

Challenge

WHEN LIGHT CURVES THROW US **CURVE BALLS**

The Team

INTERNATIONAL BOYZ



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Overview

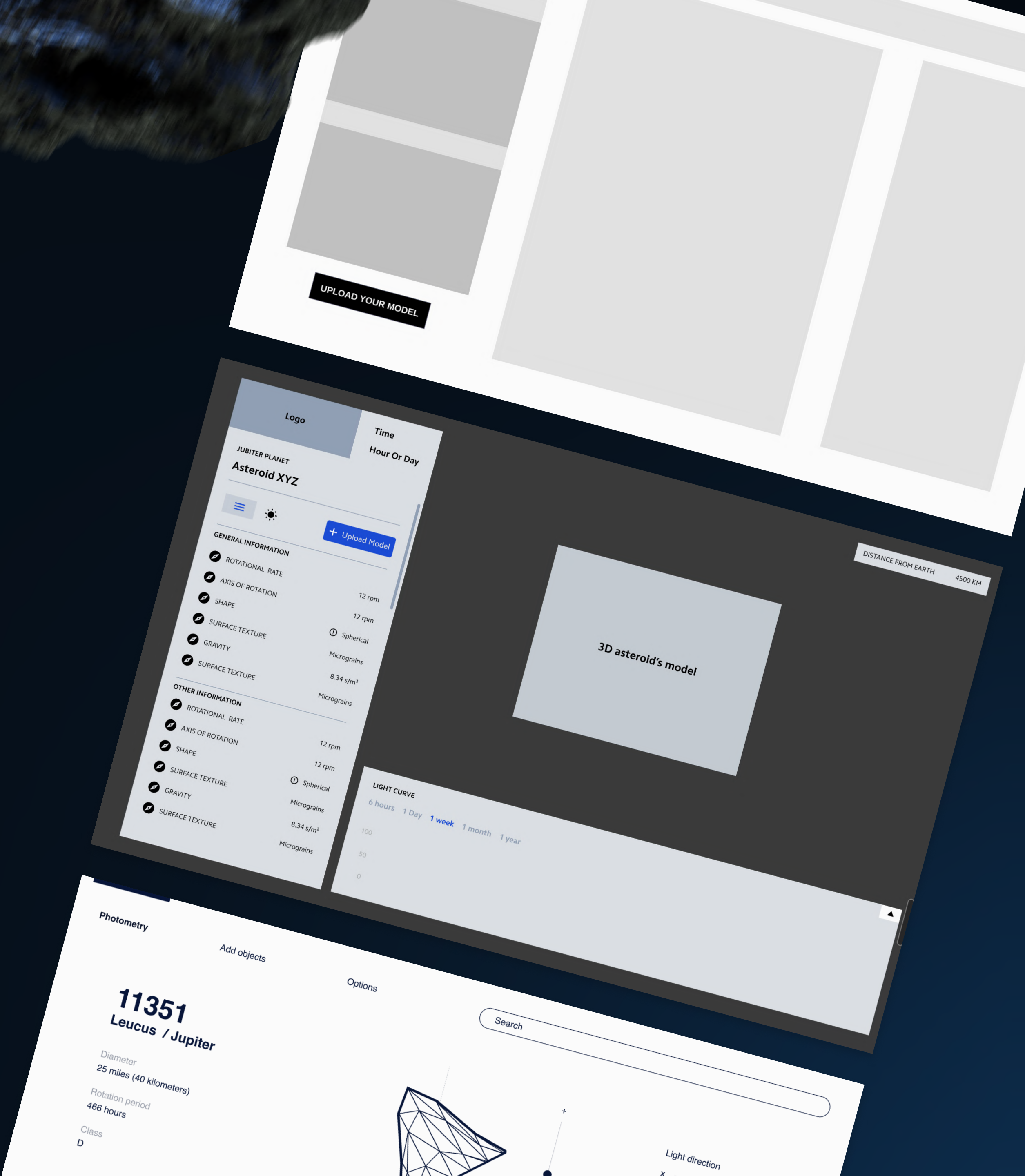
PROBLEM

Scientists want to find out the shape of Trojan asteroids by examining their light curves, but can't determine their shapes as they only appear as tiny bright lights from the earth.

