	It's About Time **© Houston Museum of Natural Science**
Falling clocks until big white and black clocks fall. Grandfather clock sequence --- words appear until clocks start to move. Grandfather clock fades to black as it falls Black background, white tetters	**SuperScene A** A heart beats every second, the Earth turns every day, There's a full moon once a month, and the seasons change in a yearly cycle. What happens to these Earth clocks when we leave our planet behind? What clocks keep time in the universe beyond? Mt. Kilimanjaro Tanzania, Africa July 2075
Mt. Kilimanjaro animation flying across the plain toward the mountain in the distance.	In the 20th century, the science fiction writer, Arthur C. Clarke described an elevator that could take astronauts into space. Imagine hsi dream coming true in the late 21st century, on Mt. Kilimanjaro, a gigantic extinct volcano in east Africa, close to the Earth's equator.
Mt. Kilimanjaro in full view	Mt Kilimanjaro was born a million and a half years ago and its summit is Africa's highest point.
Drop down into the volcano's crater and see the space elevator buildings.	The Clarke Space Elevator complex would fill the volcano's summit crater. Each tower would be a docking bay for a space elevator cabin. A cable would connect the towers to an elevator terminal in orbit 35,000 kilometers above.
Lights come on in the Space Elevator complex.	Imagine that the Space elevator complex is real, the future is now and your elevator cabin is ready for boarding.
Camera moves toward the briefing room.	Your pre-trip briefing is about to begin in the glass-walled visitor's center between the gantry towers. It's time for tomorrow.
Full briefing room with logo in front	**SuperScene B** Welcome to the visitor's center of the Clark Space Elevator on Mt. Kilimanjaro. Please make yourselves comfortable as we explain how the Space Elevator works.
Illustrations of the complex	Outside these glass windows, you can see the two launch towers for the elevator complex and the sun just rising along the Eastern horizon. In just a few minutes you will enter the tower to your right and board the Space Elevator.
Animation of cables	You can see nanofiber cables extending toward space from each

	tower. These ultrastrong cables connect under this building and in space to create one giant loop. While one part of the cable carries your elevator to orbit, the other cable is bringing the second elevator cabin back to Earth. This briefing explains the science behind this new era in safe and affordable spaceflight.
Video of astronaut lift-offs with rockets ignited -- fade to close-up of elevator cabin on cable.	In the 20th century, astronauts traveled into space atop ignited rockets with the downward rushing gases propelling the spacecraft upward. Spaceflight was very dangerous and required years of training. With the space elevator, there are no exploding fuels. Inside the cabin, the ride is smooth, the acceleration is minimal, and no training is required.
Diagram of elevator cabin on cable from Earth to orbit.	This elevator will soon carry you comfortably to geosynchronous orbit – a journey of 3 days, covering over 35,000 kilometers. The acceleration will be gentle and steady for a very smooth ride. At geosynchronous orbit, you'll circle the Earth once each day – always remaining over this elevator terminal.
Close up of cabin with downward viewing windows highlightede	Your elevator's observation deck has windows facing outward and downward so you can watch Mt. Kilimanjaro growing smaller as you leave the Earth behind.
Close up of the Space Elevator terminal -- station turns as we describe the components.	As you approach the orbiting space elevator terminal, you will see the docking bay for the elevator. The tall tower contains the hotel and offices of staff who live and work in the terminal and on the nearby Time Telescope. The ring area of the space station contains the repair shops and construction facilities to keep the elevator and telescope in good working order.
The time telescope pull away from the space station.	Your trip also includes a visit to the Einstein Time Telescope which lies next to the Elevator platform. This incredible telescope uses Einstein's physics and a wormhole encased in a lens structure to see through time. This telescope can bend space, just as Einstein predicted. Normally when we look at an object, we see it as it was many thousands or millions of years ago -- because it takes light that long to travel from the object to us.
Time telescope animations	A light year is the distance light travels in a year – over 9 trillion kilometers. If an object is 10 light years away, we see it as it was 10 years ago. The Einstein Time Telescope removes this distance factor so you can see distant objects as they appear from Earth and as they are right now. Astronomers——and now the public——can visit this telescope because of the Clarke Space Elevator.

