

MIT GAMES-TO-TEACH PROJECT

Design Document for:

La Jungla de Optica

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Design History

Overview.

This document was created the summer of 2001. Kurt Squire put it in a template, November 2001.

The design history explains the history of the document, including major changes. It helps us track what was done, by whom, and for what rationale.

Version 1.1

Updates by Kurt Squire 11/12/01.

1. Updated Table of Contents.
2. Added User Scenarios.

Version 1.2

Updates by Kurt Squire 11/26/01.

1. Added proper credits
2. Added User AIs.
3. Several wording changes.
4. Added scenarios 6-7
5. Added single player / player + Melanie game dynamic

VERSION 1.3

Updates by Kurt Squire 12/15/01.

3. Corrected spelling and wording errors
4. Moved appendices to beginning for better presentation

Version 1.4

Updates by Kurt Squire

Corrected grammar issues. Tightened prose.

Jungla de Optica

Professor Carlson, an archaeologist, and his niece Melanie have been in the jungle for several months, exploring Mayan ruins in search of the *Sien de la Luz* -- the Temple of Light -- a legendary chamber of glass and jewels that's breathtaking in both its artistic beauty and scientific sophistication.

As Carlson and Melanie work, bandits arrive and steal valuable artifacts from nearby ruins. Learning that Carlson has found the mystical Sien de la Luz, the thieves raid his camp and maim his leg when he refuses to divulge the location of the temple. Carlson, desperate to protect and save Melanie but unable to move beyond their destroyed encampment, begins to lose hope. He sends his niece out on short hikes through the jungle to find help. That's when the player arrives...



The player is dropped deep in the Amazon -- in the fabled Jungle of Optics. Initially, the player is not sure of who he /she is and why he/ she's there. Soon, the player meets Melanie, who takes the player back to camp to meet Carlson. There, Carlson and Melanie explain that the player will need to help them escape the horde of treasure bandits and return home.

Through this adventure simulated world game, players will:

- (1) Learn basic concepts and equations in optical physics.
- (2) Apply what they learn to solving problems in "mission critical" scenarios.
- (3) Travel through a rich, textured game and narrative space that makes learning meaningful and fun.

Players learn by doing as they use their knowledge of optics to solve optics puzzles and complex open-ended problems. In addition to rich real-time feedback, players and teachers both will receive detailed analysis of students' progress in the game. Players demonstrate knowledge of physics by constructing artifacts, such as telescopes and cameras, and by completing puzzles, where they position mirrors and lenses. The game records players' progress through the temple, offering an analysis of user performance that can be used for assessments.

Gameplay

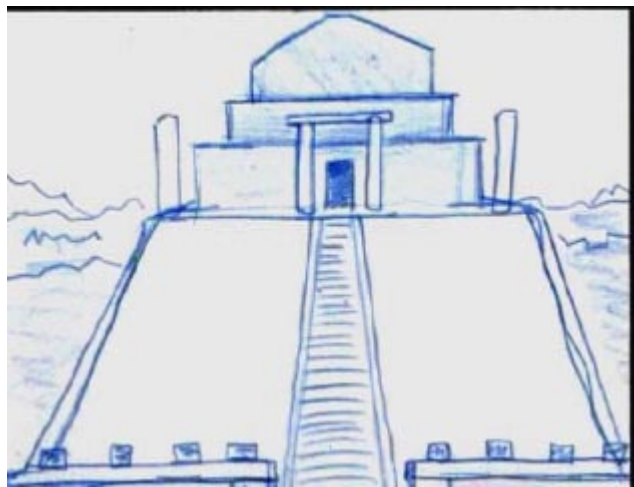
La Yungla de Optica is a mix of simulated world/ rpg/ puzzle game dynamics. Each level consists of open-ended challenges that a player can solve in a variety of ways. Through each scenario, part of the story is revealed to the player. The player uses a rich set of resources and tools, including lenses, lights, cameras, rope, optics books, and pieces to a telescope.

While in the “Sien de la Luz”, The temple of Light, the gameplay becomes more structured, reminiscent of a puzzle-adventure game such as Myst. Through completing these puzzles, players gain lenses, tools, and camera equipment as well as skills like focusing, camera steadiness, or climbing ability.

As players choose between various tools and skills, they develop a unique, differentiate character. Some players may develop strength or climbing skills and become action photographers, while others may develop hand-steadiness and concentration, enabling them to see over great distances. This design is intended to reach a broad range of player tastes and accommodate a range of use scenarios.

Example Scenario: Building a Telescope

At some point during the game, the player spots the bandits' hideout, possibly due to the smoke rising above the trees. The bandits are crowded around a tent, discussing plans and rifling through papers. The player might attempt to get a closer look, using the lens from her camera or a set of binoculars. Perhaps the player attempts to take a snapshot of the camp to gather information about the bandits' plot. If the player gets too close, a guard will pursue, ending the game.



To get a closer look, the player will need to use a lens. Melanie suggests hiking to the observatory on the hill, crawling through a cave that leads closer to the opposite side of the camp, or climbing a nearby tree. The player chooses to walk the winding path to the observatory. At the top of the observatory are the remains of an old telescope. There is a fixed, stationary viewfinder where the player can insert a lens. The player must estimate the distance and calculate the proper focal length for the lens. If the player does not have the proper lens, she must consider another vantage point, or return to the temple to obtain another lens.

Game Overview

Philosophy

The Jungle of the Optics tries to create an immersive experience by situating characters in an interactive world with a strong storyline. La Jungla de Optica is also designed to support more casual gamers through “designed puzzles” located in the Temple of Light.

Philosophical point #1: Engaging Narrative to Appeal for non-gamers

The Jungle of the Optics provides a strong narrative that introduces set of gameplay problems that can only be solved through displaying a thorough knowledge of optical physics. Much of the appeal comes through exploring relationships with Melanie and the Professor, and the reward of helping them off of the island. The game uses an Artificial Life technology

Philosophical point #2: Flexibly Adaptable to Different Usage Scenarios.

The game combines open-ended and closed-ended story problems. This supports both adventurous and tentative player types. Learners who prefer to work through games linearly can work through the temple. Others can learn more by trial and error. This also allows teachers to:

1. Access the puzzles at any time (i.e. just-in-time instruction)
2. Use puzzles as homework
3. Use puzzles for demonstrations of key concepts.
4. Point to puzzles as examples in supporting lectures.

Philosophical point #3: Simulated World

This game is about the simulation of optical physics. Therefore, a player should be able to do absolutely anything with optical tools (including combinations of optical tools) that she desires.). This complex optics engine that simulates how lenses shape light is an innovation within gaming (both educational and entertainment. Giving players such a simulation tool to play with within an open-ended problem-solving environment builds on free, less-constrained style of gameplay of simulated world games like *Thief*. In Jungle of the Optics, the player is free to use the environment as tools to solve problems in unique and creative ways.

Philosophical point #4: Embedded Assessments

Players are given rich, detailed, visual feedback on their performance, including:

- Time taken on problems
- Analysis of patterns in their performance – e.g. frequently made mistakes.

