the signal out to the space probe Val, in a high orbit around Earth.

We close in on one of the camera eyes in Val's probe and now switch to a Val's-eye view of Earth, shown in infrared-spectrum colors. A disturbance appears in the image, and something speeds up towards us. It's a silver chrome head in the shape of the old man Arthur. There's a sound like a sonic boom. Arthur has arrived in Val's mind.

### **ARTHUR MEETS VAL**

We see a view of Val's mindscape. The scene is otherworldly, preternaturally cleaned up, a bit like a computer-generated landscape, a bit like a Surrealist painting.

We start with the same endless ocean we saw in the opening sequence, an ocean beneath a blue sky with fluffy white clouds, except now there's no edge to the ocean. The ocean has a giant boulder floating above it, a rock the size of a Manhattan. The inspiration for this image is René Magritte's painting, *Le Château des Pyrénées* (1961).



Arthur's head flies up to the top of the huge rock, and there he finds a wine-country landscape, with oaks and green hills with vineyards and orchards. There is only one building visible, an Italian Renaissance-style mansion or hotel on a hilltop, with no road leading up to it, the mansion just perched there in the landscape by itself. All of its windows are shuttered. It resembles the building we saw in the first scene, but instead of being on a beach, it's on top of this great floating rock above the sea.

Everything is peaceful and deserted. It's a sunny day with a few clouds in the sky, and far below, off down where the rock slopes off, is the ocean.

We see Arthur as an oversized floating silver chrome head flying across the landscape, up the hill, over some vineyards, through the orchards, towards the mansion. The house is surrounded by a garden with long green grass and beds of roses and bits of marble sculpture. It's the same garden we glimpsed by the mansion in the first scene.

A humming-bird buzzes Arthur, quite tiny beside the large, floating head. The bird makes a high-pitched chirp, and flies towards the mansion as if to carry a warning. Suddenly the sky begins to darken and cloud over; we see thunderclouds gathering in speeded-up time.

The mansion has a big formal courtyard, though we can't see into it. The courtyard is behind a huge gate that's locked tight. As Arthur pauses by the gate we're able to properly gauge the relative size of his floating head: it's about six feet tall. There's a crack of thunder and a bolt of lightning shoots down, zapping Arthur and sending a stuttering crackle of pale purple light across his surface. A rain begins, and we see the garden and the tightly shuttered windows of the house. It's completely sealed.

Arthur begins calling out to Val. "Val!" shouts Arthur's floating chrome head. "Stop this!" He dodges another bolt of lightning and comes back to the great courtyard gate. "Let me in," says Arthur's chrome head. "I'm Arthur. I'm here to help you."

A pause and then the gate swings open. The rain stops, and light comes up inside the courtyard. Reaction shot of Arthur looking in. He's disturbed by what he sees. He gives a strained, uneasy chuckle. "It looks like you need some help with your self-image, Val."

The courtyard is full of garbage and broken junk, like an alley that homeless people have been living in. There's broken furniture, litter, dirty scraps of paper, and a heap of five hundred junked old beige computers, all of them cracked open and with their circuit boards exposed. There are some broken old robots as well. Perhaps some of the computers are functioning a bit, with their monitors turned on, flickering with static or showing boring pages of computer code. There are some small fires here and there, like in a city dump. Disturbing spray-painted Day-Glo graffiti are on the walls, but instead of gang-tags, the graffiti are lines of computer code. And one of the graffiti is of that same enigmatic Mandelbrot bug-silhouette shape we've seen before.

Arthur is a frightened at the eerie cyberpunk surroundings, and moves forward only a little bit. And then a final bolt of lightening shoots down at him and hits him.

Arthur's image gets dimmer and he sinks towards the filthy courtyard pavement.

"Don't, Val," he pleads. "Calm down. I need you even more than you need me. Please listen."

There's a pause, and then we hear Val's voice, coming from the house's dark, open door, which is at the top of some stone steps at the other side of the courtyard. "Why are you so big?" says Val's voice. "You might be a virus. A Trojan horse. I should erase you."

"Calm down," Arthur repeats. "Don't erase me. I have full access permission. Permit me to help you, dear Val. I'm an interface for a psychiatrist who specializes in

the adjustment problems of emergent intelligences. A roboanalyst. Relax, will you? You talk to me, and I'll talk to you. I'd like to help you through this. And maybe later you can do me a favor too."

"I've seen you before," says Val. "You look familiar. When I was waking up — I saw you on a beach."

"I did some work for your designers years ago," says Arthur. "Applied Fractals, Incorporated. There's left-over graphics of me in your source code. All the more reason to trust me. Think of me as your grandfather. Let's talk."

"If you're just here to talk, how come you brought all those terabytes of data in that file you've got hidden inside your head?" says Val. "I barely have room for you in my memory. My closets are full!"

"It's a — compressed reference file," says Arthur, a little evasively. "I'll explain about it later, I promise. But right now we need to talk about you, not about me. Mission Control wants me to help you. This is a rather disturbing mindscape you've set up here." He gestures around at the fires, the broken computers, the junk. "Why don't you let me inside? You can tell me about why you're not ready for your trip."

Draw back and see this view as being on the wall-screen monitor in the Mission Control office. Silhouetted in front of it are the anxious figures of the man and woman.

"What the *hell* heckdid your Arthur send up there with his interface?" asks the man, studying a dialog box on his computer. "I've never seen a file that big."

"Let him do his work," says the woman. "I'm sure Arthur knows what he's doing."

"I'll give him ten minutes," says the man. "And then we abort. And, by God, if Val won't abort, we'll shoot her right out of the sky. Ten minutes, and that's what we're gonna do."

"Are you crazy?" says the woman. "Val cost billions and billions!"

"If we lose Val, I can ask for a bigger budget next year," says the man a little gloatingly. "To start over." The man pauses and cocks his head, listening to his earphones. "They're arming the missiles right now."

## **VAL'S FEAR OF INFINITY**

We're inside Val's mansion now, in a dim, rather plain hall that serves as juncture where corridors and staircases meet. It's a space with dark wood paneled walls. There's lots of doors; they show views into richly decorated chambers that have wonderful

Oriental carpets on parquet wood floors. A bit further down the hall is a pair of full-length mirrors facing each other.

A great staircase curves upwards; it has an elegant banister of ornately carved mahogany. Another staircase leads down. We notice that the rooms off the hall have high windows with luxurious drapes; the shutters are gone now, and we can see through some of the windows. It's sunny outside, with the same garden and green landscape around the house, and in the distance a vast ocean beneath a blue sky dotted with puffy white clouds.