OUR SOLUTIONS

We developed a tool that allows users to explore how the shape of an asteroid affects the appearance of its light curve by

- Freely moving the asteroid, and examining how its shape determines its brightness in the light curve.
- Easily accessing its properties on the same screen
- Uploading 3D models to test several shapes
- Study shapes of available asteroids in the Nasa's database



Prototype

Light curve generator

After the 3D asteroid has completed its first rotation, users can generate a light curve chart by pressing the enabled button.

Change between asteroids

Using Nasa’s data, users can switch between asteroids

Controlling light

Users can control and change the type of light

SCIENTIST LABORATORY

ASTERIODS APP

JUPITER PLANETS

2/8 ASTEROIDS

1620 GEOGRAPHOS < >

GENERAL INFORMATION

Observation Arc65.37 yr

Aphelion1.6629 AU

Perihelion0.8276 AU

Semi-Major Axis1.2453 AU

Eccentricity0.3354

Orbital Period1.39 yr

CategoryNEO, Apollo, PHA

Rotational period5.2220±0.0003 h

TECHNICALS

Radius3,983 KM

ClassCARBONACEUS

ClassCARBONACEUS

+ UPLOAD YOUR MODEL

Rotation controls

▶ Play

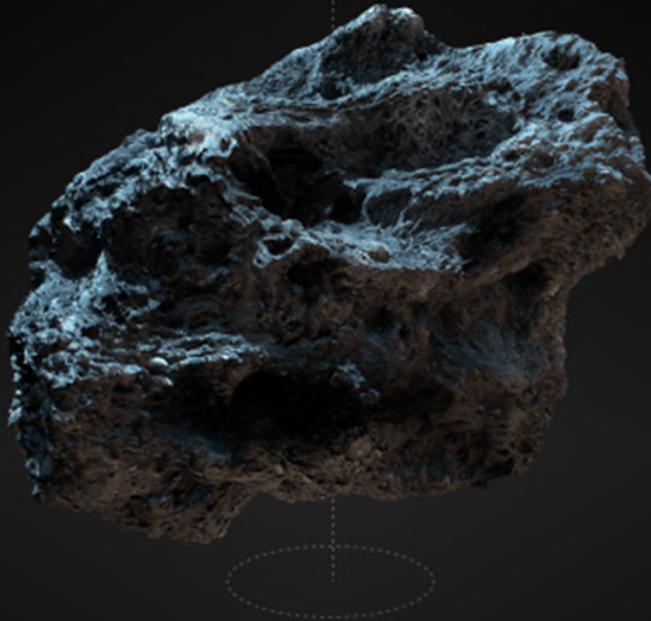
○ Reset

1.0 x

▼

Rotate right

▼



GENERATE LIGHT CURVE

14:30 PM EST

2 NOV 2021

LIGHTING CONTROLS

Intensity< 0 >

+ ● —

Left or right (x)< 0 >

+ ● —

Up or down (y)< 0 >

+ ● —

Forward or back (z)< 0 >

+ ● —

ROTATION PERIOD-

T0 - TDB-

JDO (LTC)-

AMP-

© DESIGNED BY AVHIJIT NAIR, ALESSIO FERRACUTI, LEONARDO GOGIALI

Prototype

Animation controls

Users can choose how to rotate the asteroid

Light curve chart

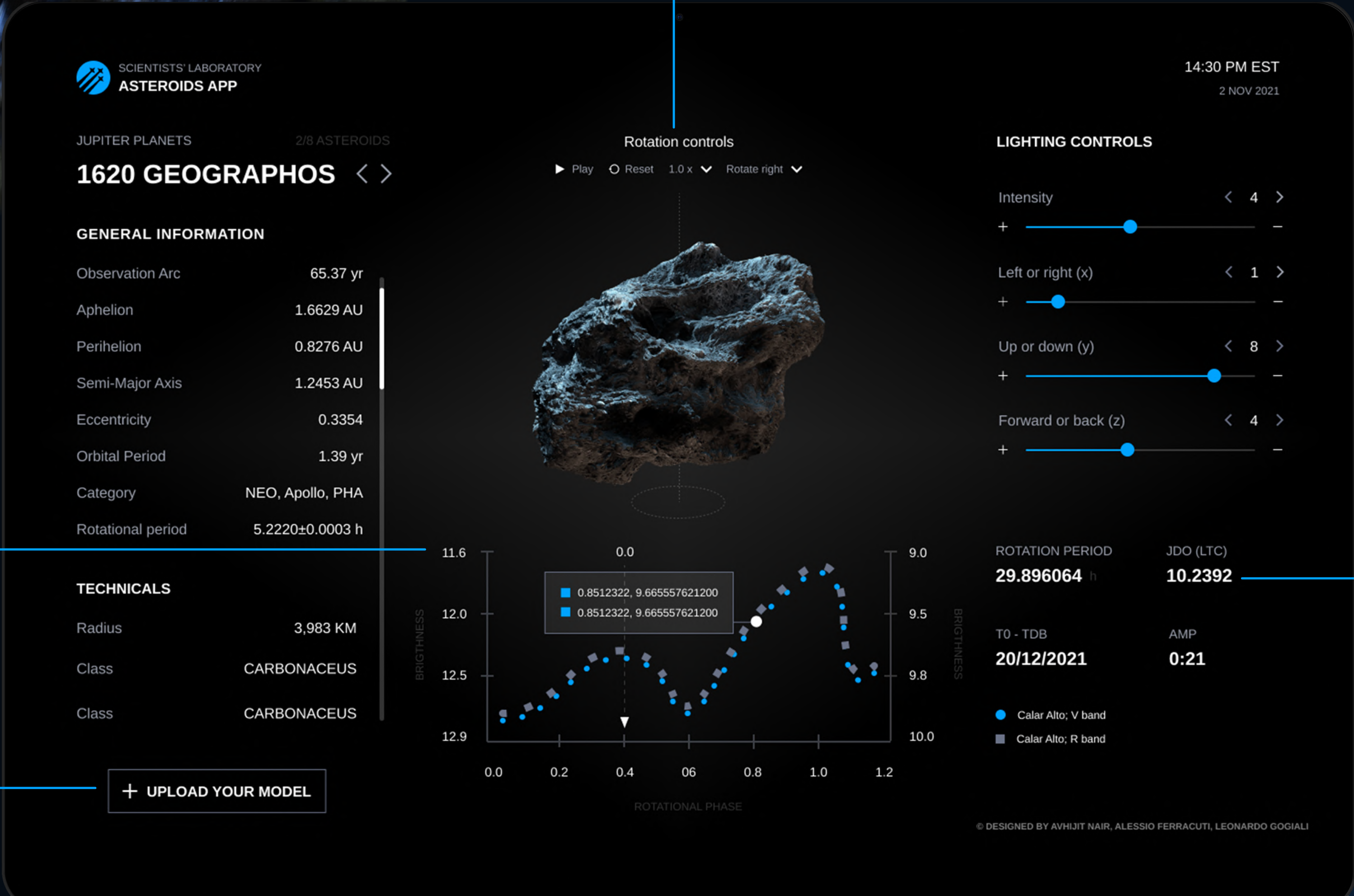
The light curve chart displays the rotational phase and brightness of the asteroid's shape

Upload your model

Users can upload their own 3D model

Chart's KPIS

These values change according to the graph



Process

METHODOLOGIES USED

We collaborated within the team to bring solutions to life by using the following methodologies