This information is also recorded and aggregated for teachers

- % correct on all puzzles
- time taken per puzzle

Common Questions

What is the game?

The player is lost deep in the Amazon -- in the fabled Jungle of Optics -- trying to help an archaeologist and his young niece escape a horde of treasure bandits and return home. Through this adventure simulated world game, players will:

1. Learn basic concepts and equations in optical physics.
2. Apply what they learn to solving problems in "mission critical" scenarios.
3. Travel through a rich, textured game and narrative space that makes learning meaningful and fun.

Players learn by doing as they use their knowledge of optics to solve optics puzzles and complex open-ended problems. In addition to rich real-time feedback, players and teachers both will receive detailed analysis of students' progress in the game.

Why create this game?

This game highlights the potential for using narrative within a simulated world. The optics engine is a reusable simulation tool that can be used in future games. Melanie and Dr. Carlson pave the way for creating characters that players really care about. Their AI can be shared across gaming platforms.

Where does the game take place?

A dense, dark jungle of a Caribbean island. It is in the ruins of a Mayan village. It is roughly the 1940s.

What do I control?

You control the main character, who has the ability to run/jump/move and construct objects with optical parts. Through the player, you can break apart objects, combine objects. Controlling views becomes important as you look through telescopes, etc.

How many characters do I control?

1 Player, first person view.

What is the main focus?

Players investigating the terrain, solving a series of problems to get them off of the island.

Getting them off of the island requires the following missions:

1. Unpack and understand lab kit and tools
2. Light up the Temple
3. Rescue lost relics from the temple
4. Spy on the bandits through a spyglass
5. Take several photos of the bandits
6. Hi jack an airplane
7. Take a picture of the island from a plane using a wide-angled lens

Puzzles and problems involve the following tasks.

- Build and test simple lenses
- Build and test telescopes (spyglass), microscopes

- Focus light and start a fire
- Repair a camera
- Take photographs in a variety of media
- Send signals to passing planes / boats.

Pedagogical foci:

1. The main focus is collecting information and then using their knowledge of optics to solve the problems.
2. Working through the challenges in the temple of the optics to gain the knowledge, skills, and materials to complete the problems.
3. Interacting with Carlson and the girl to gain information, or learn about the story
4. Experimenting in the interactive laboratory.

What's different?

- An educational game with open-ended challenges where players create and tools to solve problems.
- A game that tries to foster a deep relationship between the protagonist and both a mentor and a mentee.
- A game that tries to use a rich narrative and melodramatic techniques to create more engaging action.

What will people learn through playing this game?

Introductory-level optical physics, generally at the advanced high school, introductory to college level. Students will learn:

- The basics of Light and Wave Theory
- Snell's Law
- Indices of Refraction
- Focal length and scale
- Circles of confusion and depth of field
- Lens assembly
- Telescopes
- Photography
- Reflection, glare, and critical angles
- Grating and diffraction
- X-Ray diffraction
- Young's single and double slits

How will people learn through playing this game?

The Jungle of the Optics combines a number of proven pedagogical models, including Problem – Based Learning, Learning as doing and learning by design.

- Ill -Structured Problems. Players will learn the fundamentals of optical physics as they create and test combinations of lenses and work through the puzzles in the temple of light. Because the lenses are built on a simulation engine, players can experiment and play with lenses in whatever manner they wish throughout the game. Players will need to have a command over lens theory in order to create spyglasses, telescopes, magnifying

glasses, and camera lenses in the game to solve ill-structured problems driven by the story of the game.

- Well-structured problems. The temple of the Topics contains 3Dimensional representations of problems typically found in physics textbooks. These puzzles are also useful to teachers looking for problem sets and materials for demonstrations.

Tensions

One way of capturing the fundamental issues of a design task is through “tensions” (Wenger, 1998). Tensions are dialectical relationships between opposing (often related) concepts. The idea behind a tension is not that they are either / or trade-offs, but that they interact. Often, the more the importance of one element goes up, the importance of the other does as well.

Tension # 1: On-line and offline

Working with simulated lenses is great, but this digital world may potentially have very constrained situation constraints – meaning, players may get very good at solving optics problems in this space, but not transfer these practices to off-line spaces or other worlds. One way to deal with this challenge is to give teachers and players world editing tools (not much different to unreal/quake/dues ex tools) so that they can create their own spaces where using telescopes and lenses is useful. Another way is to package the game with a set of lenses, and create some optional lenses as well, that can be purchased.

Tension # 2: Simulated worlds and Constrained Puzzles

It's commonly accepted among many, many gamers that adventure games suck. I happen to be one of those who believes that, although I've played (and solved) more adventure games than I'd like to admit. The reason is, that *most* adventure games are linear, and the gameplay is simply a matter of collecting the "right" objects and doing with them what the designer wants. Rather than being immersed in a rich world, you're simply trying to unlock pre-ordained script. Most players (myself included) are left thinking that "if you wanted to tell me a story, tell me a story" but I want to play a game, so give me a game.

So, to invoke some work of Warren Spector and other designers, we argue that for this game to be self-actualized, it will need to become an action-rpg, or what Warren Spector calls a "world simulation." A simulated world game provides players a compelling role playing experience by creating a world which the character can interact solve challenges through creative expression. To simplify: Good gaming is providing players a world to think creatively in, and the tools to think creatively with. Through choices in the game, players develop a character with which they identify. Players' choices result in individualized characters with particular strengths and weaknesses that enables them to approach problems differently. How this plays out in our game is detailed below.

Tension 3: Interactive Story

Jungle of the Optics contains a linear story. The player arrives on the island, is confronted with choices on where to go, but then is pretty much (eventually) locked into a series of events where he / she must:

- * figure out her location

- * figure out what's up with "the bad guys" (construct a telescope / looking glass)
- * explore the temple and learn some optics
- * get a plane and/ or get the hell out of the jungle
- * get the plane running
- * photograph the island

We can change the order of some of these events, but most of them we're stuck with in this order. There are several challenges in such a linear storyline.

Here is how this might play out in our "taking a picture of the hidden statue" level.

The goal of the story is pretty well set. Get a picture of the statue. But, there are several different ways that the player might accomplish this. Do you try to sneak up and get a close shot? Do you get a few long range shots that give better perspective? Do you do both? What tools have you selected from your earlier adventures? What are your character's strengths? either way, this suggests that we should have multiple win-conditions for each level (i.e. multiple ways of winning the level).

Single-Player Game

Overview

The player completes a series of missions that build from the main narrative and involve solving both problems and puzzles. The game is only a single player game.

Story

Professor Carlson, an archaeologist, and his niece Melanie have been in the jungle for several months, exploring Mayan ruins in search of the Sien de la Luz -- the Temple of Light -- a legendary chamber of glass and jewels that's breathtaking in both its artistic beauty and scientific sophistication.

As Carlson and Melanie work, bandits arrive and steal valuable artifacts from nearby ruins. Learning that Carlson has found the mystical Sien de la Luz, the thieves raid his camp and maim his leg when he refuses to divulge the location of the temple.