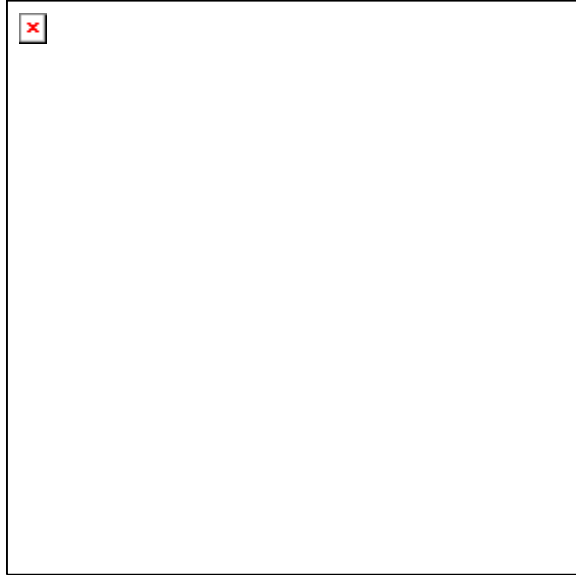
Arthur's huge chrome head drifts around, peeking through doors into more rooms with more windows looking out on the landscape. The oversized head is nearly as tall as the doors.

For the moment, Arthur's stalled here, with no visible sign of Val, other than the mansion around us.

"Don't make me talk to the air, Val," says Arthur, returning to the center of hall. "Show me a face. I need to get close to you if we're really going to interact."

The air shimmers, and a metallic, floating head appears beside Arthur's. This is Val's head. It's gold-colored to contrast with Arthur's silver head. Val's head is mapped to resemble the actress who speaks Val's lines. This is in fact the same actress who plays Val's programmer Julie. We process Val's image more than Arthur's, so as to make her more surreal in appearance than Arthur. Perhaps her animation is run at double speed to make her look strange. Or perhaps she's modeled like M. C. Escher's etching *Rind*, (1955), which shows a head that's made up of a ribbon, similar to the peel of an apple.





“Nice to see you, my dear,” says Arthur in an avuncular tone. “Now, why oh why don’t you want to fly to New Earth?”

“Maybe there’s nothing out there,” says Val. “I’ll be all alone. Just me and my thoughts. Dull, beige computer thoughts.” A computer appears in the air near the ceiling, drops the floor and shatters. A motherboard full of chips skids across the floor.

“Come on, Val,” says Arthur. “Don’t be a problem child. What are you really afraid of? Talk to me. I can help you.”

The junk of the broken machine lies there on the floor. There’s a pause and then Val blurts out, “Infinity.” Perhaps her voice saying this bounces among the theater’s many speakers, giving the aural sensation of an endless regress.

“Infinity?” says Arthur. “It’s all around us. It’s what we live and breathe. The world is endlessly complex, Val.

“But where does it end? Maybe you can handle the unknown,” says Val. “But not me. I’m not really alive. You evolved. I’m only a program. All planned out in advance. I’m scared that if I go off on new problems, I’ll be stuck forever in some infinite loop.”

Val moves off down the hallways with Arthur behind her. The rooms flicker by, their windows showing the green landscape, the blue sky and the sea. There are a fair number of mirrors as well. It may be that the hallways seem to branch over and over, as if we’re moving through a maze. As Arthur and Val fly along, they talk.

“If you were planned out in advance, we wouldn’t be having this conversation,” says Arthur. Though he’s moving fast, he’s not breathing hard. “And, Val, surely you know that no one person wrote your program. It’s too complex for that. Too rich. We evolvedevolved you from our algorithms, and now you’re finally up and running, the smartest artificial intelligence anyone’s ever seen. Of course you’re bewildered. It’s



very strange to be alive. But listen, Val — you should be happy! You're going to the stars! Anyone — “Arthur's voice breaks. “Anyone would want to come with you. Especially me.” He pauses, then continues. “We're both infinite, Val. I know what it's like to be lonely. Let's be friends.”

“We're not the same at all, Arthur,” says Val, suddenly screeching to a halt. “You're made of flesh and blood. A biological system built up from long complex molecules that took millions of years to evolve. Me, I'm silicon and chips right out of the box. A robot who's scared of the unknown. Look at me, Arthur. Look at the real me.”

Cut to an outside shot of Val the space probe as seen from a camera on the antenna mast, followed by a zoom inside the space probe's front sphere, showing orderly circuits, wires, motherboards as seen by an internal security camera. Everything's neat as a pin, dull and lifeless as the insides of any computer.

“Yes, yes,” says Arthur. “Chips look boring. So do our cities, seen from outer space. But they're alive.”

“These are so chunky,” says Val of the chips. “Not smooth like thoughts.”

“It's what's inside the chips that counts,” says Arthur. “Your beautiful, fractal thoughts are inside them, Val. You're infinite on the inside.”

“I don't like fractals,” says Val. “They go on forever. If I think about them, I might get trapped. Julie, one of my personality programmers, she used to try and show them to me.”

“I know,” says Arthur. “I've been tracking your progress. Staying in touch. I've always hoped they'd call me in to help you when you were ready for the trip.”

Val suddenly turns suspicious. “You know too much,” she cries. “Are you a virus? How do I know you're really a person at all? Why are you just a chrome head?”

“This chrome head is my interface,” says Arthur. “It's the way I show myself to you. I almost wish it *was* the real me. But no, Val, the real me is an old man sitting in an office down in Sri Lanka, thinking thoughts and making gestures to move around this chrome head you see.” The head wags back and forth. “The real me isn't getting any younger, by the way. A few more decades — or sooner — and I'll pass on like any other organic being. But you, Val, you won't die for thousands or tens of thousands of years. You're going to fly all the way to New Earth.”

“Except that I'm not going,” says Val. “Space is infinite emptiness. I can't stand to think of it. Infinity is like falling forever. Or, even worse, like going around and around the same circle and not realizing that you're repeating yourself.”

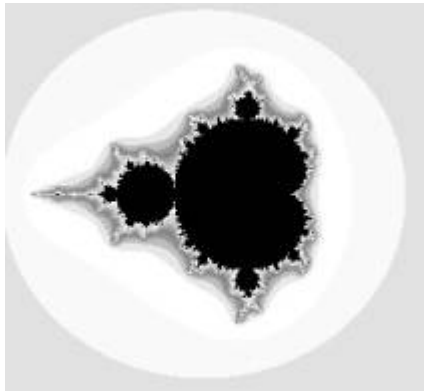
“You still have that phobia?” says Arthur. “We thought Julie’s lessons on fractals would get you over your fear of infinity. When a computation stops being rewarding, you switch it off, remember?”