- Brainstorming sessions & Prioritization of features
- User journey maps
- Protopersonas
- User testing with the prototype

OUTCOMES


Before we started full development, we tested a realistic prototype with master graduates from the Space exploration and development systems’ programme of Turin:

“ *I am amazed by how intuitive it is*”

Participant 2

“ *I can finally look at an asteroid’s properties so easily*”

Participant 1



Age
34

Occupation
Spacecraft’s scientist

Favourite orbites
Jupiter orbite and Trojan asteroids

Albert

“ I want to find out the shape of an asteroid by examining its light curve so that I can study how its shape affects its brightness when exposed to reflected sunlight ”

User goals

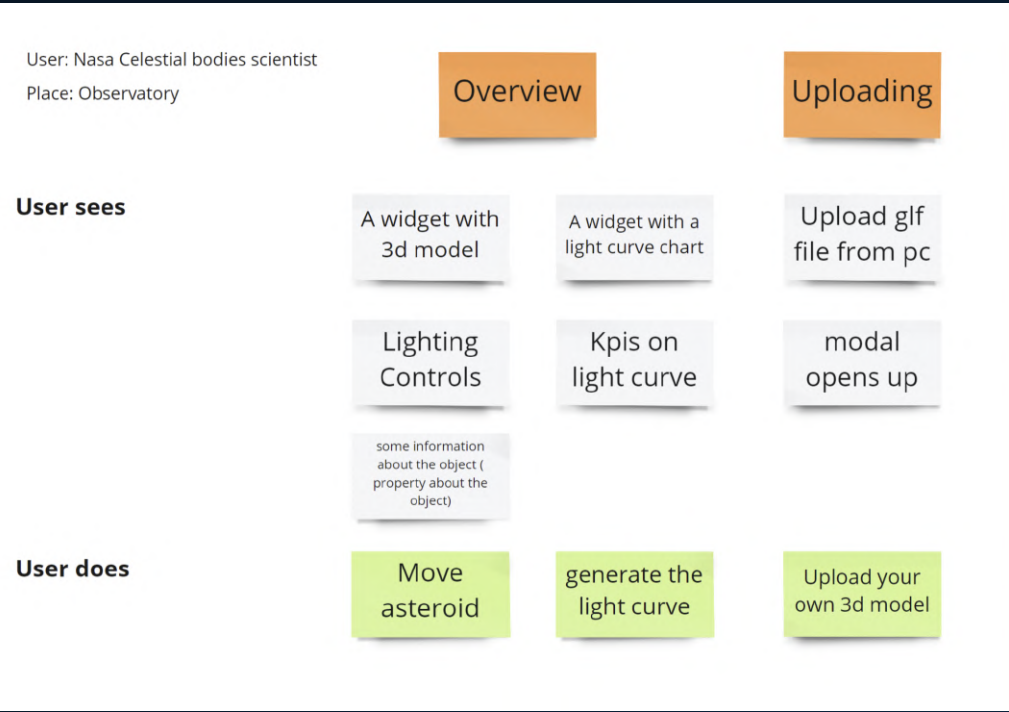
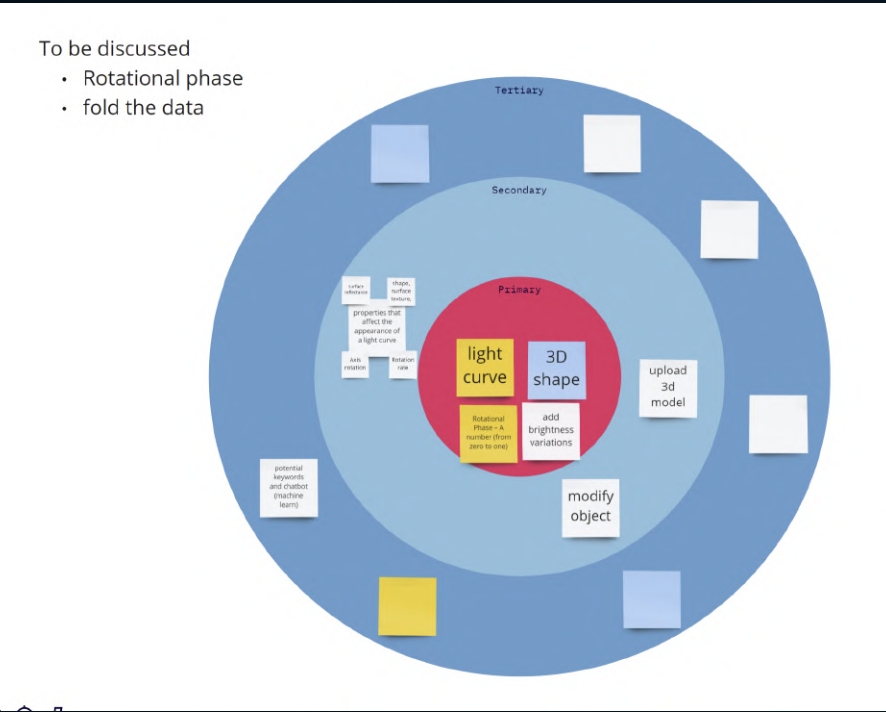
- Examine how bright the asteroid is and how that brightness changes with time.
- Determine an asteroid’s rotation speed and shape as it spins