Carlson, desperate to protect and save Melanie but unable to move beyond their destroyed encampment, begins to lose hope. He sends his niece out on short hikes through the jungle to find help. That's when the player arrives...

See missions for a fleshing out of the rest of the story.

Hours of Gameplay

The puzzles can be completed in under 15 hours (making this approximately a 2-3 week unit in a classroom). However, there are over 40 hours of anticipated gameplay. If the player were to explore all options, dialogues, gameplay would total approximately 80 hours.

Victory Conditions

Each level / mission has multiple paths toward the win condition. The win condition of the game is to get off of the island.

Two distinct styles to playing the game:

- 1) Take Melanie with you for most of the challenges. She knows a lot about the island, and shows you secret paths.
- 2) Go about it alone. You can move quicker, but gain less skills, etc.

Rationale:

In addition to being more fun and engrossing, they're good from an educational standpoint. Too many "educational" games have one win condition, which implies that there's "one right" answer and learning is not done to find the answer that meets the needs of the situation, but in order to fulfill the teacher's wishes. Multiple win conditions also allow students to examine one another's responses and critically reflect on different solution paths. This is a central problem of most K-12 education (See Bransford, 1977). Multiple win conditions also allows for replayability.

Failure States

Overview.

One key to reaching a diverse audience (particularly females) is in having "fun" failure states. You have to make them "enjoy" losing to an extent, and not feel totally dumb. We'll need to consider more deeply when they realize that they did not solve the puzzle (in the test case, take a good picture). How they get this information and how this is presented to them will be important. Another trick in this game design will be balancing the game so that there are multiple failure states. There should be multiple ways to screw up.

Player is captured by bandits.

When the player is within clear sight of the bandits, they shoot tranquilizer darts at the player, disabling him or her. (Bandits carry darts to kill animals). The player is taken to the opposing camp, where she is held captive. Perhaps the player will be brought back with trust points deducted.

Player out too late.

The player is returned to home base with penalties of trust awarded – particularly if Melanie is along.

Game Scenarios

Overview

Each scenario is roughly one mission – or the critical element to each mission.

User TimeLine

Time	Event	Decisions / Experiences
1 minute	Enter the World	This first phase is all about raising questions in the player: Where am I, who am I, why am I here? A technique a bit similar to Half Life. The player meets Melanie.
5 mins.	Meet Melanie, Run to Camp, Explore World, Meet Dr. Carlson	The player has a quick dialogue with Melanie. She runs back to the camp. She might explore a bit in the world, and learn some of the rules of the space (what is interactable, what is not). Melanie limits interaction by guiding the player verbally and medically.
15 mins.	Create Camp. Begin 1 st puzzle	The player sets up camp and looks through the inventory. Player is introduced to first puzzle.
1 hour / 1 Session	Player completes first puzzle	Player completes first puzzle, demanding knowledge of inventory, etc. Save Game
2 hours	Player Meets bandits	Carlson takes the player aside. “Now that you’ve been here a few days, there’s something I need to tell you.” We’re not alone on this island. There are a group of Tomb Raiders who have made camp just over the mountain side. Fortunately, they have yet to find this current camp. They think that this area is cursed, so we’re safe here. However, I haven’t seen them in weeks, so I’m fearful that they may be up to something. We need you to go and spy on their camp. Melanie can’t do it alone...” Of course, Melanie does know a lot about what places are safe and not, as she’s been spying on them for days. However, with you knowledge of optics, you can create a lens that allows you to spy on them closer. DECISION: Do you take Melanie with? If yes, she knows details of their camp. If no, you gain some extra skills. Player begins to experiment with tools
10 hours	Player has constructed 1-2 telescopes. Player finds camera	Player can now begin taking pictures. Extra lenses are found in the temple of optics.
25 hours	Player Escapes from Island	

Plot Outline

This is the current bare-bones plot structure. Other plot points need to be added. Other plot elements can arise as a result of actions among the simulated characters.

- Meet Melanie
- Meet Dr. Carlson
- Set up Camp
- Explore Island, gather materials
- Enter Temple of Light
- Illuminate the Temple
- Construct Spyglass to map out bandits' hideout (and rest of island)
- Build tools in chamber
- Explore the temple and learn more optics (puzzles 2-20)
- Learn about bad guys from Carlson
- Figure out what's up with "the bad guys" (construct a telescope / looking glass)
- Find Camera
- Construct lenses
- Photograph Bandits
- Suffer raid from bandits
- Establish new hideouts free from view
- Rescue relic from chamber
- Sneak into bandits' camp
- Get the plane running
- Get a plane and/ or get the hell out of the jungle
- Photograph the island

Game Scenario 1: Game Introduction: Meeting Melanie and Professor Carlson.

The player wakes up, surrounded by darkness. As her eyes come to focus, she is aware that she is in a dense jungle. She can look around, and sees dense jungle foliage. There is a small clearing ahead, where she can look up and see through the canopy. The silence is broken by the sound of an airplane. Looking up, she sees a 1940s model single propeller aircraft.

“You made it...we thought you'd never get here...we were afraid...” interrupts the voice of a young girl. Behind the player, stands a girl, about 12 years old. The player turns to her, and try to speak, but before she can, she speaks, “Quick, before...just hurry.”

The player doesn't know who this girl is, or why he or she is here, or what this danger facing them might be. She takes off running through the forest. The player is not on rails here, but is expected to follow. If the player runs off in another direction, Melanie follows, pestering the player. The player darts through the forest, with the girl. If you try to interact with her...she responds curtly – we don't have time, or I'll explain it in a moment. Just hurry...you'll know more in good time. Dialogue items:

“Come on, hurry”

“There are dangerous things in the jungle”

“I’ll tell you more when we get there, I promise”

“Please hurry, I’m getting annoyed”

“I’ll explain it in a moment, I told you”

“You’ll know in good time...Now come on”

With each statement, she grows more annoyed. Finally, if the player doesn’t follow, Melanie approaches the player and injects her with a tranquilizer.

After a 1 minute jog through the forest, you arrive at a clearing. Melanie introduces you to her home. Here....(gasping) we made it. She points to her left. There, you see a small tent, provisions and an older man. Melanie introduces you to her uncle: Professor Carlson.

“Welcome to our camp. As you can see, I’ve suffered from ... Right now, I can’t walk. My dear Melanie, here, does what she can to help me, but we need your help.”

Questions the player should be asking: What the dangers are that Melanie speaks of? What happened to Dr. Carlson? Why were they here? Why are you here...how did you get here? What kind of help might I offer?

First, you’ll want to get settled. Pick a spot to set up camp and then get back to me.

Game Scenario 2: Solving Puzzles in the Temple of Light: Illuminating the Room.

Somewhere in the middle of the gameplay, when the player has traveled in various directions through the jungle, overcome challenges, and proven competency in basic optics practices, Carlson suggests that Melanie take the player to the Temple of Light. There, Carlson promises the player will be amazed by what he sees and learns.