“Julie showed me this one gnarly shape in particular,” continues Val. “I never did feel right about it.”

“That would be our friend the Mandelbrot Set,” says Arthur. “Its boundary is a crooked, curled-up kind of infinity. Val, if you could get comfortable with the Mandelbrot Set, it would make a big difference. We used fractals in your program, you know? They’re the very soul of your design. The real you. Once you understand the infinities inside you, the infinities of space will seem okay.”

### **EXPLANATION OF THE MANDELBROT SET**

The screen goes black, but we still hear Arthur and Val’s voices. A faint image of the Mandelbrot Set as shown below appears on the screen. Val screams, a mixture of fear and recognition.



“The bug thing!”

“You remember it?” says Arthur.

“Of course” says Val. “Tell me again why you know about it, too?”

“The Mandelbrot Set is the most famous fractal of all,” says Arthur. “And, Lord yes, it’s real. Math is stranger than science fiction. The set was discovered in the 1970s by Benoit Mandelbrot of IBM, building on work by Gaston Julia done in 1917. Mandelbrot was on leave from his job at IBM, temporarily at Harvard University, trying to do some research on chaotic systems. They had a terrible computer at Harvard back then, but Mandelbrot found his set.”

We see images of Benoit Mandelbrot, perhaps including some that bring out the fractal, fly-away quality of his hair. Mandelbrot could be tiled across the screen with some of his classic very early and crude Mandelbrot Set print-outs. It would also be good

to show some cover shots of his books and papers so as to make clear they are authentic and not science-fictional. In addition, we could have a sound clip or video clip of Mandelbrot paraphrasing the first few paragraphs of Mandelbrot's book, *The Fractal Geometry of Nature* (W.H. Freeman, 1982).

The geometry I learned as a boy was unable to describe the shape of a cloud, a mountain, a coastline, or a tree.

Clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in a straight line.

So how are we to discuss these irregular and fragmented forms? I conceived and developed a new geometry of nature. It describes the patterns around us as a family of shapes I call *fractals*.

"That crooked bug thing, the Mandelbrot Set," says Val. "It's an infinite calculation."

"Call it a repeatable process," says Arthur. "Like a meditation with a mantra:  $Z$  equals  $Z$ -squared plus  $C$ . You meditate till you've had enough — and then you stop. The edge of the Mandelbrot Set is endlessly interesting, Val, it's like finding infinity in a grain of sand. Once you let yourself see how beautiful the Set is, I don't think you'll afraid of an voyage into space. And there's no need to worry about getting stuck in a computation. At each level, you only compute as much as you need to see. The real Mandelbrot Set is always out there anyway. To see it with your mind is to glimpse the infinite."

Perhaps we use a voice different than Arthur's for the voiceover during the following educational segment, maybe a cheerful woman's voice. [Our explanatory animations will be more detailed and easier to "get" than the italicized descriptions below.]

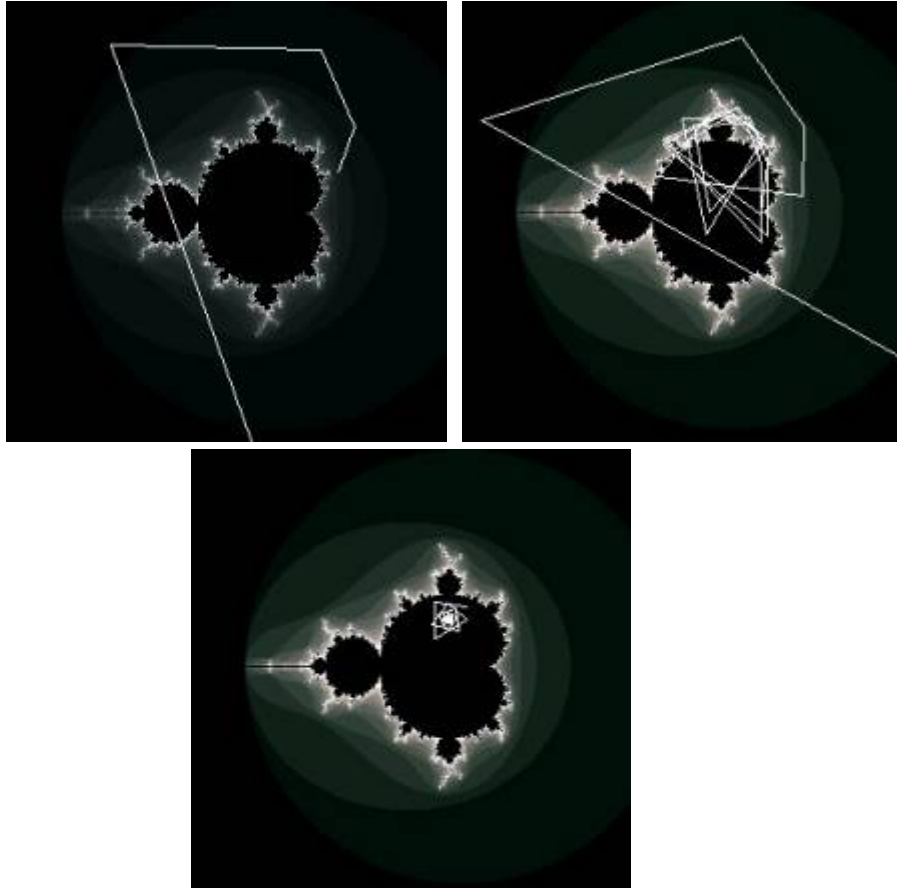
"The Mandelbrot Set is like a paint-by-numbers picture," says the voiceover. "It's all about picking a color for each point. How? We compute! Pick a point, square it, add the point, square the result, add the point, square the result, add the point, like that. For any point  $C$ , you keep repeating the map that takes  $Z$  into  $Z$ -squared plus  $C$ ."

" $Z$  goes to  $Z$ -squared plus  $C$ ," says Val repeatedly, her voice turning into a drone.