Motivations

- Trojan asteroids contain clues about the origins of the giant planets and solar system
- Study an asteroid’s texture and shape
- Find out why brightness varies so often

Pain points

- Can’t determine their shape from the earth
- From earth asteroids only appear as lights
- Scientist’s only clue so far is that their brightness varies over time



Technical details

ALGORITHM STEPS USED TO GENERATE THE LIGHT CURVE

- The user specifies a rotation period for the asteroid (here we're considering 1 second = 1 hour for the purposes of simulation) and clicks the play button to rotate it 360 degrees and generate the data.
- During each frame of rotation, the brightness of pixels is calculated and used as a data point for that particular time step. The time step here acts as our rotational phase.

So for example if the user selects 10 from the dropdown, then the 3d model rotates 36 degrees per second, a snapshot of the frame is taken and the pixel brightness is calculated.

In this way, if there are 'm' frames and the pixel array size is 'n', then the algorithm grows by an order of $O(m*n)$.

```
script>
const canvas = document.querySelector('#c');
let chart;
let date = new Date();

let imageValues = [];
let timeValues = [];
let lightCurveValues = [];
let abc = (pngBytes) =>{
  const reader = new PNGReader(pngBytes);
  reader.parse(function(err, png) {
    imageValues.push(png);
  });
}
let imageFrames = async () =>{
  const image = canvas.toDataURL("image/png").slice(22);
  const pngBytes = atob(image);
  await abc(pngBytes);
}
let getBrightness = () =>{
  for(let i = 0;i<imageValues.length;i++){
    let brightness=0;
    for(let j = 0;j<imageValues[i].pixels.length;j+=4){
      brightness+= Math.floor((0.2126*imageValues[i].pixels[j])+(0.7152*imag
    }
    brightness = ((brightness/10000000)*(20));
    lightCurveValues.push({x:timeValues[i],y:brightness});
  }
}

let plotLG = async() =>{
  await getBrightness();

  chart = new Chart("lg", {
    type: "scatter",
    axisX:{
      title: "ROTATIONAL PHASE",
    }
  });
}
```


Conclusion

FINAL THOUGHTS

Collaboration and diversity of our skills led us to develop a fully working product in a matter of few hours.

IDEAS FOR THE FUTURE

If we had more time, we would have liked to make more advanced features, along with a complete user journey. From users logging into the tool and selecting the orbit they are interested in, to accessing an overview of all asteroids and examining their light curves individually.

If we had more access to resources and the internal NASA team, we would have loved to speak with celestial bodies observers to understand what values are most crucial to them when examining light curves.