Indeed, the first thing the player must accomplish upon entering the temple is to fill the chamber with light. This can only be achieved by focusing sunlight from a small overhead portal through a series of lenses to a large reflective surface that will illuminate the chamber. The player must analyze the angles of the lenses – some of which are fixed in place, remnants of the Mayan’s work, but broken, -- and then calculate the type of lenses to use from the backpack (by this point in the game, the player has accumulated 5-6 other tools in the backpack, so there is no need to send Melanie on an errand – unless the player is annoyed and just wants to get rid of her ☺).

You approach a gigantic Mayan structure. You’re amazed by the tall pillars and monumental stature.

Melanie leads the way, seemingly familiar with the ways of these ruins. “Don’t worry...I was scared my first time in here, too.” Just be care and don’t touch anything.”

Around a corner, you notice a large lens contraption – but there is no way to get to it.

“Look..here”. Melanie scans the room and quickly darts through an open hole. “Up here...this the lens I was telling you about. I think that if we point it the right direction, we can bounce the

light off of that mirror, and light up the room. But wait...around the mirror it looks like there might be some traps. You better get this right, or we might never get out of here. I hope that Uncle Carlson knew what he was talking about when he explained to us the way that lenses work....

You look in your toolkit. Maybe we have the right parts. Consulting your optics book, you check over what you know about light and lenses. This can work. Since you can't fit through the hole, Melanie shouts instructions back to you.

Melanie calls out..."the mirror is 14 feet, 2 inches from the wall. It's six feet off of the ground, I think...it's a little taller than I am, though. According to our notes, the hole we want to hit is 3 feet off of the ground, and it's 2 1/2 inches across. Where do you think we should put the lens?

After double checking your notes and scribbling some equations, you venture a guess. Place the lens at a 36 degree angle from the ray of light. Use the biggest lens you have – the one that's 6 inches across. Now, hold the lens between 9 and 11 inches away from the mirror that you tilted. And cross your fingers...

After the first try, you missed your target. It looks like the lens needed to be angled downward. You try again with the adjusted calculations. The soft glow of light from the room beneath you lets you know that you've succeeded.

Now that you can see the room, you see that there is a column of small holes...what are those for? Do we shine the light into them? Melanie wants to use another lens to shine the light through the middle hole. Your next challenge awaits.

Game Scenario 3: Building a Camera and Taking Photographs

Using the spyglass she created, the player has located the bandits and mapped out their hideout. Dr. Carlson is intrigued by some documents that you described seeing. Now, your challenge is to gather information on them to take back to Dr. Carlson. But how?

Carlson suggests that you put together a makeshift camera. You have many of the parts from Carlson's camera that were broken in the raid. Now, your challenge is to create a lens for the camera by combining various elements. Having checked out the camp site several times, and gone through your stash, you have estimated the distance to the camp from your vantage point. Now, the trick is to put together a lens that will work. Using glue, some sticks, and some pieces of plastic, you put together a lens at your camp.

After the lens dries, you take it down to the camp. You climb down a ravine and up into a tree – which you believe offers the best vantage point, given your set of lenses. If you have time before sundown, you might also head to the other side of the camp. Melanie stays back up on top of the ravine and walks to the other side so she can keep a look out. You've made up a set of signals using a mirror to shine light that you can use to communicate if someone is coming.

You snap 4 or 5 pictures of the camp, getting good shots of their jeeps, their supplies, and the hangar off in the distance, which might conceal a plane. A light flickers in the distance. It's

Melanie. There is a series of three flashes of light, which signals that an intruder is coming. You gingerly get down from the tree, protecting your camera. These are your only lenses, so if you lose them, you're in trouble. You wonder if there was enough light for the pictures to come out as your feet land on the ground.

You scurry up the ravine, and hide behind a rock. Luckily, it looks like you're ok. On your way back, you notice a wonderful sunset over the horizon. Thinking to yourself, "When will I be in the Amazon again?" you snap a few photos for posterity. (Later, you can upload these to the website).

Getting back to the camp, you hand the film over to Dr. Carlson to develop. When nightfall comes, Dr. Carlson heads into his tent, carefully closing the flap behind him so as to create a makeshift darkroom. You'll have to wait for the morning to see if you're in luck....

Game Scenario 4: Building a Telescope

At some point in the game, the player spots the bandits' hideout, possibly due to the smoke rising above the trees. The bandits are crowded around a tent, discussing plans and rifling through papers. It looks like the bandits are planning some sort raiding plan. But of what sort? The bandits are also loading up jeeps, signaling to the player that disaster is imminent. The player feels a sense of immediacy as she realizes that she must move quickly. But, what are they planning? A raid on Carlson and Melanie's camp? Stealing something from the temple?

The player might attempt to get a closer look, using the lens from her camera or a set of binoculars. Perhaps the player attempts to take a snapshot of the camp to gather information about the bandits' plot. If the player gets too close, a guard will pursue, ending the game.

To get a closer look, the player will need to use a lens. Melanie suggests hiking to the observatory on the hill, crawling through a cave that leads closer to the opposite side of the camp, or climbing a nearby tree. The player chooses to walk the winding path to the observatory. At the top of the observatory, there are the remains of an old telescope. There is a fixed, stationary viewfinder where the player can insert a lens. The player must estimate the distance and calculate the proper focal length for the lens. If the player does not have the proper lens, she must consider another vantage point, or return to the temple to obtain another lens.

Thus, there is no "penalty" for miscalculating the focal length, other than lost time. Running back and forth from the camp to various vantage points takes time. Hours could be spent running back and forth getting lenses if the player tries to solve the problem through trial and error. If the player takes time to calculate the correct lens, she will save time.

Game Scenario 5: Experimenting with lenses in the dark chamber.

Having inspected the island, you've collected a lot of data. You found several good vantage points for viewing the bandits' caves through a spyglass. You've calculated all of the distances, but before you head all of the way over there, you figure you'll test out some of these ideas in a controlled environment. You still have a few questions about focal lengths, etc.

You shut the doors to your tent, letting in just a single ray of light. You carefully hold a lens.

You have located the hideout, including the hangar where you believe the bandits keep their airplane. You've rescued the relic from the temple. Now, your task is to try and commandeer the airplane, escape from the island, and turn the bandits into the authorities.

Feature Set

General Features

- Richly textured world
- Ornate, twisting, “temple of the optics”
- Complex optics engine that allows players to
 - take pictures
 - view objects under varying degrees of magnification
 - see the effects of various focal length/ lens sizes, producing effects like blurring.
- Complex characterization and AI in both Melanie and Dr. Carlson
- Unique simulated world techniques. All of the objects can be broken, burned, or put back together to create tools.
- Online optics “textbook”
- Integrated Web Community for uploading and sharing pictures

Multiplayer Features

Multiplayer is integrated through the web community. Players can take pictures and upload them to a website.

Editor

Comes with world editor that teachers can use to add objects into the game.

Advanced levels unlock lens editing tools, allowing them to create their own configurations of lenses.

Gameplay

Keys to the gameplay:

- Creating potential differentiation of character abilities so that people have actually interesting decisions (e.g. do I get a close up picture or do I take one from a long ways away with the proper lens).
- Creating a world with interesting vantage points for pictures.
- Creating some interesting materials to work with – essentially supporting open-ended play.
- Much like Myst the puzzles will rely on beautiful aesthetics.
- Creating interesting emotional decisions with the other characters – situations where the player has to choose to put them at risk and / or rescue them.