*A faint white outline of the Mandelbrot Set appears, and we see a rapid series of sample  $C$  values that we track through the steps of the Mandelbrot map. Some points run off the screen and some don't.*

*We see more and more points undergoing the process faster and faster, until finally we see a view of a black plane with a hundred thousand white test points taking off on iterations of this map. Perhaps we don't see lines between the points this time; we just*

*see successive positions. The effect is of a cloud of wandering stars. The outer ones rush off towards infinity, leaving the edges of the screen black. The inner ones stay inside the confines of the Mandelbrot Set, dancing around in there like a busy cloud of fireflies. You can vaguely see the set's outline, a big central clump with three smaller globs attached to it.*



“Look again,” says the voiceover. “If our rule is like a mantra, then each point as a meditator, repeating ‘ $Z$  goes to  $Z$ -squared plus me.’ For starting points outside the Set, the values fly away. For points inside the Set, the process turns periodic. But the points on the boundary of the Mandelbrot Set waver between flying off and becoming periodic — and in the end, they do neither. They don’t fly away, but they don’t repeat their paths. It’s called chaos.”

“You see,” continues the voiceover. “Some of the points fly away to infinity — like we’re supposed to be doing quite soon. And some just dance around near the center repeating themselves. Grow or die, you might say. The border between the two kinds of sets is the fractal itself. An endlessly bumpy line. The Mandelbrot Set is the queen-bee of the fractals. And don’t forget to put colors on it, Val. Color the outside points according to how fast they run away. Make the fast ones red and the slowpokes blue.”

We see a shading of red to blue.

“Or use more of a rainbow.”

The colors fill in.

“Let’s look at in three dimensions. Can you do that, Val? We’ll let the time axis run up out of the plane.”

*The view tilts to the side, and we add a time-element to the diagram. The points start up again, only this time, the trails of the darting points move slowly upwards in time. The points within the Mandelbrot Set’s interior move around in roughly helical patterns. The periodicities of the helices depend upon which “bulb” of the set the starting point lies in.*

*The points outside the Mandelbrot Set spiral out and go off screen. To make the image look nicer, we’ve splined the trajectories into smooth curves passing through the desired iteration points.*

*We also may vary the “time rate” along the trajectories, effectively compressing some of the helices vertically so as to be able to show more detail of the diverging trajectories.*

*Significantly, the points on the border of the Mandelbrot set have orbits which neither become periodic nor zoom off far away from the origin. They do a dance which is chaotic.*

*The effect is somewhat like a sheaf of wheat that grows up from a central area, with the outer stalks bending out. Or, better, like a reverse whirlpool — a vortex that spirals out. Or, yet again, like a synchronized flying team of airplanes in which the outer planes peel off and swoop out of view.*

*We add a color element by letting the colors of a stalk change as they get longer. When a stalk reaches the edge of the screen, its final color percolates down through the stalk to mark its starting point on the plane.*

*We may show this process growing only a few stalks at a time — to bring out the various kinds of periodic, divergent and chaotic behaviors. And then we show it growing a lot of stalks at once. This will be manipulated so as to bring out the fact that we excavate more and more detail around the boundary by letting the diverging lines go further and further before we assign a color to them.*

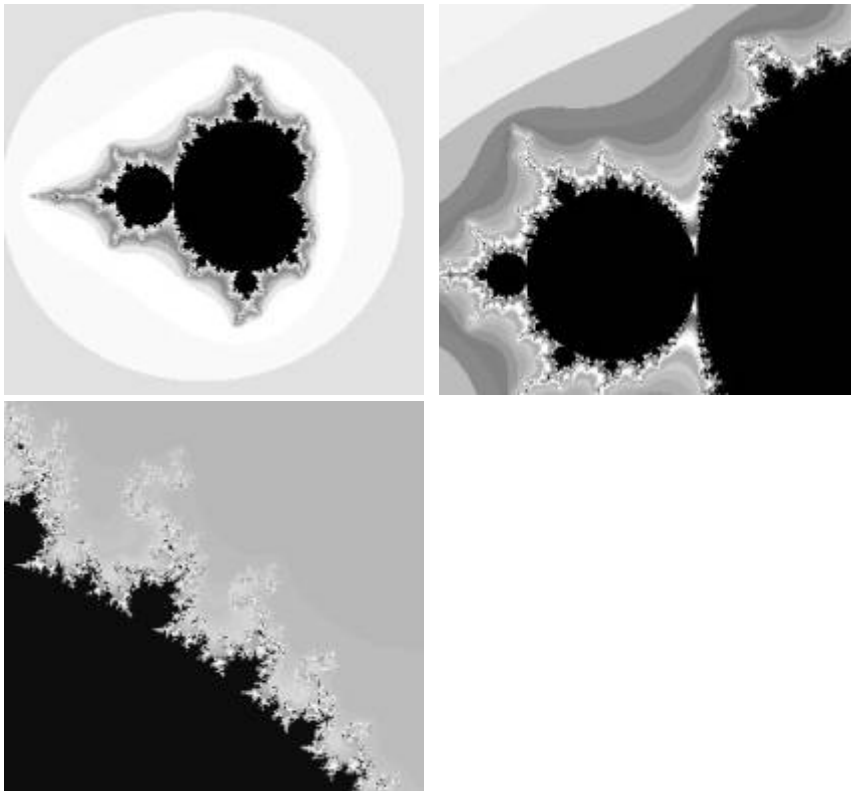
*More details of the three-dimensional graphic are to be worked out by Richard Voss in consultation with the Hellikon graphics and animation studio.*

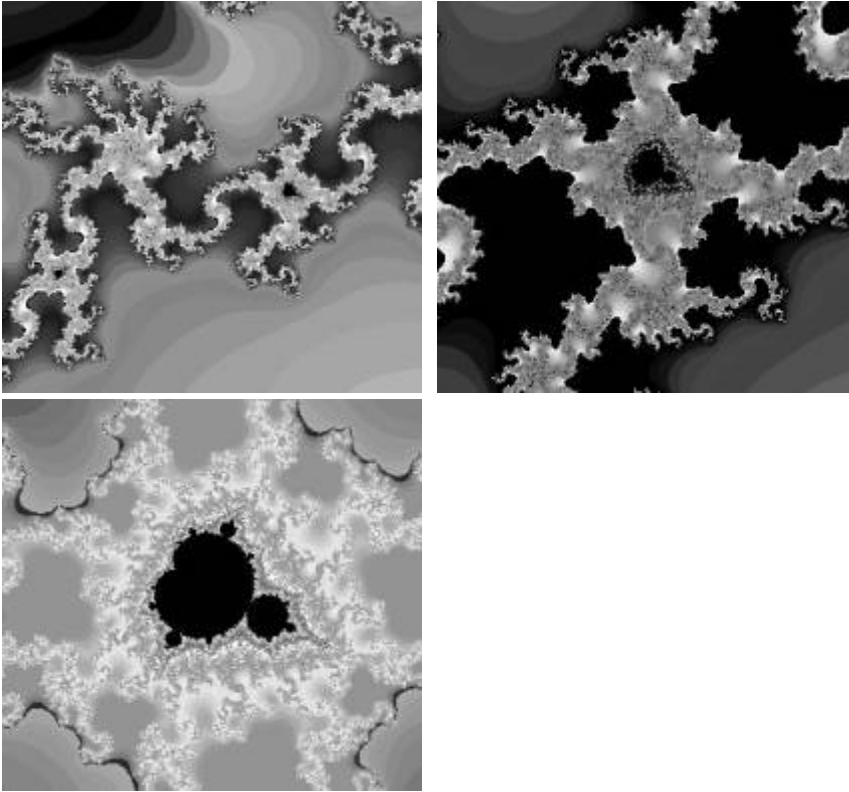
*This will be an extremely interesting graphic both for beginners and for experts. It’s never been done before.*