	This time telescope is the ultimate adventure through time. -- an adventure that you began when you traveled to Mt. Kilomanjaro.
Image of Africa from space	Africa is a continent linked to the history of time. Modern humans began migrations from East Africa to the other continents about 200,000 years ago. Now another African migration has begun, as humans leave the Earth for space from this African Space Port.
Rotating Earth under the sun	On Earth we keep Earth time. Our bodies evolved with the programming of Earth's time cycles. As the Earth rotates once on its axis, the planet's surface moves from sunlight into darkness and back into sunlight again-—causing our 24-hour clock cycle. You can watch day and night on the Earth below during your ride on the Space Elevator.
Space Station	Keeping this day-night time cycle has been challenging during spaceflight. On the International Space Station in low Earth orbit, astronauts see a sunrise every 90 minutes – 16 day and night cycles every 24 hours. Yet they're programmed for one sunrise every 24 hours. We've had to recreate this natural cycle with artificial lights and shades. On the Space Elevator we have the luxury of 24-hour days all the way up to geosynchronous orbit.
Moon base	Our astronauts on the moon face a different time cycle challenge. The moon's surface has two weeks of sunlight followed by two weeks of darkness. Lunar astronauts must create daylight when it's dark outside and nighttime during the long lunar day.
Africa again in July	You will see another of Earth's time cycles on your space elevator journey. By the second day of your trip, you will see that Europe is much greener than southern Africa this time of year. In July, the sun is much higher in the sky north of our equatorial launch site.
Africa in December	If you were to visit us in December, you would see summer greenery in South Africa and winter snows in Europe.
Elevator over Kilimanjaro	We can keep all of our familiar Earth clocks on our trip on the Space Elevator because our elevator remains directly over Mt. Kilimanjaro. Our day, month, and year are exactly the same as those experienced on the Earth below. Speaking of time, it's now time to board the space elevator. Your astronaut guide is waiting on the elevator pad.

	SuperScene C
building interior	Welcome to the departure bay of the Clark Space Elevator. Cargo has been loaded in the storage decks and the elevator is ready for passengers. As you enter the elevator's observation deck, please
inside launch bay	move toward the end of each row. Take a seat, engage your shoulder harness and prepare for ascent.
ground latches retracting	The ground latches are being withdrawn as the elevator prepares to leave Earth. As we climb, you'll feel lighter and lighter until you're floating off your seat when we're in orbit.
fly around cabin	On either side of the elevator cabin are detachable life-pods, capable of gliding through the atmosphere and returning passengers safely to the Earth's surface. There are enough life-pods to carry all passengers to safety. The space elevator is so safe that I've never seen these deployed.
elevator climbs up	*COMPUTER: Cable engaged. Begin ascent operations* The other cabin has been released from the orbiting terminal above us, its fall is now pulling us slowly upward. You'll feel a gradual acceleration until the elevator reaches climbing speed.
elevator leaves station	Watch as we clear the station gantry. *COMPUTER: Time in Transit: 4 hours* *Distance from Earth Terminal: 2,000 km*
view of elevator climbing	The elevator cable arcs toward space, allowing us to look down at the Earth. You can see Mt. Kilimanjaro growing smaller below us.
seeing Earth below	As the Earth turns eastward under the sun, daylight is coming to the world below us. The Arabian Peninsula is at the top of our Earth view. Below it we can see the horn of Africa and our launch site on Mt Kilimanjaro. The eastward turning Earth has brought daylight to all of the African continent. The Earth grows smaller by the hour as we climb upward into space. Soon we'll be passing through the Van Allen Radiation belts. We should clear the radiation belts before morning. *COMPUTER: Good Morning. It's Day 2 of Ascent* *Time in Transit: 24 hours* *Distance from Earth Terminal: 11,700 km*

Seeing Earth below again	Good morning! It's day 2 of our elevator ride. We're now so far above Earth that we can easily see the whole planet below. We're looking eastward over the Indian Ocean. The island of Madagascar lies just off the African coast.
Show video of sun up close through monitors	From the observation deck we can see the sun in the distance. Since we're less protected from the sun's radiation on the Elevator, we must monitor the sun's activity continuously using video feeds from solar telescopes on Earth and in space. Today's sun shows many dark sunspot groups - each marking a region of solar storms and heightened activity.
flare begins	*COMPUTER: Warning. A sunspot group has just produced a large flare.*
flare continues.	A storm of charged particles has been ejected into the solar wind and has been detected moving toward Earth. But don't be alarmed. We have the Earth's magnetic field to protect us. We're very close to maximum in the sun's 11-year sunspot cycle. This level of solar flare activity is normal. *COMPUTER: Approaching mid-point of Ascent* *Time in Transit: 36 hours* *Distance from Earth Terminal: 17,500 km*
passing cabins	We've reached the midpoint of our trip. It's time for the other elevator cabin to pass us as it moves toward Earth while we ascend. It's loaded with scientists, visitors, and support staff returning to Earth after a few days or weeks in orbit.
Earth outside once more	Below we can see the sun setting over the Sahara Desert. The high sun of summer brings incredible heat to this vast desert covering much of northern Africa.
approaching station and docking	*COMPUTER: Good Morning. It's the end of Day 3 of Ascent* *Time in Transit: 72 hours* *Distance from Earth Terminal: 35,000 km* *Stand by for cabin docking.* *Contact. Geosynchronous Orbit achieved.*
transfer corridor	Welcome to the Space Elevator Terminal. The transfer corridor is now extending toward the elevator's passenger portal. Soon the elevator doors will open. Remember you're now weightless and will float out of your seats. Prepare to grab the guide rails as you