Character Development

Consistent with most RPG design, this would also suggest that we need to have significant character differentiation. Character differentiation is a critical element of any RPG because it allows the player to build a sense of identification with the character and creates unique gameplay. It’s through character differentiation that rpgs are rpgs and not adventure games.

Warren Spector’s description of RPGS:

RPGs are character-driven. Unlike any other game genre, they rely on differentiated player characters. As such, unique, personal character growth is vital. Players must feel that they control the destiny of their alter egos and that their choices throughout the game result in increasing stature and a growing ability to impact the game world and its denizens.

Every design decision you make when crafting an RPG should first be filtered through the following simple screens:

- Does each game system, design philosophy, or mission help the character play his or her role more effectively?
- Does each serve to differentiate one character from another?

I think that we have room for character differentiation, albeit in a somewhat limited form. I already suggested two possibilities: do you specialize in close-ups or long range shots? This is a good one, IMHO, because it allows for us to leverage different game-playing tendencies. Your Quake fans will go for the close-ups, your long range shots will be your archer/ thief types (See Koster's book for more on this). Perhaps, your MYST fans, who spend all of their time in the temple, and typically like to "play it safe" will do both, meaning that they can venture out into the world with a full cadre of skills (to a degree).

The tunnel can allow us to create rewards that push people in a certain direction (ala Deus Ex)? For example, you solve puzzle a. You can choose between a lens, a piece that can be used to extend a rod, or perhaps a rope. (What the rope would do, I don't even know).

Here are some possible character variables. Ideally these should ideally fit into the game mechanic as much as possible:

- hand steadiness
- lens crafting skill
- running speed (a nice one for convenience, if nothing else)
- climbing ability
- Focusing ability

In the inventory, we might have the possible items:

- clothing
- tools
- types of film
- clothing
- tools (ropes, etc.)
- film speed
- camera type
- developing chemicals
- Extension rods
- Other miscellaneous stuff.

So, perhaps you've built a sneaker profile:

- -Concentrated all of your skills/ practices in stealthiness

- -Obtained camouflage clothing
- Gotten the proper lenses for close shots
- Better film (can you take a picture from a dark crevice, say)
- Gotten some other object / skill that puts you in a position to get close (i.e. tools to climb a tree,
- Gear that enables you to be relatively mobile

Or, maybe you've gone for the "long range" profile. You prefer to not get in the skirmish of things. So, you get a tripod, good lenses, not so much clothing, maybe running speed to run away. So, for example, there might be the following critical variables to manipulate in camera scenario:

- distance to object
- angle in relation to object
- lighting
- number of lenses
- length of tube
- types of lenses
- placement of the object (making multiple photos necessary)
 - the addition of a bonus lens gained in the temple can make a new vantage point more possible
- film
- chemicals
- camera

Pedagogical Approach

Temple of the Optics leverages several pedagogical approaches, depending largely on the classroom contexts in which it is deployed.

Learning By Doing

Loosely speaking, this game uses a learning by doing framework (Berman & Schank, 1999; Schank, 1994). The scenario starts by establishing goals which are tied to a mission. In the Jungle of the Optics, the goals of the game emerge from the narrative. The players develop goals emerging from the narrative – which Schank refers to as a cover story, and then use the optics tools and resources to solve to the problems.

Communities of Learners

(Biealcyck & Collins, 1999). Through the web-based community, we hope to foster communities of learners. Players can use communication tools provided via the web to upload images, pose solution to problems, and explain how and why they solved particular problems. We are particularly excited about the opportunity for players to share pictures taken in this environment.

Problem-Based Learning

The game combines both open-ended and closed ended problems (Jonassen, 1998). This allows teachers & learners to focus both on specific concepts, and to experiment mobilizing them in more open-ended situations where they can think creatively with the concepts. Players can identify problems they want to solve, and use the optics lenses as tools and the optics books, diagrams, etc. as resources to solve complex problems (e.g. Savery & Duffy, 1996).

The Game World

Overview

The game world is a simulated world with scripted “triggered” events. Masked within the game is an underlying “mission structure” where AI routines, etc. change as the missions develop. AI and robots run on AI routines. T

Fully Adaptive Optics Engine

Everything in the world can be viewed at varying magnifications – also, objects appears blurry if the objects are not in focus. Because players are used lenses at fixed distances (as opposed to modern lenses with auto focusing), they will not be able to simply adjust objects until they are in focus (with the possible exception of microscopes).

Fully Interactive Simulated World

Objects can be

- broken into smaller parts
- put together
- lenses interact with one another realistically

Objects have

- melting points
- water has boiling point
- glare can be manipulated off of reflective surfaces

The Physical World

Overview

The world is a jungle island – 4 miles long, 1/2 mile wide. The colors are bright and sunny at nighttime – dark and more foreboding at night. The night is a more dangerous time – which is communicated to the player through sounds. Running across the island is entirely possible. There is typical tropical foliage. The island looks a little like *Castaway* (starring Tom Hanks), but less dreary. There are 3 main areas:

Key Locations

- Professor & Melanie’s camp
- The bandits’ camp (in a deep basin, a river running through it)
- The Mayan settlement

Travel

Character can run, walk, jump, climb, or swim through the world.

Melanie has a semi-autonomous AI. Mostly, she follows you around. She can run back to camp if she feels that it’s too dangerous. You can also order her back to the camp.

Scale

Realistic scale.

Objects

- Trees
- Chunks of wood (can be broken into pieces – going from bigger to small)
 - Trunks
 - Large Branches
 - Medium Branches
 - Small Branches
 - Large Sticks
 - Long Sticks
 - Twigs

- Several species of plants
- Several species of tropical birds.
- Other lizards, animals.
- Leaves
- 4-6 sizes of rock (Boulders → Pebbles)
- Rope
- Animals & birds
- Wild Boar
- Skeletons and bones
- Back Pack
- Broken bit of glass
- Tubes / Plastic casing for lenses
- Glue
- String
- clothing
- tools
- types of film
- film speed
- camera type
- developing chemicals
- Extension rods

Objects at Carlson's Camp

- Tents (3)
- Tent stakes
- Supply crates
- Food packs

Objects at Bandits camp:

- Crates

- Tents (8-10)
- Jeeps (old)
- An old plane

Weather

Mostly sunny during the day. At some points in the story, it will get rainy during the day to match the mood of the story. The environment should be open and inviting to attract non-gamers.

Day and Night

The game it goes from day to dusk. The player has to get back by nightfall to get Melanie home. If not, an animation kicks in, and you're taken home.

Time

Time runs on a realistic time scale. (1 second game time = 1 second real life).

Camera

First person camera perspective.

The World Layout

Overview

- Jungle
- allows for darkness and more variable light conditions
- allows for more opportunities for being hidden.
- interesting and inviting flora and fauna.