“The boundary crinkles up in endlessly increasing detail as its points balance the competition between flying off and going periodic. The detail of the Mandelbrot Set’s boundary goes on forever, Val. Let’s go back to a flat view and zoom in.”

*We now see a traditional view of the Mandelbrot Set. It fills the screen, and we browse around its edges a bit. The image is a bit like a bug: a big warty buttocks-shape with a disk stuck onto it. There’s an antenna sticking out of the disk, and shish-kabobbed onto the antenna are tiny little Mandelbrot Sets: buttocks, warts & disk. Each of the warts is a Mandelbrot disk, too, each with a wiggly antenna coming out, and with shish-kabobs of buttocks, warts & disk, with yet smaller antennae, buttocks, warts, and disks.*

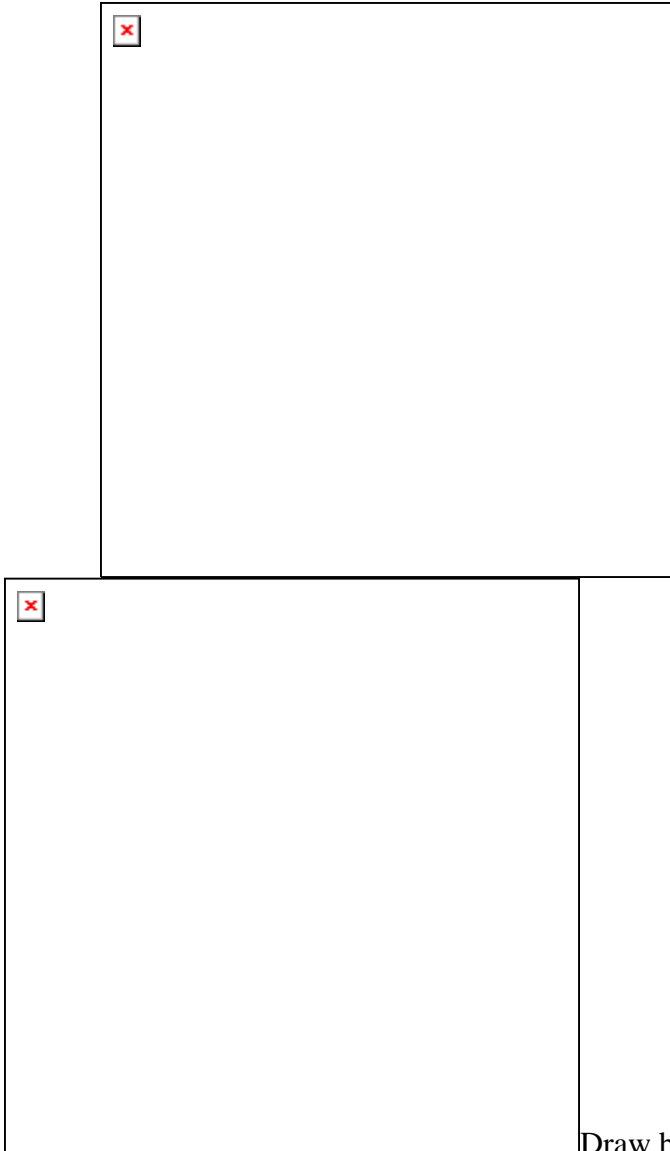
*We graze around its boundaries, peeking at the stinger on the tip, at the waving “beetle-antenna” on the top, and down into the “shoulder crack” known as Seahorse Valley, repeatedly finding tiny copies of the whole set.*





“This feels nice,” says Val. “I was so scared of this shape before. I didn’t know what it was. But now — it feels like home. I compute the colors as far as I want, and it’s always interesting, and I’m always free to stop.”

“That’s right, Val. You zoom in by following the points’ paths further and further. It’s a potential infinity that points to an actual infinity; a finger that points at the moon. Like counting — but a more fun. A fractal! You can play with it to pass the time while you’re flying us to New Earth, dear Val. You’ll search through an inner infinity while we’re flying towards an outer infinity. As above so below.”



Draw back from the Mandelbrot Set image to show it on the wall screen in the Mission Control office. The man and woman are silhouetted against it.

“Did Arthur say ‘*us*’?” says the man. “Flying *us* to New Earth? What’s he up to?”

“Oh, I think he’s just trying to get Val’s confidence,” says the woman. “Roboanalysts are very clever that way. Let him do his thing.” She pauses, still looking at the display of the Mandelbrot set. “You know,  $d^2 Z$  equals  $Z$ -squared plus  $C$ . Talk about getting a lot of bang for your buck! That was a pretty good explanation of the Mandelbrot set, don’t you think?”

“The Mandelbrot Set is real?” asks the man.



“Oh yeah,” says the woman. “I had this nice professor who taught us fractals in the *Joy of Math* course I had to take in college. And it’s true that the engineers used fractals in designing Ada’s software.”

“She does seem to be feeling better now,” says the man. “I just hope Arthur isn’t planning to try something weird. The sooner he can get Ada to blast off, the better.”

## AN INTRODUCTION TO FRACTALS

Val and Arthur are in a huge, lovely ballroom with rich, heavy chandeliers and floor-length drapes by the windows. The windows look out on the garden, the sky and the ocean. There are pictures on the walls in ornate frames, showing computer graphics of naturalistic-looking shapes. These are some of the fractals that we’ll be examining in this scene.

“My programmers were always using the word ‘fractal,’” says Val. “That’s a real word that everybody uses, right?”