	float through the door and into the connecting corridor.
fly around station	This terminal has a dormitory, cafeteria, and a small shop for the convenience of astronomers, astronauts, and overnight guests. Laboratories and workshops require special access.
Time Telescope in view	The Einstein Time Telescope hovers above the cableway. Soon you will reach the docking port for the Telescope shuttle. The shuttle has been prepared and is ready for your arrival. An astronomer is waiting to continue your tour. I'll see you again on your return trip to the Earth's surface. Good bye and great viewing.
Set up for ETT with fly around	**ASTRONOMER VOICE - SuperScene D** Welcome to the observation shuttle for the Einstein Time Telescope. Today we'll be photographing distant objects that show dramatic changes over time. Please take your seats inside the shuttle. I'll explain telescope operations as we leave the elevator terminal and approach the telescope's docking ring. The time telescope looks like a giant lens, a very special lens with a wormhole at its center. Solar panels provide energy for the telescope. The mounting ring has small maneuvering engines to turn the telescope toward any object in the heavens. A yoke holds the viewing ring at its center. We are now docking with this viewing ring. The telescope is now pointed toward a spiral galaxy called M51, 31 million light years away and containing billions of stars. Using the Time Telescope as a regular lens, we can see this galaxy as it looked 31 million years ago.
worm hole effect	But when we engage the worm hole, the telescope bends space to create a short cut for light to follow -- a wormhole tunnel between us and the distant galaxy.... This is how M51 really looks today. There are very few changes – for a galaxy, 31 million years is a short period of time.
Slight turning and reddening of H2 regions	To see more time pass, we must find an object that is much farther away. The telescope is now scanning a distant cluster of galaxies to find traces of more distant objects that lie beyond it. This cluster has become a gravity lens bending light toward us

See Abell 2218 cluster	from more distant galaxies. This faint smudge is all we can see of a very distant galaxy -- over 13 billion light years away.
Pan and zoom to more distant object	This object dates back to a time just after the Big Bang explosion that started the universe on an expansion that continues today -- an explosion we can see as we look backward in time.
Big Bang explosion	As the universe began to cool, the first matter called quarks formed....Over millions of years, the quarks combined and turned into the nuclei of hydrogen and helium atoms.
Quarks	These charged particles collected into young hot stars. These stars grew old quickly and in death they exploded and enriched the universe with heavier elements like carbon and oxygen....
Supernovae	
Spiral galaxies	Gradually the universe cooled and spinning clouds turned into the familiar shapes of galaxies. The distant smudge we found in Draco is really a spiral galaxy today. By warping space, we've seen the beginning of time.
	Now let's see if we can bend space just enough to see the birth of individual stars.
M33	I'm slewing the telescope to M33, a nearby spiral galaxy in the constellation Triangulum..... This galaxy has a massive star birth cloud called NGC 604.
zoom into NGC 604	The NGC 604 nebula is over 2 million light years away. The stars inside look very young. Through the wormhole, we can see how this cloud will change over the next two million years.
birth cloud	As we bend space, we see young stars appearing within the dark dust clouds.. This is a birthplace of stars, a stellar incubator. The light of these new stars will not reach Earth for millions of years. Like humans, stars have a life cycle and this birth cloud is just the beginning.
Eta Carinae	Stars also grow old and die. To see this, we must visit another kind of cloud – a cloud that is really a star's death shroud. I am scanning the constellation Carina for a famous nebula called Eta Carinae... This is really a massive unstable star. It cannot survive very long as we see it now. Through the wormhole, we can watch this star change as we move forward in time.
Eta Carinae exploding	Look… the star is exploding!-- just as we predicted. Eta Carinae does die in an incredible supernova explosion that