Professor & Melanie's camp

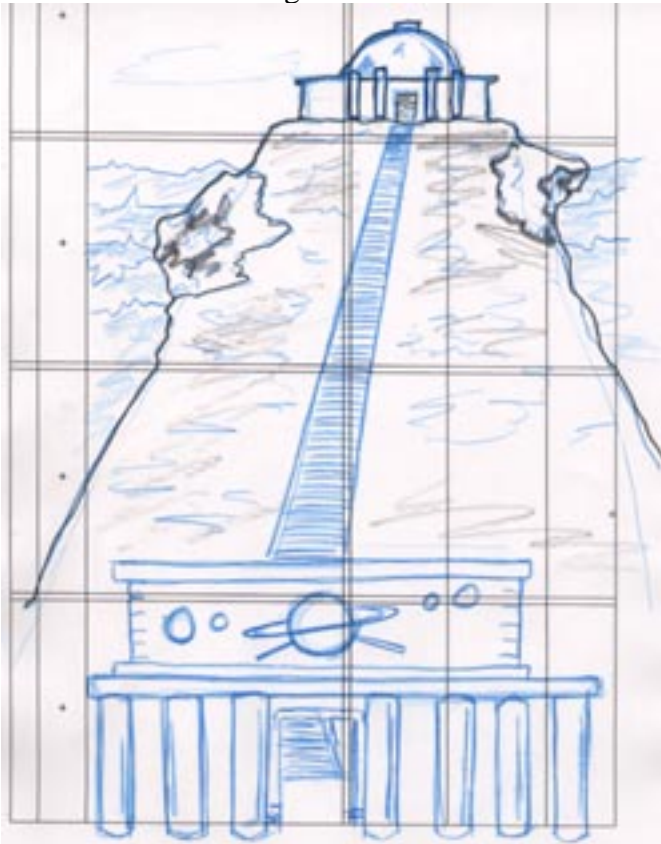
The camp is nestled in a small clearing. It consists of 3 tents, several supply crates, and some folding chairs. Carlson's objects resemble an archeologists' camp.

The bandits' camp (in a deep basin, a river running through it)

The bandits live in a medium camp of 8-10 tents. There are 8-10 bandits. Each is armed with a tranquilizer gun. There are supplies strewn about the camp which are locked up in vaults every evening.

The Mayan settlement

See the mirror challenge...



Game Characters

Overview

- Main Character
- Carlson
- Melanie

Bandits

- Leader
- Guard/ henchman

Creating a Character

Skills

- hand steadiness
- lens crafting skill?
- running speed (a nice one for convenience, if nothing else)
- Lung capacity (swimming / endurance while running)
- climbing ability
- Focusing ability

Character Types

So, perhaps you've built a sneaker profile:

- -Concentrated all of your skills/ practices in stealthiness
- -Obtained camouflage clothing
- Gotten the proper lenses for close shots
- Better film (can you take a picture from a dark crevice, say)
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- film
 - chemicals
- camera

Profiles

Protagonist

Unlike most role playing or adventure games, the protagonist is the player. Thus, the player is never called by name, or shown in any shots.

Melanie

Melanie is a 13 year old niece of Dr. Carlson. Bold and confident, she is a lot like a young Natalie Portman in “The Professional”. Melanie is quick to offer help and not afraid of danger. For several summers, Melanie has traveled with her uncle on archeological digs and has seen the world – from Rome to Australia to Africa.

Melanie’s own parents are very busy professionals. Harvard professors, they are active in the Boston intellectual scene. They see these summers as Melanie’s chance to get out doors and experience other “cultures.” Because of their busy lifestyles, Melanie has been forced to become very self-sufficient. Growing up around adults has made Melanie highly self-confident. Most of Carlson’s colleagues have treated her as an adult, so she is used to being in grown up situations. This situation may be beyond Melanie’s experience, and her headstrong, if not arrogant attitude could get her in trouble.

Melanie has fit into the role of caretaker for Carlson easily, now that he’s incapacitated. At times, she worries that you’re getting in between them, so she’s a little cold toward the protagonist. Underneath, there are signs that Melanie might be afraid. Deep down, she knows that she’s still a kid, but is too afraid to show her vulnerability in front of Carlson. There is also a darker undercurrent to Melanie. She has become a bit distrusting from all of this, and she’s of the

Professor Carlson

Professor Carlson is a professor of Archeology at The University of Chicago. His research is in the use of caves by the prehistoric maya and in Mayan science. He has become fascinated by a set of drawings that suggest that the Mayan had a very sophisticated understanding of optics. He’s hoping that this work can be a big contribution to the history of science.

As such, he’s been interesting in having you, the protagonist, add your expertise. One of the hooks of the game is that we’re not telling the player why he/she is here. It would be fun to have an in joke or two about this. The player is free to fill in the holes as to why he/ she is there. Presumably, that expertise is in optics.

Carlson is a middle-aged, Sean Connery like professor. He is an idealist, but has become disheartened by these events. He is somewhat afraid of the bandits and the situation, but he attempts to maintain his composure for Melanie.

Carlson plays it tough on the outside, but inside, may be even more scared than Melanie. The longer he’s trapped here, the more he’s coming to realize that the things that drove him to

archeology – love of research, exploring, taking your time to appreciate ancient artifacts, are not what is required here. Secretly, he is mostly reassured by Melanie’s strength and cunning.

See “Norman Hammond” who works at the University of Chicago. as an archeologist in Mayan work (music).

Character AI:

Melanie has a complex AI built on a Minsky-derived Artificial Life model. Similar to The Sims, the characters operate on the basis of needs. As such, she behaves more like a Sim or a creature in Black & White rather than a scripted Lucas character.

Characters have the following needs based on Maslow’ derived Hierarchy. (<http://www.maslow.com>):

Primary needs These needs must be at a certain threshold before Melanie or Carlson will do anything else.:

- Sleep. When sleep/tiredness gets below 20%, They will return to camp for a nap. You can wake them when they get over 50%. (can the player do things to modify this in Melanie?).
- Hunger. When Hunger gets below 40% Melanie will start complaining. Carlson only goes below 50%.
- Thirst.
- Waste Excrement / Bathroom
- Love / Respect

Secondary Needs:

- Safety
- Curiosity
- Approval – via protagonist or Carlson

Events impact on characters

Events (i.e. discoveries, fights, conversations) have an impact on characters. So, when Carlson sees you talking to Melanie kindly, his attitude towards you increases. Certain events / cut scenes are unlocked when a character’s attitude needs / relationships (ala Sims) reaches a certain threshold.

Events

- You tutoring Melanie
 - + 5 trust to Carlson
- You disobeying Carlson/ Melanie
 - – 10 trust to either
 - + 2 respect Melanie
- You putting Melanie in danger
 - +2 trust Melanie
 - -10 Trust Carlson
- You solving a puzzle
 - +1-20 trust Melanie / Carlson
- You rescuing something from the Temple

- +30-50 trust Melanie / Carlson
- You causing physical harm to any of characters
 - -50 affection & trust

Character Disposition toward Other Characters

Events trigger the following dispositions toward characters.

- Fondness
- Trust
- Fear

These can be mix and matched.