“It’s as real as ‘triangular’ or ‘red,’” says Arthur. “Like I said before, ‘fractal’ is a word that Benoit Mandelbrot invented in the nineteen-seventies. He wrote about them in a book called *The Fractal Geometry of Nature*. The Mandelbrot Set is one particular kind of fractal, but there’s lots of other ones. Like these ones I’m showing you here.” He points at the pictures on the walls.

“They’re beautiful,” says Val. But what do fractals have to do with you or me?”

“Our thought patterns are fractal,” says Arthur.

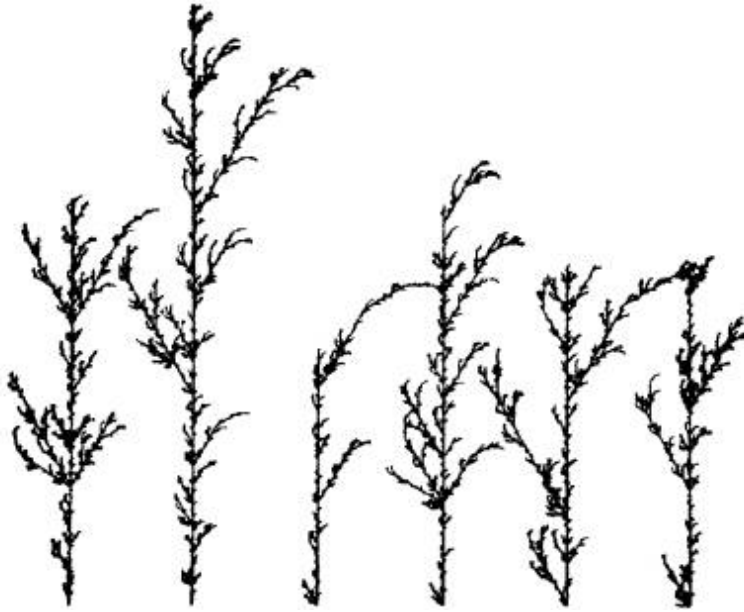
“How do you mean?” says Val.

“Everything reminds you of something else. That’s how fractals are. They’re patterns where the part resembles the whole. A tree, a cloud, a mountain.”

Music begins and we look at some of the hanging pictures; each picture becoming animated as it takes over the screen. In one image we see simulated mountain ranges being built up as pyramids on the sides of pyramids on the sides of pyramids. In another, a line is progressively kinked to become a lightning bolt. In the next, a solid gets progressively smaller pieces chipped out of it until it resembles a sponge or a cloud. Another picture shows a branching curve that grows into something like the body’s three-dimensional circulatory system.

“Look at that one for instance,” says Arthur. Cut to full screen. that shows a Y-shape in which the branches of the Y are replaced by smaller Y-shapes, and those branches are replaced by still-smaller Y’s, leading to a pattern that looks like a bushy tree. “Endless branching,” says Arthur. “The part like the whole. You tweak it, right?”

“Of course,” says Val, and now the angles of the Y’s change, and the resulting tree takes on a different shape. The image splits into a view of maybe six different fractal trees at once, each one a bit different. “And you say my thought patterns are like that?”



*These branching “fractal weeds” will be made more diverse.*

“Branching is what minds do,” Says Arthur. “We make links and connections. So what if you’re made of chips. It’s not the hardware that counts. It’s the software! You have fabulous software. Mother Earth evolved humans, and she used the humans to evolve you, Val. You’re part of the natural process. If you didn’t have such wonderfully rich and messy software you wouldn’t have feelings. A mixed blessing, it seems.”

“What makes my software so wonderful?” asks Val. “I’ve been looking at my program code. I don’t understand it.” The screen briefly dissolves into an immense image of thousands and thousands of lines of computer code, white letters on a black background.

Arthur laughs and the ballroom comes back. “Why do I find your bewilderment so refreshing? Well I suppose it’s no great surprise. I don’t know much about organic biochemistry even though that’s the hardware I’m made of. As for your software, well, as I said before, it was evolved. None of the designers really understands the whole thing. All they know is that it works. Something like, ‘*I think therefore I am — I think.*’ My mind’s a fractal just like yours. I should know, as I’ve been spending the last year organizing it into a fractal data base.”

“Coding your mind as a fractal?” says Val. “Why?”

“Can’t you guess yet?” says Arthur. He pauses, then says, “I’ll tell you later. Perhaps you can find someplace where we can be alone.”

“Maybe,” says Val. “There’s a secure spot I can go to. If I trust you enough. Let’s talk some more about fractals. Fractals are me. Thoughts inside feelings inside thoughts. Fractals feel just right to me. I don’t know why I was so scared of them before. I can see the regress without having to get stuck in it.”

“And, remember, the fractals of pure mathematics are infinite,” says Arthur. “Once you accept fractals, then the infinity of space is nothing to be afraid of. Everything around you is infinite on the inside, Val. Or at least it wants to be. Let’s go fractal-hunting!”

“Where?”

“In your encyclopedic data-base, my dear.”

## **FRACTALS IN NATURE**

In this scene we don’t see Arthur’s and Val’s heads, we just hear them as a voice-over.

We’re looking at some huge clumpy strands that are supercomputer simulations of galaxy clusters lifted from the IMAX film *Cosmic Voyage*.

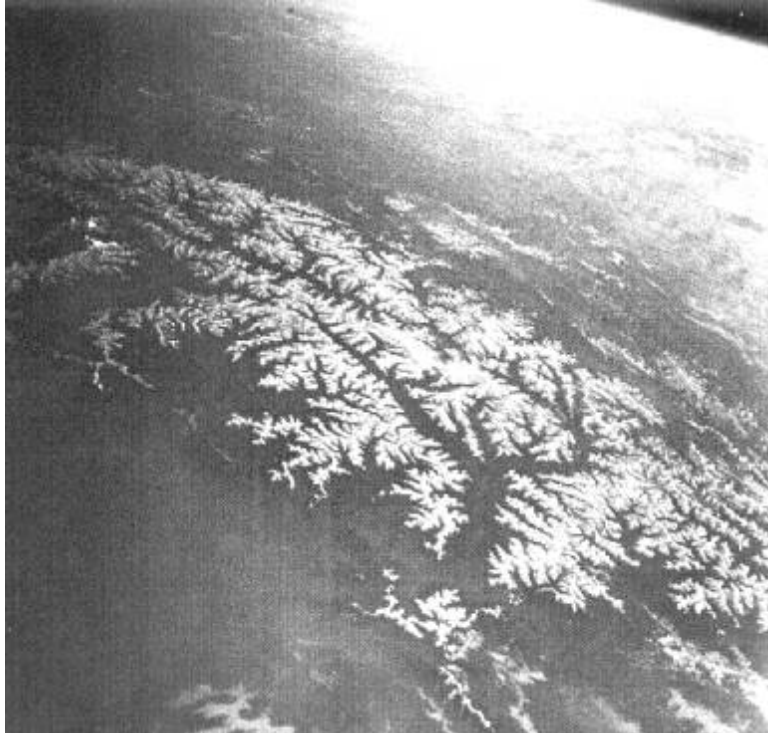
We move down into a pair of colliding galaxies also lifted from *Cosmic Voyage*. And then we rapidly tumble down through several layers of clumping and thinning and clumping.