Pulsar	destroys the star, leaving only a pulsing neutron star behind. In this explosion Eta Carinae will become so bright that people on Earth will see it in the daytime – when the light of the explosion reaches Earth in about 4 thousand years. When we see Eta Carinae from Earth today, we are really seeing an object that has already died! Just as stars begin from gas and dust, the cycle is complete when they return their gas and dust to the universe. ALARM SOUNDS
Solar flare	The alarm warns that a solar flare could happen at any moment. I'm slewing the telescope to the sun – only 8 light minutes away in the constellation Cancer. Through the time telescope, we can see the sun eight minutes before its light reaches Earth – an extra 8 minutes of warning if a flare explodes.
Explosion	Wow! there it goes. This is the second giant flare in three days. This is very rare and very dangerous. The earlier flare has compressed the Earth's protective magnetosphere so much that we are no longer shielded, leaving humans at the Time Telescope and on the space elevator terminal exposed to dangerous particles of the solar wind. The high energy radiation will reach us in just a few minutes and the radiation belts will build rapidly over the next few days. We must evacuate the telescope immediately.
Evacuating the Space Station	All non-essential personnel are required to return to the Elevator Terminal and prepare to board the Space Elevator. All telescope viewing has been suspended and the telescope must be stowed for its own protection during the period of high solar radiation. This viewing pod will carry you back to the elevator terminal and your astronaut guide will instruct you on descent procedures. Move quickly and you will be safe.
Space Elevator	**ASTRONAUT VOICE - SuperScene E** Everyone, please proceed to the space elevator. The elevator cabin has been prepared for immediate departure. Although the Space Elevator has some shielding, we must drop below the Van Allen radiation belts for maximum protection before most of the solar particles arrive. Please take your seats quickly and fasten your safety harnesses.

Elevator descends	All windows have been closed for maximum shielding as we descend. *COMPUTER: Docking clamps disengaged. Elevator descent initiated.* While we descend, the permanent station crew are securing the terminal and the Time Telescope. The permanent station crew and all sensitive electronics must be shielded from the incoming solar particle stream. The second elevator cabin has just been released from the Kilimanjaro ground station. It is bringing repair equipment and may be needed to transport any crew harmed by the solar storm. We are on an accelerated descent so you may have a falling sensation. *COMPUTER: Time in Transit: 24 hours* *Prepare to pass the empty ascent cabin.* We have just passed the rising elevator cabin. We are half-way to safety on the Earth's surface. *COMPUTER: Time in transit: 40 hours* *Van Allen Belt transit successful* *Particle damage to elevator minimal* *Elevator speed in excess of safe docking with current passenger loading*
Deploy escape pod	Stand by all passengers. We have verified that we are safe from the sun's radiation and have received a minimum exposure. But we have another problem. Our elevator cabin, loaded to capacity with visitors and non-essential crew, is dropping too fast for a safe docking at Mt. Kilimanjaro. Passengers must board the life-pods. As soon as the elevator has reached the optimal deployment elevation, your pod will detach from the elevator and an astronaut will pilot and land your craft. *EC: Escape pods ready for boarding* *and cleared for cabin disconnect.* *Vectors programmed for a desert landing* *Glider wing deployment set for 5 minutes after pod disconnect* Passengers, please buckle shoulder harnesses and seat restraints. Our entry trajectory is set. It's time to hang on for the flight of

Landing on Earth	your life. Welcome back to Earth. All gliders have landed safely and your transport to Kilimanjaro has been arranged. The empty elevator has also docked safely at Kilimanjaro station and is being refitted for a return to orbit. It looks like we made it back to Earth just in time.
Clocks animation	**SuperScene F** Consider what we have just seen and imagine all of time happening in one cosmic day. At midnight, the universe begins in a Big Bang explosion. Before 7 AM , the Milky Way galaxy forms. Just after 3 PM, the Sun and its planets are born. By 6 PM, Earth life has appeared. Just after 11 PM, plants first live on land. Less than a second before midnight, humans appear. And in the last tenth of a second, they leave Africa. In the last ten thousandths of a second before midnight, Egyptians invent the modern solar calendar. At midnight of this first cosmic day, humans launch satellites into orbit. Perhaps we will begin the second cosmic day leaving earth on a space elevator and seeing the universe in real time. After all, it's all About Time!