These base factors produce the following states

- Hatred – (low fondness, low trust) gets to a certain point and the character is asked to leave.
- Love
- Trust
- Respect
- Friendship
- Ally

User Interface

Overview

Provide some sort of an overview to your interface and same as all the previous sections, break down the components of the UI below.

User Interface

There are two competing theories of interface that will need to be resolved through usability testing.

- 1) The main interface is unobstructed. Players access menus to see
 - Their watch (time)
 - Their endurance (heart beating)
 - Inventory
- 2) Traditional game interface with information available on screen.
 - Endurance level = beating heart that pulsates as you go
 - Time
 - Hunger / Thirst Levels

Musical Scores and Sound Effects

Overview

Mostly the game makes use of ambient sounds. Sound is very important in the jungle – or in nature. People use sounds as means of getting information (i.e. birds can send alarms, etc.) The game will model sounds in this way people will make noises, as they move, which then trigger other sounds, e.g. birds, etc.

Natural Sounds

A big element of this game is realistic outdoor sounds. When players walk, they project sounds which can be detected by birds and animals. They create noises which the users can use to gauge the whereabouts of other players.

Music

The game has a musical score drawing on tribal rhythms. The music picks up pace during chase sequences.

World Editing

Overview

The world editor will allow players to create and move objects. They will have

- a library of pre-made objects
- textures
- and a 3D imaging tool

the goal is to enable teachers to create puzzles like the ones in the temple of light for students to use.

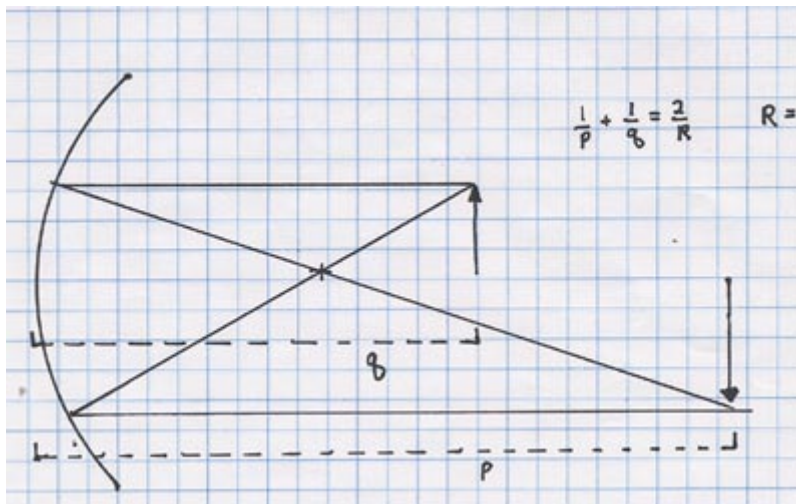
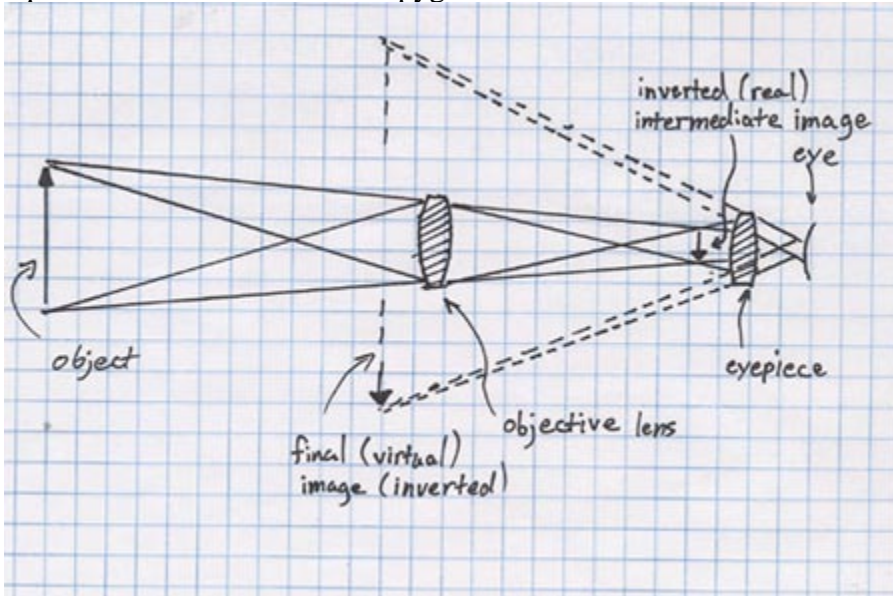
“Story Appendix”

Professor Carlson, an archaeologist, and his niece Melanie have been in the jungle for several months, exploring Mayan ruins in search of the Sien de la Luz -- the Temple of Light --a legendary chamber of glass and jewels that's breathtaking in both its artistic beauty and scientific sophistication.

As Carlson and Melanie work, bandits arrive and steal valuable artifacts from nearby ruins. Learning that Carlson has found the mystical Sien de la Luz, the thieves raid his camp and maim his leg when he refuses to divulge the location of the temple.

Carlson, desperate to protect and save Melanie but unable to move beyond their destroyed encampment, begins to lose hope. He sends his niece out on short hikes through the jungle to find help. That's when the player arrives...

This image shows the formulas for calculating the focal point for an object. This diagram/ equation will be used for the spyglass/ camera levels.

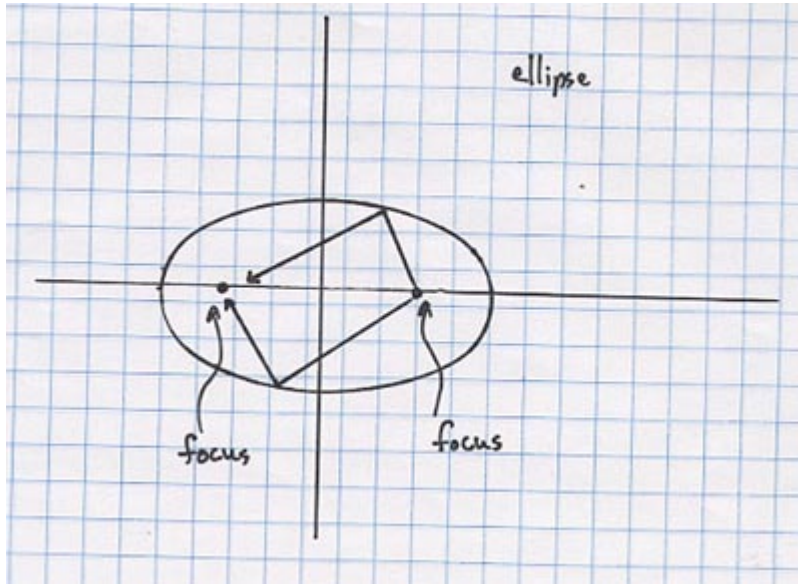


for concave R is "+"
convex R is "-"