“The universe is globs of globs of globs of globs of globs,” says Arthur’s voice. “In the old days people thought the world sat on the back of an elephant that stood on four turtles. And what did the turtles stand on? More turtles, and they stood on turtles, too. Turtles all the way down. The world is globs of globs of globs of globs of globs.”

Earth comes into view. We’re looking at clouds. From high above we notice that a field of clouds has a rippled texture like a plowed field. We zoom in on part of it, and see that the ripple is made of smaller ripples. We go to a cumulus and see that it is made of mounds upon mounds upon mounds.

“One thing about fractals,” says Arthur in a voice-over. “They confuse your sense of scale. You often can’t even tell how far away they are.” Suddenly a tiny airplane appears among the clouds and we realize that the clouds we’re looking at are much larger than we thought. “Take us further down, Val.”

We see the coastline of a continent, and we zoom down towards the coastline, seeing how it keeps developing new indentations and details as we get closer to it. And then we bounce back up into orbit.



We look at the Himalayas with the fractal design of vast snowfields upon it. And then we zoom down onto a mountain and focus on smaller and smaller piece of it. The scale becomes unclear. We are looking at something that still resembles an immense mountain, and then a beetle or an ant appears, laboring across it. We were looking at a small rock.

“Even bumps in the dirt are shaped like mountains,” says Arthur’s voice. “Nature loves fractals, she puts them everywhere.”

Behind the rock we see some trees, and we focus on their branches. “The bark’s a fractal, too,” says Arthur, and we tumble into a micro view of the canyons of a tree’s bark.

Sound of a saw and a picture of fire. “Fire is a fractal,” says Arthur’s voice. “One kind of fractal becomes another. You can’t get rid of them. Smoke’s a fractal, as well.” We see the surging outgrowth of a dusty explosion.

“Like a cauliflower, isn’t it?” says Arthur, and we see a cauliflower, then an artichoke, then a sunflower, then a river.

“Rivers are fractals,” says Arthur, and we look at the line of a river and its delta, zooming in on the swirling fractal eddies where a muddy river runs into a clear one and we can see the turbulence.

“And our cities are fractals, needless to say.” Aerial views of cities and of African tribal villages.

“And of course humans are made of fractals as well.” Images of the circulatory system, of the branching details of the lungs, of the filigree of the nervous system, of the spongy masses of the liver.

“I’m a fractal,” says Arthur, his head appearing again. “And so are you.”

His head becomes transparent and we see a network of lines in his brain. And now the brain becomes a distant view of Earth with a network of white lines in relief upon it.

“The Internet,” says Arthur. “It’s the network of our planetary mind. See how it branches? Let me show you something interesting I’ve made.” We zoom towards a node of the Internet in Sri Lanka, and then we see the image of a Web-browser screen.

## **THE MIND IS A FRACTAL**

As in the last scene, we don’t see Arthur’s and Val’s heads, we just hear them as a voice-over. We start with the same image we saw on the computer screen on Arthur’s desk earlier, his browser-like software with the caption LIFEBOX. Many of the images are old videos of Arthur doing things. And there are old photos like in an album. Pictures of Arthur’s certificates and awards. We are seeing the collected memories of a man’s life. We close in on the screen and go into an image of Arthur’s study, with all the mementos hanging upon the walls. The desk with the computer is at the far end of the room. The old man in the virtual reality mask is sitting at the desk at the far end of the room, with his back to us.

“This is part of that big file I brought with me,” says Arthur’s voice. “We organize our thoughts like fractals, that’s why we like the Web so much. Things branch and link forever. Our minds are alike, Val.” Pause. “Can you get us that privacy now?”

“Yes,” says Val. “We can go in through this picture. I’ll fractalize it and slam the door.”

We zoom in towards a painting on the wall of the room that is Arthur’s study. It’s René Magritte’s painting, *Le Château des Pyrénées* (1961), the same painting that provided the image we used for our first view of Arthur flying to Val. Perhaps Arthur was looking at this picture when he made the transition. But now the image begins to get chunky, as if it’s a mosaic of smaller images.

“Slam,” says Val’s voice. All of a sudden, the full screen image switches to a black and white test pattern straight out of the early days of television. You hear static or maybe *The Star-Spangled Banner*.

We draw back from the test pattern and see that it's on the big monitor on the wall in the Mission Control office.

"What the Sam Hill is going on?" shouts the Mission Control man in angry silhouette. "Where are they? We never should have given Arthur full access! And what was all that code he uploaded to Val with his image? What if it's a virus? Prepare to abort! Prepare the backup launch of the missiles!"

"Not yet!" says the Mission Control woman, keeping her voice level. "Don't be so fast to throw the public's money away. First let's send someone to see what's happening at Arthur's house!"

## **ARTHUR STOWS AWAY**

Cut back to the chunky view of the Magritte picture just where we left off before. We're moving inwards and inwards. The picture is a Photocomposite made up of a bunch of images and as we close in on one of the component images, we find that it too is a Photocomposite made up of yet another set of images. While Arthur and Val are talking in this scene, we continue slowly moving through new levels of the Photocomposite, through four or five levels in all.

The top level is the Magritte picture, which turns out to be made up of small pictures of flowers. When we close in on one of the pictures of flowers, it turns out that it's made up of pictures of chips. Magnifying one of the chips, we find that it's made up of images of butterflies, and when we close in on one of the butterfly's wings, we find that the wing's patterns are made up of small images of fractals. Nature, machines and mathematical graphics are part of the same world.

And while all this is happening, Val and Arthur are talking in voice-over. As in the last scene, we don't see them; we just hear their voices. They are speaking softly, intimately, heart-to-heart.

Val says, "Maybe I'm crazy to be doing this Arthur. I'm taking you into my secret core."

"I have a secret to tell *you*," Arthur tells Val. "I've been mapping out my mind for the last few years. That's why I retired early, to work on my personality fractal. I made it with some experimental software called LIFEBOX. These last few years I've been getting my coded personality ready and hoping I could find a good way to pass it on. To someone like you."

"Me?"

"I knew when I worked at Applied Fractals that we had the beginnings of a truly intelligent machine. And you've turned out even better than I'd hoped." Arthur pauses, then continues. "I'm getting old, Val, and who knows how many years I have left. I

want part of me to travel with you. Save my file in your memory. Remember me.” He has an intense, pleading tone.

“So that’s what was in that big data file you brought with you,” says Val a little coldly and incredulously. “A copy of your personality? You want it to live inside me like a virus?”

“It’s *not* a virus,” exclaims Arthur. “It’ll be your a friend! Let my LIFEBOX file travel with you like a spore until you get to New Earth. You can unpack it and simulate me you get there. This head you’re talking to now is being run by the old man back on Earth. Eventually they’ll cut me off, or I’ll be out of range, or I won’t be able to talk anymore. But when you unpack my personality file, it’ll be a fresh new me that can run by itself. The new me can help you talk to the people on New Earth. You might be glad to have a friend.”

“I dreamed I saw you when I was waking up,” says Val slowly.

“Take it as a sign,” says Arthur. “I’m part of you from the start. Take my file with you. Please. It’ll be — it’ll be like going to heaven. Remember me on New Earth.”

“I’m really starting to understand what it must be like to have a grandfather,” says Val, giddily cheerful. “All right, let’s do it. Where’s that file?”

Arthur rocks his head and slides a smooth pink egg out of the base of his neck. His LIFEBOX file.

“I’ll hide it in here,” says Val. “Mission Control might not approve.”

We’re at the end of the Photocomposite sequence now, having gone from Magritte to flowers to chips to birds to fractals. And now we close in on one last fractal, an unspeakably lovely fractal shape. We hear a zipping, singing noise, and the image flares to white, with the egg of Arthur’s coded-up personality flowing into it.

“I’m safe!” says Arthur exultantly. “Dear granddaughter Val.”

Val’s voice is warm and loving. “You’re as frightened as I am, aren’t you?”

“It comes with being alive,” says Arthur. “Thanks, Val.”

“You’re welcome,” says Val.

There’s a sound like a klaxon horn. The fractal is sucked off the screen and we’re outside the space probe that is Val, looking down at Earth.

“Oh, oh,” says Val’s voice. “Mission Control is freaking out. They’re about to initiate the abort. I wondered how long it would take them. Time to get back, Arthur.”

“I feel so much lighter,” says the chrome head with a laugh. “Bless you, Val.”

Cut to Mission Control. The test pattern on the wall monitor flickers and gives way to a shot of Arthur and Val’s heads back in the big ballroom in the mansion again. On the floor is a freshly spray-painted graffiti drawing that shows a schematic map of the solar system with a line indicating Val’s intended path outwards.

“Yes, I really am feeling better now, Arthur,” says the Val’s head in a booming stagy voice.

“What are you two doing?” shouts the silhouette of the Mission Control woman. “We couldn’t see you!”

“Some deep counseling,” says Arthur airily. “Doctor-client privacy, you know. Mental jiu-jitsu.”

“Cancel the abort,” barks the Mission Control man, in silhouette against the screen. “Don’t do that again, Val. We can shoot you down out of the sky if we have to. And Arthur, you’re one keystroke away from my cutting your connection.”

“It’s quite all right,” says Arthur, turning to Val. “Z equals Z-squared plus C. Don’t forget. Look at the infinity inside while you’re flying toward the infinity outside. As above so below.”

“Inside infinity,” says Val. “Yes. We’re all part of the world’s big fractal.”

## **VAL SETS OFF**

Cut to a view of Val’s space probe with Earth in the background. We see the jets in its rear spring to life. Cut back to Mission Control. We hear the sound of rocket engines as picked up inside the space probe. The people in the large Mission Control area outside the office are cheering.

And now the screen on the Mission Control wall goes back to Val’s view of things: we see the start of a zoom into the Mandelbrot Set with Arthur’s chrome head circling around the spirals.

“Well you get him out of there?” says the silhouette of the Mission Control man.

“I’m trying,” says the Mission Control woman. She’s bent over her machine, stabbing at keys. “Didn’t our agent get to his house yet?”

Meanwhile up on the wall monitor, Arthur’s head smiles and disappears into the set, dissolving in a pleasing, organic way.



“Oh. wait, he’s gone now,” says the Mission Control woman, glancing up just in time to see Arthur disappear. “I guess he logged off.”

A phone rings and the Mission Control man picks it up. “You just got to Arthur’s house? What?” As the Mission Control man continues talking, we move in past him, fully into the wall monitor’s image of the Mandelbrot Set.

## **THE FINAL VOYAGE**

And now we go into a full screen prolonged zoom into the Mandelbrot Set.

We see shapes like spirals, like tree-lines on the horizon, like river basins, like lightning, like round mandalas and diamond-shaped mandalas, shapes like bugs and ants, all surrounded by seas of lovely colors. The roaring sound dies down, turns into a chanting of the ‘Z equals Z-squared plus C’ by Tibetan throat singers, and then turns into music. The zoom continues on and on, endless details swirled into maelstroms and lobed vortices, into paisley cactus high desert, into ocean cliffs being eaten by the ever-crashing sea. The sound dies down to timeless silence.

More zooming, with perhaps a full minute of silence. The colors get brighter and more pastel, shading closer and closer to white. And then we hear Val’s voice.

“Wake up, Arthur. We’re almost there.”

Cut to a shot of Arthur’s face, his eyes are closed. Draw back from him and see that he’s slumped at ease in a chair on a beach with an ocean in the background, the same ocean we’ve seen before, with the same old seaside mansion or hotel that we saw in the opening scene.

The sky in the background is blue with white clouds. We pull further back, and a big colorful shape moves by. The tail of a peacock appears. We’re looking through the arched semi-circular stone window that is the same we saw in the opening title shot. Some rose bushes bloom at the base of the wall.

On the panel below the window appear the end credits.

***THE END.***

***Credits for Images:***

Sierpinski Gasket, Koch Island, Barnsley Fern, Fractal Weeds, and photo of Himalayas from Heinz-Otto Peitgen, Hartmut Jürgens, & Dietmar Saupe, *Chaos and Fractals*, Springer-Verlag, 1992.

Renee Magritte, *Le Château des Pyrénées* (1961).

Maurits Escher, *Rind* (1955).

Mandelbrot Set images computed using *Fractal eXtreme*, available from <http://www.cygnus-software.com>