if $q > R/2$ $M < 0$
 $q < R/2$ $M > 0$
 $q = R/2$ $M = 1$

if $q = \frac{1}{2}R$ $p = \infty$
 $q < R/2$ $p < 0$
 $q > R/2$ $p > 0$

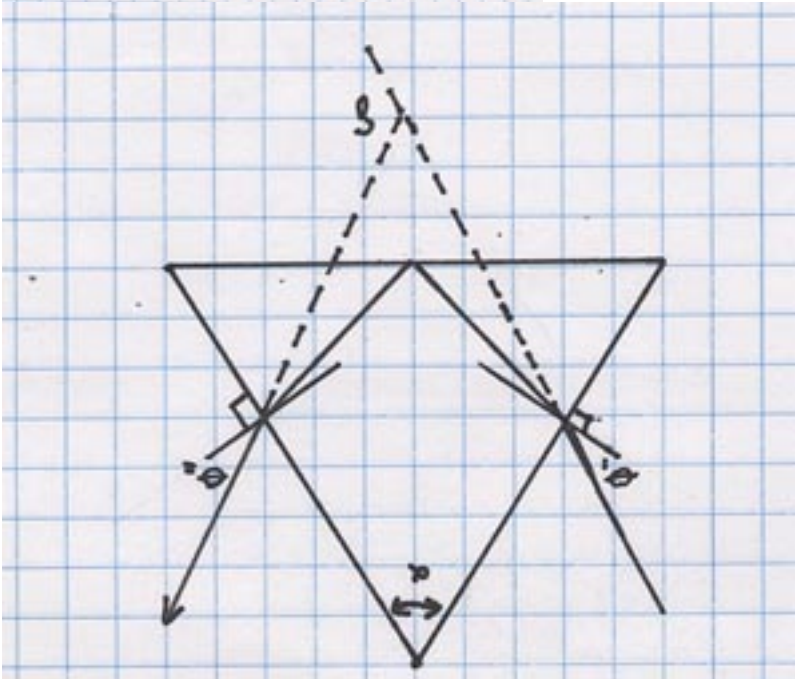
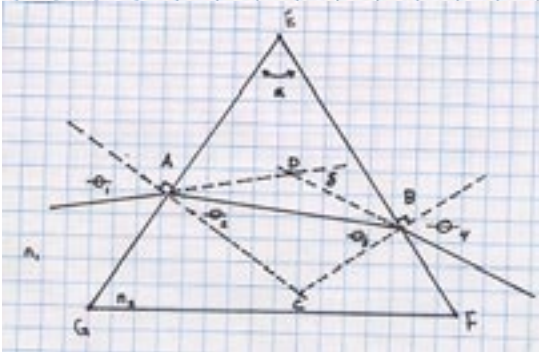
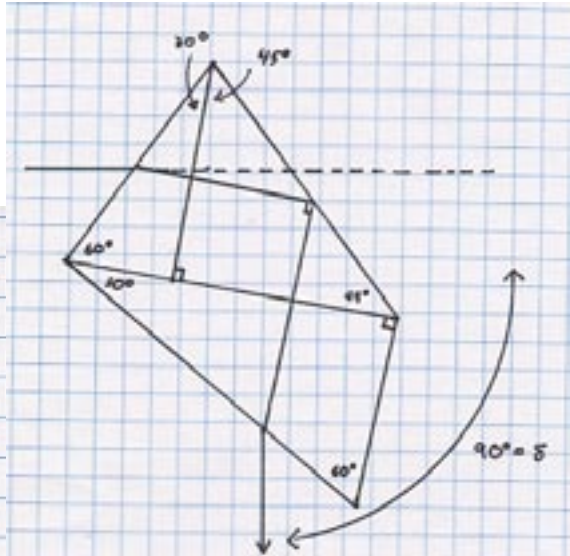
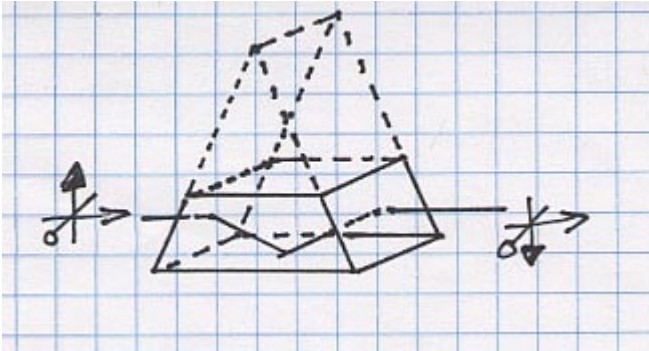
Ellipse.



any ray originating at a focus of an ellipse will be reflected in the direction of the second focus

$$1 = \frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} \quad \text{eg for ellipse}$$

PRISMS



REFRACTION

from snell's law

$$n_1 \sin \theta_1 = n_2 \sin \theta_2 \text{ and } n_1 \sin \theta_4 = n_2 \sin \theta_3$$

this being a glass-air interface ...
 $n_1 \approx 1$

thus...

$$\left\{ \begin{array}{l} \sin \theta_1 = n_2 \sin \theta_2 \\ \sin \theta_4 = n_2 \sin \theta_3 \end{array} \right. \begin{array}{l} \text{eq 3} \\ \text{eq 4} \end{array}$$

because we have $\triangle ABD$ we write

$$\pi = \angle ADB + \angle BAD + \angle ABD$$

by inspection... $\angle ABD + \theta_3 = \theta_4$ and $\angle BAD + \theta_2 = \theta_1$

thus... $\pi = \angle ADB + (\theta_1 - \theta_2) + (\theta_4 - \theta_3)$

by inspection we see $\pi = \delta + \angle ADB$

thus...

$$\left| \delta = (\theta_1 - \theta_2) + (\theta_4 - \theta_3) \right| \text{ eq 2}$$

$$\theta_1 + \theta_4 - \alpha = \delta$$

$$\theta_1 + \arcsin(n_2 \sin \theta_3) - \alpha = \delta$$

$$\theta_1 + \arcsin(n_2 \sin(\alpha - \theta_2)) - \alpha = \delta$$

$$\theta_1 + \arcsin(n_2 (\sin \alpha \cos \theta_2 - \cos \alpha \sin \theta_2)) - \alpha = \delta$$

$$\theta_1 + \arcsin(n_2 (\sin \alpha (1 - \sin^2 \theta_2)^{\frac{1}{2}} - \cos \alpha \sin \theta_2)) - \alpha = \delta$$

$$\theta_1 + \arcsin(\sin \alpha (n_2^2 - \sin^2 \theta_2)^{\frac{1}{2}} - \cos \alpha \sin \theta_2) = \delta$$

because we have $\triangle ABE$ we write...

$$\pi = \angle ABE + \angle EAB + \angle AEB \text{ or } \pi = \angle ABE + \angle EAB + \alpha$$

because $\overline{EF} \perp \overline{CB}$ and $\overline{EB} \perp \overline{AC}$ we know that

$$\angle ABE = \frac{\pi}{2} - \theta_3 \text{ and } \angle EAB = \frac{\pi}{2} - \theta_2$$

therefore $\pi = (\frac{\pi}{2} - \theta_3) + (\frac{\pi}{2} - \theta_2) + \alpha$

or $\boxed{\alpha = \theta_2 + \theta_3} \text{ eq 1}$

